SOUTHEAST ASIAN MILKFISH CULTURE: ECONOMIC STATUS AND PROSPECTS[1]

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Historically, milkfish (*Chanos chanos* Forsskal) has been the premier aquaculture product in Indonesia, the Philippines, and Taiwan. Approximately 480 000 ha of brackishwater and freshwater ponds and 30 000 ha of fishpens in these areas produce almost 285 000 t of milkfish annually. However, there are significant differences in the industry's performance among and within these places, especially in terms of yield. These differences can be explained by different factor (land, labor, capital) endowments and by the fact that producers have generally been responsive to these conditions.

In Taiwan and the Philippines, milkfish production is becoming less profitable over time. In Taiwan, per capita fish consumption has levelled off with rising per capita incomes; in the Philippines, declining real wages and inflation have reduced per capita fish consumption. In both places, brackishwater pond producers of milkfish are caught in a cost-price squeeze as input costs have increased more rapidly than market prices. Indonesian producers also face market constraints because high regional transport costs often isolate them from major market centers.

In response to declining profitability of milkfish, producers have been changing their production techniques (e. g., to polyculture with shrimps and to deep water systems) and

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shifting to the culture of other species such as tilapia that currently have greater domestic or export market potential. Although total milkfish production continues to increase, in the Philippines and Indonesia at least, milkfish's traditional share of total aquaculture production in all these places has declined quite dramatically over the last 10 years, and this trend is likely to continue.

While shifts to other more profitable techniques or species may bring higher profits to producers and lower cost protein to consumers, research and extension institutions that have been devoting much of their energies to milkfish may not be able to shift their focus quite so rapidly. The declining profitability of milkfish production in brackishwater ponds also has important implications for aquaculture development policy, because less efficient farms are likely to be driven out of the industry in the near future.

INTRODUCTION

While milkfish (*Chanos chanos* Forsskal) has for centuries been the premier aquaeulture commodity in Southeast Asia, its position is being eroded by the interplay of economic factors that are beginning to favor other species. Taiwan, the Philippines, and Indonesia have traditionally raised milkfish in brackishwater ponds, and the industry has grown over the past 400 years until the present time, when almost 500 000 ha produce almost 285 000 of milkfish annually (Table 1). In the last decade, this rearing area has also included freshwater pens in the Philippines, which have recently expanded to over 30 000 ha (Coronel 1983). While the historical growth of this substantial industry can be explained by a variety of technical, economic, institutional, and entrepreneurial dimensions that vary among the three locations, economic dimensions seem to be the prime determinants of the future prospects of the industry. Technologists may debate this point, but from our perspective as economists it appears that most of the basic technical procedures for managing brackishwater milkfish ponds have been worked out over the past few decades. Technical research, with the exception of that related to reproduction and stimulation of artificial breeding, appears to be in a refinement stage, where dramatic advances in knowledge and hence in industry growth are unlikely. Certainly there are large numbers of producers in Indonesia and the Philippines who lag behind the industry leaders in their respective countries in terms of output per hectare — we will return to this special problem of the industry later in this paper—but here we wish to draw attention to the fact that, for the most part, the industry leaders among private producers have "caught up" with the researchers and are already producing levels of output that maximize their profits, given the technology available to them. Consequently, future growth in total output from the milkfish industry, while theoretically possible from a variety of sources (e.g., technical breakthroughs, expansion in area under production, increased production from those existing producers who produce less than the economically efficient maximum), may be possible only through basic

Table 1. Milkfish production in Taiwan, the Philippines, and Indonesia.

	Total pond and pen culture[a] area (ha)	Pond and pen production (t)	Productivity of all species (kg/ha)	Milkfish as percent of total pond and pen production	Estimated milkfish production (t)
Taiwan, 1982[b]					
Brackishwater ponds	20 345	51 044	2 509	46	23 416
Freshwater ponds	17 652	117 531	6 658	5	6 104
Philippines, 1981[c]					
Brackishwater ponds	195 832	170 431	870	90[e]	153 388
Freshwater pens	25 000	56 299	2 252	99[e]	55 736
Indonesia, 1979[f]					
Brackishwater ponds	181 792	93 644	515	49	46 200
Freshwater ponds	41 300	69 359	1 679	0	0
Total/average	481 921	558 308	1 159	51	284 844

[a]Not including padi and cage culture, reservoirs, or mariculture.
[b]Source: Taiwan Fisheries Bureau (1983).
[c]Source: BFAR (1981) except where noted.
[d]Approximately 34 000 ha of fishpens were identified during an aerial survey conducted by the Laguna Lake Development Authority in 1983 (Coronel 1983). 25 000 ha is our estimate by 1981.
[e]Our estimate.
[f]Source: DGF (1981).

shifts in the economic environment in which producers or the milkfish transformation sector operate (Fig. 1). Significant economic constraints to future growth of the industry appear to be developing, however, in the form of increased competition from other species and changing consumer preferences.

Throughout these three areas of Southeast Asia, milkfish is produced almost exclusively by private producers who can be assumed to respond to the profit motive to varying degrees. Non-economic factors such as land ownership for security or social purposes may explain the behavior of some producers, but the majority seek to combine the inputs at their disposal — their land, labor, and capital — in such a way as to maximize their returns (Neal and Smith 1982). The more economically sophisticated producers, for example, will say that they are less interested in maximizing their physical yields than they are in maximizing their net economic yields. To achieve this objective, milkfish producers must take into account not only their production costs but also the likely prices that their produce will fetch in the market. The supply of inputs and the demand for the marketable product will thus influence producer decisions (Smith 1982).

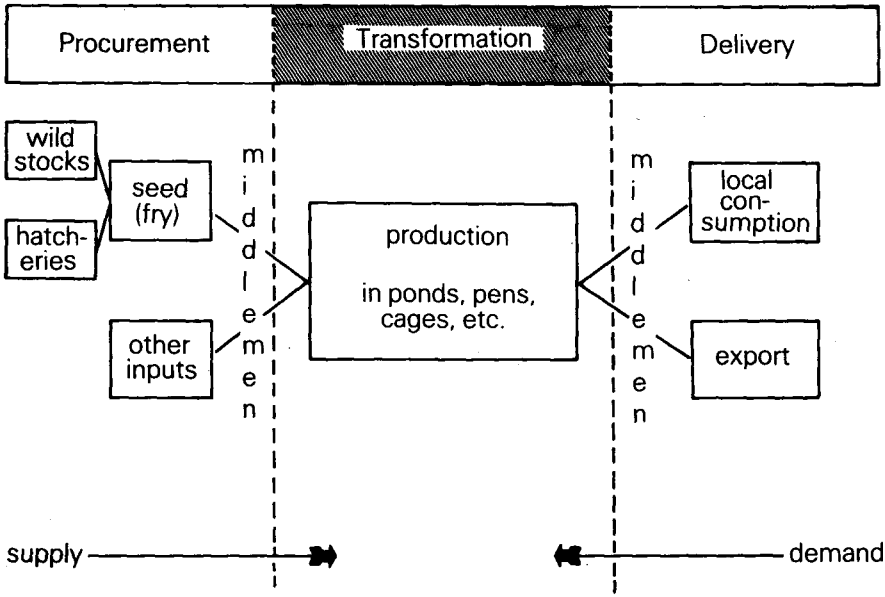

Fig. 1. The milkfish resource system (Smith 1982).

In addition to combining their inputs more efficiently, producers may also consider changing their product mix (e.g., raising *Penaeus monodon* in polyculture with milkfish) or they may switch to another species altogether. While there are certain technical constraints such as pond design, soil quality, and water salinity that circumscribe the producer's flexibility in this regard, even these can be overcome in the long term. The innovative entrepreneur can even sell his brackishwater ponds and embark on a totally new endeavor such as freshwater culture if economic conditions favor such a shift.

Traditionally, aquaculture systems, including that for milkfish, have been evaluated in terms of their production per unit area (i.e., the land input). Such evaluations can be misleading in the strictly economic sense, however, because society is primarily interested in the "value added" by any productive process. Moreover, if labor or capital is the scarce resource, and not land, it makes more sense to evaluate the milkfish industry in terms of production per labor or capital input, rather than per unit area. Relative factor (land, labor, capital) endowments will vary from one country to another and even within countries.

Ideally, then, an economic evaluation of the status and potential of the Southeast Asian milkfish industry should include an examination of (1) the availability and costs of various inputs used in milkfish production, (2) the prices of market-size milkfish, (3) the relative profitability of other activities that require the same inputs as those used by milkfish producers, (4) the supply and prices of other products with which milkfish competes in the marketplace, and (5) historical trends of milkfish output and area under production. From such information one could state with some confidence how the milkfish industry is likely to fare in the near future.

Such a comprehensive evaluation is not possible at the present time. There are two major limitations. First, reliable secondary data on inputs and output of the milkfish industry are not available in full in any of the three areas. The second impediment to adequate predictions of the potential of the milkfish industry is the paucity of sustained economic research. Most of the economic research conducted in the early and mid-1970s (Guerrero and Darrah 1974; Librero et al 1976,1977; Shang 1976a, b; Ramirez 1978; Wiratno 1978) is now out of date. More recent studies, while comprehensive, have not been followed up (Chong et al 1981, 1982; Lee 1983). There is not a single up-to-date costs and earnings study available. This is really quite shocking when one considers that the retail value of the milkfish produced in Southeast Asia probably exceeds US$200 million annually.

Nevertheless, despite the above limitations and data gaps, it is possible to draw some inferences from what information is available in each place. The data generally support our contention that the milkfish industry is likely to decline in importance relative to other aquaculture species in years to come. The following sections of this paper examine each locality in turn.

TAIWAN

The aquaculture sector in Taiwan is undergoing dynamic growth. By 1980, almost one ton in five of the total fisheries production of 936 000 t was contributed by aquaculture (Westbrook 1983, Taiwan Fisheries Bureau 1983). Despite this overall expansion, however, the relative contribution of milkfish has declined significantly (Table 2). While the aquaculture sector is thus growing rapidly, comparatively speaking the milkfish industry is not.

This decline is not due to lack of innovation on the part of Taiwanese milkfish producers. In fact, in response to declining profitability of milkfish production, producers have recently made three major shifts in brackishwater production techniques. However, in two of these cases, which continued a concentration on milk-

Table 2. Taiwan brackishwater milkfish area and production, 1965-1982[a].

	Total brackish-water and freshwater pond area (ha)	Brackish-water area (ha)	Brack-ishwater area as % of total pond area	Brackish-water pond area (ha) devoted to milkfish	Milkfish area as % of brack-ishwater area	Total pro-duction from brackish-water area (t)	Milkfish production (t)	Milkfish produc-tion as % of total produc-tion from brackish-water area
1965	20 956	15 612	74	15 612	100	29 812	27 562	92
1970	23 403	16 738	72	16 360	98	31 606	27 857	88
1975	30 124	18 115	60	16 800	93	44 652	33 490	75
1979	36 016	19 654	55	15 345	78	52 574	32 034	61
1982	37 997	20 345	54	14 563	72	51 044	23 416	46

[a]Does not include milkfish production from freshwater ponds, which was 6104 t from 651 ha in 1982.
Source: Taiwan Fisheries Bureau (1983) and earlier Fisheries Yearbooks as reported in Lee (1983).

fish, the economic "laws of supply and demand" have resulted in only short periods of increased profits. The third case, which involved shifts to species other than milkfish, has been somewhat more successful.

Lee (1983) reported that the rate of return on operating capital for the average Taiwanese milkfish farmer in 1980 was only 10%, less than the opportunity cost of capital. Shang (1976b) had reported a higher rate of 18% for 1972 but drew attention to the narrowing profit margin due to the fact that input costs were increasing faster than milkfish prices. Facing these reduced returns, three changes occurred in the industry:

(1) Many producers began raising other species such as crabs and shrimps (especially *P. monodon*) in the brackishwater ponds formerly used for milkfish.
(2) Some producers began specializing in the production of milkfish fingerlings to be used as baitfish by longliners based in Kaoshiung.
(3) Some producers began experimentation with the so-called deep water method of producing milkfish in 2-3 m deep ponds using commercial feeds and pond aeration. An increasing number of these ponds are in freshwater areas.

Certainly the first of these changes has resulted in increased profits for producers, but milkfish has not played a part in this particular change. Liu (1977), for example, reported that grass shrimp culture in Tainan and Pingtung gave considerably higher profits per hectare than did milkfish culture in the same areas.

The second of these changes provided an alternative outlet for milkfish farmers, and Lee (1983) reported that profits for these fingerling producers in 1979-80 were significantly higher than for those who continued to produce market size milkfish (Table 3). However, as Lee pointed out, due to increased fuel costs, the longliners that used the fingerlings as baitfish were reducing their fishing efforts and hence their demand for fingerlings. The market for fingerlings as baitfish was thus quickly saturated, with high profits being unsustainable over the long term.

The third and most recent change in Taiwanese milkfish farming is the most imaginative and the most expensive. By deepening brackishwater ponds from their traditional 10-30 cm depth to 2-3 m, and by using commercial feed, higher stocking rates (20 000 pieces/ha per year of 15-18 cm size), and pond aeration, average yields can be increased from the previous 2 t/ha per year to over 10 t (Chen 1981). Using this deep water method, profits could also be substantial, surpassing even those of shrimp farming (Table 4).

The potential farm income per hectare of US$770 reported by Chen (1981) is considerably higher than the US$240 reported by Lee (1983) for the traditional shallower ponds. Although published information on the deep water system of Taiwan is scanty, apparently large numbers of producers have deepened their ponds and increased their production markedly. Deep water ponds using fresh water have also been developed. Chen (1981) warned about the negative impact that increased production could have on prices, and, indeed, 2 years later, retail prices were reported to have fallen from US$4/kg in 1980 to less than US$2/kg (Westbrook 1983, Liao and Lei 1983). Based on Chen's 1981 data (Table 3), deep water milkfish producers would have experienced losses at these prices.

The inability of the Taiwanese domestic market to absorb increased production of milkfish is a major constraint to expansion of the milkfish industry. The problem

Table 3. Comparison of annual costs and returns (US$) per hectare for milkfish fingerling rearing (for baitfish) and market size rearing, 1979.

	Fingerling rearing	Market size rearing
Gross receipts	4304	2551
Variable costs		
Fry	2269	919
Feeds	69	617
Fuel	24	33
Materials	63	60
Labor	447	459
Water/electricity	27	16
Maintenance	33	—
Subtotal	2933	2104
Fixed costs		
Land rent	30	50
Interest	23	93
Taxes	18	2
Depreciation	12	66
Subtotal	83	211
Total costs	3016	2315
Residual return to owned inputs	1288	236
Rate of farm income	29.8%	9.3%

Source: Lee (1983).

of this cost-price squeeze on producers can best be shown through a comparison of prices of milkfish fry (one of the major inputs) and of market size milkfish adjusted for inflation. The real prices of fry have been increasing steadily since 1970; in comparison, the real wholesale price of market size milkfish (which closely approximates the ex-farm price) has changed little during the past decade (Fig. 2).

Why have real wholesale prices of milkfish in Taiwan not increased during the past decade? The answer appears to lie in the consumption patterns of the population. Between 1952 and 1980 there was a dramatic five-fold increase in real per capita income in Taiwan (Table 5). Until 1970, annual per capita fish consumption also increased, but since that time it has levelled off in the range of 37-39 kg. In contrast, consumption of other competing protein products such as meat, eggs, and vegetables has continued to increase. In 1977, meat consumption per capita passed fish consumption per capita for the first time. As disposable incomes have increased, total protein intake has also increased, but a consumer preference for meat over fish has emerged. Per capita consumption of fresh fatty fishes, in particular, has declined. Some experienced observers (Liao and Lei 1983) also believe that young Taiwanese do not care for bony fishes like milkfish.

During this period, Taiwanese fish exports also increased, leading to increases in producer prices for those products that were exportable in large quantities. Relatively speaking, however, milkfish is less exportable, and it appears that, as the limits of the domestic market have been reached and prices stabilized, many producers have shifted to other more profitable species.

Table 4. Comparison of financial return per annum (US$) between deep water milkfish farming and farming of shrimp *(Penaeus monodon)* from 0.1 ha in Taiwan (1981).

		Milkfish farming	
Operating costs		US$	%
Fingerlings	2000 (15-18 cm) at $0.20	400	22
Feeds	2160 kg at $0.45	972	53
Electricity		230	12
Labor		180	10
Others		63	3
	Subtotal	1845	100
Income			
Sale of fish	1176 kg (98% survival) at $2.50/kg	2940	
Gross profit		1095	
		Shrimp farming	
Operating costs		US$	%
Juveniles	12 000 at $0,015	430	28
Feeds	612 kg at $1.00	612	40
Electricity		230	15
Labor		180	12
Others		63	4
	Subtotal	1515	100
Income			
Sale of shrimp	306 kg (95% survival) at $7.75/kg	2372	
Gross profit		857	

Source: Chen (1981). Note: Although fixed costs also need to be deducted from the above gross profit figures to obtain a return to the owner's own inputs (capital, labor, and management), this table provides a useful comparison of the relative profitability of milkfish and shrimp farming, given the prices of inputs and output that prevailed at that time.

Table 5. Changes in per capita income, per capita fish consumption, and per capita consumption of other selected protein products in Taiwan, 195Z-80.

	Real per capita	Per capita consumption of selected protein products (kg)			
Year	income (1976 US$)	Fish	Meat	Eggs	Vegetables/fruits
1952	256	15.1			
1955	297	18.7	16.3	1.7	72.0
1958	324	20.7			
1960			16.2	1.6	83.0
1961	352	25.3			
1964	444	28.2			
1965			19.2	2.4	77.8
1967	533	28.7			
1970	665	34.2	25.3	4.1	130.1
1973	894	37.0			
1975			27.0	5.2	164.8
1976	987	35.3	31.6	5.9	180.5
1977	1054	35.1	35.3	6.3	179.8
1978	1157	36.5	36.1	7.6	169.3
1979	1223	38.1	40.3	7.8	194.1
1980	1252	38.7	39.6	8.0	199.7

Source: Taiwan Food Balance Sheet and Taiwan Statistical Data Book as reported in Lee (unpubl.).

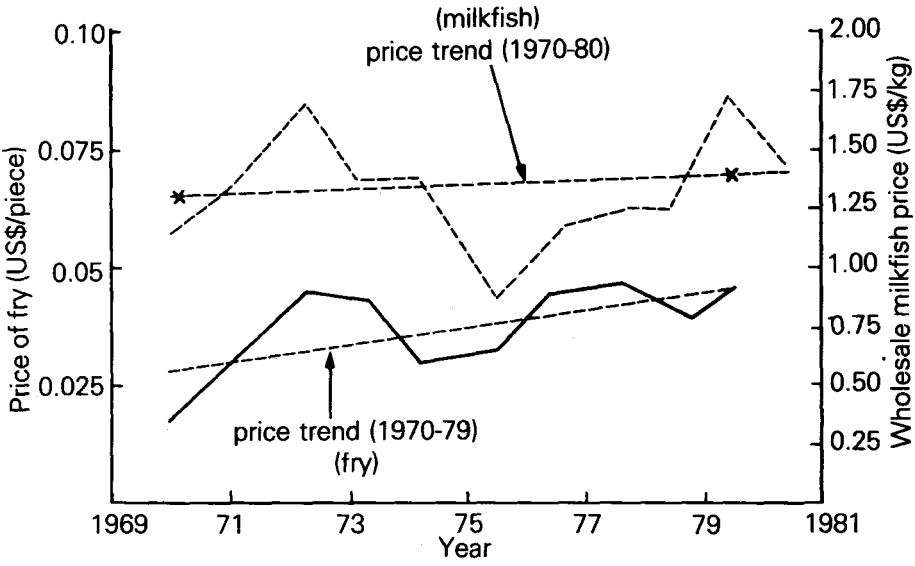

Fig. 2. Comparison of prices of milkfish fry and market size milkfish in Taiwan in constant US$ (i.e., adjusted for inflation using 1970 prices as the base year).

THE PHILIPPINES

As in Taiwan, the relative contribution of milkfish to total aquaculture production in the Philippines is declining, though in absolute terms it continues to increase. The major increases in milkfish production that have occurred in the past decade have come from the establishment of freshwater fishpens in the 90 000 ha Laguna de Bay near Manila. Steady increases in yields from brackishwater ponds are also apparent (Table 6).

Official statistics on Philippine aquaculture production and productive areas, however, are not rigorous, and industry observers are often reduced to conjecture based on qualitative assessments or, if funds are available, to expensive field surveys of producers. Several such economic surveys have been conducted during the past decade (Librero et al 1976; Chong et al 1982, 1983).

The absence of reliable secondary data on Philippine aquaculture certainly complicates research on the industry. Certain commonly held observations regarding Philippine aquaculture are worth mentioning here, however, before proceeding to an analysis of price data, which fortunately permit some assessment of the status and prospects of milkfish culture in the country.

For several centuries, milkfish was the only major cultured species in the Philippines (Herre and Mendoza 1929), and it remains the dominant species today. However, the recent rapid expansion of freshwater aquaculture, while significantly adding to the domestic fish supply, has produced competition for milkfish in local markets and has diminished milkfish's share of total production. In particular, tilapia (*Oreochromis niloticus*) has become increasingly popular with producers and consumers alike (Guerrero 1983).

Table 6. Aquaculture area, production, and yields in the Philippines, 1955-1980.

Year	Brackishwater			Freshwater production	
	Area (ha)	Production (t)	Average yield (kg/ha per yr)	Milkfish (t)	Other (t)
1955	104 952	36 734	350		
1960	123 252	60 119	488		
1965	137 251	63 198	461		
1970	168 118	96 461	574		
1973				19 204	
1975	176 032	106 461	605		
1976				47 020	
1980	176 230	135 951	771		
1982	195 832	170 431	870	55 736	17 514[a]

[a]We believe that this is almost certainly an underestimate.
Sources: BFAR (1981) and other annual fisheries statistics of the Philippines as reported in Chong et al (1982).

Philippine milkfish producers using brackishwater pond methods have for several years been complaining publicly that their profits have been declining. In the mid-1970s, Librero et al (1976) and Nicolas and Librero (1978) reported that brackishwater ponds and freshwater pens returned positive net revenues to operators (Table 7). A later study reporting on the 1978 crop year (Chong et al 1982) showed just slightly higher profits, but small farms less than 6 ha in size incurred losses in most provinces surveyed (Table 8). In the traditionally more advanced provinces (Iloilo, Pangasinan, and Bulacan) returns were still positive at that time. Unfortunately, more recent data on costs and returns are not available.

The problems of the Philippine milkfish industry are most apparent, however, in the trends of retail prices over the past decade. Market constraints have generally

Table 7. Annual costs and earnings per hectare (in pesos) of milkfish producers in the Philippines, 1974/1975 and 1978 crop years.

	Brackishwater ponds		Freshwater pens	
	1974[c]	1978[b]	1974[c]	1975[d]
Receipts				
Cash	2 241	4 772	19 307	18 444
Non cash	53	—	167	•3 481
Total	2 294	4 772	19 474	21 925
Expenses				
Cash	1 437	3 158	13 697	16 478
Non cash	21	236	966	4 288
Total	1 458	3 394	14 663	20 764
Net earnings (current pesos)	836	1 378	4 811	1 161
Net earnings (1974 pesos)	836	1 037	4 811	1 070

Sources: [a]Librero et al (1977).
[b]Chong et al (1982).
[c]Nicolas et al (1976).
[d]Guerrero (1975).

been ignored by researchers (e.g., PCARRD 1982). With capture fishery supplies in the country levelling off and population continuing to grow, one would expect milkfish prices to exhibit steady increases. In fact, Metro Manila retail prices for milkfish have not increased significantly since 1979 (Table 9). A similar pattern has occurred in other major market centers around the country. In real terms adjusted for inflation, Metro Manila prices in 1983 up to June were actually 21% lower than they were in 1974 and 30% lower than in 1977 and 1979. Milkfish fry and organic fertilizer prices have continued to increase, although in the absence of data their rates of increase cannot be compared with that for market size milkfish. Certainly, too, there are variations in economic viability of milkfish production in different parts of the country, but in general Philippine milkfish producers, in a manner similar to their Taiwanese counterparts, are caught in a cost-revenue squeeze with declining profits being the result.

In response to these pressures, brackishwater ponds are increasingly being used for polyculture with shrimp (*P. monodon)* and even for shrimp monoculture; shrimp, of course, have greater export market potential for Japan and, although no data are available to prove this, apparently produce higher returns for producers (but at somewhat higher risk).

There are two apparent reasons for the current decline in profits for brackishwater milkfish producers. The first has to do with increased availability of lower cost milkfish from the freshwater fishpens in Laguna de Bay and of other substitute species such as tilapia. Before Laguna de Bay became overcrowded with fishpens, yields approached 6-7 t/ha annually (Delmendo and Gedney 1974, Nicolas and Librero 1978). Growth rates, and hence annual yields, slowed as more and more of the lake was converted to fishpens (34 000 ha by 1983). But if one conservatively assumes annual yields of 1.5 t/ha, these fishpens may still have produced as much as 50 000 t of milkfish in 1982. This increased supply of milkfish and of tilapia as discussed earlier has undoubtedly contributed to the levelling off of milkfish prices in Metro Manila, with secondary effects on other regional producers, who traditionally supplied part of the Metro Manila market.

The second reason for declining profitability of brackishwater milkfish culture is related to the buying habits of consumers and their preferences. Milkfish has historically been a first-class fish in the Philippines, priced higher than many marine products. Unlike Taiwan, where per capita incomes (in real terms) have been steadily increasing, real per capita incomes in the Philippines have declined by almost 30% since 1972 (NEDA 1982) due to the high rate of inflation as measured by increases of the consumer price index (CPI). The annual per capita consumption of fish declined as a result from 38 kg in 1970 to just over 20 kg in 1980 (Fig. 3). These disturbing facts have had a special impact on the milkfish industry because demand for fish is more elastic at lower incomes than at higher incomes. In other words, a continuing fall in real per capita income will result in an even greater reduction in demand for fish, especially of the traditional first-class fish such as milkfish. Other cheaper species have and will become in greater relative demand.

Another aspect of this declining demand for milkfish is that many consumers appear to be shifting their preference toward other species, especially tilapia. In

Table 8. Annual costs and earnings per hectare (in pesos) of Philippine milkfish farms by farm size (1978).

	Small farms (<6ha)	Medium farms (6-50 ha)	Large farms (>50ha)	All farms
Revenues	3248	3757	6392	4772
Costs				
Stocking materials	444	375	712	520
Fertilizers	259	517	894	686
Pesticides	55	59	66	62
Supplementary feeds	141	52	218	167
Labor[a]	1954	1080	552	926
Miscellaneous	1101	1070	973	1033
Total	3956	3154	3415	3394
Returns[b]	(708)	603	2977	1378

[a]Hired and family labor.
[b]Return to owner inputs (land, labor, capital, and management).
Source: Chong et al (1982).

Table 9. Yearly average retail prices of milkfish (₱/kg) in Metro Manila, Philippines, 1974-1983.

	1974	1975	1976	1977[a]	1978	1979	1980	1981	1982	1983[b]	Percent change 1974-1983
Current pesos	6.45	7.14	7.26	8.97	8.84	11.46	11.98	12.90	12.92	12.25	+ 90%
Constant pesos[c]	6.45	6.60	6.32	7.24	6.63	7.23	6.42	6.39	5.58	5.09	-21%
CPI (1972=100)	152.2	164.6	174.8	188.6	202.9	241.1	284.1	335.2	352.2	366.2	

[a]January-June only.
[b]Average for first 6 months of the year.
[c]Constant peso price = current peso price deflated by the consumer price index (CPI) for all items (1972=100).
Sources: 1974-1977: Bureau of Agricultural Economics.
1978-1983: Philippine Fish Marketing Authority.

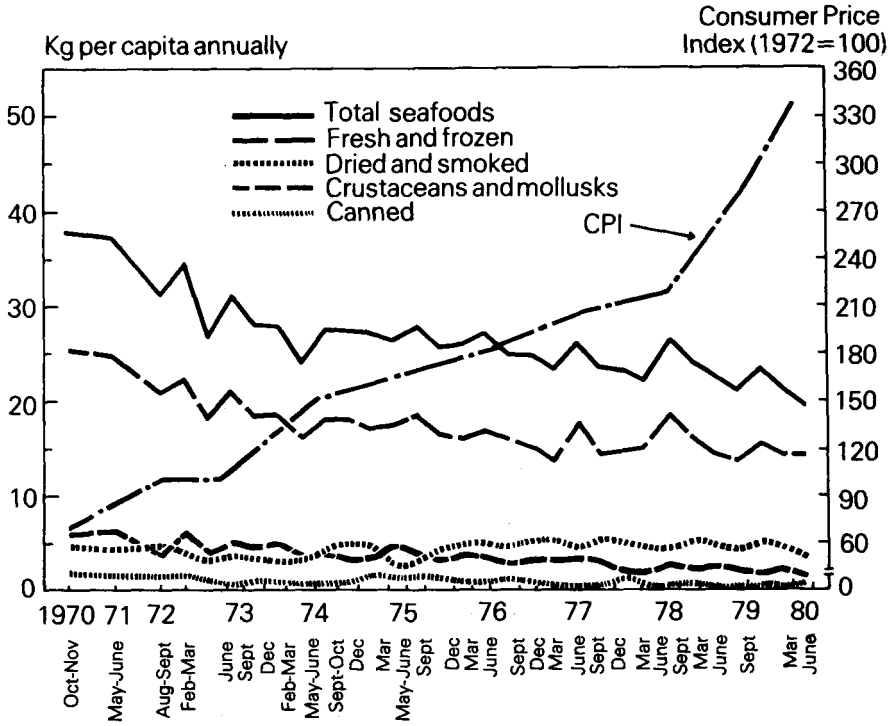

Fig. 3. Average annual per capita rates of use of seafoods and related products, 31 surveys, Philippines, 1970 to 1980. Source: Food Consumption Surveys, SSD, Ministry of Agriculture, reported in Regalado 1983.

part, this can be explained by the lower prevailing prices of tilapia (although currently tilapia sells for about the same price as milkfish in Metro Manila). Also, the recent introduction of the Nile tilapia (*O. niloticus*) has made available a fish that is increasingly attractive to consumers. Milkfish producers should be concerned that this attractiveness may result in a permanent shift in demand away from milkfish in the Philippines and a continuing constraint to further milkfish industry growth.

INDONESIA

Although Indonesia's brackishwater pond area is approximately the same as that of the Philippines, average yields (515 kg/ha per year in 1979) are only two-thirds those of the Philippines. Also, since brackishwater polyculture is more prevalent in Indonesia than elsewhere in Southeast Asia, total milkfish production is less than 50 000 t or only 40% that of the Philippines, which has an equal area of brackishwater ponds, and only 40% more than Taiwan, which has only 1/10 of the brackishwater pond area. Since 1973, the brackishwater area in Indonesia has stabilized at approximately 182 000 ha, while in contrast the freshwater area has increased by almost 37% to 42 300 ha (DGF 1981).

While milkfish production since 1973 has increased by 20%, tilapia and shrimp production have each increased at substantially higher rates (Table 10). Consequently, milkfish's share of brackishwater pond production declined from 64% in 1973 to 40% in 1979, while those of tilapia (primarily *O. mossambicus)* and crustaceans increased to 11% and 26%, respectively. As in Taiwan and the Philippines, these statistics imply a relative shift toward species other than milkfish. Despite this relative shift, however, it will be some time before these other species are able to supplant the role of milkfish in brackishwater fish culture in Indonesia.

Unlike Taiwan and the Philippines, where the changing industry pattern is already clear, the picture of the Indonesian brackishwater aquaculture industry is still emerging. Milkfish as a cultured species in brackishwater fishponds (*tambaks*) is being neglected by the *tambak* operators. Because the higher value shrimps are allowed to enter the *tambaks* to grow, *tambak* operators have not given the lower value milkfish the attention they have paid to shrimp.

This is not to say that the shrimp are given supplemental feeding or provided with other inputs to boost yield. For the naturally stocked shrimp, the major input cost is labor. Even though milkfish is artificially stocked, *tambak* operators do not generally apply the necessary production inputs such as organic and inorganic fertilizers and pesticides to increase production in spite of many government attempts to encourage them to do so.

The economic reasons for this behavior remain unclear to us (but perhaps not to the producers themselves), because there has been so little economic research on Indonesian aquaculture. We have been unable to locate a single complete costs and returns study based upon actual farm data, although some hypothetical projections have been made based upon experimental data (Cremer 1983). Partial data for 1974 and 1975 are perhaps indicative in that they show that increases in input prices such as milkfish fry, rice bran, and organic fertilizers were 100% or greater between the 2 years, while the price of market size milkfish increased by only 10% (Padlan 1979). Although no later data are available, perhaps Indonesian milkfish fanners are being caught in a cost-price squeeze similar to their Taiwanese and Philippine counterparts. More recent experience in Aceh and North Sumatra shows that farm yield and industry production increases are often accompanied by added marketing risks and falling prices due to marketing constraints (Sullivan 1981). Remote areas such as these perhaps face their biggest constraint in the marketing costs involved in shipping milkfish to major demand centers in Java.

Relative prices of the major aquaculture species give some evidence of consumer preferences. Unlike Taiwan and the Philippines, carp rather than milkfish is the favored species in Indonesia, as evidenced by its higher price (Directorate General of Fisheries, unpubl.). The milkfish retail price (Rp. 1169) was 72% of the carp retail price (Rp. 1619) in 1982. By contrast, tilapia prices were considerably lower (Table 11), especially for *O. mossambicus,* which is produced primarily in brackishwater ponds. Sullivan (1981) suggested that the primary market competition for milkfish, in Aceh at least, comes from higher priced marine species. Consequently, milkfish prices and marketability may depend upon the supply of these other species.

Table 10. Brackishwater and inland pond production (in tons) in Indonesia, 1973-1979 (milkfish and other major species).

	1973	1974	1975	1976	1977	1978	1979	Percent change 1973-1979
Brackish water ponds								
Milkfish	38 439	41 650	44 692	44 072	48 641	48 287	46 187	+ 20%
Tilapia	1 243	2 264	5 345	7 746	8 075	8 049	10 165	+ 718%
Crustaceans	9 576	11 616	9 994	14 621	21 462	21 797	24 426	+ 155%
Others	11 223	11 226	18 745	13 764	9 426	9 862	12 866	+ 15%
Subtotals	60 481	66 756	78 776	80 158	87 604	87 995	93 644	+ 55%
Inland								
Tilapia	6 491	6 128	2 616	3 115	10 327	15 477	16 441	+ 53%
Others	45 379	48 611	52 787	49 516	44 014	42 203	52 918	+ 17%
Subtotals	51 870	54 739	55 403	52 631	54 341	57 680	69 359	+ 34%

Source: DGF (1981).

Table 11. Prices (Rp/kg) for selected food items in Indonesia, 1973-1980.

Item	1973	1974	1975	1976	1977	1978	1979	1980	Average
Jakarta prices[a]									
Beef	561	812	964	1030	1179	1393	—		990
Tinned corned beef	562	786	813	885	1040	1195		—	880
Fish (*bawal*)	302	435	529	582	661	719			538
Milkfish	—	—	—	—	301	375			338
Imported sardines	439	634	650	665	787	941	—	—	686
All Indonesia prices[b]									
Brackishwater tilapia	176	88	196	147	167	176	216	304	184
Freshwater tilapia	235	255	196	265	304	265	343	559	303

[a]Statistics of Indonesia, Biro Pusat Statistik, 1977-1978 and Directorate General of Fisheries, Jakarta as cited in Sullivan (1981).
[b]DGF (1982). Freshwater tilapia consists of *Oreochromis mossambicus* and *O. nilotica,* while brackishwater tilapia is *O. mossambicus* only.

As in the Philippines and Taiwan, where changing economic forces have determined the pattern and direction milkfish producers have taken, in Indonesia until recently no major development occurred. However, with the 1981-82 ban on trawlers which exploit coastal shrimp resources, a stimulus was set in motion which may shape the future of brackishwater aquaculture in Indonesia. Already the Government has announced plans to build 200 shrimp hatcheries in various parts of the country. This government investment may encourage an even greater emphasis on shrimp over milkfish in Indonesian brackishwater farms.

Although the data are far from complete, some indications of milkfish marketability in Indonesia can be obtained from price and consumption data. Milkfish is priced lower than many other animal protein products (Table 11). Fish is also the major source of animal protein (Table 12), but the overall level of fish intake per capita (8.66 kg/yr) is well below intake levels in Taiwan and the Philippines. Though these data are only indicative, the market constraint for milkfish in Indonesia may be in the form of low effective demand, i.e., limited purchasing power of consumers. The extent of this potential problem could only be assessed if producer profitability and marketing costs were known. Certainly, too, it would vary from region to region in a country as large and diverse as Indonesia.

IMPLICATIONS FOR THE FUTURE

Based on available secondary data and previous economic studies, the preceding sections of this paper have sought to demonstrate the declining attractiveness of milkfish farming in Taiwan, the Philippines, and Indonesia relative to other species with which milkfish competes either in production or in marketing. Our emphasis on market constraints, in particular, is at variance with much previous research (including our own), which has tended to focus on production constraints (e.g., Chong et al 1983) and thus has identified credit, extension, and information dissemination bottlenecks as the primary impediments to expansion of the industry.

Milkfish is clearly no longer an infant industry in the early stages of dynamic growth. Expansion of the production area is unlikely in Southeast Asia; the pressure for alternative use of the resources required for milkfish is just too great. The fishpens in Laguna de Bay for example, have clearly overexpanded to the detriment of both milkfish growth rates and the capture fishermen who also use the lake. Fishpens are currently being dismantled by the Laguna Lake Development Authority to reduce the areas used substantially. Increased concern for conservation of remaining mangrove area holds promise of future restrictions on continued conversion of these areas to milkfish farming. Taiwan, of course, has faced high land and labor costs for many years, which explains the higher productivity per unit of land area there. With suitable milkfish producing areas becoming less readily available in the Philippines and Indonesia, consequent pressure will be put on producers in these two countries to intensify their milkfish production methods, i.e., to increase their use of non-land inputs such as fertilizer and supplementary feeds. Availability of these inputs will thus be a prime determinant of the ability of milkfish to remain the species of choice of producers.

Table 12. Per capita consumption of selected food items in Indonesia, 1977.

Item		Quantity (kg/yr)
Meat		
Cow		0.97
Buffalo		0.26
Goat		0.28
Sheep		0.09
Chicken		0.51
Pork		0.50
Other meat products		0.06
Offal		0.51
	Subtotal	3.18
Fish		
Inland freshwater fish		2.63
Marine fish		6.03
	Subtotal	8.66

Source: Food Balance Sheet in Indonesia, Agricultural Statistics, 1977 as cited in Sullivan (1981).

Milkfish production is not carried on in isolation from other sectors of national or Southeast Asian economics. The Philippines experiences highly variable availability of organic fertilizers (Chong et al 1983); the resulting high prices in some locations thus work against intensification of milkfish production methods: Another area of impact on milkfish farming comes from the recent bans on shrimp trawling in all of Indonesia (Sardjono 1981) and in the coastal waters of the Philippines. With expected reductions in the supply of shrimp from capture fishery and increased prices in the export market, shrimp farming in brackish water should become increasingly attractive. If tilapia can be successfully raised to market size in brackishwater ponds, milkfish may lose much of its current comparative advantages for the use of brackishwater rearing areas.

Certainly there is potential for making milkfish more competitive with other species through reductions in the average costs of production. For example, the Taiwanese deep water system is one way in which producers have been able to reduce their average production costs and thus increase their profits. Similar benefits to individual producers exist through increased use of supplementary inputs in the Philippines and Indonesia (Chong et al 1982, Wiratno 1978). However, market constraints apparently limit the extent to which reduction in production costs will produce marked growth in the industry.

Should this apparent levelling off of growth in the milkfish industry be of major concern? The primary interest of Southeast Asian planners and fisheries departments is to maintain or increase the supply of fish protein at reasonable return to producers. Consequently, at this level one should not expect any particular attachment to milkfish per se except perhaps as it pertains to issues of producing for domestic markets vis-à-vis export markets. Nor should the private fish fanner be expected to retain some emotional attachment to milkfish if alternative species can be raised for larger and more sustainable profits.

Institutional changes however, are likely to lag behind those changes in the production sector brought about by changing economic conditions. Large investments have been made in all three areas to support the milkfish industry. Indonesia, for example, is developing a milkfish hatchery at Gondol, Bali, while at the same time planning 200 shrimp hatcheries. If successful in supplying seed at prices competitive with naturally caught seed, each approach offers hope of benefitting brackishwater producers. At some point, however, careful assessments must be made of aquaculture investments and research projects (including artificial breeding programs) in light of current economic conditions. In particular, research institutions that have invested much in milkfish research are faced with the choice of intensifying their milkfish research so as to recover milkfish's competitive edge or of diversifying their programs to include other species. The task of transferring research results to the private sector through extension and information programs is made more difficult, too, by diversity in production systems and rapid changes in the private sector. The current situation thus presents a substantial challenge to governments and to the research community.

There are, of course, numerous courses of action. Because the declining profitability of milkfish production seems to emanate primarily from market constraints, market diversification becomes increasingly important. The Taiwanese benefits from using milkfish as baitfish have been previously mentioned; further development and promotion of "boneless *bangus"* and canned milkfish (sardine-style) in the Philippines perhaps offer similar benefits. The economic potential of these options remains to be documented, though the availability of these products in the market indicates some private sector interest.

In all three milkfish producing areas of Southeast Asia, fry and fertilizers make up the bulk of production costs. Combining these inputs with land and labor in the most cost-effective manner remains the goal of the more progressive producers in the private sector. Transmitting information on economically viable options to the private sector, in our view, is one of the greatest needs of the milkfish industry at the present time. The research community has fallen far short of meeting this need in the past. To do so in the future it is necessary, for economists at least, to take a broader view than that which is solely commodity-specific. This is not to suggest that milkfish economics research be abandoned; rather, this micro-level analysis must be supplemented, on the one hand, to include analysis of other potentially profitable options open to brackishwater producers (some would say a farming systems approach) and, on the other hand, as begun in this paper, to examine structural aspects of the market demand for milkfish and other species.

Given the market limitations to increased milkfish production and apparent declining profitability, pressure will be brought to bear upon less efficient farmers. Research advances, to the extent that they lower average costs for producing milkfish, are likely to assist farmers to become more efficient, but at the same time may concentrate the industry in fewer hands as less efficient farmers are weeded out. With increased competition for markets, smaller farmers are likely to be in a precarious position. Studies of economies of scale in milkfish production and marketing are particularly needed to see to what extent small farms will be able to remain competitive under these changing economic conditions.

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