Aquaculture in Malaysia

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Abstract

Aquaculture in Malaysia is experiencing rapid growth. Total production in 1992 amounted to 79,699 tons valued at RM 207.4 million. These figures are 23% and 25% higher than the previous year's. Semi-culture of the cockle *Anadara granosa* was still predominant, contributing about 70% of the total output. Culture and production of the oyster *Crassostrea iredalei* is still insignificant. Sea bass *Lates calcarifer* constituted over 80% of the production from marine cages. Cage culture of grouper *Epinephelus* sp., snapper *Lutjanus* sp. and pompano *Trachinotus blochii* were also done in much smaller scale. The mangrove snapper *Lutjanus argentimaculatus* was recently spawned in captivity and larvae and juveniles were produced. In 1992, the tiger shrimp *Penaeus monodon* constituted about 87% of brackishwater pond production. Pond culture of the white shrimp *P. merguiensis* and the mudcrab *Scylla* sp. is at the experimental stage. Red tilapia hybrid was the major freshwater species cultured in cages, with 1,486 tons harvested in 1992. Freshwater pond production was valued at RM 100.85 million, 22% of which was due to the eel *Anguilla japonica.* Production of freshwater ornamental fishes is also becoming significant. Other exotic species recently bred and cultured are the African catfish *Clarias gariepinus* and the pacu *Piaractus brachypomus.* The indigenous freshwater catfish *Mystus nemurus* and carp *Probarbus julleini* have recently been bred in captivity and cultured experimentally. Lately, there have been attempts to culture non-conventional species such as the bullfrog *Rana catesbeiana,* the soft-shell turtle *Trionyx sinensis,* and aquatic ornamental plants.

Introduction

Development of aquaculture in Malaysia is relatively recent. The earliest beginnings can be traced to the turn of the century, but sizeable farms only began in the 1950s with the semi-culture of cockles and the culture of Chinese major carps in mining pools. Significant changes took place during the last two decades after the introduction of fish culture in marine cages in the

early 1970s (Chua 1979, Chua and Teng 1979, 1980), and more recently, the involvement of the corporate sector in commercial marine shrimp culture (Kuperan 1988).

The industry has grown rapidly in recent years. Production from aquaculture in 1992 was 79,699 tons valued at RM 207.4 million (Table 1). These figures are 23% and 25% higher than the corresponding figures the previous year. However, aquaculture contributes only 7% of the national fish production of 1,023,516 tons. Employment was also insignificant, as only 17,852 fish farmers were involved, 90% of whom were in freshwater aquaculture. Total pond area for aquaculture in 1992 was 8,360 hectares, 80% of them freshwater. In the same year, a total of 426,846 m^2 of cages were used, 93% of them for marine fish cages.

Table 1. Aquaculture production in Malaysia in 1992, by farming systems. Data from Annual Fisheries Statistics, Malaysia, 1992. US$1=RM2.5

Fanning system	Area (ha)	Production (ton)	Value (RM x 1,000)
Cockle semi-culture	4,316	55,587	14,534
Mussel culture	4.7	1,493	629
Oyster culture	3.6	33	324
Marine cages	39.8	3,369	36,189
Brackishwater ponds	1,703	3,225	51,431
Freshwater ponds	5,598	14,162	97,618
Freshwater cages	2.9	484	3,403
Mining pools	1,059	1,346	3,227
Total		79,699	207,355

No less than 30 species are being cultured in Malaysia for food. In addition, hundreds of fish varieties are being bred and traded as ornamental organisms. The cockle *Anadara granosa* is the main aquaculture species in terms of production, but the tiger shrimp *Penaeus monodon* is the largest single contributor in terms of value.

Cockle Culture

Cockle culture is the mainstay of Malaysian aquaculture in terms of output. Production of cockle in 1992 was 55,587 tons valued at RM 14.5 million (Table 1). This production was 16% higher than the previous year's inspite of a 24% drop in the total culture area. Cockle production areas are on the west coast of peninsular Malaysia, particularly in Perak, Selangor and Penang, which have extensive mudflats. The industry still depends on natural spatfalls for the supply of seed. Spatfalls occur throughout the year mainly in the above-mentioned states and only in smaller quantities in other areas. Spatfalls occur with two peaks in one year. The peaks differ slightly between regions but generally occur between December and April and between May and July (Ng, in press b). The yearly abundance and seasonal occurrence of spats vary for unknown

reasons. Cockle spats were abundant in 1985 (nearly 14,931 tons) but amounted to less than 1,800 tons in 1982-83 and only 3,481 tons in 1991 (Annual Fisheries Statistics, Malaysia, 1992).

The cockle culture method (Ng 1984, Broom 1985, Noordin 1988) has remained unchanged. Spats collected from the wild are spread over the culture beds. Present regulations stipulate that only spats larger than 6.4 mm may be collected from natural spatfall areas. The culture densities vary depending on the spat sizes. Stocks are culled after 3 months of culture. Optimum production is usually attained after a year of culture. Present regulations stipulate a minimum harvestable size above 3.2 cm. Average annual production is about 30 tons/ha.

Although cockle has been successfully bred in captivity (Kamal 1986), hatchery spat production on a commercial scale is not economical at the moment. Spat supply from natural sources is still abundant, but there has been a gradual decrease in the amount of spats in the last few years, and appropriate measures are necessary to protect natural spatfall areas.

The post-harvest quality of cockle has been improved through depuration. The Fisheries Research Institute has developed a pilot-scale depuration unit using UV radiation capable of reducing the bacterial load of cockles to below 20 cells per gram after 36 hours. A number of such depuration units have already been used by the private sector for mollusks in general.

Mussel Culture

Culture of the green mussel *Perna viridis* also depends on natural spats. Major spat collecting areas are in the southwestern coast of peninsular Malaysia, in the southern states of Johore and Melaka. The main source of mussel seed in recent years has been Melaka. The season for spat collecting is normally between March and May. The techniques for mussel culture have hardly changed from those described by Choo (1983) and Noordin and Choo (1989). The mussels are mostly cultured in discarded trammel nettings hung from floating raft, rack or longline systems. Attempts to transfer the culture operations to other regions of the country have been technically successful, but the interest generated could not be sustained. Among the major reasons are the low marketability of mussels and the occasional problems with seed supply. There is no attempt yet to produce mussel spats in the hatchery due to the low economic return. Production in 1992 was a meager 1,493 tons (Table 1), less than the previous year's 1,563 tons. Efforts are being made to give added value to mussels by canning and processing.

Oyster Culture

Oyster culture is a recent effort in Malaysia that started with experimental culture in Sabah. The Fisheries Research Institute under the Bay of Bengal Programme generated interest in oyster farming in peninsular Malaysia. Prior to this, oysters were collected and sold in the form of shucked meat that fetched a low price in the market. With the introduction of oyster culture, mainly of the *Crassostrea iredalei,* the oysters are marketed shell-on at significantly higher returns. Production of cultured oyster in 1992 was 33 tons valued at RM 0.3 million (Table 1). Other species being cultured include *C. belcheri* and *Ostrea folium,* both of which are mainly marketed as shucked meat. The sources of *C. iredalei* spats are some river estuaries in the northeastern coast of peninsular Malaysia. Spats of *C. belcheri* are found on the west coast.

Spats of *C. iredalei* can be produced in the hatchery at the Fisheries Research Institute, but the technology has not yet been taken up commercially. Present research on oyster seed production focuses on the development of remote setting techniques for the eyed larvae (TM Wong, personal communication).

Marine Fishes in Cages

Culture of marine fishes in floating cages has rapidly developed since its introduction in the early 1970s. The production in 1992 was 3,369 tons valued about RM 36.2 million (Table 1). Marine cages are sited mostly near human settlements in Penang, Selangor and Johore. The last few years also saw a significant increase in marine cage culture in Kedah and Perak. Nonetheless, productivity is still low, with a national average of 8.5 kg/m^2 per year.

The sea bass *Lates calcarifer* is the main species cultured, constituting 81.5% of the total output (Table 2). The technology for sea bass seed production has been developed locally (Ali 1987a, 1987c) and there are a few hatcheries, but a significant number of small juveniles still has to be imported to meet the demand of the cage culture industry. The Malaysian government envisages the establishment of 330,000 m^2 or 8,250 units of marine floating cages for the culture of sea bass; production is expected to increase to 4,000 tons by year 2000 (Ali 1987b).

Other species being cultured in cages include the grouper *Epinephelus malabaricus* (Chua and Teng 1979, 1980) and the mangrove red snapper *Lutjanus argentimaculatus.* One problem in grouper culture has been vibriosis (Wong et al. 1979). Lately, cage culture of the golden pomfret *Trachinotus blochii* has been initiated by some farmers in southern peninsular Malaysia. There are at present a few local hatcheries for mangrove snapper and the grouper *Cromileptis altivelis.* Research on the propagation and seed production of mangrove snapper and grouper is ongoing at the Marine Fish Production and Research Center, Terengganu. *Epinephelus suillus* has been spawned in captivity, and larval rearing techniques are being refined (Doi et al. 1991).

Shrimps in Brackishwater Ponds

The tiger shrimp *Penaeus monodon* constituted 87% of the 1992 production from brackishwater ponds and was valued at RM 46.3 million (Tables 1-2). The other pond-grown shrimp is *Penaeus merguiensis.* Aquaculture production of shrimps has risen from 60 tons in 1984 to 2,963 tons in 1992, whereas marine landings have ranged from 81,627 tons in 1984 to 126,405 tons in 1992 (Annual Fisheries Statistics, Malaysia, 1992).

The grow-out technology for marine shrimps has not changed much from that described earlier (Ong et al. 1989). At present, most shrimp farms practise the semi-intensive system of culture with an initial stocking density of 10-20/m^2 giving a yield of 2-3.5 tons/ha-yr (Singh and Kamaruddin, in press). The prevailing production cost ranged RM 9-14/kg and the ex-farm price ranged RM 18-22/kg.

Table 2. Production of fishes and crustaceans from marine cages and brackishwater ponds in 1992. Data from Annual Fisheries Statistics, Malaysia, 1992. US$1 = RM2.5

Culture system Species	Production (ton)	Value (RM x1000)
Marine cages		
Lates calcarifer	2,784	25,572
Epinephelus spp.	288	7,648
Lutjanus spp.	281	2,857
Others	16	112
Brackishwater ponds		
Penaeus monodon	2,820	46,260
Penaeus merguiensis	143	2,917
Scylla serrata	71	586
Fishes	191	1,668
Total	6,594	87,620

At present, hatchery production of shrimp postlarvae is more than adequate to supply the local shrimp industry. There were 44 shrimp hatcheries producing 3.7 billion postlarvae in 1992 (Singh and Kamaruddin, in press). The local hatchery technology has not changed significantly and still depends on gravid females from the wild. The National Prawn Fry Production and Research Centre (NAPFRE) in Kedah is the only hatchery with a broodstock maturation program (using eyestalk ablation) for the production of nauplii. NAPFRE produced 80 million postlarvae in 1993 and proved that the nauplii were not different in quality from those spawned by wild broodstock (PC Liong, personal communication).

Mudcrabs in Brackishwater Ponds

Crab fanning in Malaysia started in the 1970s but has not become attractive to fanners. Lack of juveniles is the major constraint. At least two species of crabs are being cultured: the brown mangrove crab *Scylla serrata* and the green sea crab *S. oceanica tranquebarica* (Liong and Subramaniam, in press). The green sea crab fetches a better market price and grows faster. The small juveniles for culture are obtained from the wild in Malaysia and also imported from other countries in the region. Crab juveniles have been successfully produced in the NAPFRE hatchery, but the cost of production is still high and hence, commercial seed production is not yet economically feasible.

Two distinct operations are involved in crab production. Culture involves rearing of juveniles for several months (during which crabs molt several times) to the harvestable adult stage. Culture in floating net cages results in low survival. Nowadays, crabs are cultured in 100-500 m^2 tidal ponds (Liong and Subramaniam, in press). The ponds are provided with adequate fencing to

prevent escape of the crabs. Continuous stocking is usually practised and 'trash' fish is used as feed. Culture period is normally 3-5 months and survival varies between 40 and 80%, depending on the initial stocking size, density, and duration of culture. Some farms use methods to induce molting because soft-shelled crabs fetch a better market price.

Fattening involves holding and feeding already big or adult crabs for short periods often to adjust to favorable market conditions. Crab fattening is done in cages placed in river estuaries or in ponds. Two types of cages are presently used: converted fish cages (3 × 3 × 1 m) with wooden covers and smaller wooden-frame Netlon cages (2 × 1.5 × 0.6 m). At present, there are less than 20 crab-fattening projects around the country (Liong and Subramaniam, in press).

The other pond-grown species are the mangrove snapper, sea bass, and grouper. There are also a few farms in Penang that culture milkfish *Chanos chanos* mainly as baits for tuna fishing.

Freshwater Fishes in Cages

In Malaysia, freshwater cage culture is usually done in disused mining pools and reservoirs. Production in 1992 was 483.5 tons (Table 1) down from 574 tons in the previous year. Tilapia is farmed at semi-intensive to very intensive levels with production up to 300 tons/ha-yr (Ng, in press a). Red tilapia hybrid is the dominant species contributing 70% of the total output. Other species cultured in cages include the Javanese carp *Puntius gonionotus,* grass carp *Ctenopharyngodon idella,* and river catfishes *Pangasius sutchi* and *Mystus nemurus.* Commercial culture of *M. nemurus* in the Kenyir reservoir uses larvae and juveniles caught from the reservoir.

Freshwater Fishes in Ponds

In terms of value, freshwater pond culture is the largest contributor to aquaculture production. In 1992, a total production of 14,162 tons was achieved with an estimated value of RM 97.6 million (Table 1). The increase in production over the previous year's was mainly due to greater pond area and greater average production per unit area.

The production of eel, *Anguilla japonica* increased from 442 tons in 1991 to 1,572 tons in 1992, making eels the largest single contributor to freshwater aquaculture in terms of value (Table 3). Commercial production of eel in Malaysia started in 1990 in a single 2,000-hectare farm on the east coast of peninsular Malaysia. The farm has 400 eel culture ponds about two hectares each and employs no less than 1,600 workers (Sukor, in press). The elvers are imported from East Asian countries and cultured either in monoculture or in polyculture with tilapia. The harvested eels are mainly exported, either live or processed, to Japan.

Various strains of tilapia contribute about 20% of the total production from freshwater ponds (Table 3). Tilapias, particularly the red tilapia hybrid, are also grown in concrete tanks under very intensive systems with aeration and supplemental feeding. Average tilapia production is about 15 kg/m^2 after 150 days of culture starting with 80 gram juveniles (Ng, in press a).

Table 3. Production of freshwater fishes and giant prawn, 1992. Data from Annual Fisheries Statistics, Malaysia, 1992.

Species	Production (ton)	Value (RM x 1,000)
Anguilla japonica	1,572	22,008
Oreochromis niloticus	3,145	20,814
Red tilapia	1,486	5,886
Puntius gonionotus	2,505	13,258
Cyprinus carpio	1,703	15,119
Aristichthys nobilis	1,222	2,792
Ctenopharyngodon idella	913	4,087
Leptobarbus hoevenii	481	3,710
Oxyeleotris marmoratus	115	2,610
Clarias spp.	904	3,341
Other fishes, ornamentals	1,852	9,099
Macrobrachium rosenbergii	94	1,526
Total	15,992	104,250

Chinese and Indian carps are mainly cultured in earthen ponds, mostly by small-scale operators using polyculture and integrated farming systems (Kechik, in press). The Chinese major carps, once the dominant group in freshwater aquaculture, are gradually being replaced by tilapias. Present-day extensive culture of Chinese carps is mainly confined to disused mining pools under the 'put-and-take' system. The Javanese carp *Puntius gonionotus* contributes 17.5% of the total output from freshwater ponds (Tables 1 and 3).

The marble goby *Oxyeleotris marmorata* is the largest freshwater eleotrid; it can grow to 2 kg and 50 cm total length. It is the most expensive freshwater table fish in restaurants in Malaysia, fetching retail prices of RM 20-50/kg, in contrast to carps and catfishes at RM 2-7/kg (Senoo et al., in press). Artificial seed production of the marble goby has been developed but not yet commercialized.

The last few years saw the introduction of many exotic species into the country, either intentionally or otherwise. The African catfish *Clarias gariepinus* and its hybrid with the local *C. macrocephalus* have become very popular among farmers due to their hardiness, ease of culture, high growth rates, and availability of fry. However, their market acceptability and price are low compared to those of the local *C. macrocephalus.* These catfishes are stocked in ponds at 5-20/m^2 and fed a floating pelleted diet with 18-24% protein, usually supplemented with chicken viscera, 'trash' fish, and rice bran (Thalathiah, in press).

Another exotic species that has generated some interest among farmers recently is the South American pacu *Piaractus brachypomus* (Zaini et al., in press). However, the culture of this species is regulated to prevent wrongful introduction into natural water bodies. Hence, pacu culture is small-scale, mainly for ornamental purposes.

Breeding and Culture of Ornamental Fishes

Breeding and culture of ornamental fishes gained prominence in the 1980s with the establishment of farms particularly in southern peninsular Malaysia. The industry has grown rapidly ever since. There were about 18 farms in 1988 and 366 farms in 1993 (Ismail and Mazuki, in press). Of these farms, 311 were directly involved in fish breeding, 12 in the propagation of ornamental aquatic plants, and 43 in the production of live feed for aquarium fishes. The export of ornamental fishes has also increased in recent years. In 1989, a total of 79 million pieces worth RM 5.9 Million were exported. At least 166 varieties of fish were produced, with goldfish and Koi carp constituting 28.6%, barbs and danios 18.7%, and poecilids 21.8%. Different states in Malaysia specialize in the production of particular ornamental fishes.

Despite the rich ichthyofaunal resource in Malaysia, most of the ornamental fishes that are bred are not indigenous. Lack of knowledge of the biology of indigenous species limits their aquaculture. To remedy the situation, research is being focused on the propagation of indigenous species. Recently, the indigenous and highly priced arowana *Scleropages formosus* was successfully bred in captivity by a private farm. This species is at present classified as endangered under CITES. Breeding and culture technologies are being developed for the indigenous carps such as *Tor tambroides* and *Probarbus julleini* and the river catfish *Mystus nemurus.*

Breeding and Culture of Bullfrog and Terrapin

The breeding and culture of the fast-growing and highly marketable bullfrog *Rana catesbeiana* has been actively pursued in Malaysia (Lim, in press). Currently, there are at least 12 bullfrog farms in Malaysia producing about 80 tons of frog meat annually. Breeding is done in the farms. The culture ponds are 10-100 m^2 wide and 2-10 cm deep. The stocking density is about 50/m2. Mortality up to 30% occurs usually during the first 60 days of culture, mainly due to cannibalism. After 4 months of culture, the frogs attain the harvest size of 250-300 grams. The dressed carcass is normally packed and deep frozen for the market. At present, the entire production is absorbed by the domestic market, where the retail price of RM 20/kg is better than the export price. Domestic consumption of frog meat is about 400 tons annually. With better technical personnel and better feeds, Malaysia can meet the local market demand for bull frogs and even compete with India and Indonesia for the European and Japanese markets.

The culture of soft-shell turtle or terrapin *Trionyx sinensis* was introduced to Malaysia by Singaporean farmers about eight years ago. Now there are two well established terrapin hatcheries and a few small-scale grow-out farms in peninsular Malaysia (Heng, in press). Ponds are 200-1,000 m^2 with sandy bottom and specially constructed vertical concrete embankments or 'basking areas'. Stocking rates range 8-12/m^2 depending on availability of hatchlings. It takes about a year for the terrapins to reach the harvest size of 500-600 grams, with 'trash' fish and chicken offals as feed. Harvesting may be partial or complete. Terrapins are normally sold live in the local and export markets. Poor grade hatchlings are also sold for ornamental purposes. Terrapin culture has very good potential because of the increased demand in both local and overseas markets, but technical know-how is insufficient.

Scope and Potential for Further Development

There is considerable potential for further expansion and development of aquaculture in Malaysia, both in terms of available resources and supporting infrastructure and services. Aquaculture is being accorded due recognition by the government and has been identified as one of the thrust areas for development under the New Agricultural Policy (1991-2010). By year 2010, aquaculture production is projected to reach about 200,000 tons and contribute about 15% to the total fish production annually. Shrimp culture and fish culture are expected to be the main areas of growth. Although cockle culture is still expected to be dominant, its percentage contribution is projected to decrease from 70% to about 20%. Rapid growth of oyster culture is foreseen.

The strategies for aquaculture development include:

- Development of new sites for the various culture systems

Availability of potential sites for aquaculture is well recognized. Efforts are now being made to identify and map these areas for future planning, especially in the formulation and subsequent alienation of 'Aquaculture Development Areas' (Tan, in press). Mapping is done through remote sensing and geographical information systems. One of the setbacks in the past has been the indiscriminate alienation of land, sometimes in conflict with the interests of aquaculture, and resulting in low success rates and discouragement in the industry. Through zoning, further development and better management of aquaculture will be facilitated.

Construction of dams for various purposes in recent years has presented a vast resource for freshwater aquaculture. Most of the reservoirs (total surface area about 100,000 hectares) are not optimally used for fish production. Present government policy encourages the use of marginal agricultural lands near the coasts for brackishwater pond culture. Research is also conducted to develop cage culture systems in more exposed coastal waters and cockle culture in deeper waters.

- Development of new culture systems and species

Malaysia has vast untapped ichthyofaunal resource. Research is needed to identify potential species for exploitation by the aquaculture industry. Introduction of new species adds impetus to aquaculture development. Demand for new varieties is very acute in the ornamental fish industry. Priority is being given to the indigenous riverine species such as *Tor tambroides, Probarbus julleini,* and *Mystus nemurus.*

Marine and brackishwater species such as the seaweed *Gracilaria* sp., sea cucumber *Stichopus variegatus,* golden pomfret *Trachinotus blochii,* and abalone *Haliotis* sp. have been identified for further research. In addition, research is being initiated on the application of biotechnological and genetic principles in the improvement of cultured species. Such efforts include production of gynogenetic, polyploid, sex-reversed, and transgenic fishes.

- Refinement of present technologies

Efforts are also focused on the refinement of present hatchery and grow-out technologies to make them more efficient and cost-effective. Among the objects of research are the hatchery technologies for marine fishes, oysters, and mudcrab, and culture technologies for mudcrab, white

shrimp, and the freshwater prawn. Further research is also needed for the development of artificial feed for marine fishes, biomanipulation of culture ponds, and handling and post-harvest technologies.

Conclusion

The aquaculture industry in Malaysia is undergoing rapid development. Subsectors like marine cage culture and freshwater pond culture have grown tremendously. Shrimp culture and mussel culture need new impetus to move away from the present status. Inadequate supplies of larvae and artificial feeds, especially for marine fishes, require appropriate solutions. The future development of the aquaculture industry depends on effective fish health management. Overall, the outlook for further expansion of the Malaysian aquaculture industry is bright, but judicious planning, strong institutional support, and attractive credit and incentive schemes are still required.

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