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**ECONOMICS OF AQUACULTURE, SEA-FISHING
AND COASTAL RESOURCE USE IN ASIA**

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**Proceedings of the
Second Biennial Meeting
of the
Agricultural Economics Society of Southeast Asia
November 3-6, 1977
Tigbauan, Iloilo, Philippines**

*Agricultural Development Council
Philippine Council for Agriculture and Resources Research
October 1979*

RESOURCE POTENTIAL AND POLICY IN MARINE FISHERIES AND AQUACULTURE IN SINGAPORE

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Historical Development of the Fishing Industry in Singapore

The humble beginning of modern Singapore in the early 19th Century was as a small fishing village, whose inhabitants employed primitive methods of fishing. The rapid development of the then British Crown colony soon provided a vast increase in demand for fish which the local fishing industry was unable to cope. Imports to meet the deficiency in supply came from neighbouring Indonesia and mainland Malaya. These were subsequently augmented by landings from Japanese-operated vessels. During the period 1920-1940, this additional source of supply provided almost half of the total market landings.

The development of Singapore also began to open up many more attractive opportunities for the investment of capital and alternative shore employment for labour. In addition, the concentration and expansion of commercial activities at the mouth of the Singapore River displaced fishing activities there and caused these to move further outside the developing urban center.

Another reason for the comparative early neglect and decline of the fishing industry in Singapore is related to the very reason for the success of Singapore as a trading centre in the region, namely its geographic location. To the north, the Singapore island is hemmed in by the Malay Peninsula and to the south by the interlacing territorial waters of Indonesia. To the east, the South China Sea is closed to small boats during the north-east monsoon. To the north west lies the Straits of Malacca which are heavily fished by fishermen residing along the shores of the Straits. Thus the fishing resources available to the local fishermen are very limited.

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By the late 1940's and early 1950's, it became apparent that the adjacent waters of Singapore were fully exploited. The maximum production achieved did not exceed 40,000 tons per annum. Since this represented a fraction of Singapore's requirements, it became necessary to extend the fishing operations to the open seas.

Exploitation of offshore fishing grounds required the use of more sturdy vessels to withstand the north-east monsoon and they must also be sufficiently large to facilitate operations in the more distant waters of the Indian Ocean. Moreover the resources of these waters were and are still relatively unknown.

With increasing population growth annual consumption of fish in Singapore grew apace. Between 1960-1965, it was about 50,000 tons.^{2/} Of this amount, only about 10,000 tons were caught by Singapore fishermen. Thus nearly 80% of the annual fish consumption was met by imports. This is still basically true today.

The average consumption of fish per person is about 55 lbs. This appears to be very high. It is much higher than that of some well-known maritime countries such as France (14 lbs.), UK (22 lbs.) and Denmark (29 lbs.). In Japan, where fish and rice also figure importantly in the national diet, consumption is 44 lbs. per person.

The prospects for increasing fish production from inshore waters decline progressively due to the limited number and size of fishing grounds, the increasing competition for the same resources by land reclamation projects, and water pollution of coastal areas from industrial wastes. However the bulk of the Singapore fishermen operate in these areas. Of the total 4,000 licensed marine fishermen more than 60% may be considered as inshore fishermen. They account for about 40% of Singapore's total marine fish landings.

Another area of the fishing industry which has suffered as a result of swampland reclamation is the cultivation of fish and prawn ponds. The average under cultivation had decreased from 1915 acres in 1960 to 1527 acres in 1965. The only promising sign is the cultivation of Japanese carps which were introduced in the Republic by the Primary Production Department. The cultivation of this fish (*Tilapia*) is growing in popularity.

The ban on trawling has also impeded significantly the expansion of the fishing industry. Because of its higher capitalization and access to deeper waters for operation, trawling as a method of fishing has been regarded by most countries as a progressive method. In several countries notably Thailand, fish landing from trawlers have contributed substantially to the overall increase in fish production.

Pair trawling, which was introduced in Singapore in 1950's has had a limited success. After 1960 when the joint local/Japanese venture in pair trawling came to an end, no pair trawling had been in operation. Drive-in net fishing, a Japanese originated method (*Moro-ami*) was operated successfully by local fishing vessels in the waters close to the islands of Indonesia where coral fish were abundant. Unfortunately, this type of fishing came to a stop after 1960 because of lack of proper fishing grounds accessible to the boats. Some of the fishermen entered into joint projects with fishermen in Trengganu, Malaysia to use this method to exploit the coral grounds off the coast of Trengganu. The last project ended in 1964.

Fishermen in Singapore and Malaysia first took up otter trawling in 1963. Because of the trouble that developed between inshore fishermen and trawler men in Peninsular Malaysia, the Malaysian Government banned trawling. When Singapore became part of Malaysia in 1963, the ban was extended to Singapore but not to Sabah and Sarawak. The ban, however, was difficult to enforce and illegal trawlers continued to operate in

^{2/}Singapore Primary Production Department Annual Report 1960-1965

both Malaysia and Singapore. The catches from these illegal trawlers were reported to be fairly substantial and were included in the production statistics of 1963-65.

The only promising sector within the fishing industry in the early 1960's was in the ornamental fish trade. Singapore became an export centre for aquarium fish. Thousands of dollars worth of fancy, exotic fish were exported each year mainly to North America, Europe and Australia. This trade developed into a significant revenue earner and will be discussed in greater detail later.

By the later half of the 1960's, it became apparent that the only avenue for the expansion of the fishing industry was in offshore and deep-sea fishing. A realization of the potential contribution of a thriving fishing industry to the national economy led to a closer reappraisal of the Fisheries Division of the Primary Production Department. In the Singapore second 5 year plan 1966-1970, several schemes were implemented for the industry especially in the direction of more capital intensive methods of offshore and deep sea fishing. Such a move was in the framework of the Republic's programme for a more diversified economy. It was hoped that the development of a more capital intensive offshore and deep-sea fishing industry would not only yield benefits in the form of meeting a greater portion of the domestic demand for fish and fish products but also in the establishment of such associated industries as boat building, net and gear manufacture, cold storage and refrigeration and fish processing as well as creating additional sources of employment in Singapore.

In the first phase of the modernization programme, a modern fishing port costing several million dollars was established at the Jurong Industrial Site. The Fisheries wharf and Central Fish Auction Market were completed at the end of 1967. Sub-markets and other supporting facilities were also established to improve the system of fish landing, marketing, and distribution.

At the Conference on the South-east Asian Fisheries Development Center held in Singapore in August 1967, it was decided to locate SEAFDEC's Maritime Fisheries Research Department in Singapore. This Research Department was to undertake fisheries resources research, development of fishing grounds and the training of research workers and technicians from the South-east Asian region. Nine Japanese experts were initially attached to the research centre for a period of 5 years.

At about the same time, a Fishing Training Centre, a UNDP - assisted project, was initiated at Changi to enlarge the size and scope of training of fishermen. However, the centre closed due to poor response.

In addition, a joint Singapore/Taiwan trawling project was started. Several other joint projects were negotiated. The Singapore government sought the participation of the private sector in the Fisheries Development Programme.

In spite of these ventures and plans of the government to stimulate the development of the fishing industry on a more modern basis, little progress either in terms of output of fish or employment was evident. The only area of the fishing industry that registered significant progress in the 1960's was in the export of ornamental fish.

By 1970, a crisis in the fishing industry became evident. Rising labour productivity and labour remuneration in several sectors such as manufacturing, commerce, banking, construction and tourism clearly indicated that the local fishing industry had to reach a higher level of technical sophistication and productivity if it were to compete successfully for the increasingly better trained and educated labour force and the higher expected rate of returns on investment. Otherwise, it might have to cease operations in Singapore altogether as a commercial enterprise.

The prospects for improvement in the early 1970's were not good. Indeed, there was a steady decline in local fish output. In 1967 local output was 17,921 tons and it fell to 15,662 tons in 1972. The reasons for the decline have already been mentioned. The decline came about because of loss of inshore fisheries resources due to land reclama-

tion and water pollution resulting from industrial activities. The sharp decline in inshore fish catches was more than what can be compensated by the increase in offshore catches.

Deep-sea fishing may be the only solution if the fishing industry is to survive in Singapore. It was granted pioneer status but so far nothing tangible has been achieved. Requests by the Singapore deep-sea fishermen for permission to fish in the Indian non-territorial waters around Andaman and Nicobar islands were rejected by the Indian Government. Another difficulty encountered is said to be the great reluctance of Singaporeans to work in the deep-sea fishing which generally requires long periods of absence from Singapore as well as long and irregular working hours.

Problems of the Industry

From the above historical sketch of the development of the fishing industry in Singapore, one can identify the following major problems facing the industry.

First, there is very limited amount of inshore fisheries resources in Singapore. Over the years these have been fully exploited even using primitive traditional methods. This limited amount has actually declined because of land reclamation and water pollution by industrial wastes. The declining catches also indicate the possibility of over-fishing.

Second, the technological level of the local fishermen, especially those operating inshore, is low. Modern methods and equipments, however, may not be enough since other barriers to the development of the fishing industry include the inability of the industry to attract and retain better trained and better educated labour partly because of the nature of the job and the availability of more attractive alternatives on shore, and the lack of adequate researches in various aspects of tropical fisheries.

The fishing industry in Singapore faces severe labour problems, probably of a type quite different from those confronting the fishing industries of the other nearby countries. Labour turnover is high and the industry experiences great difficulty in attracting and retaining labour although the wage rate paid is high compared to that in other countries in the region. Thus, local fishermen are paid an average of \$300 per month plus free board and lodging on board. This is better than twice the amount obtained by Thai fishermen.

Because of the Singaporean worker's reluctance to have to work long and irregular hours for long period away from Singapore and the availability of more attractive alternatives, the number of fishermen in Singapore had declined from 5.0 thousand in 1960 to less than 2 thousand in 1976 (See Table 1). As a result of this shift of labour from the industry to other sectors of the economy, several joint ventures had failed.

Table 1. Number of fishermen engaged in the fishing industry ^{a/}

Item	1960	1965	1969	1972	1974	1976
1) Fisherman employing non-powered vessels	2637	1619	363	233	287	N.A.
2) Crew and fishermen on powered vessels						
a) Inboard	1065	1230	664	1602	1471	N.A.
b) Outboard	1128	886	237	430	436	N.A.
3) Prawn pond fishermen	153	48	34	N.A.	N.A.	N.A.
Total	4984	3783	1340	2265	2194	

Source: Primary Production Department Singapore.

^{a/}Figures here do not include fishpond operators and those fishermen employing gears which did not require licensing.

Third, the attempts to venture out into the off-shore and deep-sea fishing have been hampered by the problem of piracy and uncertain access to national territorial waters.

While most forms of fisheries in Singapore have found the Singapore situation inhospitable, and many are threatened with extinction, the story is a relatively rosy one for the ornamental or aquarium fish industry. The aquarium fish industry has grown tremendously. In 1960 we exported \$462,350 worth of aquarium fish and in 1974 we exported \$12.6M worth (See Table 2). With this increase there has also been an increase of difficulties. The 1973 Census of Agriculture estimated that 60 hectares of land used as farm holdings also reared aquarium fish as part of their activity. An average of 12% of farm holdings rearing fish were resettled. This makes approximately 250 farms. Out of the number of farm holdings rearing fish, about 50% of these are aquarium fish farms.^{3/} Thus the number of resettlements in that year for aquarium fish farms approximated 120. These resettlements are due to the land constraint coupled with the impact of urbanization and industrialization moving into the outlying rural areas. However these new locations also created problems for the aquarium fish industry:

- a) The locations given are unsuitable for breeding due to difficulties in obtaining the facilities required. These locations have a lack of free water resources and the extended distances make it more isolated and thus more difficult to sell to the middlemen.
- b) Aquarium fish are reared mainly in mixed farms as a secondary activity and the difficulties resulting from the relocation may induce the breeders to abandon the aquarium fish rearing altogether.

In this relatively new industry mutual co-operation would be very beneficial. Co-ordinated efforts in marketing, transfer of knowledge and research facilities could then be affected to improve the position of the industry as a whole. However this has not been possible, the problem of wide geographical distribution and large number and sizes have made the coordination of these breeders more difficult as shown by the Singapore

Table 2. Imports and exports of aquarium fish.

	Imports		Exports	
	No.	\$	No.	\$
1960	1,147,716	192,979	2,676,079	462,350
1961	1,183,473	195,289	3,181,345	549,649
1962	1,795,970	218,280	4,026,420	583,937
1963	2,434,451	287,264	5,975,080	782,174
1964	4,390,542	448,172	7,558,685	1,059,473
1965	8,282,342	854,921	11,140,897	1,634,194
1966	9,943,204	1,073,465	17,160,680	2,272,734
1967	13,650,794	1,418,721	20,507,007	2,573,680
1968	12,830,763	1,048,348	29,224,457	3,642,095
1969	399,416	30,810	10,469,231	455,063
1970	21,273,349	1,865,737	70,155,880	6,167,407
1971	NA	1,855,529	NA	7,591,172
1972	NA	2,816,005	NA	9,604,923
1973	NA	2,774,164	NA	13,359,429
1974	NA	3,218,356	NA	12,552,867

Source: Department of Statistics, *Singapore External Trade Statistics*

^{3/}Census of Agriculture, 1973.

Aquarium Fish Breeder's Association, the Singapore Aquarist Society and the Singapore Guppy Club are merely meant for hobbyists or aqua fish enthusiasts and not for commercial breeders.

The general decrease of price of aquarium fish over the past decade provides another problem. This decrease has been due to an increased number of breeders and an increased scale of operation which has increased supply. Demand however has not registered the same levels of increases. Secondly aquarium fish must be sold quickly once they reach the "exportable" size. This is to maximize their profits as additional costs would be incurred in feeding and maintaining unsold fishes. Increased space is also required. Thus rather than run the risk of unsold fish most breeders are willing to accept lower prices for their fish.

Thirdly, there exists price-undercutting by some breeders. This is particularly in the case of large-scale breeders. They are able to reduce the price of aquarium fish supplied due to the economies of large-scale production. Price-cutting is also a problem among exporters. To secure foreign orders, exporters especially the established ones resort to price-cutting. This only encourages their competitors to counter by undercutting them in return. The reason being that the aquarium fish is a homogeneous product. The seller is only one of the many who can meet the requirements of the buyers. Secondly there is no controlling body to oversee the price of the exported fish.

In addition, a high degree of risk and experience is involved in this export trade. Newcomers find great difficulty in securing new orders as they have to compete against the well established exporters who have both the experience and the reputation as quality fish exporters. Sometimes, there is little incentive for expansion by newcomers. Also, the fear of being swindled makes them apprehensive towards increasing their scale of activities.

In the aquarium industry, the family-orientated business style is prominent among the larger and more established breeders and exporters. This limits the transfer of knowledge and skills relevant to the business to only family members. These 'secrets of the trade' thus do not benefit the industry in general. Although there are about 100 exporters engaged in the export of aquarium fishes today, it is mainly monopolised by a handful of exporters. Approximately 70% of the total value of aquarium fishes exported in 1974 were derived from only 10 exporters.

Finally, the worldwide inflation has also affected the aquarium industry through increased transportation costs such as increased freight charges, packing materials costs and associated services. These increased costs has further dampened the market because the cost has to be passed to both the suppliers and the buyers. With increased costs and decreased prices, new suppliers are not readily induced to enter the industries.

Policy Objectives and Evaluation of Government Initiated Measures

Some mention has been made of the steps taken by the Singapore government to help the fishing industry. Practically all of these were initiated after 1966. Prior to that, there was little or no attempt to influence the fishing industry one way or another. In any case, being such a small sector both in terms of contribution to GNP and total employment, the fishing industry does not warrant a high order of priority for government attention.

In view of our limited resources and the various problems faced in the fishing industry, the government policies had been towards the development of those fisheries with greater potential. The Singapore Government agreed to contribute 1/3 of the actual operating cost to the Research Department subject to a maximum of US\$40,000 p.a. As there is little scope for the development of the inland and coastal fishery the emphasis had been towards the development of the offshore/deep-sea fishery. This was done in the hope that increased offshore production could compensate for the declining production in the inland and coastal fisheries. Many joint ventures with foreign centres

were formed, e.g. Tri-Marine, Morrisco, etc. In addition, in December 1967, Japan, Malaysia, Philippines, Singapore, Thailand and Vietnam signed an agreement to establish the Marine Fisheries Research Centre of the SEAsian Fisheries Development Centre. The government policy and rule was mainly one of providing the infrastructure and clearing the actual operations to the private sector. This Marine Fisheries Research Department (MFRD) aims to develop the fishing grounds in South East Asia by experimental fishing. Secondly it also carries out research in fishing gears, equipment, fishing methods and general handling of fish at sea, with close co-operation from the training sector. Another function of MFRD is to conduct investigations of fisheries resources and research in fisheries oceanography for South East Asian countries. Lastly, it also aims to train research personnel and technicians.

Emphasis on fishing research was placed on applied research, i.e. search for new fishing grounds, ponds and better exploitation of existing grounds since its establishment, many research projects have been carried out such as: -

- a) Pelagic fisheries resources survey which involves
 - (1) Evaluation of fisheries resources potential in the region
 - (2) Hydrocaustic survey on the distribution and detection of pelagic fish schools and study on the methods for estimation of fish abundance
 - (3) sampling of fish school by means of purse seine and mid-water trawls
- b) Demersal fisheries resources survey which involves
 - (1) Monitoring survey in the south China and the Andaman Sea
 - (2) Exploitation of resources in untrainable grounds
- c) Evaluation of fishing efficiency of different types of trawl fishing gears
- d) Effect of pollution on main organisms

The above outline is impressive. However, the emphasis of the research as applied research has yet to be fulfilled. For one, the research projects are hampered by lack of financial support (the US Grant ended in 1973) and the detention of 'RV Changil, the survey ship. Thus many barriers have to be overcome before the research findings can be of commercial value such as:

1. the applicability of findings to the local fishing industry;
2. transferability of the knowledge to local fishermen;
3. adoption of these new methods or findings as against using traditional practices.

In its efforts to modernize the fishing industry, the Government also encouraged the establishment of the fishery training school in 1967 at Changi. The purpose was to train fishermen and youth in modern methods of fishing (as well as retraining fishermen to switch from inshore to offshore and deep-sea fishing). This was set up with the assistance of the UN Development programme. However, in the yearly training course, only an average of 6 trainees were from Singapore. The poor response and the utilization of the land in Changi for the construction of Changi airport finally led to the closure of the \$8m Training school in Jan. 1976. The school was running at a substantial loss.

In conjunction with its emphasis on deep-sea fishing development, the government had also made efforts to change the consumer tastes. A campaign was launched recently to encourage the people to eat frozen fish. Many supermarkets and fishmongers had indicated that there had been an increase in their sales of frozen fish which could give encouragement to the deep-sea operators.

Another effort of the government was the centralizing of the fish markets and the building of a fishing port in Jurong which were completed at the end of 1967. The fish market serves as a central auction market for Singapore. This has greatly helped to

stabilize both prices and supply and also offers the investors assurances that the catches brought back by the boats would be promptly and fairly marketed.

The government has also encouraged foreign companies to use the Republic as a base for deep sea fishing. As already mentioned joint ventures were also encouraged with these foreign companies which could then supply the finance and expertise needed in the fishery industry.

Examples of these joint-venture include Tri-marine, Morrissco (Russian/Singapore joint venture), Pans Seas Enterprise which is a Taiwan/Singapore Venture. As already mentioned, these ventures also encountered several problems.

On the whole, the success of the efforts in encouraging deep sea fishing can be seen in the increased catch from 3739m tonnes in 1960 to 6626m in 1965 and 10051 tonnes in 1976. (See Table 3).

The aquarium sector had also been very promising. The government policy is helping to develop this fish hobby into a big earner. The Primary Production Department had hoped to turn it into an appreciable foreign exchange earner by helping and encouraging the local breeders to discard old techniques of cultivation and embark on new techniques. Experiments were conducted to rear these tropical fishes in cement ponds instead of the glass tanks. In addition, the Van Kleef Aquarium had assumed an additional role as a research centre for tropical and aquarium fish rearing. In July 1967, the Primary Production Department launched a publicity campaign to draw the attention of the public to the potentialities of other new export-oriented industry. Advances had also been made in the techniques and methods of tropical and aquarium fish rearing through research at the Sembawang research station for the past years.

The Sembawang station provided extension and advisory services to fish breeders and hobbyists. Research was also conducted on fish diseases, nutrition, growth rates and packaging of fish for transport. Experiments were also done by the Freshwater Fisheries Laboratory to grow aquarium fish in cages floated in ponds. The results were promising. The Changi aquarium station had also carried out studies on induced breed-

Table 3. Fresh Fish Supplies (Metric tonnes)

	1960	1965	1969	1973	1976
1) Local production					
a) Inland	5481	4276	83409	710	654
b) Inshore				5685	5724
c) Offshore/deep sea	3739	6626	13680	12265	10051
d) Total local production	9220	10971	17089	18660	16429
2) Imports					
a) Imports from W. Malaysia	25367	44522	38742	50277	37641
b) Imports from territories other than W. Malaysia	6107	3765	3880	7520	15645
c) Total imports	31474	48287	42622	57797	53286
3) Total availability					
1 (d) + 2 (c)	40694	59258	59711	76457	69715
4) Exports					
a) Exports to W. Malaysia	2644	1951	719	770	1772
b) Exports to territories other than W. Malaysia	198	609	1086	5290	6538
c) Total Exports	2842	2560	1804	6000	8310
Total consumption 3-A (c)	37852	56698	57907	70397	61405

Source: (1) Department of Statistics, Singapore

(2) Primary Production Department, Ministry of National Development, Singapore.

ing of marine aquarium fish. Singapore also aimed to act as a distribution centre for international markets. The number of countries exported to had increased from 36 in 1966 to more than 60 by 1974. These exports went mainly to developed countries such as the US, Western Europe, Australia and Japan. In fact, 70% of the exports were absorbed by only 7 countries, while 92% of Singapore's imports came from 4 countries, namely Hongkong, Thailand, W. Malaysia and Taiwan. Most of these were re-exported, thus emphasizing the importance of Singapore as a collection and distribution centre.

On land, the emphasis is also one of intensive cultivation, especially in the case of freshwater fish and prawns. The Primary Production Department has made a major breakthrough in fish production through the cage-net system which will enable land-scarce Singapore to rear fish on a large-scale within a confined space. The Freshwater fisheries laboratory had been experimenting with the system for the past few years and had succeeded in rearing between 400 and 800 fish in a net cage measuring 3m x 0.9m. These cages offer economic potential in terms of maximum utilization of land and water resources. They can be floated in lakes, reservoirs, rivers and coastal seas. The emphasis is to rear these high-valued fish such as the marble goby on 'soar rock'. However, the question remains as to whether the local breeders will accept such new technique and the costs involved since most of the breeders have very little capital investment.

The government scheme for prawn production is also an intensive one. Here the national development is to improve the production techniques and breeding methods at authorized prawn ponds. To date Singapore is still very dependent on imported prawns. About 60% of the prawns for domestic consumption are imported.

Conclusion

From the facts and discussion presented above, it seems clear that the fishing industry has been and will continue to play a very small role in the total Singapore economy, except possibly at the time of the founding of modern Singapore. It is not only getting smaller in relative terms but also absolutely whether measured in contribution to GNP, value added or employment terms. Hence, its role in the past and in the future as well could only be described as marginal.

In the context of this Conference's perspective of fisheries development as a means to improve the income and welfare of peasant fishermen and the protein component of the diet of the general population, the conclusion that one must come to in the case of Singapore is that these objectives are and have indeed been better achieved in other ways. These include pursuing a policy of rapid economic development with sectoral transformation and resource allocation to create more lucrative job opportunities in the high growth sectors and to use the enhanced purchasing power thus generated by the overall increase in productivity of resources to import those goods for which Singapore does not enjoy comparative advantages. It seems that fishery production may well be one of these, at least, at this stage of Singapore's economic development.

Just as it is inefficient for Singapore to produce its own rice and that it is beneficial both to Singapore and to other countries that it imports what it requires from countries better able to produce a rice surplus for export such as Thailand so it is with fish.

While the role of Singapore in the production of fish in this region is small and is likely to continue to be so, it does not necessarily mean that Singapore cannot or will not play an important role in the marketing, processing and distribution of fish and fish products or in the research training and servicing of the fish and related industries in this region. The prospects are that it will have an important role to play in some of these areas.

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