

AQUACULTURE DEVELOPMENT IN MALAYSIA IN THE 1990s

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Aquaculture is still at an early stage of development in Malaysia. In 1991, for example, Malaysia's total aquaculture production amounted to only 64,344 t, while the overall fish production for the year totalled 976,272 t.

In recent years, however, there have been significant aquaculture expansion and development in the country. This was fueled not only by the declining catch rates in coastal and inland fisheries but also by the technical advances in aquaculture. There is still considerable potential for further development and production is expected to increase steadily for all the cultured species. With concerted efforts by the public and private sectors, aquaculture could contribute an annual production of more than 200,000 t by year 2000.

Existing aquaculture practices

There are several successful aquaculture systems in the country. These include:

- Cockle culture on coastal mudflats
- Freshwater fish culture in ponds and cages
- Freshwater prawn culture in ponds
- Penaeid or marine shrimp culture in brackishwater ponds
- Crab culture or fattening in brackishwater ponds
- Culture of marine fishes in brackishwater ponds and cages
- Mussel and oyster culture

Cockle culture. Cockle culture started in 1948 and has since developed into the most important aquaculture industry in Malaysia. The culture is, however, only semi-intensive as seed cockles are collected from natural spatfall areas and not hatchery-produced. The Fisheries Research Institute in Glugor, Penang has succeeded in the spawning and larval rearing of the cockle though large-scale (commercial) production of seed is still to be developed. So far, the supply of natural seed has been able to sustain culture operations, and the collection of seed is facilitated by the occurrence of a definite breeding season. Hence, spatfall in certain areas is definite.

Cockle thrive well on coastal mudflats with salinities of 18-30 ppt. They are sedentary and feed directly on the natural food abundant in the intertidal

Table 1. Cockle production and total marine landings

Year	Total marine landings (t)	Cockle production (t)
1991	911,933	46,625
1990	951,307	35,931
1989	882,492	39,346
1988	825,631	34,867

zone, and hence, require very little effort when cultured. The key factors in culture are (1) selection of suitable site (soil and water conditions) and (2) proper sowing and distribution of seed on culture beds. Extensive studies carried out on the growth of cockle have shown that maximum yield is obtained when they are harvested after a 1-yr growing period.

Cockle culture in Malaysia continues to be a viable industry although there has been no significant increase in production in recent years. In fact, there are indications that cockle production has declined with respect to the total marine fish landings (Table 1).

In view of the increasing consumer concern over mollusc sanitation - high faecal coliform counts frequently occur in samples of cockles from some selected localities - and the sanitary standards imposed on bivalve imports by many countries, the Fisheries Research Institute established in 1986 a depuration system for cockle. Purification to the required levels (<20 FC-MPN/g) could be achieved within 36 h even with highly contaminated cockle (1,260 FC-MPN/g).

Freshwater fish culture in ponds. Freshwater fish culture in Malaysia started more than 60 years ago. Progress was, however, slow in the early years, and significant expansion of freshwater fish culture only took place in the 1960s. The total number of freshwater ponds in the country in 1991 was 29,817 with a total area of 4,860 ha (excluding 644 ha of ex-mining pools).

Many species of freshwater fish are being cultured. These include the Chinese carps like the bighead (*Aristichthys nobilis*), grass carp (*Ctenopharyngodon idella*), and common carp (*Cyprinus carpio*); Indonesian carp (*Puntius gonionotus*); rohu (*Labeo rohita*); Nile tilapia (*Oreochromis niloticus*); sultan fish (*Trichogaster pectoralis*); jelawa (*Leptobarbus hoeveni*); patin (*Pangusias sutchi*); ketutu (*Oxyeleotris marmoratus*); and kalui (*Osphronemus goramy*). Although some of the freshwater species (ketutu, patin, and tilapia) are monocultured, most are grown under polyculture, with the ponds stocked with a suitable combination of different fish species which occupy different ecological niches. Polyculture fully utilizes the three-dimensional growing space and the diverse food organisms in the pond.

In a typical polyculture, the fish species stocked usually include the silver carp and the bighead carp which live in the upper and middle layers and feed on the phytoplankton and zooplankton in the pond, respectively; the grass carp and the Indonesian carp which live in the middle layer and feed on larger

aquatic plants (macrophytes); and the common carp which lives close to the pond bottom and feeds mainly on bottom-living organisms. Small number of carnivorous fish species can also be included to feed on the small fishes and shrimps that constitute the nekton of the pond ecosystem. However, the majority of the fish stocked in polyculture are plankton-feeders and herbivores. Primary production can be easily boosted by increasing pond fertility, often through organic (animal manure) fertilization. Hence, polyculture is often integrated with animal husbandry as the manure can be used to enrich the pond, and other agriculture crops, e.g., tapioca leaves, can be fed to the grass carp. The pond bottom accumulates rich organic matter which can be excavated and used to fertilize land crops.

The tilapias, very popular fish in some countries, are still not greatly demanded in Malaysia. There is, however, a growing interest in Nile tilapia; this species has a better appearance and market potential than the more common *O. mossambicus*. The main problem with tilapia is that it breeds readily unlike other freshwater fishes. It is also smaller. As a result, small-sized tilapias compete with each other as well as other fishes for food and space. Inclusion of carnivorous fish such as the giant sea perch (*Lates calcarifer*) checks tilapia population and increases harvest value.

Many of the polyculture ponds show very good growth and survival rates, and yields of more than 3 t per ha per year have been reported.

The seed supply of freshwater fish is comparatively easy to obtain as breeding techniques have been developed, although fry of some species are imported. The bighead carp, common carp, Indonesian carp, sepat siam, temakang, and kalui are bred at the Department of Fisheries stations set up in different parts of the country. Their fry are distributed free to fishfarmers. Only the fry of the Chinese major carps, particularly grass carp, are imported. The Freshwater Fisheries Research Centre at Batu Berendam, Malacca has succeeded in spawning the grass carp, rohu, catla, and ikan jelawat. While freshwater fish culture in ponds is predominantly polyculture, monoculture of some fishes, e.g., ikan ketutu, is also practiced but only in small scale. In monoculture, the fish normally do not depend on the pond's natural food. In the case of ikan ketutu, low-grade fish and cockle are fed, and although the feeding cost and labor are quite high, these are offset by its high price in the market. The fish can be artificially bred but because the fry grow slowly, mass propagation is not yet possible. Fry are instead collected from the wild, i.e., old mining pools.

Freshwater fish and prawn culture in ponds. Freshwater ponds that are used for polyculture and without predatory fish (such as snakehead or ikan haruan, catfish or baung dan keli) are suitable for udang galah (giant prawn, *Macrobrachium rosenbergii*) culture. The udang galah has many attributes that make it a very desirable species for culture, primarily its fast growth rate. It is also omnivorous, feeding on vegetable matter or commercially available chicken feeds, among others. It breeds readily in captivity and broodstock is easy to obtain. However, both its larval development and grow-out periods are considerably longer than that of the marine shrimp, and although it has a high market value, its export potential is not as large as shrimp. Male prawn usually

grow faster than the females, and in view of the prawn's territorial behavior, it cannot be cultured intensively.

In grow-out culture, udang galah is usually stocked at 5,000-10,000 juveniles per ha in combination with 750-1,000 fish (the plankton feeders, big-head and silver carp; and the herbivores, grass carp and lampan jaya). The bottom-living common carp is excluded as this competes with the prawn. Survival of prawn ranges 50-90%. Polyculture of udang galah with fish has advantages over intensive culture of udang galah like lower feed costs and lower volume of water required. More recently, monoculture of udang galah has been carried out, and stocking densities range 2-15 juveniles/m². The prawn are fed commercial formulated feed. Water quality is maintained by regular exchange, i.e., pumping of water, and by the use of paddle wheels. The prawn are partially harvested or culled after 4 months. Average yield is 1 t/ha/cycle.

Freshwater fish culture in cages. There are many large impoundments or bodies of water where fish pens, enclosures, or cages can be set up. In 1991, about 60% of the freshwater cage farming was carried out in Selangor, Perak, and Malacca. The red tilapia is by far the most important species cultured in cages, accounting for 60% of the total production (573.97 t) in 1991. Other species cultured include the lampam jawa, grass carp, and ikan jelawat. Cage culture of tilapia is also advantageous in that tilapia are prevented from multiplying. In impoundments where phytoplankton and zooplankton are abundant, plankton-feeders like the silver carp, bighead carp, and rohu can be cultured without feeding; the fish filter off the plankton at the same time improving the clarity of the water. Culture of other species such as ikan patin can also be developed as mass fry production has already been achieved in the Freshwater Fisheries Research Centre in Batu Berendam, Malacca. The hatchery technique can be extended to fish breeders.

Penaeid or marine shrimp culture in brackishwater ponds. The culture of marine or penaeid shrimps in ponds built in coastal low-lying areas is mostly carried out in the southern part of Johor. These shrimp ponds are fairly extensive and large sluice gates allow juveniles to enter the ponds with the tidal inflow. Shrimp are fed chicken feed pellets. Market-sized shrimp are harvested in bagnets placed in sluice gates during tidal outflow. Included in the harvest are large shrimps such as *Penaeus merguensis* and *P. indicus* which fetch very good prices. However, the bulk of the harvest consists of medium-sized, immature shrimps, mainly *Metapenaeus ensis*.

Teaseed cake is occasionally used to selectively kill fish predators and competitors. However, harvest is inconsistent as this system depends solely on natural stocking. The operation is confined to areas where shrimp seeds are abundant.

There has been growing interest in the development of more modern systems of shrimp farming in Malaysia. More hatcheries are set up and more well-designed brackishwater ponds are constructed. At the Fisheries Research Institute at Glugor, Penang several species of marine shrimps, including the giant tiger shrimp (*Penaeus monodon*) and the banana shrimp (*Penaeus merguensis*), have been reared to sizes suitable for pond culture since 1969. Improve-

ments in hatchery design and operations have been incorporated in the designs of private hatcheries, including that of the National Prawn Fry Production and Research Centre in Kampung Pulau Sayak, Kedah.

Shrimp postlarvae from the Fisheries Research Institute and the National Prawn Fry Production and Research Centre have been used in grow-out research at the Brackishwater Aquaculture Research Centre (of the Fisheries Research Institute, Department of Fisheries, Malaysia) in Gelang Patah, Johor. Recent experiments in pond culture produced approximately 8 t of shrimp per ha every 3-4 months of culture. This considerable experience and other advances have fueled optimism that marine shrimp farming can become a major aquaculture industry in Malaysia. The private sector has been expanding, the price in export markets is good, and the general conditions of shrimp culture in the country is favorable.

Of the many species of marine shrimps, the giant tiger shrimp is preferred as it is hardy, fast-growing, and highly priced. Adults used in hatchery operations are mainly caught by trawlers. The unilateral eyestalk ablation technique in induced spawning has enabled many hatcheries to use even non-gravid adult shrimps. In the future, it is likely that gravid females will be produced from pond-raised broodstock.

Large-scale commercial culture of marine shrimps depends, to a large extent, on suitable and cost-effective feeds, as feeds often constitute more than half of the variable costs in aquaculture production. The Brackishwater Aquaculture Research Centre at Gelang Patah has recently developed several shrimp feeds. Also, many local or imported commercial shrimp feeds are readily available. The steady supply and constantly improving quality contribute to the rapid development of shrimp culture in the country.

Crab culture or fattening in brackishwater ponds. The mangrove swimming-crab or ketam batu (*Scylla serrata*) is very hardy. It can live in a wide range of salinity and even remain out of water for long periods. The crab has a very high market value and supply from the wild has declined due to indiscriminate fishing. The growing interest in crab culture, therefore, is no surprise.

At present, brackishwater ponds in Johor and other places are into the culture or fattening of the mangrove crab. Small to medium-sized and even large but "thin" crabs, which have low market value, are stocked in ponds. The crabs are fed trash or low-grade fish. After two months, the crabs are already marketable with the females having well-developed gonads. They sell at a considerably higher price. Cages are also used for fattening crabs. The crabs must be well fed to reduce cannibalism.

The mangrove crab has been artificially propagated at the Fisheries Research Institute at Glugor, Penang but the production of young crabs was very low, mainly due to cannibalism and lack of hatchery facilities. Further research on crab seed production and culture is being carried out at the National Prawn Fry Production and Research Centre that has better facilities. Sufficient number of young crabs have been produced during the first few months, and this has supplied the pond culture trials which were participated in by fisher-folk. A considerable number of young crabs are also used for coastal ranching. With further improvements in technology, it is likely that hatchery-produced

young crabs will provide increasingly large quantities of seedstock for crab farming in the country.

Culture of coastal fishes in brackishwater ponds. Pond culture of coastal fishes is a very recent development in Malaysia. It is carried out in only a few areas (Kedah, Penang, Johor). The species cultured are ikan siakap (giant sea perch, *hates calcarifer*) and ikan kerapu (grouper, *Epinephelus suillus*/*E. malabaricus*/*E. tauvina*) based on young fish collected from the wild, though some fry of siakap are imported from Thailand. Both siakap and kerapu are carnivorous, feeding on trash or low-grade fish. Their high market price makes culture profitable. Both fish can withstand low salinities, and siakap can even be raised in freshwater. However, siakap is not as tolerant to handling as kerapu although it is quite hardy and fast growing. Its growth is often uneven among individuals in a single population.

The supply of siakap and kerapu fry, collected from the wild, is inadequate to sustain large-scale culture. Being carnivores, they occupy the top of the food chain and biological pyramid of numbers; hence, it is unlikely that very large numbers of their fry can be collected from the wild. In 1982, the Department of Fisheries began producing siakap fry in their hatcheries and by 1986, the hatchery-raised siakap which were transferred to cages had matured. They provided the broodstock for spawning and breeding of siakap at the Coastal Finfish Hatchery Centre at Terengganu. While larviculture and nursery operations of siakap can still be improved, the Department of Fisheries has already provided training and extension services in siakap culture. The Department of Fisheries also successfully propagated the grouper and the snapper at the Tanjung Demong Coastal Finfish Hatchery Centre. Although spawning has been consistently achieved and larvae produced by the millions, seed supply is still low; further research and development is required before artificial propagation of these species can be carried out on a big scale.

Research on the culture of coastal fishes especially giant sea perch in brackishwater ponds is undertaken at the Brackishwater Aquaculture Research Centre of the Fisheries Research Institute in Gelang Patah, Johor. Suitable artificial feeds have been developed for siakap culture as well as a practical raceway system for nursing the fry.

Culture of coastal fishes in cages. Culture of coastal fishes in cages suspended from floating rafts anchored in sheltered inshore areas is carried out mainly in Penang, Selangor, and Johor. The species cultured are the carnivorous ikan siakap and ikan kerapu. Trash or low-grade fish is fed but suitable pellet feeds are likely to be used in the future.

Cages and floating rafts are not as expensive as brackishwater ponds. Also, the number and relatively small size (approximately 3 x 3 x 2 m) of the cages allow for easy separation and maintenance of fish according to body size. The small size also facilitates maintenance of the cage itself.

Culture of mussel (*kupang/suput*, *Perna viridis*). The Fisheries Research Institute has successfully conducted research on mussel culture, and the Strait of Johor has been found to have a great potential for mussel culture. An increasing number of fishermen are now going into mussel culture.

Mussel culture can be carried out by setting up rafts in suitable areas and

suspending ropes from these rafts. Mussel settle on the ropes and they are harvested once the market size is reached. In areas where the currents are too strong for the raft method, the stake method may be used. Mussel efficiently filter microscopic plants (phytoplankton) from the moving water, and reach marketable size (70 mm) in 5 months. (European mussels are cultured for 2 years.) They are also among the hardiest and most easily gathered organisms, and mussel culture is the most productive form of saltwater aquaculture. Mussel culture is now already well developed in France, Italy, Philippines, and Thailand, and is considered to have very good potential in Malaysia.

The Fisheries Research Institute has recently introduced mussel culture to other parts of Malaysia by transplanting mussel spats collected in Johor Strait to other coastal areas. Various localities including Malacca, Pulau Ketam (Selangor), Lekir/Pangkor (Perak), Batu Maung and Pulau Aman (Penang), and Pulau Langkawi (Kedah) have been found to be suitable for mussel culture.

Oyster culture. Recent advances in oyster culture have further encouraged its development. In the Muar River, shells thrown into the river serve as collectors and growing substrates of spat oyster. This culture system is known as on-bottom culture. In Sabah and Sarawak, attempts were made to develop the raft and rack methods for oyster culture, but while oyster (*Crassostrea belcheri*) culture for food has not taken off, the commercial culture of pearl-oyster (*Pinctada* sp.) for pearl production has become established. The Fisheries Research Institute at Glugor continues to carry out research on oyster culture, testing various types of collectors and culture methods in different parts of the country. Earlier work carried out in Pulau Langkawi has shown that *Ostrea colium* may have culture potential. In 1988, the institute in collaboration with the Bay of Bengal Programme for Fisheries Development succeeded in the spat collection, transplantation, and culture of *Crassostrea iredalei* and *C. belcheri* in several areas, particularly Sungai Mercang and Kuala Setiu (Terengganu), Batu Lintang (Kedah), and Kg. Telaga Nenas and Kg. Telok (Perak). Since both species command a good price at seafood restaurants and leading hotels, the development of oyster culture in Malaysia is receiving increasing attention especially spat production, culture techniques, and marketing. Malaysia also imports some 250 t of dried oysters a year.

Promoting aquaculture development

The Department of Fisheries of the Ministry of Agriculture has two main functions in promoting aquaculture in the country: (1) research and development and (2) extension services. Both are largely directed at overcoming the constraints encountered in aquaculture, particularly the scarcity of fry especially of the species for which controlled breeding techniques have only been recently or are still being developed. The Department also addresses the inadequacy of skilled manpower and lack of facilities especially for fry production, the lack of capital or financing available to the rural and coastal poor, and the threat of aquatic pollution.

Aquaculture research is carried out at the Fisheries Research Institute with its headquarters situated in Glugor, Penang; its branches are located in

Batu Berendam, Malacca (Freshwater Fisheries Research Centre); Gelang Patah, Johor (Brackishwater Aquaculture Research Centre); Kampung Pulau Sayak, Kedah (National Prawn Fry Production and Research Centre); and Tanjung Demong, Terengganu (Marine Finfish Fry Production Centre). Major research findings in Glugor pertain to the biology and culture of the cockle, mussel, oyster, the giant sea perch, the udang galah or giant Malaysia prawn, and the marine shrimps. Research on freshwater aquaculture is carried out at Batu Berendam, Malacca where successful induced breeding techniques have been developed for various freshwater species including bighead carp, jelawat, rohu, catla, tilapia merah, patin, and keli. At Gelang Patah, pond grow-out systems are developed for marine shrimps especially giant tiger shrimp (*Penaeus monodon*), and for coastal fishes, especially siakap. At the Kampung Lulau Sayak Centre, research is focused on shrimp fry production, including studies on captive broodstock and suitable feeds for both hatchery and nursery operations. Training courses on shrimp hatchery technology and coastal aquaculture are held at this center. Research and training in the artificial propagation of coastal fishes (*Lates calcarifer*, *Epinephelus* spp., and *Lutjanus* spp.) are conducted at the Marine Finfish Production Centre in Tanjung Demong, Terengganu.

The Department of Fisheries extends technology through its Extension and Training Division and the Fisheries Offices in the various states/regions/districts/stations. Extension activities include advisory and information service, demonstration and training, and supply of fry. The advisory and information service facilitates the dissemination of information from research and other sources to the industry, and is achieved through publications, audio-visual aids, and the mobile unit. Demonstrations and training are conducted at the Department's stations and centers as well as established farms. Fish and shrimp fry are being produced at the Breeding Stations situated in various parts of the country especially for distribution to small-scale aquaculturists. Relevant training courses in seed production are given to fishfarmers and private individuals to facilitate the setting up of more private hatcheries/breeding stations and for the production of fish/shrimp fry to help meet increasing demand.

To ensure the smooth development of aquaculture in the country, rules and regulations governing aquaculture have also been made. The law governing fisheries in Malaysia is contained in the Fisheries Act of 1985. Included in this law is the Fisheries (Marine Culture System) Regulation that covers rack and pole culture, raft culture, cage and pen culture, and on-bottom culture systems. Besides these regulations, the Government has also introduced various incentives for the development of aquaculture in the country. These incentives include pioneer status, investment tax credit, and export incentives.

Discussion

The technical issues discussed by the workshop participants include:

- English and common names for some species that can be polycultured with tiger shrimp
- Pollution problem in cockle and oyster culture
- Stocking density of shrimp
- Lack of a standard pond management technique

The representative from Malaysia noted that their extension services are largely directed to commodities that have only been recently developed, and skilled manpower is generally lacking.