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Status of knowledge on farming of Seabass (*Lates calcarifer*) in South East Asia

L. CHEONG
Primary Production Department. Aquaculture unit
300 Nicoll Drive CHANGI POINT — SINGAPORE 1749 — Singapore

Abstract — *A review is made on the various techniques of farming seabass (**Lates calcarifer**) in South-East Asia, namely, Thailand, Malaysia, Philippines, Indonesia and Singapore. The management and husbandry aspects are discussed, and the potential of farming this fish under highly intensive conditions is mentioned.*

INTRODUCTION

Lates calcarifer, commonly called the giant sea perch, seabass or barramundi, is an important coastal, estuarine and freshwater fish in the Indo-pacific region. It supports extensive commercial and recreational fisheries in Australia and Papua New Guinea, and is farmed in Thailand, Malaysia, Indonesia, Singapore, Hong Kong, Taiwan, and more recently, in Australia, in both brackishwater and freshwater ponds, as well as in cages in coastal water (Kungvankij et *al.*, 1984; Grey, 1987 ,). The fish has a delicately-flavoured flesh, is popular in the region, and has a high market price whenever it is available. It has a fast growth rate, grows to a large size, and can be bred in captivity, thus making it very suitable for aquaculture.

World fisheries production of seabass in 1983 was reported by F.A.O. (1985) to be 14895 tonnes, of which 11456 tonnes (77 %) was contributed by South-East Asia, with Indonesia producing 11010 tonnes (from both inland waters and marine) and Malaysia 446 tonnes. In the same year, farmed seabass production in South-East Asia was 2416 tonnes, the producing countries being Indonesia (1105 or 46 %), Thailand (1084 or 45 %), and Malaysia (227 or 9 %) (SEAFDEC, 1985). Singapore's production of farmed seabass was 100 tonnes in 1983, rising to derived from by-catch from brackishwater culture of milkfish. This is also the case for the Philippines, but production statistics are not available. Farmed seabass are usually marketed at around 500-800 g, while wild-caught ones usually weigh 7 kg or more.

Thailand is well known for its seabass culture as it was here that culture techniques were first developed -in the 1970's (Wongsomnuk and Manevonk, 1973). Culture of this fish has been fairly widespread since then, but, in the past, has been conducted mostly in connection with other types of culture and on a very small scale (Department of Fisheries, 1984). Presently, Thailand produces more than 100 million seabass fry annually (Anon, 1985), and the culture is on a larger scale and done on its own. In 1983, there were 1000 seabass farms in Thailand with a total farm area of approx. 9 ha (Sirikul et *al.*, 1988).

FARMING PRACTISES

Seabass may be farmed in ponds or in netcages, with the latter being more predominant. In the former, seabass is farmed either in brackishwater or freshwater ponds, while, in the latter, it may either be in fixed or floating netcages in coastal waters. Farming of seabass may also be carried out in brackishwater ponds like shrimp ponds, but this is not common, and has been reported only by Department of Fisheries (1984) for Thailand. Even then, this practise is not widespread in Thailand, and is used only by some of the shrimp pond operators there.

Site selection

a) Salinity

Being a euryhaline species, seabass can be farmed either in freshwater, brackishwater, or seawater. In parts of Thailand, seabass is reported to be farmed in freshwater ponds, while in Tahiti, seabass is successfully cultured in seawaters of 35 ppt (Fuchs, pers. comm., 1989). However, the fish is more commonly farmed in salinities ranging from 10-30 ppt. Hence most of the farms are located either along the coast or in coastal waters.

b) Temperature

Seabass grows best in warm waters of 26-32°C, and growth is slowed down under cooler water conditions. Mortalities arise when temperatures drop below 20°C over prolonged periods. Optimum temperature range is reported to be 26-32°C (Kungvanki et al., 1984). Minimum water temperature for seabass was found to be 15°C, beyond which the fish died within minutes (Wu, pers. comm., 1989).

c) Water quality

Other water quality parameters suitable for the rearing of seabass, as given by Kungvankij et *al.* (1984), are pH 7.5-8.5; dissolved oxygen 4-9 ppm; ammonia (NH_3-N) < 1 ppm; $H_2S < 0.3$ ppm; and turbidity < 10 ppm. The level of dissolved oxygen is usually high, around 7-8 ppm, in floating netcages due to the continuous exchange of water in the netcages from tidal influx. Other parameters can also be met with good tidal flow. Wu,(pers. comm., 1989) found that seabass can tolerate dissolved oxygen levels of 1 ppm for short durations of less than 30 minutes.

d) Water exchange

Sites should be located in areas with good water exchange, i.e. having wide tidal fluctuations of 2-3 m and/or strong currents ranging between 1-2 knots (50-100 cm/sec). If floating netcages are used, the nets must be at least 2 m off the bottom so that currents can sweep away the siltation and detrital wastes that accumulate on the seabed. In fixed netcages, the nets should be at least 1 m off bottom. However these are often resting on the bottom resulting in heavy siltation of both net and substrate. Ponds located along the coast or mangrove areas will have placed where water can enter with the flooding tides. A good site is one where tidal exchange can be effected 20 times monthly.

In Singapore, sites for floating netcages are located in a narrow waterway, called Strait of Johor, to take advantage of the fast tidal movements (1-1.5 knots) yet relatively deep (8-10 m- and sheltered (wave heights not exceeding 1 m) conditions, the latter condition to minimize strain on the wooden frames and anchor ropes of the floating netcage. Floating netcages are therefore best placed to take advantage of the features in the topography and hydrography of various sites, as opposed to more permanent establishments like ponds.

e) Soil and other characteristics

This criteria does not apply directly to the sitting of netcages, since coastal seabeds usually consist of marine clay. However netcages can be located in areas with sandy bottoms. For sitting of earthern ponds, the soil at the proposed pond site should be loamy, with sufficient clay content to ensure good water holding capacity. Brackishwater ponds are usually located at sites similar to those of shrimp ponds, i.e., in coastal mangroves and close to the sea, and the problem of acid soil, frequently encountered with mangrove soils, may also arise.

Farm sites should be away from possible sources of pollution, e.g. sewage and/or industrial discharges. The incidence of biofouling organisms should also be assessed, as a high rate of biofouling would require considerable net cleaning effort.

Design of culture structure

a) Ponds

Earthern ponds are used, and these are usually rectangular in shape, ranging in area from 800 m^2 to 2 hectares. Pond depth is about 1-2 m. According to Department of Fisheries (1984), ponds in Thailand are of 2 categories : the small ponds of 800-1600 m^2, and the large ponds of 0.3 ha and more. The pond may be built by excavation or by having the dikes above ground. Each pond is provided with an inlet and outlet gate to facilitate water exchange. Pond bottom is flat and slopes towards the outlet gate.

b) Fixed/floating netcages

Generally, the fixed/floating netcage farm comprises several units of netcages suspended from a floating raft and anchored to the seabed, as in the case of floating netcages, or several units of netcages tied to wooden or bamboo poles implanted into the seabed, as in the case of fixed netcages. In Singapore and Malaysia, all netcage farms are floating ones, with size (in terms of area occupied by the netcage) ranging from 40-1600 m2. Fixed netcage farms are seen in Thailand's Songkhla Lake, although this method is said to be not as popular as pond or floating netcage culture because of the difficulty of finding suitable production sites (Sirikul et *al.*, 1988).

The raft frame may be constructed of wood, bamboo or galvanised iron. Although bamboo is frequently cheaper in those countries with a ready source of the material, it can last only for a short period -about a year in Malaysia (Hussin, 1987), and wooden or galvanised iron frames, which are longer lasting, are used. In the Singapore experience, wooden frames, with adequate maintenance, can last for at least 5 years. Galvanised iron pipe rafts could be protected by a coat of anti-corrosive paint to extend their life-span. All the rafts described are kept afloat by polystyrofoam blocks, plastic or metal drums.

Netcages are frequently made of polyethylene material. Square netcages are used in most cases. The size may range from 3 m x 3 m, as commonly used in Singapore and Malaysian farms, to 5 m x 5 m and 10 m x 10 m, as used in some Singapore and most Thai farms. Netcages for floating netcage culture usually have depths ranging from 2-3 m, with 1.5-2.5 m immersed in water. Those that are fixed are deeper, being usually 4-5 m deep, so that the top 1 m stands above the water surface at high tides. Nets are of various mesh sizes, depending on the initial size of the stocked fish.

Anchors are usually placed at the 4 corners and mid-positions of the raft, with length of each anchor rope usually 4 times the depth of water at the site during high tide. The anchors consist of concrete blocks or cast iron ship anchors.

Stocking

a) Shrimp ponds

Seabass may sometimes be cultured in shrimp ponds. The seabass juveniles are stocked after the shrimps have been harvested. Shrimp ponds range in size from 0.3-20 ha. Stocking size is about 1-2 cm body length, and stocking density about 1 per m2. There is no record of unit production levels for such culture.

b) Brackishwater ponds

For culture in brackishwater ponds, the culture may either be monoculture or polyculture, the latter being done in combination with a forage fish, like tilapia (*Oreochromis mossambicus* or *O. niloticus*), whose juveniles serve as food for the seabass.

Stocking size and density depend on the category of pond used. For small ponds (0.08-0.16 ha), seabass juveniles of 10-15 cm (about 20 g) are stocked at 0.5-1 per m^2 (0.4-0.75 per m^3), while larger juveniles of 20-30 cm (about 100 g) are stocked at 0.25-0.5 per m^2 (0.2-0.4 per m^3) for the larger ponds (> 0.3 ha). For polyculture, seabass juveniles are stocked at 10-15 cm size at 0.3-0.5 per m^2 (0.2-0.4 per m^3) and the ponds would have to be stocked with tilapia brooders at 0.2 per m^2 (0.1-0.2 per m^3) at sex ratio of 1 :1, about 2 months prior to the stocking of the seabass juveniles to produce the tilapia juveniles (Department of Fisheries, 1984).

An experiment by Rayong Brackishwater Fisheries Station, Thailand, in 1983 showed that ponds initially stocked at 2 per m^2 (1.3 per m^3) with 20 g frys could reach a unit production of 1.3 kg/m^3/yr (Sakaras, pers. comm., 1986) compared to 0.3 normally reached in small ponds practising monoculture (Department of Fisheries, 1984).

c) Fixed/floating netcages

In Thailand, stocking density in cages is initially between 40-50 per m^3 for the first 2-3 months, and thereafter reduced to 10-20 per m^3 (Kungvankij et *al.*, 1984). In Singapore, similar stocking protocol is followed : initially at 40-50 per m^3 from 20-100 g, then to 33 per m^3 from 100-700 g. Some farmers practise a second thinning to 27 per m^3 at 300 g.

An even higher initial stocking was tested by Sakaras (1987) in Thailand. Using experimental netcages of 1.3 per m^3, he demonstrated that initial stocking can be significantly increased to 77 and even up to 231 per m^3 with high survivals. His studies showed that unit productions of 71 and 196 kg/m^3/yr could be achieved at 77 and 231 per m^3 stocking respectively, as compared to 20-24 and 27 kg/m^3/yr unit production levels achieved by commercial farmers in Thailand and Singapore respectively. The study also showed that stocking should be done with larger-sized juveniles (16 cm or 60 g) as this gave higher final mean weight than those of smaller-sized juveniles (12 cm or 22 g).

Feeding

a) Shrimp ponds

The seabass frys are not given any supplementary feed and they rely solely on the natural food (mixture of young shrimp and fish) in the pond.

b) Brackishwater ponds

The fish cultured under monoculture are fed according to the same protocol in use for those cultured in netcages, and the feeding regime will be mentioned hereunder (c). Those raised under polyculture with tilapia feed on the tilapia frys produced by the tilapia brooders stocked in the same pond as the seabass. In some cases tilapia is raised in separate ponds and the frys are collected as food for the seabass (Department of Fisheries, 1984).

c) Fixed/floating netcages

The fish cultured under monoculture conditions rely mainly on supplementary feed provided by the operator, this being in the form of chopped trash fish. In Thailand, feeding rate of 8-10 % of body weight is applied for fish less than 100 g, 5 % for fish > 100-600 g, and 4 % for fish > 600-1,000 g (IBID). In Singapore, feeding regime may be practised as following : 10 % of body weight for fish of 20- < 100 g, 8 % for fish of 100- < 300 g, 3-5 % for fish of 300- < 500 g, and 3 % for fish of 500-700 g. In all instances, the feed is usually given twice daily, in the morning and afternoon, till satiation each time.

The use of artificial feeds, like semi-moist feeds and dry pellets, is still mainly restricted to the experimental level, although some farmers have been reported to have used semi-moist feeds by incorporating a dry mash of fish meal, rice bran, etc..., to minced trash fish.

Diseases

Commonly encountered diseases are described by Ruangpan (1987), and Chong and Chao (1984). Three major diseases encountered are : Cryptocaryoniase caused by the ciliate *Cryptocaryon irritans*, Vibriosis caused by the bacteria *Vibrio* spp., like *V. parahaemolyticus* and *V. alginolyticus*, and Lymphocystis caused by the virus *Lymphocystis*.

Economic returns

The Cost Benefit Analyses for various farming methods in Thailand and Singapore have been investigated. Sale price (ex-farm) of seabass in Thailand is about US$ 2-3/kg. In Singapore, the fish fetches a premium price when sold live or freshly killed, with a sale price of US$ 6/kg. According to Kungvankij et al. (1984), a pond culture system in Thailand producing 14 tonnes/annum requires a working capital of US$ 22700, and would cost US$ 2.40 to produce a kilogramme of fish, while a floating netcage system producing 8 tonnes/annum requires a capital of US$ 12500, and cost of production would be US$ 2.30/kg. For a smaller floating netcage farm able to produce 0.35 tonnes/annum, Tookwinas and Charearnrid (1988) estimated working capital to be US$ 360 and cost of production to be US$ 1.50/kg. Pollock and Quinn (1984) calculated that a fixed netcage system producing 12 tonnes/annum requires US$ 9500 for working capital, and cost of production would be US$ 1.10/kg. In Singapore, a floating netcage farm able to produce 30 tonnes/annum would require a working capital of US$ 149700 and cost of production would be US$ 4.30/kg. Through large-scale farming, e.g. using floating raceway or semi-submersible netcage systems recently developed in the Nordic countries, cost of production, under Singapore conditions, could be reduced to US$ 3.10/kg. Such systems would be able to produce, theoretically, 200 tonnes/annum. However substantial investment of US$ 1.15 mil. as working capital is required.

CONCLUSION

Seabass farming has come a long way since the early 70's when its culture was confined to Thailand and Indonesia. Since then the species has been identified as a potential aquaculture species, and farming activities have spread over many of the South-East Asian countries, like Malaysia, Singapore, and Philippines.

However several limitations to its widespread culture remain.

1) The species is not commonly farmed in the region. Some countries, like the Philippines, have just introduced the farming of this fish, and the farmers need to develop a hands-on experience of the farming methodology. In others, like Indonesia, the farmers need to acquire the hatchery technique of producing the frys as the critical shortage of seed has been identified as a constraint to seabass culture in that country (Ismail and Danakusumah, 1987).

2) The species is not tolerant to prolonged cold water conditions below 20°C. This seriously limits its culture in countries with cold seasons to the warmer seasons only, thereby decreasing the economic viability of farming this species. Seabass cultured in prolonged cold water conditions also grow more slowly as they become off-feed.

3) The high cost of trash fish that is used as feed for the seabass cultured is another constraint. Cost of trash fish is the single most expensive item of the cost of production, comprising about 40 %. Any increase in the cost of the trash fish would significantly affect the cost of production.

4) The farming is presently confined to a small-scale level, each farm producing no more than 50 tonnes annually. To match higher market demand, it is possible to scale-up the production with the use of larger netcages, like those used in European countries. However, for such a farming, the use of dry feed for feeding the fish is absolutely essential. This is however not presently commercially available.

Future research and development work on seabass should therefore be directed towards resolving some of these limitations.

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