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Production and marketing of milkfish in Taiwan: an economic analysis

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INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
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Cover: Market-size milkfish harvested from a pond. Photo by K-C. Chong.

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Preface

Fisheries production has played an important role in the agricultural development of Taiwan. The relative contribution of the fishery sector to total output of the agricultural industry increased from 11% in 1950 to 21% in 1979, while the share of crop production dropped from 64% to 48% in the same period.

Since the oil crisis of the 1970s, the production cost of industrial products increased, and nonfarm inputs in the agricultural sector also became more expensive. Consequently, the once-steady price of farm products became unstable. To stabilize production, agriculture shifted its emphasis from the utilization of petroleum oil as means of production to less energy-intensive systems. This shift has favored aquaculture over capture fisheries because it is more energy efficient. Moreover, aquaculture is not necessarily labor intensive and in the face of labor shortages in the rural areas of Taiwan, it has had a further advantage over alternative uses of land that require large labor inputs.

In Taiwanese fish culture, milkfish production ranks first in terms of area under development. This research, in order to present the whole milkfish resource system, involved a detailed study of the gathering, rearing and marketing subsystems.

With a grant from the International Center for Living Aquatic Resources Management (ICLARM) and encouragement of Dr. Ziad H. Shehadeh, then Director General, and colleagues Dr. Ian R. Smith, Dr. Kee-Chai Chong and Dr. Ching-Ming Kuo of ICLARM, the writer was able to complete this manuscript. During the study, ICLARM not only granted financial support but also provided a good opportunity to visit the aquaculture industry in the Philippines which benefited these studies. During the collection of data, various fishermen's associations gave invaluable assistance which enabled completion of the field survey.

Besides, the writer wishes to express his thanks to the students of the Research Institute of Agricultural Economics, National Chung Hsing University, for field survey work and research assistant Mr. Wang Kuo-Ming for compiling the data.

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Abstract

Economic aspects of the Taiwanese milkfish resource system and its major subsystems of fry procurement, baitfish rearing, market-size rearing and marketing are presented. Fry gathering takes place primarily in the southern and eastern coasts of the island with transfer through middlemen to a small number of dealers in Tainan City. Gatherers receive 80% of the price paid by fishpond operators. However, due to instability of domestic supply, fry prices are also highly unstable.

Baitfish farms rear milkfish fingerlings for the use of tuna longliners based in Tungkang and Kaohsiung. The benefit-cost ratio, factor productivity and rate of baitfish farm income were found to be high, but with demand for baitfish levelling off, there is only limited potential for expansion of this sector of the system. In contrast, farms that rear milkfish for the consumer market were found to be much less profitable and efficient. In fact, the benefit-cost ratio was lower than the opportunity cost of capital. A constant-elasticity-of-substitution production function was employed for both baitfish and market-size milkfish-rearing farm data and showed significant labor saving and capital intensification on the former. On the latter, substitutability of capital for labor was easier on farms smaller than 3 ha than on larger farms.

Producers of market-size milkfish receive, on average, 74% of the retail price. Marketing margins and costs have, however, increased significantly since 1974. Only 15% of the total harvest is marketed through cooperatives, most producers apparently preferring to sell through wholesalers who offer more flexible credit, payment and transport facilities.

The relative importance of milkfish in Taiwanese aquaculture is declining in the face of higher profitability of other species, particularly shrimps, crabs and tilapia. If milkfish is to remain a prominent aquaculture product of Taiwan, it is concluded that milkfish production per unit area must be increased beyond its current 2,100 kg/ha/yr, perhaps through the use of deep-water systems.

Introduction

The fishery sector, including aquaculture, has played a significant role in the agricultural development of Taiwan. The relative importance of the fishery sector can be seen in the fact that its share of total agricultural production increased from 11% in 1950 to 21% in 1979 while the share of crop production declined from 64% to 48% in the same period (Taiwan Agricultural Yearbook).

The intensive use of land is a well-established tradition in Taiwan. Farmers have found it necessary to grow crops or raise animals all the year round wherever possible, or to change cultivated land from crops to fishponds in order to maximize the profit from their farm land and to improve their livelihood. Due to the increasing demand for protein in the diet of people, fishery production in the past 15 years increased rapidly from 381,688 t in 1965 to 929,326 t in 1979. The expansion of area for fish culture was significant in recent decades, having increased from 34,148 ha in 1965 to 60,460 ha in 1979. Milkfish is the most important species of fish cultured in Taiwan fishponds, the total milkfish production area being 15,346 ha or about 26% of the total pond area in 1979 (Taiwan Fisheries Yearbook).

Basic biological research on milkfish in Taiwan has been intensive (Lin 1968; Chen 1952, 1976), but the few economic studies of production are now out-of-date (Shang 1973, 1976). The only recent economic studies of Taiwanese aquaculture have focused on integrated farming (Delmendo 1980; Lee 1980). Moreover, there has been no economic analysis of the fry input sector nor of the marketing of milkfish in Taiwan. The Taiwanese milkfish industry faces chronic shortages of fry, relying for almost half of its annual requirements upon fry imported from the Philippines and Indonesia. Demand for milkfish fingerlings has grown as they have been found suitable as baitfish for tuna longliners based in Kaohsiung and Tungkang, the southern ports of Taiwan. However, milkfish producers in many locations are finding that shrimp or crab rearing is more profitable than rearing market-size milkfish. In some areas where ground water is available, brackishwater ponds are being converted to freshwater ponds. Nevertheless, due to the importance of milkfish as a protein source in Taiwan, the Government is anxious to maintain its production. A systematic economic analysis of production and marketing of milkfish has been needed to assist Government planners in their programs to sustain milkfish production as well as the incomes of producers and other support groups within the sector.

This research was undertaken to provide an economic analysis of production and marketing of milkfish. The specific objectives of the study were as follows:

(1) To examine the gathering and marketing of milkfish fry.
(2) To measure the production efficiency of the baitfish industry.
(3) To analyze the input-output relationship of production of market-size milkfish.
(4) To understand the marketing of market-size milkfish.

Methodology

There are a number of indicators which can be used for economic analysis of production and marketing of milkfish. Determining profitability of milkfish operations is important because it provides an indicator of the reasons for shifts in agricultural and aquacultural production patterns. For example, benefit-cost analysis has become increasingly popular and useful since it can compute the direct and indirect costs and benefits of a specific enterprise. An easy way to measure the benefit-cost ratio (K) of a specific enterprise is by the formula:

$$K = \frac{FI}{TC} \qquad (1.1)$$

where FI stands for the farm income which is equal to the difference between gross receipts and production costs, and TC represents the total costs of the production. As expressed above this reflects the benefit-cost ratio for a single time period only.

A second indicator which can measure production efficiency in agriculture is the rate of farm income. The rate (R) of farm income (FI) is computed using the formula:

$$R = \frac{FI}{FR} \qquad (1.2)$$

where FR represents farm receipts. From Equation (1.2), the larger the rate of farm income, *ceteris paribus,* the greater the production efficiency.

A third indicator is factor productivity which is a reciprocal concept of production efficiency and can be measured by output per unit of input. Setting the farm output as Q, the input of farm land as D, of labor as N and of capital as C, land, labor and capital productivities can then be explained by Q/D, Q/N and Q/C, respectively. Actually, factor productivity can be derived from the relationship between alternate factor productivities and the appropriate factor-factor ratio. For example, land productivity can be explained by the relationship between labor productivity and labor-land ratio or the relationship between capital productivity and capital-land ratio:

$$\text{Land Productivity} : \frac{Q}{D} = \frac{Q}{N} \cdot \frac{N}{D} ; \frac{Q}{D} = \frac{Q}{C} \cdot \frac{C}{D} \quad (1.3)$$

$$\text{Labor Productivity} : \frac{Q}{N} = \frac{Q}{D} \cdot \frac{D}{N} ; \frac{Q}{N} = \frac{Q}{C} \cdot \frac{C}{N} \quad (1.4)$$

$$\text{Capital Productivity} : \frac{Q}{C} = \frac{Q}{D} \cdot \frac{D}{C} ; \frac{Q}{C} = \frac{Q}{N} \cdot \frac{N}{C} \quad (1.5)$$

From Equation (1.3), if the labor-land ratio (N/D) is held constant, then any increase in land productivity (Q/D) in this case is entirely due to increases in labor productivity (Q/N). Similarly, if the capital-land ratio (C/D) remains constant, then any increase in land productivity (Q/D) is totally due to increases in capital productivity (Q/C).

A fourth indicator of production efficiency is elasticity of substitution. With two factors of production, labor (N) and capital (C), the elasticity of substitution is represented symbolically by:

$$\sigma = \frac{(C/N) \cdot d\,(N/C)}{(f_n/f_c) \cdot d\,(f_c/f_n)} \quad (1.6)$$

where f_n and f_c are the marginal products of labor and capital, respectively. The elasticity of substitution is the proportional change in the relative factor inputs to a proportional change in the marginal rate of technical substitution between labor and capital (Brown 1968). Expressed differently, the elasticity of substitution shows the proportional change in the capital-labor ratio brought about by a given proportional change in the factor-price ratio (Ferguson 1972). If elasticity of substitution is high, then a given change in the ratio of marginal products of labor and capital is associated with a larger change in the labor-capital ratio than would be the case if elasticity of substitution were lower.

A CES (constant-elasticity-of-substitution) production function was applied to measure the elasticity of substitution for this study. The CES production function is given by:

$$Q = \gamma [\, kc^{-\rho} + (1 - k)\, N^{-\rho} \,]^{-v/\rho} \quad (1.7)$$

where Q, C and N represent output, capital and labor inputs respectively; the four parameters are γ, k, v and ρ, where γ stands for a scale parameter denoting the efficiency of a production technology, k is the distribution parameter indicating the degree to which technology is capital intensive; v represents the degree of homogeneity of the function or the degree of returns to scale; and ρ is the substitution parameter equal to $(1 - \sigma) / \sigma$, where σ is the elasticity of substitution which therefore equals $1 / (1 + \rho)$. The derivation of the CES production function is explained in the Appendix.

Several methods are also available for analyzing marketing. First, the study of marketing channels is necessary for understanding the marketing system and relation of markets and market agencies to one another. Farmers use different marketing channels depending on the quantity of product they have for sale. Small producers of milkfish may sell to dealers or wholesalers for example, while large producers may ship directly to one of the city markets.

A second method is the determination of marketing margins. In the agricultural sector, marketing margins equal the retail price less the farm gate price. The share of the consumer's dollar that goes to producer or to marketing can be derived from the farm gate, wholesale and retail prices. Margins in different market channels vary widely with the type of products handled. Generally, they are higher for perishable products and lower for durable ones.

Third, marketing costs can be determined. Marketing costs are the service charges for the performance of marketing functions. Primary marketing expenses consist of assembly, transportation, freezing, profit (i.e., return to intermediaries' owned inputs) and market management fees. Generally speaking, marketing costs may be considered a reflection of the country's economy in that the costs of marketing would be higher relative to the farm price if there is a high degree of industrialization of the country's economy and consequently higher demand for a quality product.

Finally, price variation can be explained with the use of long-run trends and indices of seasonal variation and price instability measured by the Michaely Index and Von Neumann Ratio (Michaely 1962; UNCTD 1968). The two methods use long-term annual changes as a basis to observe changes in quantity and value. The Michaely Index (F) evaluates economic variance year by year and represents the degree of fluctuation or instability. The higher the value of F, the more instability is implied. If F is above 20%, extreme instability is implied; slight instability if $F < 10\%$. The Von Neumann Ratio (R) is used to evaluate the possiblity of the reverse of economic variance. It is an indication of whether the economic variance occurs in the same general direction or represents capricious movements year by year. The Von Neumann Ratio has a numerical range of 0-4. If $R = 0\text{-}2$, instability is implied but the variation is in the same direction, leading to consistent trends in the variable under examination. If $R \approx 4$, high instability and variation in opposite directions are said to occur. Price analysis in this fashion is a useful measure of uncertainty because price variation often results in income instability for producers. Consumers also prefer more stable prices.

In order to understand fully the whole resource system of milkfish, the scope of study includes three subsystems, namely: procurement subsystem, transformation subsystem and delivery subsystem (Ruddle and Grandstaff 1978). The economic structure of the milkfish system is illustrated in Fig. 1.

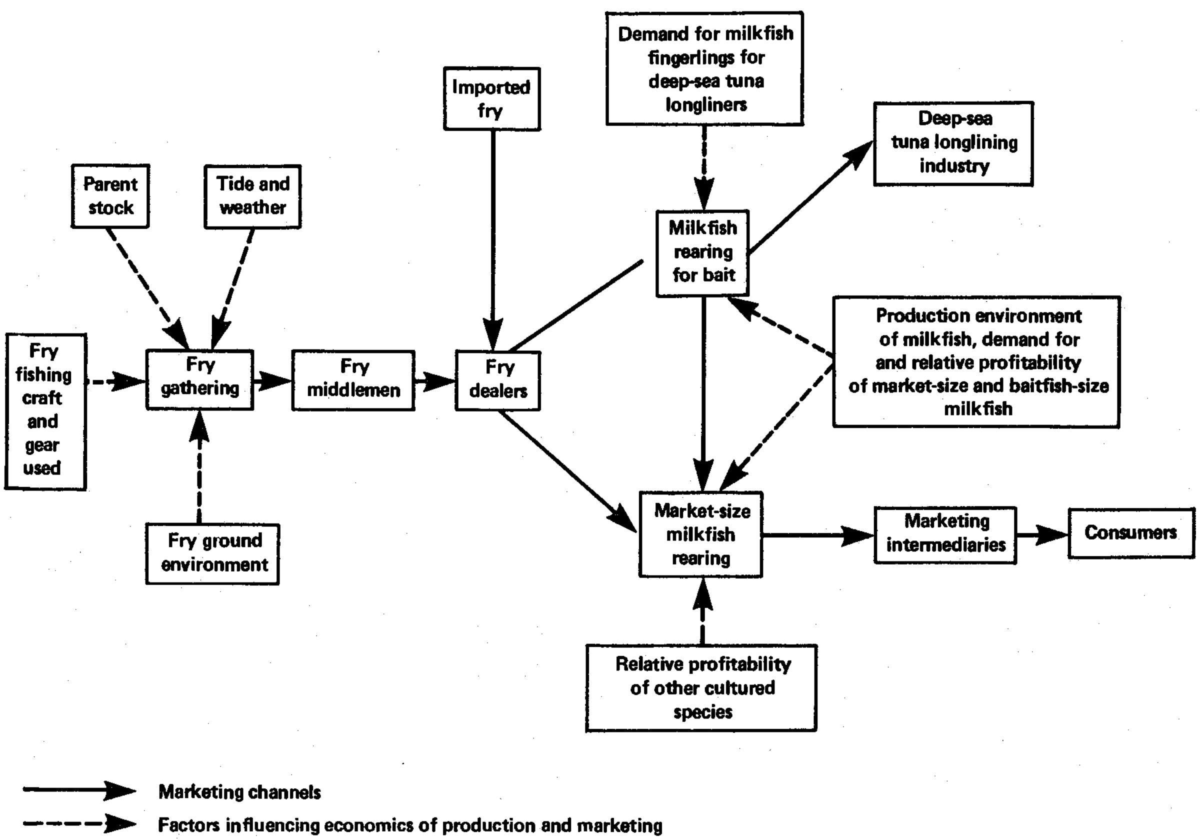

Fig. 1. The structure of the milkfish system in Taiwan.

In the stage of fry gathering, there are some factors, such as tide and weather, fry ground environment and fishing tools which affect the fry catch. The fry obtained by dealers come from domestic supply and are also imported from abroad. Milkfish rearing to market size or for bait is greatly influenced by the demand from the longline fishery, numbers of fishponds, production environment and relative profitability between market-size milkfish (approximately 300 g) and milkfish fingerlings used for bait. Another factor to be considered is the relative profitability between freshwater and brackishwater aquaculture because producers can shift from the latter to the former by regulating their water supply. There is no fishery for the adult milkfish in Taiwan, nor does the fish appear in national fishery statistics. Consequently, there is no law as exists in the Philippines to protect adult milkfish. There is no major export market for Taiwanese market-size milkfish.

The data for this study were obtained from a field survey of 234 respondents including fry gatherers and dealers, baitfish producers, milkfish producers and marketing intermediaries for the year 1979. Sample distribution is shown in Table 1 and Fig. 2. The sample of producers selected was proportional to the geographic distribution of ponds for market-size milkfish and baitfish. Producers' lists were obtained from fishermen's associations. Potential respondents were stratified by farm size and then randomly selected from each strata. Some substitution was done in cases where association officials advised that the chosen respondent was unlikely to cooperate. Baitfish farms were stratified into three groups: below 1 ha, 1-3 ha and above 3 ha. Market-size rearing farms were also stratified into three groups: below 3 ha, 3-10 ha and above 10 ha. Because fry gatherers and most fry middlemen were part-time, respondents were selected on the advice of the fishermen's associations.

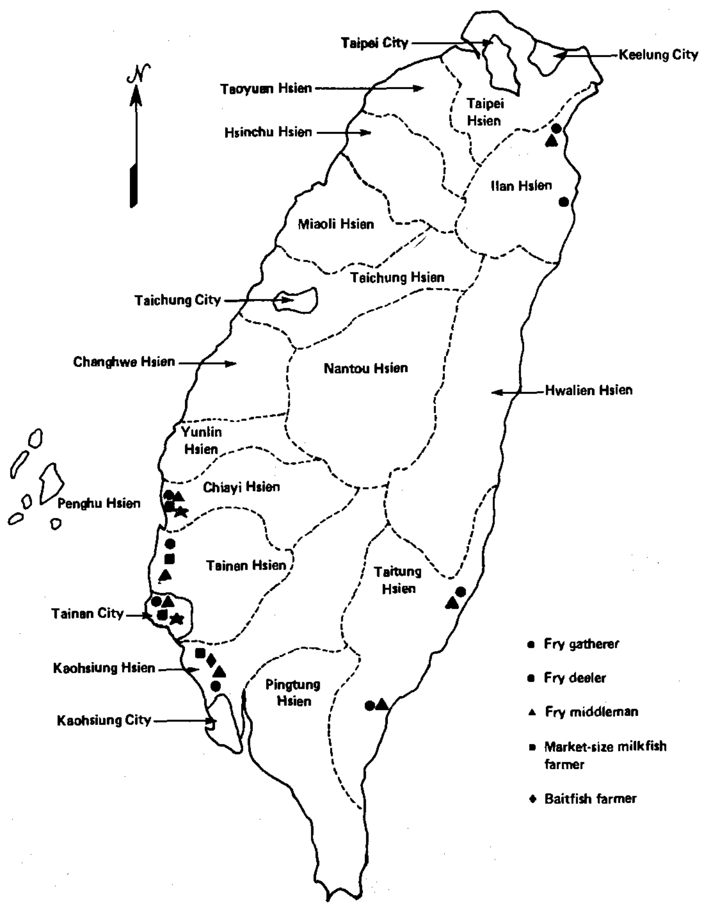

Fig. 2. Map of Taiwan showing the distribution and kinds of respondents in the 1979 survey of the milkfish industry.

Table 1. Breakdown of sample of field survey respondents in the milkfish industry, Taiwan (n = 234).

Region	District	Gatherers	Middlemen	Dealers	Baitfish producers Under 1 ha	Baitfish producers 1-3 ha	Baitfish producers Over 3 ha	Baitfish producers Total	Market-size milkfish producers Under 3 ha	Market-size milkfish producers 3-10 ha	Market-size milkfish producers Over 10 ha	Market-size milkfish producers Total	Total
Chiayi Hsien	Putai	4	2	1	–	–	–	–	3	14	5	22	29
Tainan Hsien	Peimen	4	2	–	–	–	–	–	6	11	5	22	28
	Chiku	2	2	–	–	–	–	–	3	10	11	24	28
Tainan City	Anping	2	2	5	–	–	–	–	2	15	3	20	29
Kaohsiung Hsien	Yungan	4	2	–	–	12	2	14	11	12	6	30	50
	Mitoo	–	–	–	1	–	3	4	1	2	1	4	8
	Tzukuan	–	–	–	–	2	–	2	–	–	–	–	2
	Chiatin	–	2	–	–	–	–	–	–	–	–	–	2
Pingtung Hsien	Tungkang	–	2	–	–	–	–	–	–	–	–	–	2
	Lingpien	6	2	–	5	3	2	10	–	–	–	–	18
Taitung Hsien	Taitung City	6	2	–	6	3	1	10	–	–	–	–	18
	Chungkung	6	2	–	–	–	–	–	–	–	–	–	8
Ilan Hsien	Erhchieh	6	2	–	–	–	–	–	–	–	–	–	8
	Suao	4	0	–	–	–	–	–	–	–	–	–	4
Total		44	22	6	12	20	8	40	26	64	32	122	234

In addition to this primary data, secondary data were obtained on production and prices from various monthly and annual publications of official Taiwanese institutions. The time-series data obtained cover 15 years, 1965-1979. The primary cross-sectional data covered 1979 only.

Gathering and Marketing of Milkfish Fry: Procurement Subsystem

FRY GATHERING AND CATCH

The main sources of milkfish fry are the southern and eastern coasts of the island. Comparing the two 3-year periods 1965-1967 and 1977-1979, the eastern coast (primarily Taitung and Hwalien Hsien) produced a significantly higher share of total catch than the western coast. In the 1977-1979 period, approximately 83% of total fry catch came from three Hsien: Pingtung, Taitung and Hwalien (Table 2). The decline in fry catch from Kaohsiung Hsien is thought to be due to coastal pollution resulting from the development of large industrial cities in southwest Taiwan. There are very few fry caught in the north and central part of Taiwan due to labor shortages in rural areas (higher opportunity costs) and water pollution along the coasts.

The total catch of fry varies to a very high degree from year to year. The causes for such variation are the meteorological and oceanic changes which probably affect milkfish spawning and consequently the distribution of eggs and fry.

There are a number of different methods used to catch fry, ranging from the simple hand-operated seine nets (Fig. 3) and sweepers (Fig. 4) that can easily be handled by one man, to the motorized raft and boat (Fig. 5). Hand-held fork nets, which are handled by one person wading along the seashore, are the traditional Chinese tools for fishing. Later the hand-held fork net manipulated by one man developed into the seine net hand-pulled by two men. This hand-pulled net is 12 m long, with floats along the upper edge and sinkers along the lower edge. Men can use bamboo rafts to pull this type of net, so it can be used far from shore.

Table 2. Milkfish fry procurement (thousand pieces) by region, Taiwan, 1965-1967 and 1977-1979.

Coast	Hsien/City	1965-1967 (Average) Quantity	%	1977-1979 (Average) Quantity	%
West	Taipei Hsien	239	0.25	84	0.09
West	Taoyuan Hsien	87	0.09	42	0.05
West	Hsinchu Hsien	124	0.13	316	0.36
West	Miaoli Hsien	436	0.45	289	0.33
West	Taichung Hsien	2,149	2.23	207	0.23
West	Changhwa Hsien	1,392	1.45	1,960	2.21
West	Yunlin Hsien	1,247	1.30	1,517	1.71
West	Chiayi Hsien	1,078	1.12	318	0.36
West	Tainan Hsien	5,635	5.85	437	0.49
West	Kaohsiung Hsien	7,416	7.70	1,223	1.38
West	Pingtung Hsien	6,351	6.60	17,801	20.12
West	Penghu Hsien	869	0.90	70	0.08
West	Tainan City	4,455	4.63	4,234	4.78
West	Kaohsiung City	535	0.56	698	0.79
East	Taitung Hsien	45,827	47.59	43,817	49.52
East	Hwalien Hsien	15,120	15.70	11,988	13.55
East	Ilan Hsien	3,331	3.46	3,499	3.95
Total		96,291	100.00	88,491	100.00

Source: Taiwan Fisheries Bureau, Provincial Department of Agriculture and Forestry (PDAF), Taiwan Fisheries Yearbook.

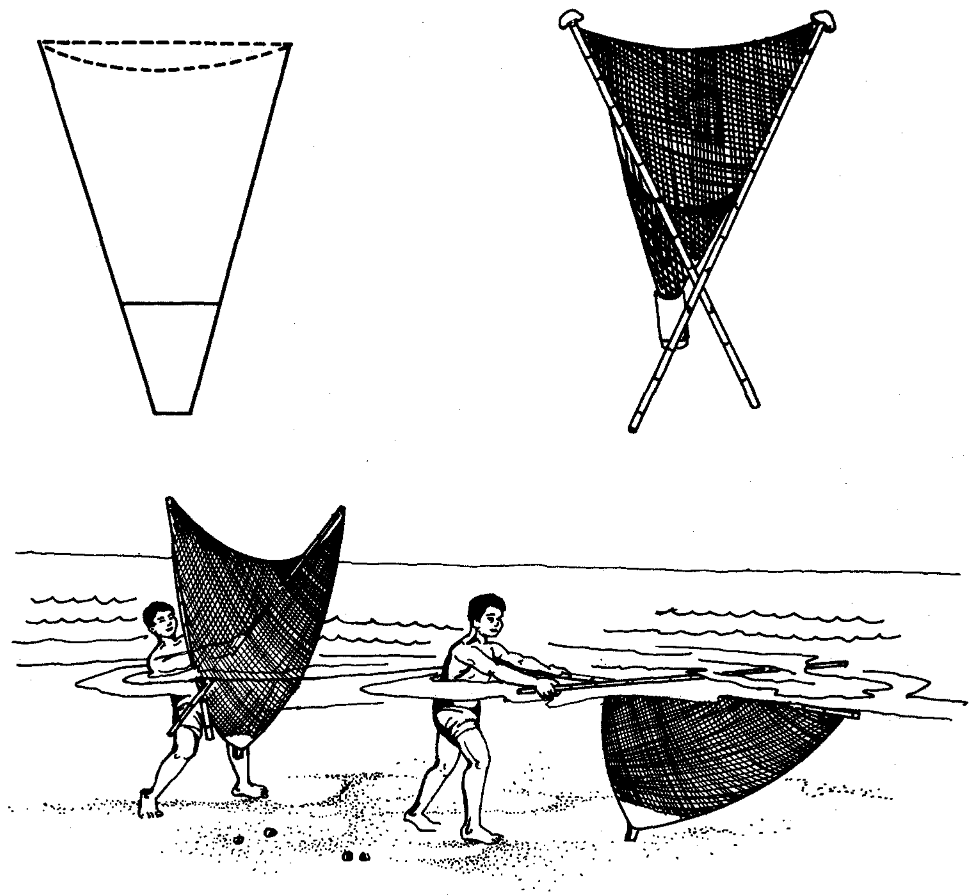

Fig. 3. Seine net (Fang Liao type) for milkfish fry capture, Taiwan, and its operation. Courtesy of the Tainan Fish Culture Station, Taiwan Fisheries Institute.

The fixed set net is placed in the river mouth or along the seashore. A bamboo fence surrounds the net and the fence is covered by a thin nylon net. At the bottom of the fixed set net, a net bag is placed for collecting the fry.

Motorized bamboo rafts began to operate in 1966. The bamboo raft is equipped with a 6-hp outboard engine suitable for shallow seas and a net for collection of fry. The net is hung on both sides of the raft for catching fry. Operating distance is one kilometer from the seashore, and the catching efficiency is greater than that of hand-held fork net (Table 3).

Small motorized boats (approximately 5 t with 22-hp diesel engine) are used for fry gathering along the east coast and south coast near Pingtung, due to the steep drop-off in those areas which are unsuitable for using the fork net and hand-pulled net. The efficiency of small boats in catching fry is very high (Table 3).

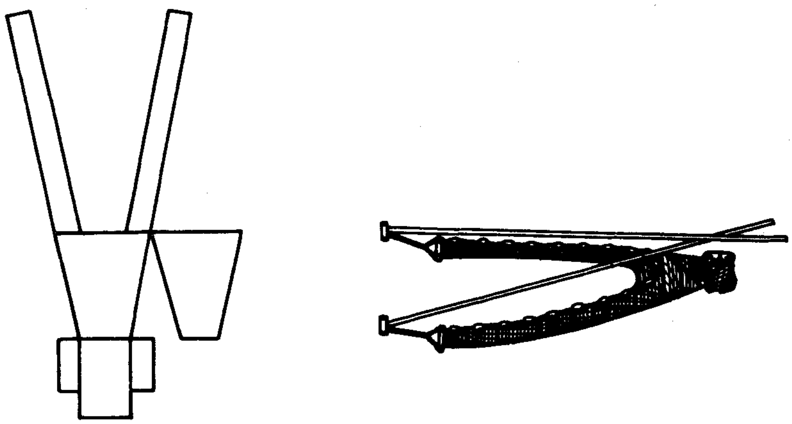

Fig. 4. Seine net (Taishi type) for milkfish fry capture, Taiwan. Courtesy of the Tainan Fish Culture Station, Taiwan Fisheries Institute.

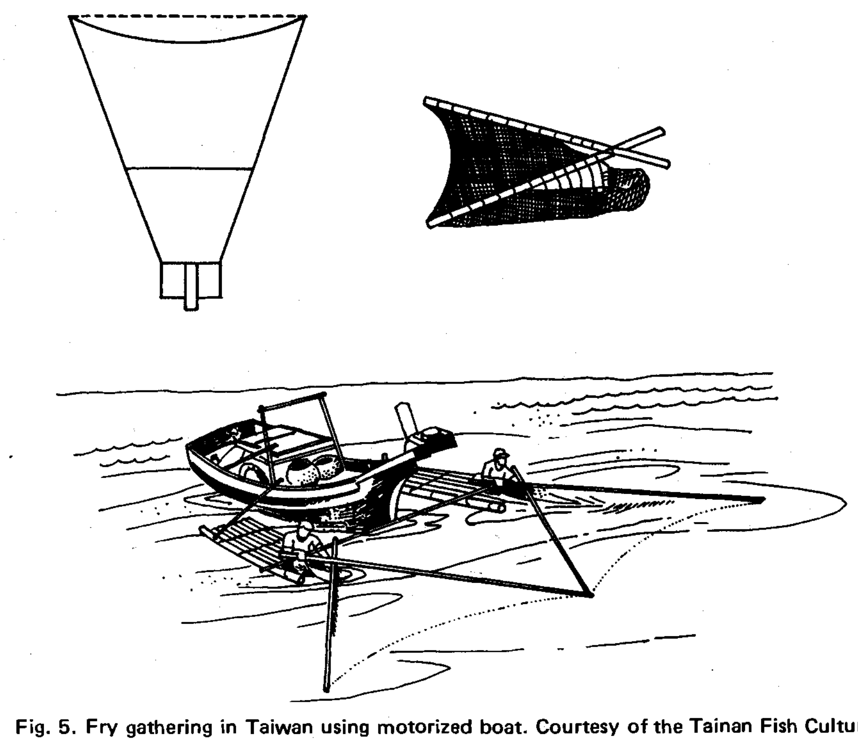

Fig. 5. Fry gathering in Taiwan using motorized boat. Courtesy of the Tainan Fish Culture Station, Taiwan Fisheries Institute.

Table 3. Fry gathering techniques and gear costs based on 1979 survey of milkfish industry, Taiwan.

Gathering unit	Regions used	Sample breakdown Households using	%	Average 1979 investment cost per unit NT$	Average annual depreciation per unit NT$	Possible fry caught per unit per day (pieces)
Hand-held fork net	Southwest South Northeast	14	32	1,500	500	150 – 200
Fixed set net	Southwest South	14	32	700	350	300 – 400
Motorized raft	Southwest East	6	14	45,000	6,428	1,500 – 2,000
Motorized boat	South East	10	23	200,000	20,000	3,000 – 4,000
Total	–	44	100	–	–	–

Note: The conversion rate for New Taiwan Dollars (NT$) to U.S. Dollars (US$) at the time of this study was US$1 = NT$36.

Rights to gather fry in particular locations can be obtained in three different ways depending upon which statutory body (if any) has control over the fry grounds. Fry grounds are either (1) controlled by the local fishermen's association, (2) controlled by a local non-profit association, or (3) open to anyone to gather. Most fry grounds are controlled by some form of association. Representatives (the local term for concessionaire) bid annually for fry gathering rights from the association. After selection of the representative, gatherers pay a cash equivalent of 1/3-1/2 of their catch to the representative. Funds earned by fishermen's associations through these concessions are used primarily for the salaries of association field workers and officials. The fishermen's associations also obtain funds from government subsidies, credit services and cooperative marketing fees. In most cases, fishing-rights income is but a small percentage of total association income. The risks of poor (or good) fry seasons thus fall upon the representative, while fry gatherers are free to sell their catch to fry middlemen as long as they return 1/3-1/2 of their sales income to the representative. The representative does not buy and sell fry; he is but an investor who expects to recover his investment through a share of the income of the fry gatherers. This is a direct contrast with Philippine milkfish fry concessionaires who buy and sell fry (Smith et al. 1978).

In the absence of a fishermen's association, the fry grounds may be controlled by a local non-profit association, which uses its fry-ground income for community development or construction projects. This is a very old system of fry control, especially in the Kaohsiung area. The oldest system, however, is apparently the 'open fry ground' which was most prevalent prior to the establishment of fishermen's associations approximately 50 years ago.

In some locations, income from fry-fishing rights is declining as the opportunity wage of fry gatherers has increased, resulting in a decline in the effective gathering effort.

Each local township has an agricultural office which is responsible for collecting and reporting fry catch and price data. The sources of these data are fry middlemen who, because rural taxes are very low in Taiwan, probably provide accurate information to the local data collector.

Fry supply fluctuates from year to year. During the years 1965-1979, fry caught varied from a low of 33.96 million (1967) to a high of 234.87 million (1970). After 1970, the fry catch decreased rapidly year by year, and reached 61.85 million in 1979. Over the 15 years 1965-1979, the overall coefficient of variation of domestic fry catch was 42.13%. If comparisons are made among the four areas (Table 4), the coefficient of variation in the central area was the highest at 81.94% and the eastern area was lowest at 38.10%.

The trend in fry catch was computed using regression techniques for the periods 1965-1979 and 1970-1979. As shown in Table 5 and Fig. 6, on the average, the trends of catch are negative. Though the fit of the equation is poor for the 1965-1979 period, it is quite good ($R^2 = 0.83$) for the 1970-1979 period.

Table 4. Domestic production of milkfish fry (1,000 pieces), Taiwan, 1965-1979.

Region[1]	Northern area		Central area		Southern area		Eastern area		
Year	Quantity	% of annual catch	Quantity	% of annual catch	Quantity	% of annual catch	Quantity	% of annual catch	Total quantity
1965	4,594	5.0	2,244	2.4	22,315	24.2	63,084	68.4	92,237
66	2,664	1.6	12,096	7.4	51,325	31.6	96,588	59.4	162,673
67	4,087	12.0	1,334	3.9	5,374	15.8	23,169	68.2	33,964
68	3,528	2.8	10,087	8.1	49,104	39.4	61,977	49.7	124,696
69	5,652	3.7	10,632	7.0	57,728	38.1	77,540	51.2	151,552
70	11,202	4.8	18,070	7.7	115,458	49.2	90,137	38.4	234,867
71	3,921	2.6	10,009	6.7	80,996	54.6	53,520	36.1	148,446
72	7,660	4.4	1,815	1.0	73,280	42.0	91,901	52.6	174,656
73	5,765	5.0	2,277	2.0	31,456	27.1	76,554	66.0	116,052
74	4,863	3.9	25,759	20.6	25,048	20.1	69,171	55.4	124,841
75	3,763	3.9	16,920	17.7	20,761	21.7	54,035	56.6	95,479
76	2,706	3.7	20,677	28.0	27,662	37.5	22,745	30.0	73,790
77	2,857	3.6	5,877	7.3	29,053	36.1	42,595	53.0	80,382
78	5,376	4.4	5,295	4.3	25,823	20.8	86,750	70.4	123,244
79	3,561	5.8	750	1.2	19,467	31.5	38,070	61.6	61,848
C.V.[2]	46.27		81.94		69.17		38.10		42.13

Notes: [1]Northern area consists of Taipei-Hsien, Ilan Hsien, Teoyuan Hsien and Hsinchu Hsien. Central area consists of Miaoli Hsien, Taichung Hsien, Changhwa Hsien and Yunlin Hsien. Southern area consists of Chiayi Hsien, Tainan Hsien, Kaohsiung Hsien, Penghu Hsien, and Pingtung Hsien. Eastern area consists of Taitung Hsien and Hwalien Hsien.

[2]C.V. stands for coefficient of (annual) variation.

Source: Taiwan Fisheries Yearbook.

Table 5. Trends in milkfish fry catch, by area, Taiwan, 1965-1979.

Area	1965 – 1979 Equations Catch = f (time)	Annual growth (%)	1970 – 1979 Equations Catch = f (time)	Annual growth (%)
Northern	Y = 5,296.07 – 60.35 t r^2 = 0.12	–13.51	Y = 8,263.27 – 562.88 t r^2 = 0.66	–0.08
Central	Y = 8,437.44 + 144.00 t r^2 = 0.08	–	Y = 14,818.47 – 740.65 t r^2 = 0.25	–93.34
Southern	Y = 56,082.82 – 1,719.94 t r^2 = 0.26	–60.03	Y = 94,464.87 – 9,011.721 t r^2 = 0.83	–14.60
Eastern	Y = 74,142.09 – 139.06 t r^2 = 0.25	–18.71	Y = 84,517.33 – 3,994.46 t r^2 = 0.50	–6.64
Total	Y = 143,957.88 – 3,005.34 t r^2 = 0.27	–18.71	Y = 202,063.9383 – 14,309.72 t r^2 = 0.83	–8.77

The annual fluctuations of fry catch are shown in Table 6. The changes from 1965 to 1979 also show extreme instability in the Michaely Index (F = 20.34%) but from 1970 to 1979 the index of F dropped to 18.71%, which still reflects substantial instability.

Table 6. The instability of milkfish fry catch, Taiwan, 1965-1979 as measured by the Michaely Index and the Von Neumann Ratio.

	1965 – 1979		1970 – 1979	
Region	F (%)	R	F (%)	R
Northern	11.10	1.92	3.83	1.53
Central	93.71	1.69	83.42	1.57
Southern	58.27	1.43	14.60	0.36
Eastern	17.55	2.30	6.64	1.93
Total	20.34	1.68	18.71	0.84

Notes:

1. F : Michaely Index

$$F = \frac{\sum_{t=2}^{n} \left| \frac{X_t - X_{t-1}}{X_{t-1}} \right|}{n-1} \times 100$$

2. R : Von Neumann Ratio

$$R = \frac{\dfrac{\sum_{t=2}^{n} (X_t - X_{t-1})^2}{n-1}}{\dfrac{\sum_{t=1}^{n} (X_t - \bar{X})^2}{n}}$$

where X : Milkfish fry procurement, t: year, n: period in years

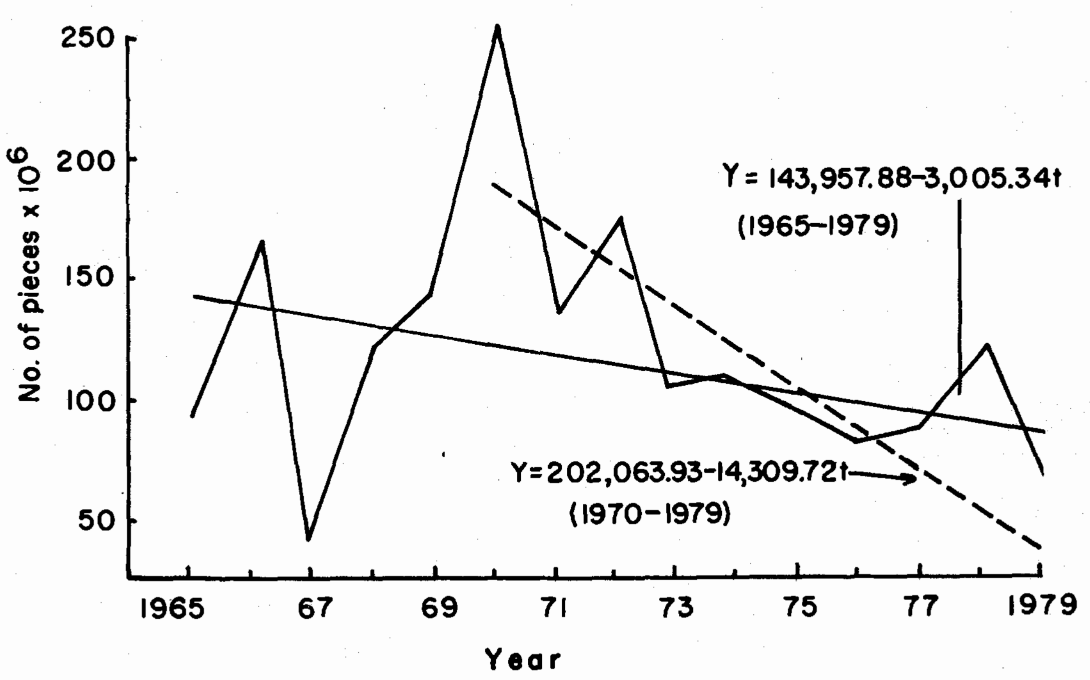

Fig. 6. Trends in milkfish fry catch in Taiwan, 1965-1979.

For 1965-1979, the value of the Von Neumann Ratio (R) is about 2, the changes are scattered and the catch variation is relatively irregular. But in the 10 years from 1970 to 1979, the changes are in the same direction (R = 0.84).

In addition to annual fluctuation, catch per effort varies from day to day and from month to month within the season. Best days occur during the high tides associated with full and new moons; the peak months are May and June. There is very little catch during January to March and October to December. Taiwanese fry procurement is thus characterized by extreme seasonality with marked peaks and slack periods. The total range of the index of seasonal variation was 0.02-578.05 and standard deviation of seasonal variation index was 120.90 (Table 7 and Fig. 7).

Although the annual supply of fry has varied greatly, the demand has been increasing, especially with the recent advent of rearing fingerlings for baitfish. Consequently, the market price of milkfish fry has also varied greatly, the annual price fluctuations being ameliorated somewhat by the import of fry from the Philippines and Indonesia.

MARKETING AND DISTRIBUTION OF MILKFISH FRY

Fry are stored temporarily by gatherers in a wooden or plastic pail. According to data provided by our respondents, approximately 94% of the fry caught survive during this storage period. The survival rate in the southwest is slightly lower than in other areas because the storage time is longer. In the east, very little mortality is experienced by fry gatherers because the larger quantities of fry caught there allow more frequent fry shipments to Taiwan. Middlemen purchase fry directly from gatherers and when they have collected 10-20,000 pieces, ship them to fry dealers in Tainan.

Table 7. Index of seasonal variation of milkfish fry procurement by month, Taiwan, 1965-1979.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total range	Standard deviation
Index	0.4	0.26	1.32	138.23	578.05	317.42	129.54	26.29	5.37	0.56	2.32	0.02	578.03	120.90

Source: Computed based on Taiwan Fisheries Yearbook.

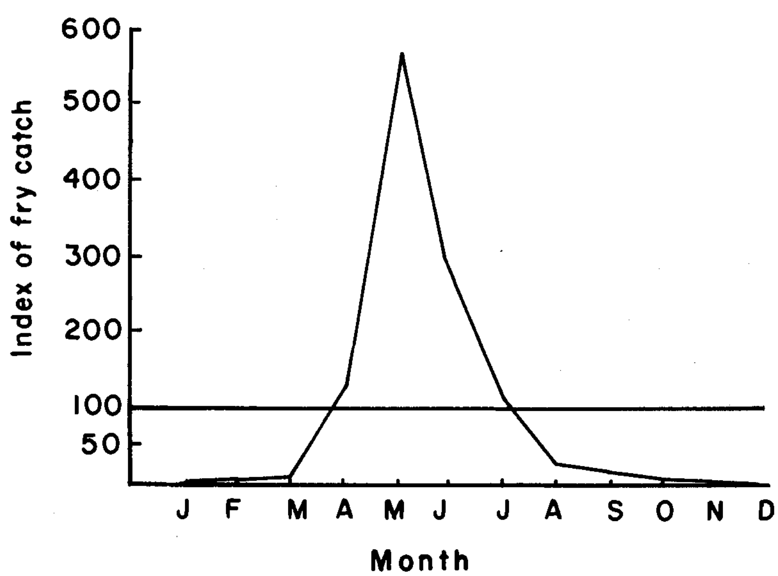

Fig. 7. Seasonal variation of milkfish fry procurement in Taiwan, 1965-1979.

The Taiwanese fry distribution system is dominated by those Tainan dealers who are located near the country's concentration of fishponds. Prior to the 1970s there were seven fry dealers in Tainan, the business having been handed down through the families for generations. Two of these seven dealers have since gone out of business, however, as domestic supply has declined and capital requirements have increased to import fry. Several of the remaining dealers also own fishponds, with holdings as large as 50 ha, which is very large by Taiwanese standards. Ninety-two percent of the domestic fry supply and all of the imported fry are handled by these five dealers. The concentration of fry dealers in a single location in Taiwan is in sharp contrast to the Philippine system where dealers are widespread, while much of the nationwide procurement is controlled by a relatively small number of nursery-pond operators (Chong et al. 1982).

There are two major factors that influence regional trade of milkfish fry. The first factor is that the supply of fry is mostly from the eastern part of Taiwan where the fry resources are plentiful and potential locations for milkfish rearing are very limited. The second factor is that the milkfish rearing areas are centered in the southwest part of Taiwan. The general direction of trade is south and west to Tainan and then to nearby milkfish pond areas (Fig. 8). Tainan City is considered the fry trading center. The major supply of fry in 1979 came from the eastern part (66.6%), followed by the southern part (30.7%). The primary demand for the dealers' fry came from Tainan Hsien, Tainan City and Kaohsiung Hsien. Some 44.1% of the domestic fry were delivered to Tainan Hsien, 24.0% to Tainan City, 14.2% to Chiayi Hsien and 11.3% to Kaohsiung Hsien.

In Taiwan, marketing and distribution are the core of the procurement subsystem, though actual number of middlemen is declining as they find alternative employment more attractive.

Transportation

As a general rule, the transport route of fry is short, consisting of only three transactions: from gatherers to middlemen, middlemen to dealers and dealers to market-size and baitfish-rearing pond operators. Table 8 presents survey data on transportation methods and transaction types used in the phase from fry gatherers to middlemen. The main methods of transport are bicycle (75%), walking (16%) and motorcycle (9%). The distances involved are short. With regard to transactions for fry, three types are used. The most common method is when middlemen go to the seashore where fry are stored temporarily by fry gatherers (75%), followed by middlemen who go to fry gatherers' houses (14%) and fry gatherers delivering their fry to middlemen (11%). All fry are sold by gatherers to middlemen, most of whom are purchasing for a particular dealer in Tainan. No fry are sold directly by gatherers to dealers or to pond operators.

Table 9 shows the transportation methods and costs of fry from middlemen to Tainan dealers. Due to longer distances involved, fry are transported by taxi (55%), motorcycle (27%), truck (9%) and train (9%). Transportation costs of this phase were found to depend on the distances and transportation facilities used; on the average, transportation costs per 10,000 pieces are NT$188* with 98% survival rate.

The last phase involves the sale of fry by dealers to baitfish growers and market-size milkfish growers. Fishpond operators all travel to Tainan to dealers to buy fry and transport them to their ponds themselves. The most common method of transport is motorcycle and truck depending on the distances involved and quantity purchased.

Marketing channels and marketing margins

Accurate data on imported milkfish fry are very difficult to assemble. Therefore, this marketing study is focused only on domestic fry. The marketing channels and distribution were found to

*US$1 = NT$36.00 at time of this study.

Table 8. Transportation methods used and transaction types for exchange of fry by fry gatherers and middlemen in the milkfish industry survey, Taiwan, 1979.

Region	Transportation methods	Households interviewed Numbers	Households interviewed Regional %	Transaction types	Households interviewed Numbers	Households interviewed Regional %	Average distance of middlemen from seashore km
Southwest	Motorcyle	4	33.3	Fry gatherers-middlemen	4	33.3	6.9
	Bicycle	6	50.0	Middlemen-seashore	6	50.0	
	Walking	2	16.7	Middlemen-gatherer's house	2	16.7	
South	Bicycle	8	80.0	Fry gatherers-middlemen	2	20.0	2.5
	Walking	2	20.0	Middlemen-seashore	6	60.0	
				Middlemen-gatherer's house	2	20.0	
East	Bicycle	12	100.0	Middlemen-seashore	12	100.0	2.4
Northeast	Bicycle	10	100.0	Middlemen-seashore	10	100.0	3.3
Total all areas	Motorcycle	4	9.1	Fry gatherers-middlemen	5	11.4	4.8
	Bicycle	36	81.8	Middlemen-seashore	33	75.0	
	Walking	4	9.1	Middlemen-gatherer's house	6	13.6	
	Total	44	100.00	Total	44	100.00	–

exhibit two phases (Fig. 9). First, there is a single fry marketing channel: all fry sold by gatherers pass to middlemen. After the middlemen phase, fry distribution is more diversified. Fry are transported from middlemen to rearing ponds for market-size fish (3.1%), to fry dealers (91.8%) or direct to baitfish-rearing ponds (5.1%). Finally, dealers distributed 57.7% of their fry to market-size milkfish-rearing ponds, 23.1% to over-wintering fry nursery ponds and 19.2% to baitfish-rearing ponds.

Because the marketing channels of fry are short, the marketing margins of fry are also small. Fry gatherers received an average of NT$2.03 per fry, middlemen received an average of NT$2.34 and dealers received an average of NT$2.55 in 1979 (Fig. 10). Total marketing margin was thus NT$0.52 and the share of fry gatherers was 79.6% of the price paid by baitfish-pond operators.

Fry price analysis

Price of fry is determined by the demand for and supply of fry. In recent years, production area and stocking rates have changed little, hence, the fluctuations in the price of fry have been primarily brought about by variable supply. As the quantity of fry caught increased, the price of fry decreased. The relationship between price of fry and supply of fry from 1965 to 1979 was calculated by regression equation as follows:

$$P_f = 5.0849 - \underset{(5.2161)}{1.1008}\, Q_f \qquad R^2 = 0.63$$

where P_f stands for the price of fry (in real terms based on 1970 as reference year), Q_f shows the quantity of fry caught and t-value is given in brackets. This equation indicates that the supply of fry was the main factor affecting the price of fry. The unexplained variation in fry prices (37%) was most likely due to such unknown factors as the quantity of fry imported annually to Taiwan. Fry prices in Taiwan were approximately eight times those in Manila in 1979.

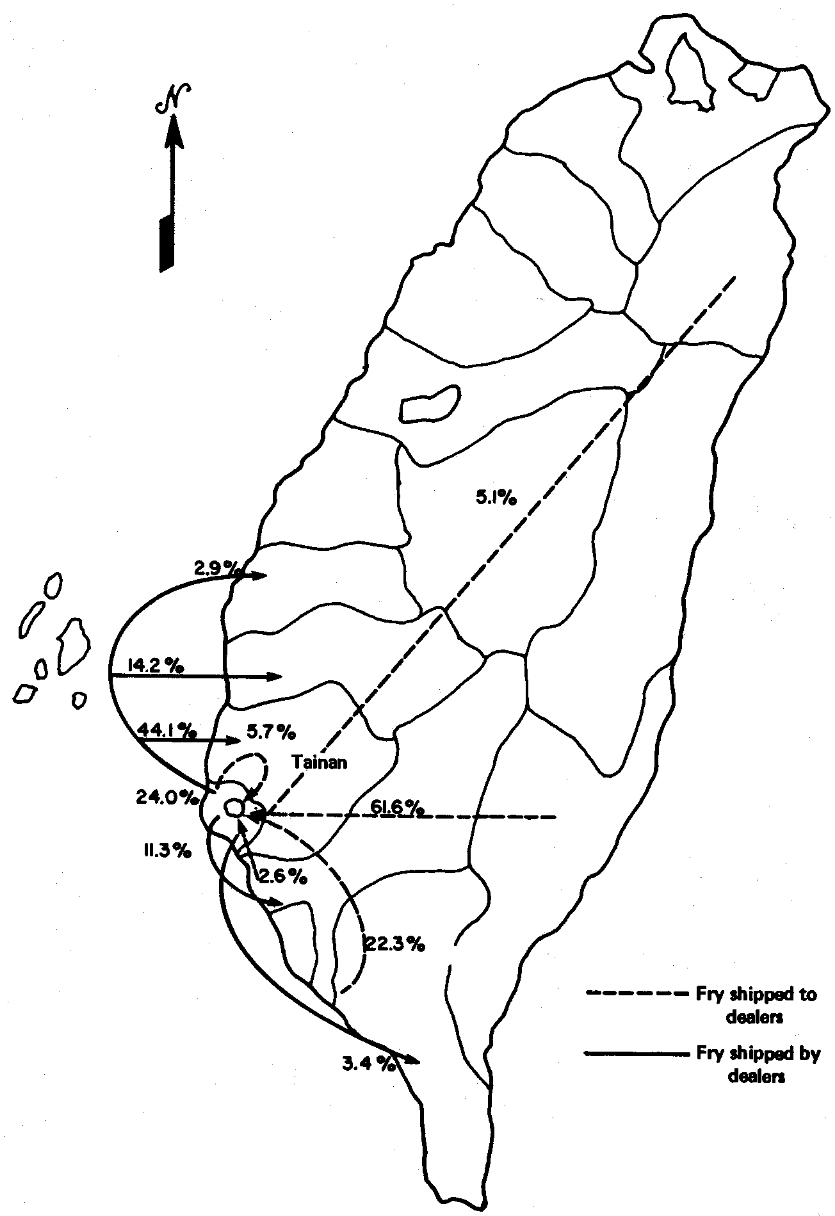

Fig. 8. Regional distribution of milkfish fry, Taiwan, 1979. Percentages are of total distributed.

Table 9. Transportation methods used and costs of fry sold by fry middlemen to dealers in the milkfish industry survey, Taiwan, 1979.

Region	Transportation methods	Households interviewed Numbers	Households interviewed Regional %	Rate of survival %	Transportation cost to dealers NT$/10,000 pieces
South-east	1. Taxi	5	62.5	95.37	114
	2. Motorcycle	3	37.5		
South	1. Taxi	3	37.5	96.71	103
	2. Motorcycle	3	37.5		
	3. Truck	2	25.0		
East	Taxi	4	100.0	99.00	273
North-east	Train	2	100.0	99.25	650
Total all areas	1. Taxi	12	54.6	97.58	188
	2. Motorcycle	6	27.3		
	3. Truck	2	9.1		
	4. Train	2	9.1		
	Total	22	100.0	–	–

NT$36 = US$1.00

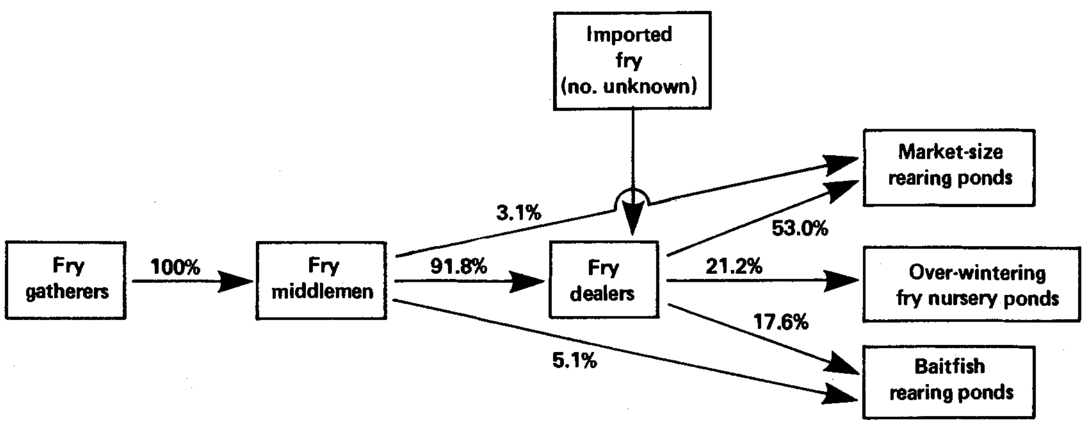

Fig. 9. Marketing channels of milkfish fry (without adjustments for mortality) in Taiwan, 1979.

Using regression techniques, the long-run trend of fry prices was calculated (Table 10 and Figs. 11 and 12). Based on the time-series data of fry prices, the average annual rate of increase at current prices was 6.2% during the years 1965-1979, but at constant prices the price of fry declined at an annual decreasing rate of 9.4%. However, during the last decade (1970-1979), fry price increased annually at both current and constant prices.

The field survey indicated that milkfish producers in Taiwan complained more of seasonal price fluctuations than they did of the recent upward trend in prices over time. Seasonal variation

Table 10. Trends in price of milkfish fry, Taiwan, 1965-1979.

Region	1965-1979 Equations	r^2	Annual growth rate	1970-1979 Equations	r^2	Annual growth rate
			(%)			
Northern						
current price	$P_1 = 0.2985 + 0.0821\ t$	0.79	21.96	$P_1 = 0.1947 + 0.1592\ t$	0.97	23.86
constant price	$P_2 = 1.4735 - 0.0124\ t$	0.11	−37.79	$P_2 = 0.8833 + 0.0623\ t$	0.57	13.91
Central						
current price	$P_1 = 0.3129 + 0.0933\ t$	0.79	44.08	$P_1 = 0.2180 + 0.1767\ t$	0.95	41.09
constant price	$P_2 = 1.5969 - 0.0086\ t$	0.59	−51.24	$P_2 = 1.0147 + 0.0652\ t$	0.40	30.89
Southern						
current price	$P_1 = 0.3439 + 0.0924\ t$	0.80	51.16	$P_1 = 0.2560 + 0.1740\ t$	0.98	23.78
constant price	$P_2 = 1.6723 - 0.0137\ t$	0.10	−74.95	$P_2 = 1.0693 + 0.0594\ t$	0.49	13.79
Eastern						
current price	$P_1 = 0.5545 + 0.0744\ t$	0.61	86.81	$P_1 = 0.2133 + 0.1818\ t$	0.97	26.30
constant price	$P_2 = 2.1923 - 0.0600\ t$	0.32	−38.17	$P_2 = 1.0007 + 0.0701\ t$	0.59	16.27
Average						
current price	$P_1 = 0.6987 + 0.0618\ t$	0.50	47.70	$P_1 = 0.1940 + 0.1862\ t$	0.99	38.63
constant price	$P_2 = 2.5631 - 0.0941\ t$	0.43	−28.11	$P_2 = 0.9720 + 0.0751\ t$	0.67	17.59

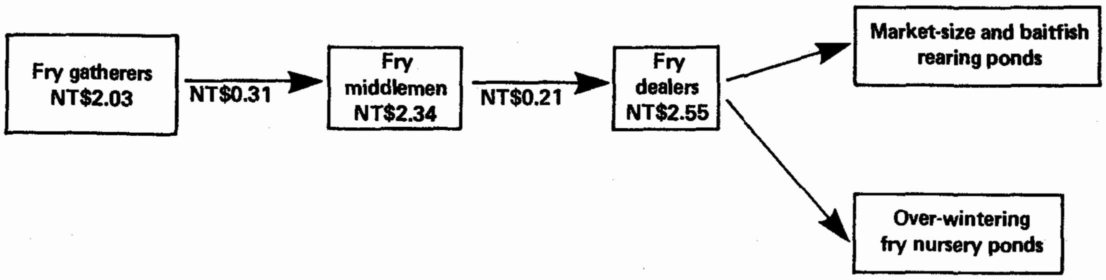

Fig. 10. Prices received and marketing margins (NT$ per piece) of milkfish fry, Taiwan, 1979.

of fry price was high due to the extreme seasonality of catch (Fig. 13). The total range of seasonal variation of fry price reached approximately 200% (April), and the standard deviation of seasonal index was 52.0.

The price stability of fry was computed using the Michaely Index and Von Neumann Ratio as was done earlier for fry supply. On average, the indices of instability of fry price at current price measured by the Michaely Index during the periods 1965-1979 and 1970-1979 were 47.7% and 38.6%, respectively, which indicate extreme instability (Table 11). In terms of constant fry price, the indices of instability were 28.1% and 17.6%, respectively, in the same period, implying extreme and substantial instability, respectively.

In comparative terms, the regularity of fluctuation in the fry price measured by the Von Neumann Ratio is modest and uni-directional (Table 11). During the periods 1965-1979 and 1970-1979, at current fry prices, the Von Neumann Ratios were 1.25 and 2.01, respectively, while at constant fry prices, the ratios decreased sharply in the same periods. For the 1970-1979 period there was no significant difference between the degree of instability of supply and prices in constant terms.

This evaluation of the procurement subsystem illustrates two major points. The first is that both fry supply and prices have fluctuated widely. The second is that fry supply fluctuations explain most of the variation in fry prices.

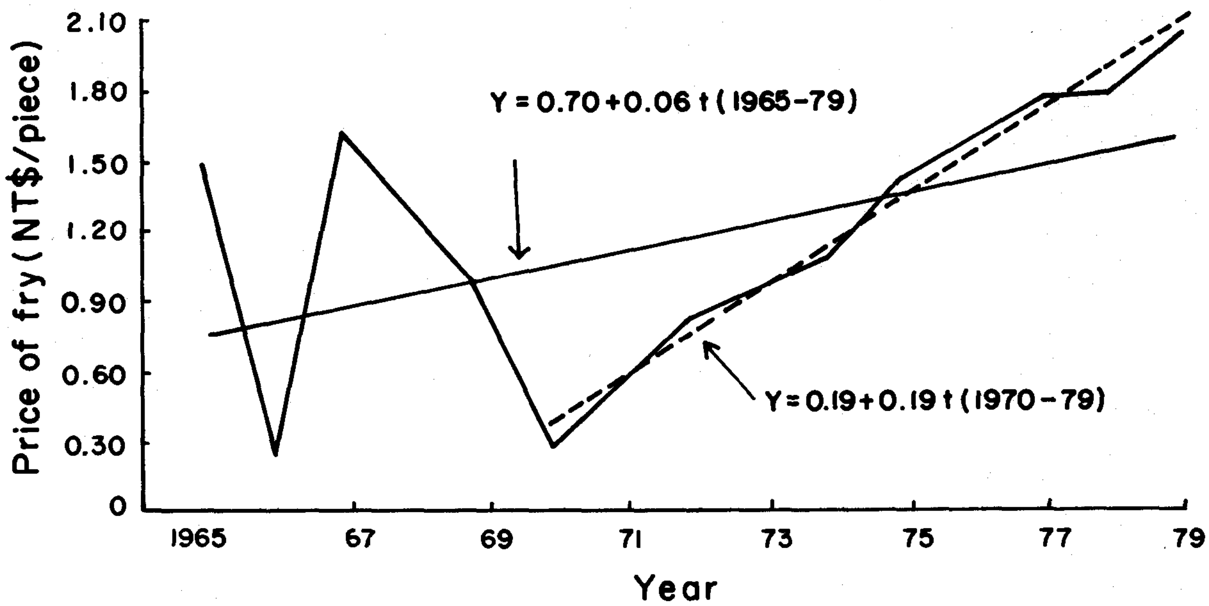

Fig. 11. Trends in price of milkfish fry (current prices), Taiwan.

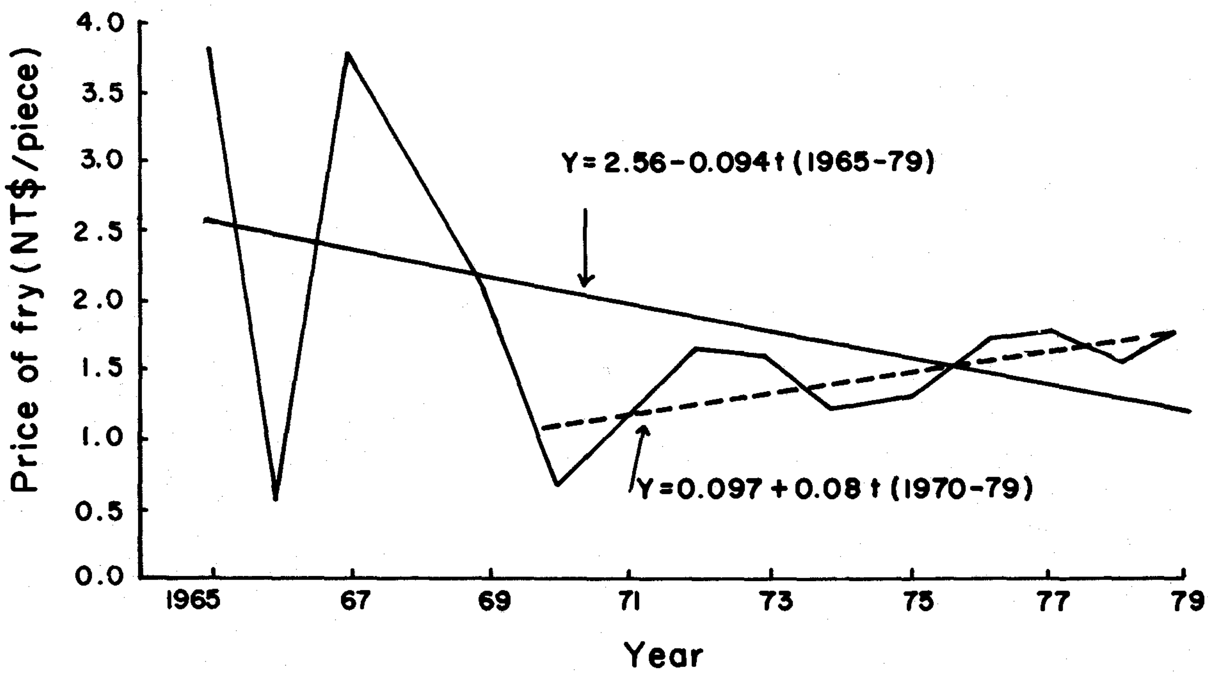

Fig. 12. Trends in price of milkfish fry (constant prices, 1970 base year), Taiwan.

Table 11. Indices of price instability of milkfish fry, Taiwan.

Region	1965-1979 F (%)	1965-1979 R	1970-1979 F (%)	1970-1979 R
Northern				
current price	21.96	0.42	23.86	0.25
constant price	37.79	1.59	13.91	1.18
Central				
current price	44.08	0.62	41.09	0.37
constant price	51.24	1.93	30.89	1.53
Southern				
current price	51.16	0.48	23.78	0.20
constant price	74.95	1.70	13.79	1.19
Eastern				
current price	86.61	1.06	26.30	0.27
constant price	38.17	2.08	16.27	1.17
Average				
current price	47.70	1.25	38.63	2.00
constant price	28.11	0.21	17.59	1.00

Notes: F stands for Michaely Index and R stands for Von Neumann Ratio.
See note to Table 6 for explanation.

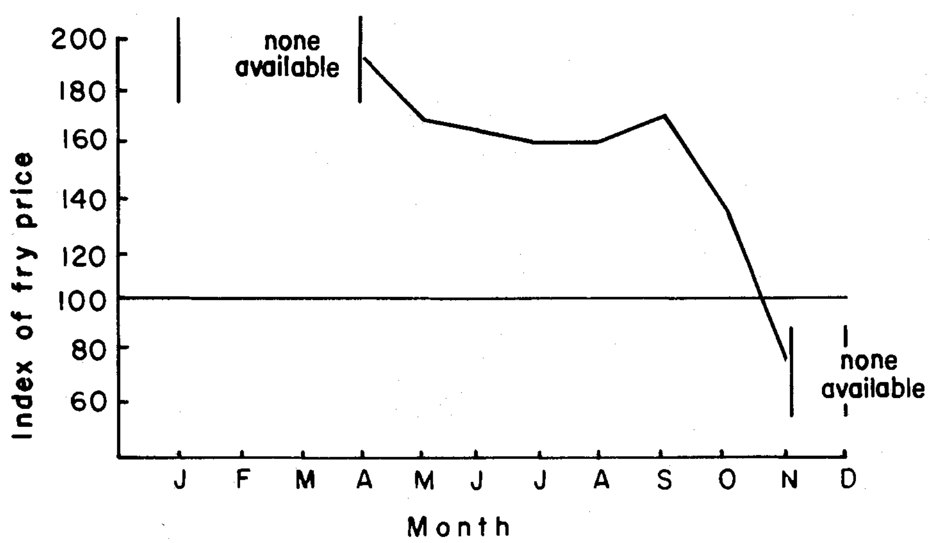

Fig. 13. Seasonal variation of price of milkfish fry (1965-1979) in Taiwan with 1970 as base year.

Production of Milkfish Fingerlings for the Baitfish Industry

Due to the expansion of the deep-sea tuna longline fishing fleet during the 1970s, large quantities of baitfish are needed each year. Among those used are saury, milkfish, sardines, flying fish, mackerel, squid, mullets, bait slices, false baits and lures. The most common baitfish are saury and milkfish fingerlings. Hence, the provision of milkfish fingerlings for baitfish has become an important aspect of the milkfish industry.

BAITFISH FARM CHARACTERISTICS

Baitfish-rearing farms are concentrated near Kaohsiung and Pingtung. Holding ponds are located near the harbors; the pond owners, most of whom are local businessmen, buy fingerlings from producers. In recent years, the demand for milkfish fingerlings to use as baitfish has levelled off. Unfortunately, the number of longliners cannot be identified from national vessel statistics which are aggregated, so it is not possible to compare this levelling off of demand with fleet size. Fuel price increases, however, have undoubtedly affected vessel profitability.

Three crops of baitfish-size milkfish fingerlings can be produced each season. The first are grown from early April and harvested before the end of May; the second crop is grown from early June and harvested within 60 days; the third batch, stocked in early August can be harvested after about 90 days. The longer growth period of the third crop is a consequence of falling water temperatures as the season progresses.

Operator characteristics

As is traditional in Taiwanese family farms, the farm operator is almost always a male. This was also true for our respondent baitfish farmers. Of the 40 respondents, most were 40-60 years old. However, the majority of farms smaller than 1 ha were operated by younger men (Table 12). Many younger men have entered the baitfish business in recent years. The majority of farmers interviewed had only a primary level of education.

Stocking rates

Quantity of fingerlings reared was found to be a function of farm size. Smaller farms tend to stock proportionately fewer fry per ha but the difference was not great (Table 13). Despite these data, it was a commonly held opinion of Taiwanese fingerling growers that larger ponds can absorb higher stocking rates per unit area. Fingerlings are sold by the piece, and if survival rates during rearing were approximately the same, those farmers with higher stocking rates would have higher yields. This is in contrast with market-size milkfish ponds in which an inverse relationship between stocking and survival rates is thought by farmers to be more likely. No data on survival rates of fingerlings stocked at different densities were available.

ECONOMIC ANALYSIS OF MILKFISH BAITFISH REARING

Baitfish rearing is more capital intensive and labor saving than rearing market-size milkfish. The average baitfish farm size was 1.81 ha; capital inputs per hectare averaged NT$114,703 and labor

Table 12. Age and educational levels of farm operators in milkfish fingerling rearing farms in field survey of the Taiwanese milkfish industry, 1979.

Characteristic	Under 1 ha % (n = 12)	Over 1 ha % (n = 28)	Average % (n = 40)
Age			
20 – 40	54.6	26.3	36.7
41 – 60	27.3	57.9	46.7
Over 60	18.2	15.8	16.7
Total	100.0	100.0	100.0
Level of education			
Primary school grades (1–6)	81.8	73.7	78.31
Middle school (7–12)	18.2	21.1	18.31
College and university	–	5.3	3.34
Total	100.0	100.0	100.00

inputs per hectare were 86 man-days (Table 14). It was significant that farm capital inputs per hectare increased and labor inputs per hectare decreased with increasing farm size.

Regarding the distribution of family and hired farm labor, the family still played a significant role in providing a large part of labor supplied in milkfish-fingerling rearing farms. On a per hectare basis, the amount of family labor input was higher on farms smaller than 1 ha than on larger farms (Table 14).

Milkfish fingerling rearing in Taiwan can be described by (1) production costs and returns, (2) benefit-cost ratio and rate of farm income and (3) factor productivity and elasticity of substitution.

According to the survey of milkfish-fingerling rearing farms, the total production costs of fingerling rearing per hectare were NT$120,644 in 1979. The main production costs were for fry (75.2%) and labor (14.8%). The balance were the costs of feed and indirect costs. Direct costs are those used directly in production; indirect costs are all others. This distinction is based upon the record-keeping format used by the provincial government for agricultural data collection. Classified by scale of operation, the total production costs per hectare for farms smaller than 1 ha were NT$118,341 and for larger farms, NT$122,143 (Table 15). The production costs per hectare in small farms were thus less than those of the larger farms.

The gross receipts per hectare for farms smaller than 1 ha averaged NT$162,770 and for larger farms, NT$174,097. The net revenue per hectare for small farms was NT$44,429 and for larger farms, NT$51,954. The larger farms earn more income per hectare than the smaller ones. Hence the output-input (in value terms) in larger farms (1.43) is better than in smaller farms (1.38). The net

Table 13. Stocking rate and survival rate per hectare of milkfish fingerling rearing farms in field survey of the Taiwanese milkfish industry, 1979.

Scale	Stocking rate per ha (pieces)	Survival rate (%)	No. pieces harvested per ha
Under 1 ha (n = 12)	37,091	95.77	35,522
Over 1 ha (n = 28)	41,621	92.27	38,404
Average (n = 40)	40,083	93.55	37,498

Table 14. Resource use (per ha) on milkfish fingerling rearing farms in field survey of the Taiwanese milkfish industry, 1979.

	Scale	Under 1 ha (n = 12)	Over 1 ha (n = 28)	Average (n = 40)
	Land (ha)	0.75	2.42	1.81
Capital, NT$	Direct	111,951	116,516	114,907
	%	94.6	95.4	95.24
	Indirect	6,390	5,627	5,737
	%	5.4	4.6	4.76
	Total	118,341	122,143	120,644
	%	100.00	100.00	100.00
Labor	Family man-days	55	44	48
	%	57	55	56
	Hired man-days	41	36	38
	%	43	45	44
	Total man-days	96	80	86
	%	100	100	100

Notes: For listing of item under direct and indirect capital inputs, see Table 15.

revenue is a residual to operator's management, own labor (not included in family labor), own capital and risk. This difference was entirely due to the difference in numbers of fingerlings produced per hectare because prices received by larger and smaller farms were the same.

Milkfish-fingerling rearing contributed not only to the overall agricultural output but also to family farm income. The benefit-cost ratio and the rate of farm income of different sized baitfish farms in Taiwan are shown in Table 15. It is very difficult, however, to give a general estimation of the total family farm income including the off-farm income, since the extent of off-farm income depends on how many members of the farm family work outside the farm.

Factor productivities are viewed as important indicators of the level of economic efficiency of production in small farming in Taiwan. Average data from this survey indicated that in 1979 land productivity, capital productivity and labor productivity were closely related to the different sizes of baitfish farm (Table 16). Factor productivity per hectare increased considerably with the adoption of intensive agricultural operations such as capital-intensive and new rearing technologies. The factor productivity of baitfish farms has advanced due to two major factors: (1) the increase of production per hectare, and (2) the profitability of rearing baitfish compared with that of market-size milkfish. It appears that baitfish farms have made significant contributions to factor productivity in Taiwan, though the levelling off of demand for baitfish constrains the ability of the industry to expand further. Another factor that limits entry of newcomers is the limited supply of suitable areas supplied by high quality water.

Table 15. Production costs and returns per ha of milkfish fingerling rearing farms in field survey of the Taiwanese milkfish industry, 1979.

	Farm size					
	Under 1 ha (n = 12)		Over 1 ha (n = 28)		Average (n = 40)	
Item	NT$	% of total costs	NT$	% of total costs	NT$	% of total costs
Direct costs						
Fry	82,570	69.8	93,362	76.4	90,755	75.2
Feeds	2,244	1.9	2,864	2.3	2,766	2.3
Labor cost (hired and family)[1]	23,200	19.6	16,967	13.9	17,892	14.8
Fuel	1,030	0.9	946	0.8	958	0.8
Materials	2,907	2.5	2,377	2.0	2,536	2.1
Subtotal	111,951	94.6	116,516	95.4	114,907	95.2
Indirect costs						
Land rent	1,384	1.2	1,165	1.0	1,197	1.0
Water and electricity	1,303	1.1	1,042	0.9	1,080	0.9
Interest on borrowed capital	485	0.4	1,000	0.8	921	0.8
Maintaining costs	1,715	1.5	1,261	1.0	1,329	1.1
Taxes	812	0.7	709	0.6	724	0.6
Depreciation in gear	691	0.6	450	0.4	486	0.4
Subtotal	6,390	5.4	5,667	4.6	5,737	4.8
Total	118,341	100.0	122,143	100.0	120,144	100.0
Gross receipts (NT$)	162,770		174,097		172,152	
Farm income (NT$)	44,429		51,954		51,308	
Output-input ratio	1.38		1.43		1.42	
Rate of farm income	27.3%		29.8%		29.8%	
Average size (ha)	0.75		2.42		1.81	

[1] Family labor cost imputed at hired labor rate.

Table 16. Factor-factor ratios and input productivity of milkfish fingerling rearing farms in field survey of the Taiwanese milkfish industry, 1979.

Items	Under 1 ha	Over 1 ha	Average
Central input per unit of labor C&N (NT$/man-day)	1,228	1,522	1,400
Labor input per unit of capital N/C (man-day/NT$)	0.000814	0.000657	0.000714
Land input per unit of capital D/C (ha/NT$)	0.000009	0.000008	0.000008
Capital input per unit of land C/D (NT$/ha)	118,341	122,143	120,644
Land input per unit of labor D/N (ha/man-day)	0.010378	0.012460	0.011605
Labor input per unit of land N/D (man-day/ha)	96.36	80.26	86.17
Land productivity Q/D (NT$/ha)	162,770	174,097	172,152
Labor productivity Q/N (NT$/man-day)	1,689	2,169	1,998
Capital productivity Q/C (NT$/NT$)	1.38	1.43	1.42

The static constant-elasticity-of-substitution (CES) production function (see Appendix) and cross-sectional data were used for examining the elasticity of substitution of production on baitfish farms. The equation was estimated by ordinary least-squares methods and the results are shown in Tables 17 and 18.

Based on the estimated parameters of the CES production function for baitfish farms, it is very clear that the effect of technology on the production of baitfish farms was significant. As demonstrated by the relative increase in capital inputs and relative decrease in labor inputs, capital inputs were significant substitutes for labor inputs; labor-saving technology has been considerably utilized in the baitfish farms.

As indicated in Table 18, the elasticity of substitution between capital and labor in baitfish farms was high, on the average being greater than unity. This is because the amount of capital input

Table 17. Coefficients of the CES production function for Taiwanese milkfish fingerling rearing farms.

	Under 1 ha	Over 1 ha	All farms
β_1	2.8358	3.5711	2.7845
β_2	0.1095	0.6961	0.2635
	(6.0180)*	(0.1358)	(0.3044)
β_3	0.6998	0.2912	0.6223
	(0.3710)	(5.7405)*	(0.6932)
β_4	9.2204	3.6017	1.4067
	(7.5015)*	(0.1172)	(0.2431)
F	54.2665	396.5886	295.7764
R^2	0.9588	0.9876	0.9715
n	11	25	36

Notes: (1) *Significant at the 95% confidence level.
(2) t-value in brackets.
(3) n is the number of farm households.

See Appendix for details of derivation of CES production function.

Table 18. Estimated parameters of the CES production function for Taiwanese milkfish fingerling rearing farms.

	Under 1 ha	Over 1 ha	All farms
γ	17.0442	35.5555	16.1914
k	0.1353	0.7051	0.2975
v	0.8092	0.9873	0.8858
ρ	−0.1948	−0.3509	−0.1520
σ	1.2419	1.5405	1.1793
R^2	0.9588	0.9876	0.9715
S	0.1293	3.5863	7.6406

Notes: Computed based on Table 17.

γ = scale parameter denoting the efficiency of a production technology.
k = distribution parameter indicating the degree to which technology is capital intensive.
v = degree of homogeneity of the function or the degree of returns to scale.
ρ = substitution parameter.
σ = elasticity of substitution.
S = standard error of the equation.

is growing more rapidly than that of labor input in this type of farming. It implies that as the relative scarcities of the factors of production (capital and labor) change (and their prices therefore change) operators of baitfish farms will be able to substitute one input for the other more easily than those in sectors where the elasticity of substitution is lower.

MARKETING CHANNELS AND MARKETING COSTS FOR MILKFISH FINGERLINGS

Marketing channels are very short for milkfish used for bait (Fig. 14). Milkfish fingerling producers bought fry from fry dealers and after rearing them for 60 to 90 days, sold them as fingerlings to operators of tuna longliners. About 35% of total fingerlings produced on baitfish farms were delivered to market-size milkfish producers due to the decline of demand for milkfish fingerlings from tuna longliners during recent years.

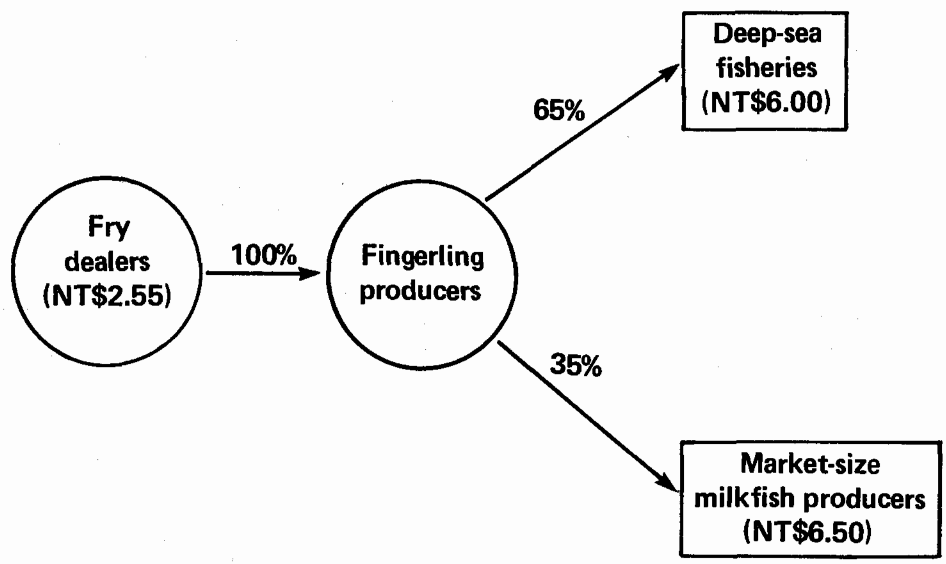

Fig. 14. Marketing channels and prices (NT$ per piece) of milkfish fingerlings, 1979.

Table 19. Marketing costs of milkfish fingerlings per 100 pieces in Taiwan, 1979.

Item	NT$	%
Labor	24	12.1
Transportation	30	15.2
Oxygen	10	5.12
Bad debts	10	8.1
Other expenses	18	9.1
Interest	11	5.6
Equipment depreciation	6	3.0
Communications	1	0.5
Returns to middlemen	100	50.5
Total	NT$198	100.00

Table 20. Types of milkfish culture by region, Taiwan, 1979.

Region	Monoculture ha	Monoculture % of Hsien total	Polyculture ha	Polyculture % of Hsien total	Total ha	Total % of Hsien total
Total	11,495	74.9	3,851	25.1	15,346	100.0
Miaoli Hsien	–	–	3	100.0	3	
Yunlin Hsien	183	40.7	267	59.3	450	2.9
Chiayi Hsien	–	–	2,174	100.0	2,174	14.2
Tainan Hsien	6,769	100.0	–	–	6,769	44.1
Kaohsiung Hsien	1,620	93.6	110	6.4	1,730	11.3
Pingtung Hsien	–	–	520	100.0	520	3.4
Taitung Hsien	1	–	–	–	1	
Hwalien Hsien	3	–	–	–	3	
Tainan City	2,919	79.4	757	20.6	3,676	24.0
Kaohsiung City	–	–	20	100.0	20	0.1

Source: Taiwan Fisheries Bureau, PDAF, Taiwan Fisheries Yearbook.

Table 21. Fry catch, production area and production of milkfish in Taiwan, 1965-1979.

Year	Fry catch 1,000 pieces	Cultivated areas (ha)	Market-size milkfish Production (mt)	Yield per ha (kg)
1965	92,237	15,616	27,562	1,765
1966	162,673	15,616	29,094	1,863
1967	33,964	16,501	23,558	1,468
1968	124,696	16,211	19,709	1,216
1969	151,552	16,298	18,996	1,166
1970	234,867	16,360	27,857	1,703
1971	148,446	15,980	30,650	1,918
1972	174,656	15,692	24,950	1,590
1973	116,052	15,634	31,576	2,020
1974	124,841	15,652	28,906	1,847
1975	95,479	16,802	33,309	1,983
1976	73,790	16,560	26,852	1,621
1977	80,382	16,148	26,361	1,632
1978	123,244	15,586	30,151	1,934
1979	61,848	15,346	32,033	2,087

Source: Taiwan Fisheries Bureau, PDAF, Taiwan Fisheries Yearbook.

Table 22. Trends in total production and yield per hectare of milkfish in Taiwan, 1965-1979.

	1965-1979		1970-1979	
	Equations	Average annual growth rate	Equations	Average annual growth rate
Total production	$Y = 23{,}832.2 + 450.7\,t$ $r^2 = 0.22$	2.67	$Y = 28{,}216.6 + 190.2\,t$ $r^2 = 0.04$	2.68
Yield per ha	$Y = 1{,}493.4 + 28.4\,t$ $r^2 = 0.21$	2.81	$Y = 1{,}742.9 + 16.5\,t$ $r^2 = 0.07$	3.36

Table 23. Aquaculture area by species, Taiwan, 1965-1979.

Year	Total (ha)	Milkfish (%)	Tilapia (%)	Common carp (%)	Grass carp (%)	Silver carp (%)	Eel (%)	Shrimps (%)	Oyster (%)	Others (%)
1965	38,148	40.94	6.27	2.67	2.54	17.54	0.10	0.07	21.88	7.99
1966	38,129	40.96	6.88	2.14	2.63	17.85	0.12	0.07	22.47	6.88
1967	39,239	40.91	6.51	2.00	2.66	17.54	0.16	0.12	23.40	6.70
1968	38,617	40.92	6.26	1.97	2.69	17.29	0.27	0.09	23.51	7.00
1969	40,494	39.78	6.40	2.11	1.29	19.41	0.39	0.10	22.98	7.54
1970	42,474	38.52	5.10	3.00	3.79	16.46	0.64	0.11	22.77	14.71
1971	43,337	36.87	5.77	3.40	4.41	16.00	1.53	0.21	22.27	9.54
1972	47,167	33.27	7.30	3.01	5.17	16.02	2.39	0.21	20.40	12.23
1973	49,470	31.60	9.15	3.95	4.97	14.56	2.10	0.99	19.30	13.38
1974	49,920	31.35	9.76	4.18	4.95	14.54	2.25	0.88	18.58	12.51
1975	53,606	31.34	10.10	3.27	5.00	15.75	2.62	0.91	18.26	12.75
1976	53,991	30.67	10.46	3.17	4.86	15.36	3.05	1.36	17.85	13.22
1977	54,953	29.39	10.79	3.24	4.55	12.86	3.12	2.02	17.81	16.22
1978	58,224	26.76	14.13	3.57	4.23	11.10	3.69	2.62	18.22	15.68
1979	60,460	25.38	14.48	3.72	4.57	10.25	3.73	4.52	18.53	14.82

Source: Taiwan Fisheries Bureau, PDAF, Taiwan Fisheries Yearbook.

Fingerling producers received a slightly higher price from producers of market-size milkfish (NT$6.50 per piece) than from baitfish users (NT$6.00). This was because the former were willing to pay a slight premium to be assured of high quality stocking material; the deep-sea fishing fleet was much less concerned with quality.

Marketing costs per 100 milkfish fingerlings were NT$198, of which returns to the capital, labor, management and risk of the middleman (at NT$1.00 per piece) was the major cost, about 51% of the total. Labor and transportation constituted the other major cost items, a further 27% of the total marketing costs of baitfish.

Production of Market-Size Milkfish: Transformation Subsystem

Milkfish production areas are centered in the southern coastal areas of Taiwan. The production areas for milkfish are spread mainly from Chiayi Hsien through Kaohsiung Hsien. Tainan Hsien and Tainan City along the coast are the major areas in cultivation, the two areas contributing 68.1% (10,445 ha) of the total production area in the island (Table 23). Other major areas are Chiayi and Kaohsiung Hsien contributing 2,174 ha and 1,730 ha, respectively. The industry is entirely in the private sector, largely family-owned with farms ranging in size from 1 to 20 ha. A very small number of companies are involved in milkfish enterprises, and own farms as large as 50 ha.

Total production area has remained at about 15,000 ha in the past 15 years (Table 20). Total production of milkfish has also been stable, ranging from 25,000 to 33,000 t, during the last 10 years, although the annual fry catch in Taiwan has varied sharply. With more intensive methods using additional supplementary inputs, annual milkfish production per hectare increased from 1,765 kg in 1965 to 2,087 kg in 1979. The low production and yields in 1967-1969 are thought to be due in part to the very low fry catch in 1967.

Although total production and yield per hectare of milkfish fluctuated year to year, upward trends were apparent for the period from 1965 to 1979 (Table 21, Figs. 15 and 16). The average annual growth rates of total production and yield per hectare of milkfish were 1.9% and 1.9%, respectively, for the last 15 years and 0.7% and 0.9%, respectively, for the last 10 years. However, none of the equations used to predict production or yields per hectare were found to be particularly good predictors because the R^2 values are very low.

Not only is market-size milkfish production influenced by the relative profitability of milkfish bait rearing which has high yields and profits (see previous section) but also by the relative yields per hectare of alternative species such as shrimp and crabs. Despite the increased milkfish yields per

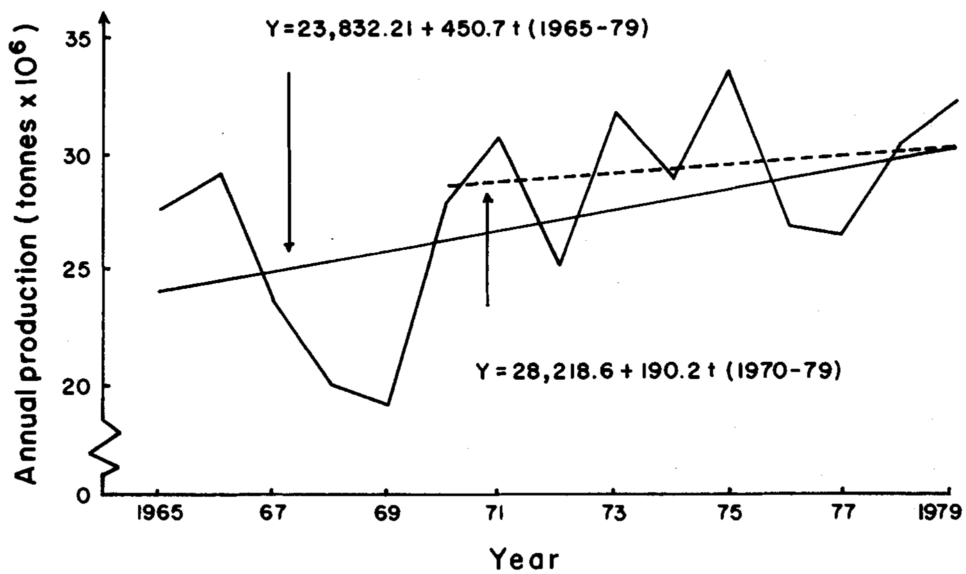

Fig. 15. Trends in total production of milkfish, Taiwan, 1965-1979.

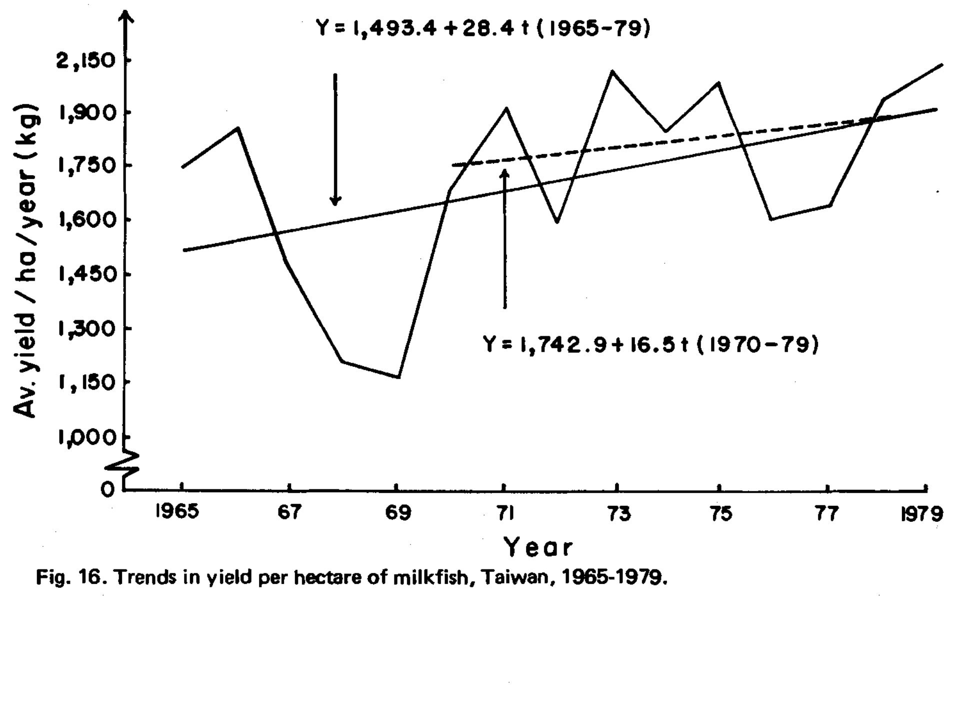

Fig. 16. Trends in yield per hectare of milkfish, Taiwan, 1965-1979.

hectare over the past 15 years, the relative area under milkfish production compared to the total aquaculture area has decreased from 41% in 1965 to 25.4% in 1979, while the production area of other species has increased from 59% to 74.6% in the same period (Table 22). The area under tilapia production alone has increased its share of total aquaculture area from 6.3% to 14.5% in the same period.

The traditional cultivation of milkfish is dominated by monoculture of which there are 11,495 ha or 74.9% of the total cultivated area. However, polyculture is becoming increasingly attractive: by 1979, an area of 3,851 ha or 25.1% of the total is in polyculture of milkfish with shrimp and/or crabs. These changes in production practices from monoculture to polyculture and from market-size milkfish to baitfish appear to be due primarily to the relative profitability of the various alternatives open to the producers. One particular advantage that baitfish rearing offers over rearing market-size fish is the faster turnover of producers' capital due to the shorter rearing period. The market-size milkfish must be raised to approximately 300 g, and for those fingerlings stocked after July, over-wintering is required.

CAPITAL AND LABOR INPUTS

During the survey, production data were obtained from 95 milkfish-rearing farms. The cataloging of inputs used in these farms indicated that with relatively small farm size as prevails in Taiwan and large inputs of working capital, the relative importance of the land resource to milkfish production has gradually decreased. Working capital has substituted for the scarce land resource to permit continued expansion of milkfish production.

The average land input per farm in 1979 was 10.61 ha (Table 24). The capital inputs used for milkfish production consisted of 90.9% in direct costs and 9.1% in indirect costs. On the average, the total capital inputs per hectare were NT$92,546, or 77% of that applied per hectare on baitfish farms. Seventy-five percent of the labor used on small farms was family labor; 77% of the labor used on large farms was hired labor. Total labor inputs per hectare decreased as farm size increased, ranging from 117 man-days/ha for farms below 3 ha, 84 man-days/ha for farms between 3 and 10 ha to 71 man-days/ha for farms above 10 ha. The decreasing trend of labor inputs per hectare was very significant.

Table 24. Capital and labor inputs per hectare on milkfish rearing farms in field survey of the Taiwanese milkfish industry, 1979.

Item			Farm size			
			Under 3 ha (n = 19)	3-10 ha (n = 45)	Over 10 ha (n = 31)	Average (n = 95)
	Land	ha	1.82	5.75	25.64	10.61
Capital	Direct costs	NT$	82,257	82,143	84,989	84,113
		%	90.9	88.8	91.7	90.9
	Indirect costs	NT$	8,274	10,344	7,686	8,433
		%	9.1	11.2	8.3	9.1
	Total	NT$	90,531	92,487	92,675	92,546
		%	100.0	100.0	100.0	100.0
Labor	Family labor	Man-day	87.2	51.6	16.5	28.7
		%	74.6	61.8	23.2	37.7
	Hired labor	Man-day	29.8	32.0	54.5	47.3
		%	25.4	38.2	76.8	62.3
	Total	Man-day	117.4	83.6	71.0	76.0
		%	100.0	100.0	100.0	100.0

ECONOMIC ANALYSIS OF MARKET-SIZE MILKFISH PRODUCTION

The total costs of milkfish production per hectare in 1979 were NT$92,546 of which direct costs were NT$84,113 and indirect costs NT$8,433. The more important direct production costs of milkfish were for fry (39.7%), labor (19.8%) and feed (26.7%), which together comprised 87% of the total production costs. Commonly used feeds were soybean cake, ricebran and chicken manure. Very little, if any inorganic fertilizers were used.

Production costs per hectare varied very little with farm size, ranging from NT$91,431/ha for farms below 3 ha, to NT$92,487/ha for farms between 3 and 10 ha and to NT$92,675 for farms above 10 ha (Table 25).

According to the survey data, the average yield of milkfish in 1979 was 2,126 kg/ha (compared to 2,087 kg according to national secondary data). Farm income (net revenue) per hectare was NT$9,475 and the benefit-cost ratio was 1.10, which was lower than the prevailing interest rate in a bank, thus reflecting a low capacity for earning profit above opportunity costs in the milkfish industry.

It can be seen that benefit-cost ratios and rates of farm income increased with farm size, due primarily to higher yields per hectare since production costs did not vary significantly. Of note is the fact that labor costs were lower and feed costs higher on larger farms. Therefore, enlarging average farm size would be one way to increase industry profit.

If we compare Tables 15 and 25 which show the benefit-cost ratios and rates of farm income in baitfish and market-size milkfish farms, it is clear that production of milkfish fingerlings for the baitfish industry is more profitable and efficient than that of production of market-size milkfish.

Table 25. Production costs and returns per hectare of milkfish rearing farms in field survey of the Taiwanese milkfish industry, 1979.

	Farm size							
	Under 3 ha		3-10 ha		Over 10 ha		Average	
Item	NT$	%	NT$	%	NT$	%	NT$	%
Direct costs								
Fry	32,803	36.2	37,437	40.5	36,683	39.6	36,749	39.7
Labor	21,110	23.3	20,134	21.8	17,498	18.9	18,349	19.8
Feeds	22,285	24.6	20,882	22.6	26,322	28.4	24,689	26.7
Fuel	1,153	1.3	1,553	1.7	1,224	1.3	1,311	1.4
Materials	4,504	5.0	1,996	2.2	2,427	2.6	2,385	2.9
Water fees	402	0.4	141	0.2	835	0.9	630	0.7
Subtotal	82,257	90.9	82,143	88.8	84,989	91.7	84,113	90.9
Indirect costs								
Rent	2,188	2.4	2,636	2.9	1,732	1.9	1,996	2.2
Tax	116	0.1	127	0.1	68	0.1	86	0.1
Interest	3,767	4.2	4,737	5.1	3,289	3.6	3,702	4.0
Depreciation of tools	2,203	2.4	2,844	3.1	2,596	2.8	2,649	2.9
Subtotal	8,274	9.1	10,344	11.2	7,686	8.3	8,433	9.1
Total costs	90,531	100.0	92,487	100.0	92,675	100.0	92,546	100.0
Yield per ha (kg)	2,013		2,080		2,150		2,126	
Gross receipts per ha (NT$)	96,625		99,886		103,195		102,053	
Farm income per ha (NT$)	6,094		7,399		10,520		9,475	
Farm income as % of total costs	6.73		8.00		11.35		10.24	
Rate of farm income	6.31		7.41		10.19		9.28	
Average farm size (ha)	1.82		5.75		25.64		10.61	
Benefit-cost ratio	1.07		1.08		1.11		1.10	

On the average, the 1979 benefit-cost ratio and rate of farm income for baitfish rearing farms were 0.43 and 30.04, respectively, while for production of market-size milkfish they were only 0.10 and 9.28, respectively.

Obviously the productivity of a factor depends not only on the quantity of a specific factor applied or used but also on the quantities of other resources used in combination with it. Factor productivities are closely related to farm size in milkfish rearing (Table 26). For example, land productivity per hectare ranged from NT$96,625 for farm sizes under 3 ha, to NT$99,886 for farms of between 3 and 10 ha, and NT$103,195 for farms above 10 ha. When these productivities are compared with Table 16, it can be seen that factor productivities are much higher in baitfish rearing farms than in (market-size) milkfish-rearing farms. Because the purpose of using the milkfish resource is to maintain adequate resource returns and farm income in the face of growing competition from other aquaculture products, a shift by some producers from milkfish rearing to baitfish rearing, if production and market environments are suitable, would be very helpful for increasing productivity and efficiency of resource use in the short term. However, as noted in the previous section, there is a declining demand for milkfish baitfish. Milkfish producers face a serious problem of potentially declining profits with no readily apparent solution except further increasing their productivity per hectare to reduce average costs of production.

Table 26. Factor productivities and factor-factor ratios of milkfish rearing farms in field survey of the Taiwanese milkfish industry, 1979.

Item	Under 3 ha	3-10 ha	Over 10 ha	Average
Capital input per unit of labor C/N (NT$/man-day)	771	1,106	1,305	1,218
Labor input per unit of capital N/C (man-day/NT$)	0.00130	0.00090	0.00077	0.00082
Land input per unit of capital D/C (ha/NT$)	0.000011	0.000011	0.000011	0.000011
Capital input per unit of land C/D (NT$/ha)	90,531	92,487	92,675	92,546
Land input per unit of labor D/N (man-day/ha)	0.00852	0.01196	0.01409	0.01316
Labor input per unit of land N/D (man-day/ha)	117.41	83.62	71.00	75.98
Land productivity Q/D (NT$/ha)	96,625	99,886	103,195	102,053
Labor productivity Q/N (NT$/man-day)	823	1,195	1,454	1,343
Capital productivity Q/C (NT$/NT$)	1.06373	1.0800	1.1151	1.1027

Capital inputs play a very important role in milkfish production. An analysis of capital inputs and elasticity of substitution between capital and labor to examine input use and technological change in milkfish production was carried out using the constant-elasticity-of-substitution production function (Table 27); the parameters are shown in Table 28. High elasticity of substitution between capital and labor in milkfish farming occurred primarily in farms under 3 ha, for which the value of elasticity of substitution was greater than unity ($\sigma > 1$). The elasticities of substitution were less than unity ($\sigma < 1$) for the other two categories of larger farms.

The substitutability between capital and labor is easier in farms smaller than 3 ha because part of the labor input comes from members of family and thus its use is more flexible. In Taiwan, hired laborers are usually hired by the year; daily laborers are much less commonly used than elsewhere in Southeast Asia, so the larger farms in Taiwan which are more heavily dependent on hired labor, face less substitution possibilities in the short term.

Table 27. Coefficients of the CES production function of milkfish rearing farms in field survey of the Taiwanese milkfish industry, 1979.

Item	Farm size			
	Under 3 ha	5-10 ha	Over 10 ha	Average
β_1	2.6376	3.1691	2.5641	2.9078
β_2	0.5288	0.6793	0.7742	0.7660
	(1.2202)	(1.1070)	(1.0507)	(1.1968)
β_3	0.4051	0.1659	0.1216	0.1070
	(0.2829)	(0.0261)	(1.0079)	(1.0044)
β_4	0.0234	–0.0019	–0.0070	–0.0033
	(0.1752)	(–1.0042)	(–0.9065)	(–0.9120)
F	143.7766	56.6120	64.6766	171.6590
R^2	0.9664	0.8457	0.9023	0.8788
n	19	45	31	95

Notes:

1. The t-values are given in brackets.
2. n is the number of fishfarm households.

Table 28. Estimated parameters of the CES production function of Taiwanese milkfish rearing farms.

Item	Farm size			
	Under 3 ha	3-10 ha	Over 10 ha	Average
γ	13.9797	23.7871	12.9883	18.3165
k	0.4337	0.8037	0.1358	0.6783
v	0.9339	0.8452	0.8958	0.7830
ρ	–0.2037	0.0286	0.1340	0.3998
σ	1.2556	0.9722	0.8818	0.7144
R^2	0.9664	0.8457	0.9023	0.8788
S	0.0830	0.0586	0.0643	0.0573

Notes: Computed based on Table 27.

γ = scale parameter denoting the efficiency of a production technology.
k = distribution parameter indicating the degree to which technology is capital intensive.
v = degree of homogeneity of the function or the degree of returns to scale.
ρ = substitution parameter.
σ = elasticity of substitution.
S = standard error of the equation.

Marketing of Market-Size Milkfish: Delivery Subsystem

The delivery subsystem for milkfish consists of all those activities involved with getting the product from producer to consumer. Because the milkfish produced in Taiwan are consumed fresh or frozen (but not processed), milkfish marketing economics center on marketing channels, marketing margins, marketing costs and price variation of fresh milkfish. Lin and Chen (1980) provide further details on fish marketing in Taiwan. In contrast to production data that were available only up to 1979, secondary price data for the analysis below were available through 1980.

MARKETING CHANNELS AND MARKETING MARGINS

There are three major marketing channels between producers and consumers of milkfish. These are:

(1) Producers → wholesalers → city fish markets → dealer-retailers → retailers → consumers.
(2) Producers → cooperatives → city fish markets → dealer-retailers → retailers → consumers.
(3) Producers → dealers → dealer-retailers → retailers → consumers.

Milkfish farmers were found to sell 70.5% of their products to wholesalers, and only 15.2% to cooperatives and 14.4% to dealers (Fig. 17). The wholesalers play a very important role in milkfish marketing, but there are regional differences. In Tainan City, for example, there was no wholesaler.

The survey data showed that producers received 73.7% of the retail price, with the remaining 26.3% absorbed in the marketing process. The wholesalers received 78.5% of the retail city prices.

The producers' share of retail price during the period 1970-80, calculated from the prices paid by wholesalers and those received by city retailers (Table 29), decreased, although there were increases in some years. The producers' share of retail price, which was 81.17% in 1970, increased to 93.0% in 1974 and then decreased to 59.2% in 1978 which was the lowest share during the last decade. Due to the impact of increased fuel prices in 1974 on the Taiwanese economy (e.g., on transport costs), after that year the share of farm price to retail price was much lower than for the 1970-1973 period. Conversely, the marketing groups' share rose from 18.8% in 1970 to 28.9% in 1980.

The difference between farm gate price and city retail price rose from NT$5.26/kg in 1970 to NT$32.86/kg in 1980; the increasing trend was thus very significant during the period under review. During the same period farm gate prices (in current or nominal terms) increased by 356% and retail prices by 407%, the difference reflecting increased marketing costs.

Table 29. Purchase price of wholesalers and city retail price (NT$ per kg) for milkfish, Taiwan, 1970-1980.

Year	Wholesale price of production (farmgate price) (1)	Retail price of cities (2)	The difference between wholesale prices and retail prices (3) = (2) − (1)	Producer's share % $\frac{(1)}{(2)} \times 100$
1970	22.68	27.94	5.26	81.2
1971	25.61	31.46	5.85	81.4
1972	30.06	33.68	3.62	89.3
1973	32.11	37.34	5.23	86.0
1974	48.63	52.32	3.69	93.0
1975	37.87	63.32	25.45	59.8
1976	43.47	68.78	25.31	63.2
1977	49.34	82.81	33.47	59.6
1978	55.67	94.05	38.38	59.2
1979	77.05	104.60	27.55	73.7
1980	80.82	113.68	32.86	71.1

Source: Taiwan Fisheries Bureau, PDAF, Taiwan Fisheries Yearbook.

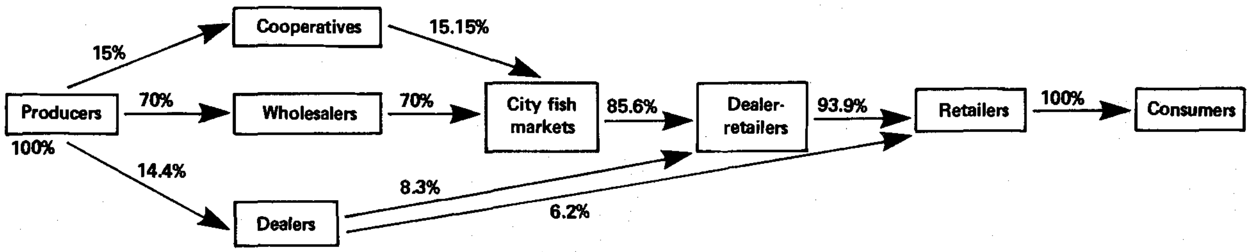

Fig. 17. Marketing channels of market-size (0.3 kg) milkfish, Taiwan, 1979.

Marketing costs

When compared with marketing costs, the marketing margins can provide a rough indication of the efficiency of milkfish marketing (Fig. 18). However, efficiency must be demonstrated by using time-series data of both costs and margins. Although the latter are available from published price data, there are no time-series data on marketing costs. Marketing efficiency therefore cannot be fully analyzed. Consequently, the analysis which follows is based upon applying the percentage breakdown of 1979 marketing costs as reported by Lin and Chen (1980) to the 1979 marketing margins as derived from secondary price data and reported in the previous section. Although the available time-series data are inadequate to test the time relation between costs, margins and efficiency of milkfish marketing, the survey data do shed light on the relative costs of alternative marketing channels.

The average marketing costs in 1979 were NT$27.55/kg, representing 26.3% of the retail price of milkfish (Table 30). Among the cost items, middlemen returns, market management and taxes, and cold storage, packaging and transportation costs were 48.4%, 17.01% and 17.1% of total costs, respectively. Returns to the capital, labor, management and risk of marketing intermediaries accounted for the highest percentage of the costs incurred in marketing.

A second manner in which to illustrate the marketing costs of milkfish in Taiwan is through the marketing costs accounted for by the different marketing agencies. The major marketing agencies of milkfish are classified as dealers, wholesalers and cooperatives. The total marketing costs of dealers, wholesalers and cooperatives in 1979 were NT$6.01/kg, NT$9.07/kg and NT$7.23/kg, respectively (Table 31). Dealers incurred the lowest costs in marketing, since the dealers transport fish direct to dealer-retailers or retailers; there are no taxes, market management or fisherman insurance fees during the marketing process. The cooperative marketing sponsored by the fisher-

Table 30. Marketing costs (farmgate to retail outlet) per 100 kg of milkfish by expenses, Taiwan, 1979.

	Marketing costs (NT$ per 100 kg)	Percentage of marketing costs
Market management	269	9.8
Taxes	199	7.2
Fisherman insurance	111	4.0
Cold storage	113	4.1
Packaging	143	5.2
Transportation	214	7.8
Miscellaneous expenses	372	13.5
Returns to intermediaries' own inputs	1,372	48.4
Total	2,755	100.00

Source: The percentage of marketing costs are based on Lin and Chen (1980).

Table 31. Marketing costs per 100 kg of milkfish by different marketing agencies, Taiwan, 1979.

	Dealer		Wholesaler		Cooperative	
	NT$	%	NT$	%	NT$	%
Salary	76	12.65	80	8.82	67	9.27
Transportation	125	20.80	124	13.67	173	23.93
Cold storage (including ice)	75	12.48	75	8.27	104	14.38
Package	38	6.32	38	4.19	57	7.88
Taxes	–	–	70	7.72	33	4.56
Market management fee	–	–	175	19.29	167	23.10
Fisherman insurance fee	–	–	91	10.03	87	12.03
Other expenses	27	4.49	36	3.97	35	4.85
Interest	20	3.33		2.10	7	0.97
Equipment depreciation	–	–	–	–	3	0.42
Water	–	–	–	–	1	0.14
Electricity	–	–	–	–	6	0.83
Fishery development funds fee	–	–	11	1.21	10	1.38
Mail and telegram	7	1.16	6	0.66	8	1.11
Returns to agencies' own inputs	260	43.26	218	24.04	–	–
Total	601	100.0	907	100.00	723	100.00

men's associations, although involving the same functions, was not as efficient as the dealers in that the associations' marketing costs per kilogram were higher.

Several problems and difficulties facing this marketing system are worth citing:

(i) On average, Taiwanese fishponds are small so that the quantity of harvest of each fish-farmer is not enough to fully utilize a complete transportation unit. It is very difficult to ensure good coordination among individual farmers in joining together for efficient use of transport.

(ii) It is also very difficult to make arrangements before harvest due to the different timing of harvest among fishponds depending upon the weather, water quality and other factors. Milkfish are very sensitive to weather changes, for example, and growers sometimes wish to harvest immediately when there is a serious change in the weather. The cooperative marketing undertaken by the fishermen's associations apparently lacks coordination while the dealers possess more flexibility. Moreover, dealers are very flexible in that they make cash payments and even pay in advance as a loan to the producers. The fishermen's associations, in the opinion of producers, cannot provide such convenient services.

(iii) The shortage of freezing facilities causes a lack of flexibility in adjusting to the demand and supply of the market, thus causing fluctuations in market prices. The fish growers usually like to know the price before delivery to the market, but the fishermen's associations find it difficult to provide price information to fish growers before harvesting. Dealers and wholesalers apparently provide better price information to producers.

The above factors explain why the dealer/wholesaler marketing channel still handles the bulk of milkfish marketed, despite the presence of fishermen's associations in most locations.

Analysis of milkfish prices

It was possible to examine the prices of market-size milkfish in terms of long-run trends, seasonal variation and price instability.

As discussed earlier, fry are the main cost of milkfish production. The price of fry may be considered a most important factor influencing the price of market-size milkfish. The relationship between price of milkfish and price of fry from 1970 to 1979 was calculated by least-squares regression. The result was as follows:

$$P_m = 6.77 + \underset{(3.7574)}{28.48}\, P_f \qquad R^2 = 0.69$$

where P_m stands for the farm price of milkfish (in real terms), P_f shows the price of fry (in real terms) and t-value is given in brackets. This equation verifies that the price of fry is the most important factor affecting the price of milkfish. If fry price could be stabilized it would bring increased stability to the retail price of milkfish.

To determine the long-run trends of milkfish prices, the least squares method was also used to compute the regression equation for the period 1970-1980 (Table 32, Figs. 19 and 20). Table 33 shows that the prices of milkfish, whether as prices paid by wholesalers or retail city prices, increased annually at both current and constant prices. The annual rate of price increase at current prices was approximately 15%. Based on constant price, the annual rate from 1970 to 1980 was 4-6%.

The high seasonal variation of milkfish price also reflected the seasonality of milkfish production. The total ranges of indices of seasonal variation of milkfish price were 89.4% and 115% from the prices paid by wholesalers and retail city prices, respectively (Fig. 21). This means that the seasonal variation was higher in retail city prices than in wholesale farm prices. Peak wholesale prices of production are from March to May, while the city retail price peaked from January to April. During the period, prices were highest in February, which often coincides with Chinese New Year when demand increases. Also, because there is very low supply from January to March, the marketing margin is higher, further contributing to higher prices.

Table 32. Trends in milkfish price, Taiwan, 1970-1980.

	Equations	r^2	Annual growth rate (%)
Current price			
Price paid by wholesalers	P = 13.65 + 5.40 t	0.93	15.28
Retail price of cities	P = 9.45 + 9.18 t	0.98	15.43
Constant price			
Price paid by wholesalers	P = 51.08 + 0.12 t	0.44	4.14
Retail price of cities	P = 47.32 + 3.22 t	0.91	5.84

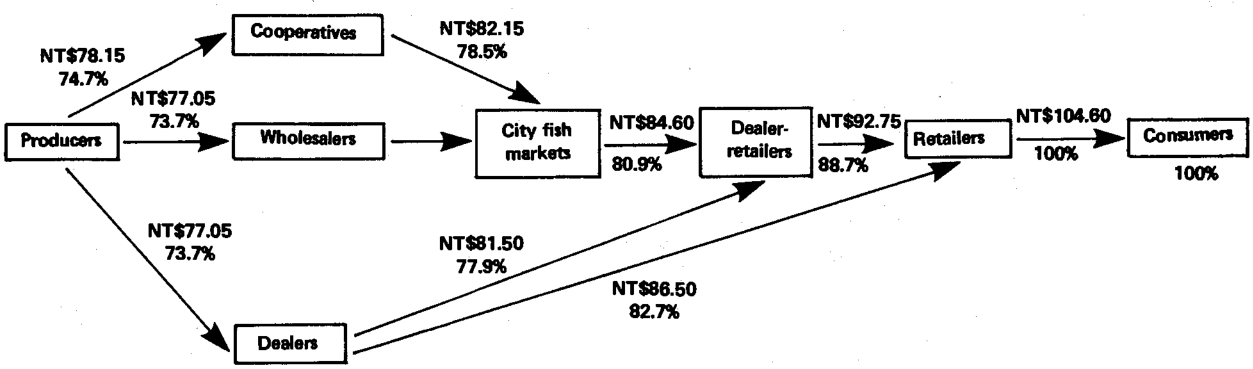

Fig. 18. Marketing margins (NT$ per kg) of milkfish, Taiwan, 1979. Prices shown are prices paid by next recipient in the marketing channel. Percentages indicate these prices as percent of retail price.

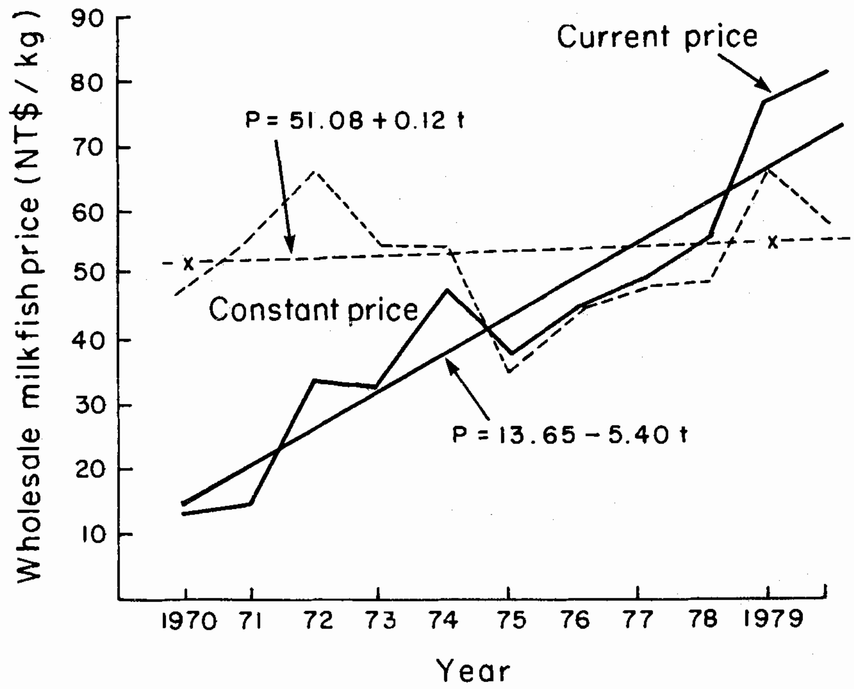

Fig. 19. Trends in wholesale price of production of milkfish, Taiwan, 1970-1980.

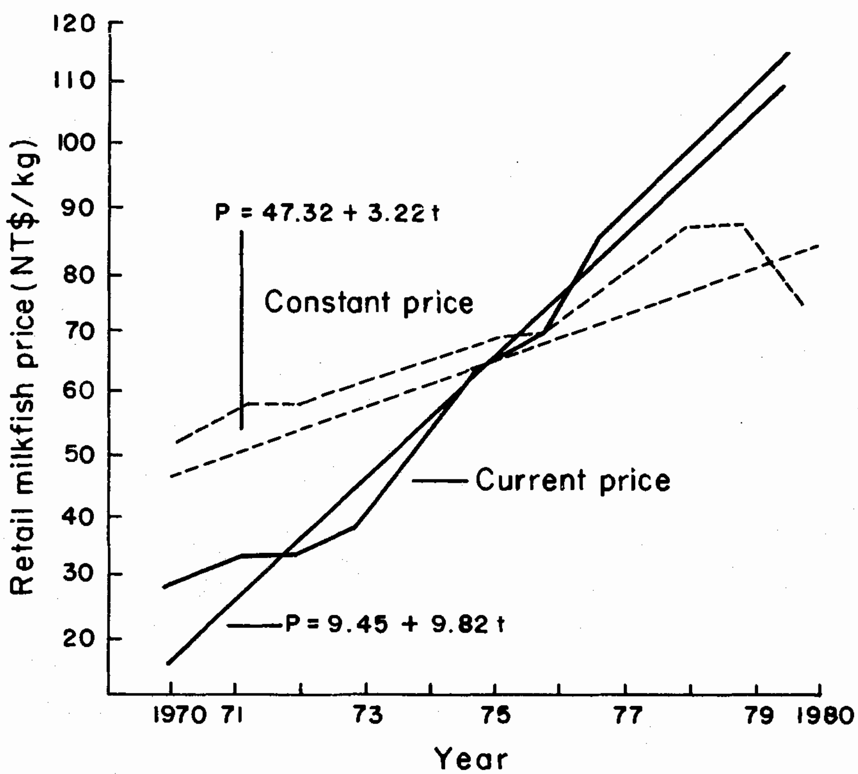

Fig. 20. Trends in milkfish retail price of cities, Taiwan, 1970-1980.

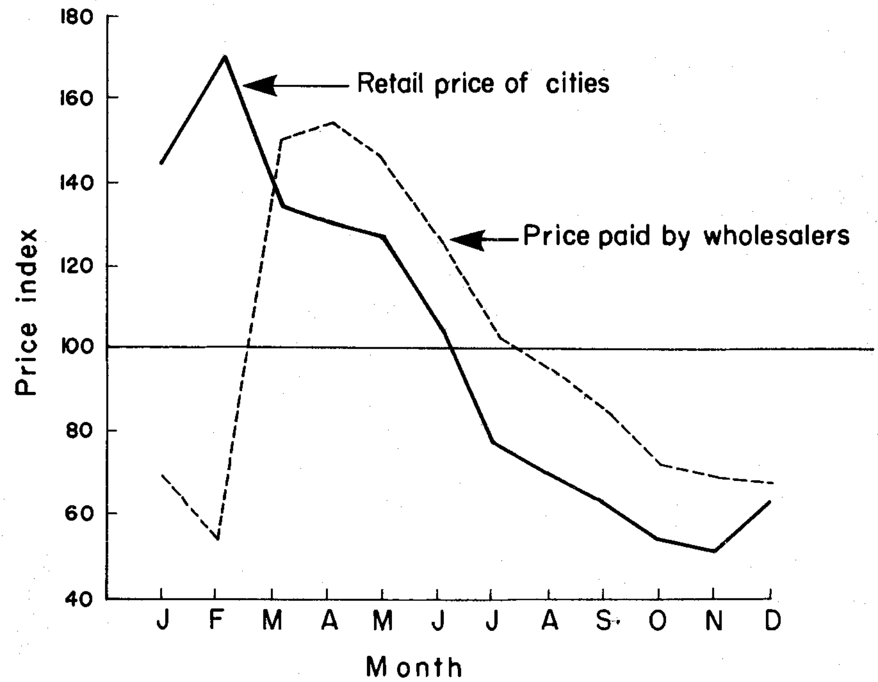

Fig. 21. Seasonal index of wholesale and retail milkfish prices, Taiwan, 1970-1980.

Table 33. Indices of milkfish instability, Taiwan, 1970-1979.

	F	R
Wholesale price of production		
Current price	16.44	0.48
Constant price	6.42	1.11
Retail price of cities		
Current price	16.16	0.14
Constant price	5.91	0.20

Notes: F is Michaely Index.
R is Von Neumann Ratio.
See Table 6 for definitions.

In order to measure the price instability of milkfish, the Michaely Index and Von Neumann Ratio were computed from wholesale farm prices and retail city prices at both current and constant price levels. Wholesale farm prices and retail city prices, in current terms, showed substantial instability; but in constant terms, both exhibited only slight instability. Since the values of the Von Neumann Ratio ranged from zero to one, the variations of the milkfish wholesale farm prices and retail city prices were also modest and uni-directional.

Since milkfish is considered a good substitute for other fish in Taiwan, comparisons of prices between other fish and milkfish were made to indicate changes in relative prices. Table 34 shows the price ratios of other fish to milkfish from 1965 to 1979. This ratio has decreased annually. The tilapia-milkfish price ratio decreased from 45.3% in 1965 to 41.7% in 1979, and the silver carp-milkfish price ratio decreased sharply from 82.5% to 37.2% in the same period. Shrimps, on the other hand, increased in price faster than milkfish in some years.

Table 34. Comparisons of prices between milkfish, other freshwater fish and shrimps, Taiwan, 1965-1979.

Year	Tilapia / Milkfish %	Common carp / Milkfish %	Silver carp / Milkfish %	Grass carp / Milkfish %	Shrimps / Milkfish %
1965	45.3	70.0	82.5	109.8	80.1
1966	45.5	20.7	82.1	108.7	96.4
1967	39.5	75.3	72.1	102.8	109.4
1968	38.4	71.1	65.6	95.1	440.4[1]
1969	41.0	69.6	63.0	89.4	79.4
1970	38.9	70.4	58.7	91.3	96.1
1971	45.6	79.1	67.2	95.2	105.2
1972	40.3	65.1	54.3	88.8	93.9
1973	42.1	60.5	49.4	82.6	100.9
1974	40.6	51.3	45.4	72.0	85.1
1975	33.9	53.3	52.9	79.0	66.0
1976	38.9	59.6	41.6	80.0	71.7
1977	32.5	40.9	35.6	51.1	62.2
1978	37.8	49.9	42.1	57.5	66.7
1979	41.7	48.2	37.2	55.5	92.5

Source: Computed from Taiwan Fisheries Yearbook.
[1]May be due to only partial data (of higher priced shrimps) collected in 1968.

Because the price ratio of other freshwater fish to milkfish decreased during the past 15 years (to 1979), milkfish must be considered as a preferred fish in Taiwan. Yet the milkfish production area relative to the total aquaculture area decreased from 41% in 1965 to 25% in 1979 (Table 35). Tilapia, common carp, shrimps, oysters and grass carp have all increased in production area compared to milkfish. The better price of milkfish did not constitute sufficient incentive for expansion of fishponds. This is probably due to improvements in freshwater fishpond management and rearing technology, such as the deep-water system, with consequent increases in the yield per hectare of other species and reductions in average production costs (Table 36). Experimentation with the deep-water system for milkfish production has begun in an effort to make the product more competitive, but the technique is not yet widely practiced commercially.

Table 35. Comparisons of cultivated area between milkfish and other fish culture, Taiwan, 1965-1979.

Year	Milkfish ha	Tilapia / Milkfish %	Common carp / Milkfish %	Silver carp / Milkfish %	Grass carp / Milkfish %	Shrimps / Milkfish %	Oyster / Milkfish %
1965	15,616	15.32	6.54	42.85	6.21	0.17	53.45
1966	15,616	16.80	5.23	43.58	6.42	0.17	54.86
1967	16,051	15.92	4.90	42.87	6.51	0.29	57.21
1968	16,211	15.30	4.81	42.26	6.58	0.23	57.44
1969	16,298	16.09	5.30	48.80	3.25	0.26	57.77
1970	16,360	13.24	7.78	42.74	9.83	0.29	59.13
1971	15,980	15.66	9.22	43.38	11.95	0.57	60.39
1972	15,692	21.94	9.07	48.17	15.53	0.62	61.32
1973	15,634	28.97	12.50	46.07	15.73	3.13	61.06
1974	15,652	31.14	13.33	49.57	15.79	2.80	59.25
1975	16,802	32.23	10.44	50.26	15.94	2.90	58.25
1976	16,560	34.11	10.91	50.07	15.84	4.43	58.18
1977	16,148	36.74	11.02	43.76	15.48	6.89	60.61
1978	15,585	52.81	13.35	41.50	15.81	9.79	8.10
1979	15,346	57.06	14.64	40.38	18.00	17.80	73.02

Source: Taiwan Fisheries Yearbook.

Table 36. Comparisons of yield per hectare between milkfish and other fish culture, Taiwan, 1965-1979.

Year	Milkfish (kg)	Tilapia / milkfish %	Common carp / milkfish %	Silver carp / milkfish %	Grass carp / milkfish %	Shrimps / milkfish %	Oyster / milkfish %
1965	1,765	181.93	89.24	19.04	76.03	–	60.34
1966	1,863	170.48	64.84	20.08	73.54	–	64.79
1967	1,468	234.81	86.65	25.27	103.00	–	86.78
1968	1,216	306.00	107.07	36.10	140.21	–	111.02
1969	1,166	313.89	113.64	33.88	318.44	–	106.78
1970	1,703	308.04	53.96	35.58	53.96	–	79.33
1971	1,918	236.81	43.38	35.67	48.44	–	68.51
1972	1,590	199.56	76.79	41.38	67.99	–	89.31
1973	2,020	143.76	64.21	41.78	100.89	46.70	74.21
1974	1,847	168.76	83.87	46.07	111.75	62.43	78.07
1975	1,982	174.22	92.84	43.24	100.55	87.23	71.44
1976	1,622	242.60	99.14	64.92	141.25	75.10	86.50
1977	1,633	229.64	101.47	68.89	138.33	77.18	93.51
1978	1,935	176.54	83.93	81.29	148.53	89.61	87.49
1979	2,087	189.65	84.48	89.08	147.29	111.99	85.19

Source: Taiwan Fisheries Yearbook.

Conclusions

As Taiwan's economic growth has quickened and per capita income and population have increased, the demand for aquatic products has increased year by year. As a result, the aquaculture area has expanded rapidly although milkfish production area has remained unchanged since 1965 at about 15,000 ha and yields per hectare have increased slowly compared to those of other species. The total revenues and profits per hectare are lower for milkfish production than for other fresh-water fish rearing.

This report concludes with some suggestions for improving the milkfish resource system in the interest of the milkfish producers.

The main problems of the procurement subsystem are the highly variable supply and price of fry. In order to increase and maintain the source of milkfish fry and stabilize the fry price, efforts should be directed towards (a) control of water pollution in the coastal areas, (b) improvement of fry-gathering techniques and (c) continuance of efforts to develop hatchery systems for milkfish fry production.

A good resource system should provide flexibility for the adjustment of farm management in response to changes in economic and technological conditions. Taiwanese agriculture has been characterized by small-scale traditional Chinese farming. For economies of scale and production efficiency, farmers should be encouraged to participate in group farming and contract farming.

To broaden the base of operations and increase their yields per hectare, adoption of new rearing technology, such as the deep-water system, must be encouraged in order to meet the dynamic economic conditions that are currently favoring other species.

In 1979, milkfish shipped to the city markets through cooperative marketing channels by the fishermen's associations comprised only 15% of the total milkfish produced. Through cooperative marketing, fish products can be collected and directly transported to markets by the fishermen's associations. By so doing, some marketing costs can potentially be saved to increase the income of producers. Although cooperative marketing of milkfish is considered by many as an excellent marketing system to increase the marketing efficiency and producer's income of milkfish in Taiwan, it must become more flexible to meet the needs of the fishfarmers. This study shows that dealers/wholesalers presently provide marketing functions at lower cost than the associations.

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Appendix

Derivation of the CES Production Function

(Adapted from Kmenta 1967)

The static CES production function is

$$Q_i = \gamma \ [kC_i^{-\rho} + (1-k)N_i^{-\rho}]^{-v/\rho} e^{\varepsilon_i} \quad (1)$$

$$(\partial > 0;\ 1 > K > 0;\ v > 0;\ \rho \geqslant -1)$$

Where Q, C and N represent output, capital and labor, respectively and e = 2.71828; the four parameters are γ, k, v and ρ where γ stands for an efficiency parameter, k is the distribution parameter; v represents the degree of homogeneity of the function or the degree of returns to scale, and ρ is the substitution parameter equal to $(1-\sigma)/\sigma$, where σ is the elasticity of substitution. Then, σ can be computed as $\sigma = 1/(1+\rho)$.

The logarithmic transformation (to the base e) of the CES production function is:

$$\log Q_i = \log \gamma - v/\rho \ \log [kC_i^{-\rho} + (1-k)N_i^{-\rho}] + \varepsilon_i \quad (2)$$

The major problem with this production function is how to obtain an estimate of the parameters, γ, k, v and ρ given data on output, capital and labor input. The simple least-square method cannot be used to estimate directly the parameters of equation (2), since the term $[kC_i^{-\rho} + (1-k)N_i^{-\rho}]$ contains undetermined parameters.

A simpler estimation of the parameters of the CES production function is possible by replacing equation (2) with its approximation that is linear with respect to ρ. Using Taylor's series expansion[1] of $\log Q_i$ around the point $\rho = 0$, and dropping the terms involving powers of ρ greater than one, then:

$$\log Q_i = \log \gamma + vk \log C_i + v(1-k) \log N_i - 1/2\, \rho vk\, (1-k)\, [\log C_i - \log N_i]^2 + \varepsilon_i \quad (3)$$

The unrestricted version (3) can be estimated empirically as follows:

$$\log Q_i = \beta_1 + \beta_2 \log C_i + \beta_3 \log N + \beta_4 (\log C_i - \log N_i)^2 + \varepsilon_i \quad (4)$$

The parameters of equation (3) are related to the coefficients of equation (4) as follows:

$\gamma = \text{antilog}\,(\beta_1)$ $\qquad$ $v = \beta_2 + \beta_3$

$k = \beta_2/(\beta_2 + \beta_3)$ $\qquad$ $\rho = -2\beta_4\,(\beta_2 + \beta_3)/\beta_2\beta_3$

The ordinary least-squares method is then used to estimate the coefficients of equation (3) from cross-sectional data.

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[1]The Taylor's series expansion of f(x) about the point x = a can be written as

$$f(x) = f(a) + (x-a)\,f'(a) + \frac{(x-a)^2}{2!}\,f''(a) + \frac{(x-a)^3}{3!}\,f'''(a) + \ldots\ldots\ldots\ldots + \frac{(x-a)^p}{p!}\,f^{(p)}(a) + R_{p+1}$$

where $f(a) = f(x)\Big|_{x=a}$

$$f'(a) = \frac{df(x)}{dx}\Big|_{x=a}$$

$$f''(a) = \frac{d^2f(x)}{dx}\Big|_{x=a}$$

•
•
•

R_{p+1} = remainder