III

SITE AND SPECIES SELECTION CRITERIA FOR CAGE CULTURE

Jayasree Loka, N.G.Vaidya and K.K. Philipose

Cage farming is one of the alternative to inland and brackish water farming to increase fish and shellfish production. Cage culture has been successfully practiced to culture marine finfish for many years. In Australia, Norway, Chile and some of Asian countries, cage culture is being successfully practiced since the 1950's. Due to their large consumption value there is an increasing demand for the culture of many marine finfishes. This further led to an increased demand for marine aquaculture throughout the world. A number of diversity of types and designs of cages are developed of which four types of cages viz., fixed, floating, submersible and submerged are the most common proposed by Beveridge (1996). To establish a cage culture system, a thorough knowledge of site where the cages are to be installed is required which can be met with the data available with Govern ment organizations, local people as well as the extensive field survey to understand the topography, water and sediment quality.

Site Selection

Site selection is the most important factor which determines the commercial viability of mariculture systems. Cage culture can be made possible only when the site for cage culture operation is located, designed and operated to provide optimum water quality and to avoid stress conditions. In addition to water and sediment quality of the site some biological and natural distribution information for the species should also be known before a site is selected for cage culture. The selection of fish for cage culture should be based on biological criteria, such as physiological, behavioural characteristics and level of domestication; marketing criteria and environmental criteria, distribution and habitat of site (Fig. 1).

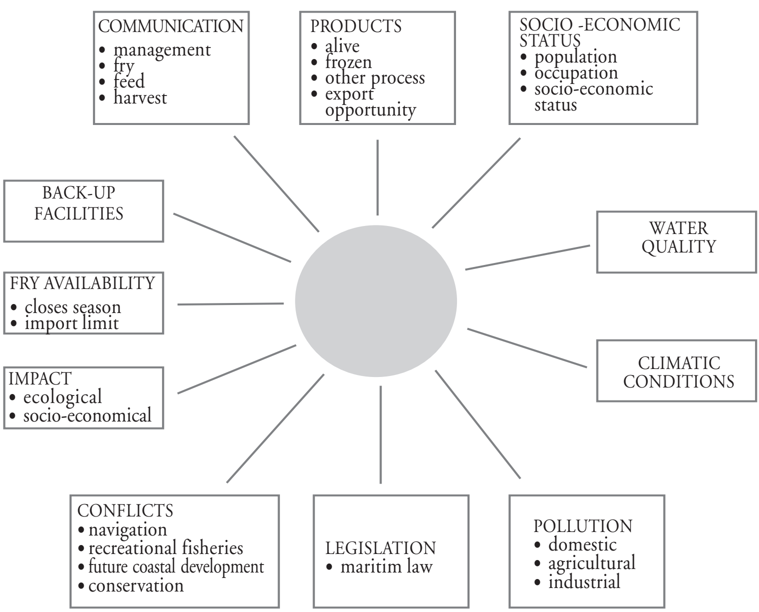

Fig. 1. Criteria for selection of cage site.

Topographical criteria:

The cage site to be selected should be of a suitable depth, have good tidal flow with optimal conditions and ideally be protected from strong winds and rough weather and have sufficient water movements. The size of wind generated waves is determined by (i) wind velocity, (ii) the duration of time that the wind blows, and (iii) the distance of open, unobstructed water across which the wind blows (fetch) (Bascom, 1964). In general, the wind velocity should be less than 5 knots for stationary cage and 10 knots for floating cage. The height of the wave should be less than 0.5 m for stationary cage and 1.0 m for floating cage. Culture sites should be placed at some distance from navigation routes as the waves may be created from the wake of passing vessels.

It is necessary to allow sufficient depth under the cage in order to maximize water exchange, avoid oxygen depletion, accumulation of debris and build up of some noxious gases generated by decomposition of the deposited wastes. In turbid water, silt will tend to accumulate in the cage preventing good water exchange. The minimum and maximum depth of the cage can be calculated as follows:

D2 = M - T + H2

D2 = minimum depth at lowest low water during spring tide

M = measured depth

T = tidal height at the time when M is taken

H2 = minimum tidal height at lowest low water during spring tide

Bottom condition

For an ideal site for cage culture, a firm substrate, with a combination of fine gravel, sand and clay will be highly productive. Depending on the type of substrate present at any given site type of cages also vary. The floating net cages over rocky substrates require more expensive anchoring blocks, but have better water exchange rate. In general, sloping areas from the shore leading to flat bottoms are suitable for cage culture because the waste build-up at the bottom is easily eliminated. Additional site selection criteria should also include accessibility to the cages and the ability to move them out of potential harmful events such as algal blooms and/or low DO events. Continuous, unattended monitoring systems that can send alerts when conditions are close to unacceptable ranges are invaluable in these situations.

Physical criteria

The main physical parameters that need to be considered in cage culture systems include factors such as current movements, turbidity and water temperature.

Turbidity: During heavy monsoons, water becomes turbid due to the freshwater runoff and more turbid waters are not suitable for cage culture. Freshwater runoff due to rains may lead to leaching of heavy metals from industrial effluents and suspension of organic and inorganic solids in the water column. Deposition of solid organic and inorganic materials to the bottom due to heavy rains may act as substrate for fouling organisms on the nets, which further prevent proper water circulation .Suspended sediments also responsible for choking of fish gills which may lead to mortality due to asphyxiation. The presence of suspended solids also relates to some disease such as "fin-rot" caused by Mycobacteria (Herbert and Merkens, 1961; Herbert and Richards, 1963). Suspended solids in a suitable site for net cage culture should not exceed 10 mg/l. But its effects also depend on the exposure time and current speed.

Water temperature: In cage culture, optimum water tempe rature depends on the type of cultivable species i.e., 27–31°C for most tropical species and 20–28 °C for most temperate species. In the Asian region the annual temperature range fluctuates from 20–35°C in tropical countries and from 2–29 °C in temperate countries. Some of the fish species can survive even at varied temperatures the growth of the fish may be affected due to its fluctuations. The change in water temperature will affect fish metabolism and activity, oxygen consumption, ammonia and carbon dioxide production, feeding rate, food conversion, as well as fish growth. The best solution is to select fast growing species (not more than 8 months) and avoid having the culture period running into the months with unsuitable temperature.

Chemical criteria: In cage culture, chemical parameters of marine waters play an important role in the assessment of water quality of cage systems. The natural tolerance of each species should also be studied for assessment of suitable site. Most important chemical factors to be considered in cage culture are Salinity, Dissolved Oxygen, pH, Ammonia, Nitrates and Nitrites.

Dissolved oxygen: Oxygen consumption for each species of fish varies, with pelagic fish like snapper and seabass requiring more than demersal species such as grouper. In general, dissolved oxygen should preferably be around 5 ppm or more and never less than 4 ppm for pelagic fish or 3 ppm for demersal species In the case of cage culture, benthic organisms and sedimented wastes may also reduce the oxygen level. Solubility of oxygen in water declines with increasing temperature and salinity. Hence depletion of DO always occurs during night time at neap tide in summer.

Salinity : For most tropical species, the optimal salinity is normal strength seawater; they cannot tolerate low salinities such as 10–15 ppt. Suitable site for cage culture should thus be with salinities between 15–30 ppt so that cultured species can be changed according to market demands. Seabass (*Lates calcarifer*) can tolerate a wide range of salinities from 0 to 33 ppt and an optimum of 15 ppt is required for culture of seabass. For culturing snappers the optimum salinity required is 25 ppt.

Hydrogen ion index (pH): The suitable pH for most marine species is from 7.0 to 8.5. Extreme values of pH can directly damage gill surfaces, leading to death (McDonald, 1983).

Ammonia: The level of ammonia-nitrogen in the water should be less than 0.5 ppm. The suitable time for measurement of ammonia level should be during neap tide when water current is slow. The ammonia level in water caused by the decomposition of uneaten food and debris at the bottom, can affect the fish. Normally in coastal area, sewage discharge and industrial pollution are the main sources of higher level of ammonia in seawater.

Nitrate (NO_3-N) and nitrite (NO_2-N): For a suitable cage culture area, nitrite level should not exceed 4 mg/litre while nitrate level should be below 200 mg/litre. The excessive amount of nitrite in water becomes toxic to fish due to oxidation of iron in haemoglobin from ferrous to ferric state (Tiensongrusmee, 1986). It will cause hypoxia in fish because haemoglobin molecule cannot bind with oxygen.

Biological criteria

Phytoplankton: Although a few tropical marine species of Cyanobacteria are toxic (eg. Lyngba and Oscillatoria, Moore, 1982), their blooms are uncommon. A number of marine algae groups form blooms, including diatoms, Cyanobacteria, prymnesiophytes and dinoflagellates. *Chaetoceros convolutus* has a number of prominent spines which interfere with gill function and loss of blood from injury (Kennedy, 1978). Excessive blooms of phytoplankton can happen whenever the suitable condition prevails such as high light intensity, high nutrient level (organic load), warm water temperature, stagnant hydrological conditions. These conditions should be avoided when selecting cage farming. Algal blooms can affect fish, not only by damaging fish gills by clogging, but also by competing for dissolved oxygen at night. Red tides commonly occur in warm water, especially during summer months.

Fouling organisms: Fouling is generally more rapid in areas with low current velocities, high temperature, high turbidity (enriched water) and high salinity. More than 34 species of algae (cyanophytes, rhodophytes, chlorophytes) coelenterates, polyzoans, annelids, arthropods, molluscs and simple chordates have been observed clinging to netcages after immersion for only two months (Cheah and Chua 1979). Colonization of fouling organism is primarily caused by silt particles deposited at the net which serve as substrate for fouling organisms. Silt particles can be more than 50% of total fouling weight (Chou, 1988).

Accessibility: The culture site should be near a shore preferably with a jetty for boat connection with farms and near a good road for land transportation. Good accessibility facilitates distribution of farm products, (especially live fish), transport of feed, fingerlings, fuel, farm equipment, supplies and other necessities. The owner can visit the farm site more often to ensure proper management if it is easily accessible.

Selection of species for cage culture

Species selected for farming in floating netcages must have a good demand and high market value should be hardy, should be able to accept external source of food under confined conditions. Food from external source may be a. natural eg. trash fish or b. artificial eg dry formulation. Criteria to be followed to select the species for cage farming are

High-valued species

a. It is preferable to culture species with high market value so as to off-set the relatively high cost of production of net cage farming.

b. As the fish can be easily harvested live, the farmer can sell the produce in prime, live condition. In doing this, he obtains a better price for the fish than would be possible if they were sold chilled or frozen as is the usual case in pond culture.

c. Other than Banana shrimp and seabass mentioned, other high valued species include finfish like the groupers, viz *Epinephelus spp.*, snappers (*Lutjanus spp*), Seabreams (*Acanthopagrus latus*), Cobia, Pampano, crab (*Scylla serrata*) and lobster (*Panulirus spp.*).

Hardy and tolerant species

a. Species selected should also be hardy and tolerant to confined, crowded conditions and to the rigours of handling during net cage changes.

b. Stocking in net cages is often more than 10 times that of pond culture eg.5/m2 compared with 40/m2 for grouper culture in ponds and net cages respectively.

c. Flan in net cages are also subjected to greater physical contact and stress during feeding as there is often a rush for the food by the main bulk of the population in the net cage. Both estuarine grouper and seabass are found to thrive well under such crowded conditions and do not respond so well to feeding when they are small numbers.

Ability to accept external source of food

a. As there are usually no other significant sources of food within the net cage except for small fish which stray in and out, selected fish must be able to accept external source of food especially if species is carnivorous. The selected feed, usually chopped trash fish, would drop through the netcage if it is not eaten by the time it reaches the net bottom.

b. The loss of feed is greater when dry feed is used. Feeding trays can be suspended in the net cage to catch the pellets as they fall and this is used in net cage culture of shrimp. Net cages can be deepened to allow greater pelleted feed retention time within the netcage, or a slow-sinking dry pelleted feed would also maximise this retention time.

c. Some fish like the grouper, seabass and golden snapper respond to feed discharged from autofeeders. In fact, the fish will swim around the feeder in anticipation of the feed drop.

d. Spiny lobsters and Rabbit fish (*Siganus canaliculatus*) are able to graze on the algas growing on the sides of the netcage and derive part of their food from this source. They can also serve as biofculing controls in netcages. Rabbit fish will also respond to feed given to them.

e. Seed availability: Seed, which is usually fry or fingerling, can be wild-caught or hatchery-bred. In the former, supply is usually seasonal and unpredictable but are however more robust and hardy as they would already have undergone pre-selection by nature. In the case of hatchery-bred seeds, supply is more predictable, and, depending on whether the parent stocks were wild-caught or farm raised could be produced on schedule in batch-operation sequence. The need to ensure that seed stock is available is important because without a certain and ready supply of seed at stocking time, farming becomes unpredictable.

Although many species are being cultured throughout the world,*Lates calcarifer, Epinephelus spp, Trachinotus sp. Rachycentron sp. Lutjanus spp., and Acanthopagrus spp.* are found to be more suitable species for cage farming in India and are being cultured successfully at Karwar by CMFRI (Fig. 2).

Acanthocephalus latus

Lutjanus argentimaculatus

Raccchycentron canadum

Trachinotus blochii

Lates calcarifer

Source :

FAO: UNDP/FAO Regional seafarming development and demonstration project in Asia NACA-SF/WP/89/13. Site selection criteria for marine finfish net cage culture.

FAO: Regional sea farming project. RAS/86/024. Training Manual on Marine Finfish Netcage Culture in Singapore. Species selection, culture and economics.