Sea Cage Farming

Suresh Babu P. P., Anuraj A., Rajesh N. and Praveen N. Dube

ICAR-Central Marine Fisheries Research Institute, Kochi
Email: sbabu78@yahoo.com

Sea Cage Farming

Cage culture involves growing fishes in the sea while being enclosed in a net cage which allows free flow of water. It is a production system comprising of a floating frame of varying dimensions and shape, net materials and mooring system, to hold and culture a large number of fishes. In order to make the cage aquaculture economically feasible, it is essential to select proper design, ideal construction material, techniques, suitable mooring and good management practices. Sea cage culture is receiving more attention in the recent years both by researchers and fishermen. Many small or limited resource farmers are looking for alternatives to traditional fishing practices. Cage aquaculture appears to be a rapidly expanding and it offer opportunities even on a small scale.

Understanding the importance of cage culture, the Central Marine Fisheries Research Institute has initiated cage culture as a research and development activity to identify appropriate design and suitability of cages under Indian context in the year 2006-07. The first open sea cage was launched in Bay of Bengal off Visakhapatnam coast during May 2007. This was a indigenously designed and fabricated 15 m HDPE cage provided with a cat walk for free working on board and stabilization. After modifications to the design, first successful harvest was made in 2008 from an HDPE cage of 15 m diameter rwhich was stocked with seabass during December 2007. This cage which was stocked with sea bass was harvested after 6 months with 75% survival. After several trials and refinements, 6 m diameter cages were designed for ease of operation and economic point of view. Recently it has been projected by ICAR-CMFRI that even if 1% of the inshore waters is used for cage farming, which can have room for 8,20,000 cages with a production potential of 3.2 mt. ICAR-CMFRI is regularly involved in promoting open sea cage culturein all the maritime states through various demonstrations.

Advantages of Sea Cage Farming

Farming fish in ponds is by far the most widespread technique used, but fish farming in cages is gradually becoming more and more popular. Following are the advantages of open sea cage farming over other farming practices

- Fabrication of cages for fish farming is faster, simpler, and cost effective than onshore farms.
- The initial start-up investment required to produce one unit of fish meat is only 30 to 40% of the investment needed for conventional pond aquaculture.
- Cage aquaculture utilizes natural bodies of water, so it does not take up valuable space on land that can be used for other purposes.
- The location and size of cages can easily be changed, so the aquaculture operation can expand more easily.
- Unutilized areas such as open sea, lagoons or sheltered bays can be utilised for farming of fishes in net cages with prior permission from concerned agencies
- It is easier and quicker to harvest fish in cages.
- Farming fish in cages makes it easier to ensure a steady supply to meet market demands.
- Alternate livelihood and additional income

Types of cages

Several different types of cage designs are used for farming the fish. The suitability of each cage design depends on the aquaculture site – the water depth, flow conditions, and the environmental setting (river, canal, lake, reservoir, sea). The species of fish being farmed is also a key consideration, as various species have different feeding habits, general behavior, and stocking densities. Based on installation, cages are categorized into following types.

1. **Fixed**- Fixed cages consist of a net bag suspended from posts in the flow of a stream, river, canal, lake, or reservoir. These cages are generally used in shallow water bodies, with depths less than 3 meter. This type of cage is very basic and lowcost to fabricate. Fixed cages are commonly used in small-scale aquaculture, but their use for more extensive, commercial aquaculture is restricted.

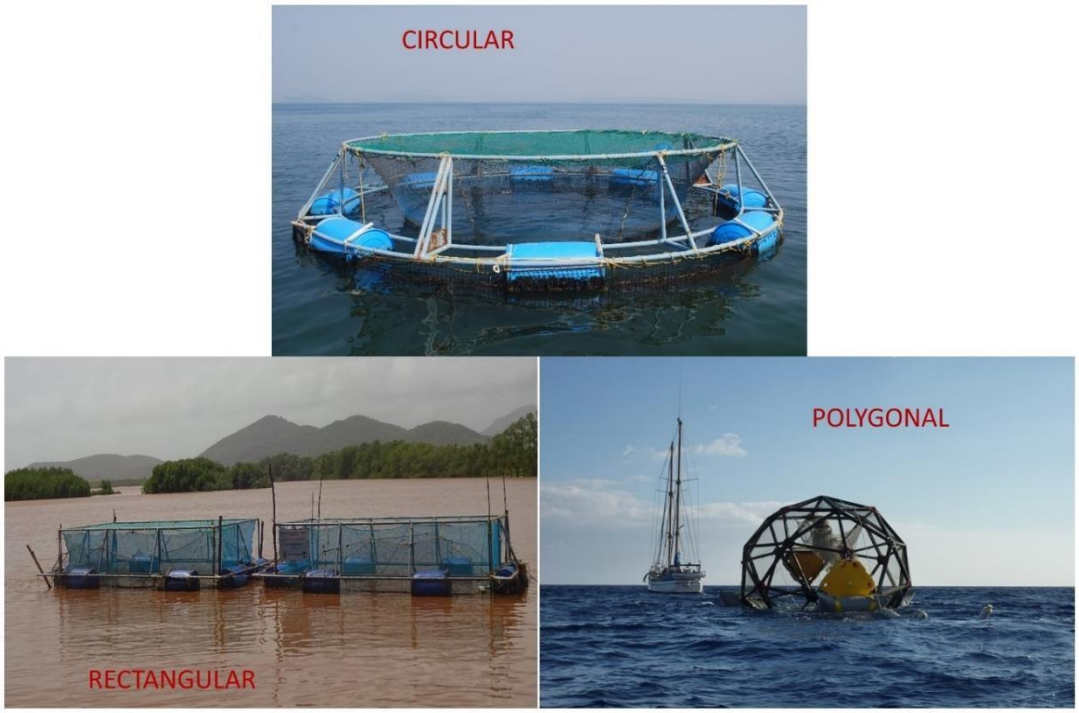
2. **Floating**- These type of cages are designed with the buoyant collar supporting the net. These cages can be made in variety of designs like square, rectangular or circular to suit the purpose of the farmer and are widely used. Rigid materials such as GI pipes, bamboos and plastic pipes can be used as frames. The floating unit consists of a number of floats below the framework to provide sufficient floatation. The types of floats used vary from ordinary oil drums to used fibreglass barrels. These cages are generally used in water bodies with depths ranging from 10-15 meters.

3. **Submersible-**Submersible cages are a variation of floating cages with either rigid or flexible netting. The buoyancy of plastic floats is variable so that the fish cage can be moved to different depths in the water column. These types of fish cages are often used in marine environments.

4. **Submerged**- These types of cages are made with wooden boxes having gaps between the slots to facilitate the flow of water and are anchored to the bottom of the substratum by poles or stones.

Cage design

Design of cages is a critical factor that pushes the limits of structural integrity and economic viability in aquaculture system. Design of cage is determined by the behaviour of the cultured species. For pelagic species which swim near the surface, bigger net space is required. Such fishes tend to aggregate in shoal and swim around in circular motion. Therefore, circular or hexagonal cages may be more suitable than rectangular or square cages Whereas, demersal fishes, which are less active, territorial inhabit and prefer to hide with underwater structure, the shape of the cages does not affect fish mobility. Under such circumstances, square or rectangular cages have an advantage over a circular or hexagonal one in view of easy assemblage of cages and management. From the economic point of view, the design should be technically simple, should be easily made with available materials, cost effective, should hold reasonable amount of water while permitting sufficient water exchange and hold the fish securely during the culture period. A good design must be safe, secure and easy to operate. Design of the cage and its accessories can be tailor-made in accordance to the individual farmer's requirements.



Different types of cage designs

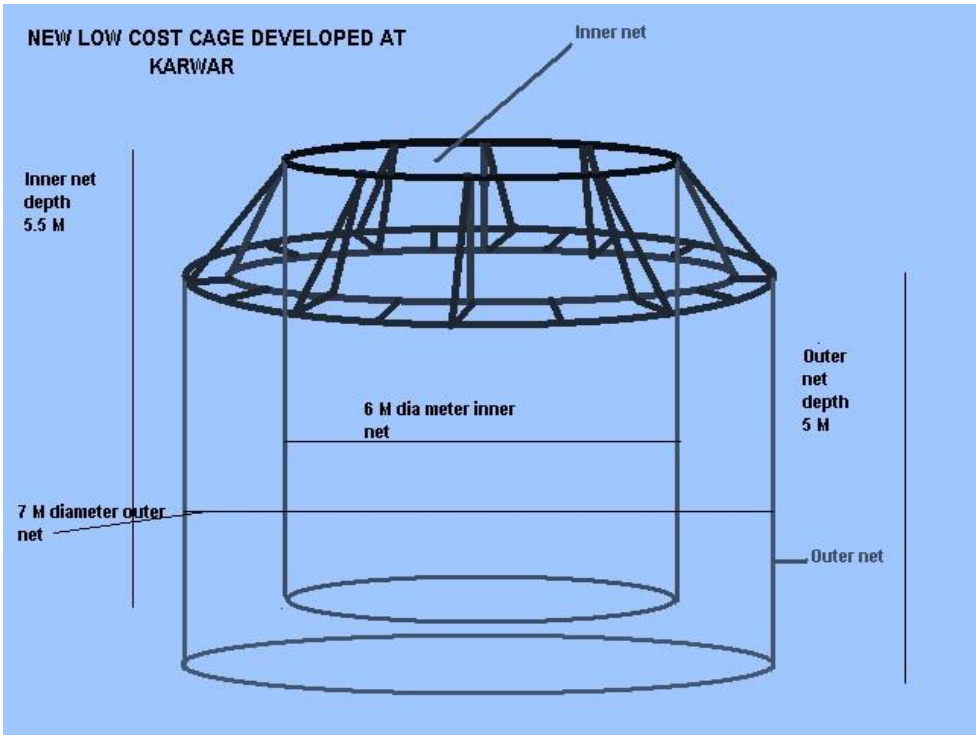
Size

Size of the cage depends on the site, species used for culture and materials used for construction. It is a fact that cost per unit volume decrease with increasing cage size, within the limits of the materials and construction methods used. It is not economical to have a cage size beyond the physical capability of the fish farmers to handle. In tropical waters, the net could get fouled in a relatively short period of time and the weight of the net would be considerably increased rendering cleaning of the net difficult. This will also reduce the floatation of the framework on which the net are suspended. Size of the cages used in marine water is larger in size than freshwater. CMFRI has developed open sea cages of 6 m dia, 10m dia, 12 m dia and 15 m dia for grow out fish culture. Ideal size for grow out cage is 6 m due to its easy maneuvering and reduced labour.

Cage frames

Commonly used materials for marine cage frames are mild steel (MS), galvanized iron (GI), poly-vinyl chloride (PVC) and virgin-grade HDPE (High Density 5 Polyethylene). Frames of iron and steel (unless galvanized) should be coated with a water-resistant substance like epoxy, or asphalt based or swimming poolpaint. In India, HDPE PE100 and GI pipes B/C class are preferred for cage frames. Cages frames are preferably made circular since circular cages can withstand sea conditions better than rectangular or square shapes. Business entrepreneurs with high capital investments can use long lasting and expensive HDPE frames can be used. Small groups and fishermen can opt for cost effective epoxy coated Galvanized Iron (GI) frames, which can be used for 2-3 years with proper maintenance.

The low-cost cage developed at Karwar is made of good quality 1.5" GI pipe (B class). The diameter of the cage is 6 m and the height is 120 cm from base to the railings. All the joints are double welded for ensuring extra strength. After fabrication the structure was provided with single coat epoxy primer and double coat epoxy grey paint to prevent rusting. The total weight of the cage is about 700 kg. The cage frame is kept floated in water by using 8-10fibre barrels of 200 l capacity filled with 30 lb air are used for floating the cage. The cage when floated on inflated barrels provides a stable platform around the cage where fisherman can stand and safely carry out works like net clearing, net replacement etc.



Low cost cage developed by CMFRI (6m dia)

Net cage

Net cages are designed as per the shape and size of the cage and depth of the site. Synthetic twines manufactured from HDPE are totally resistant to sea water, acids, alkalis and chemicals. They do notabsorb water and cannot rot very easily. HDPE is easy for handling and cleaning and are used for fabricating net cages for open sea cage farming. Also, nets made out of HDPE can last for two or more seasons with proper maintenance. The mesh size of the nets should be selected according to species and ensuring proper water exchange.

Dimensions of mesh size of net cages used for rearing/growout

Species	18 mm Mesh Fish Size (mm/g)	25 mm Mesh Fish Size (mm/g)	40 mm Mesh Fish Size (mm/g)	60 mm Mesh Fish Size (cm/kg)
Cobia	100-200/ 10-70	200-450/ 70-1100	460-750/ 1100-4000	75-100/ 4-7
Pompano	20-30/ 2	40-100/ 35	100-200/ 500	--
Seabass	20-100/ 15	40-200/ 300	200-400/ 1500	--
Grouper	20-100/ 15	40-200/ 300	300-400/ 1000	--

For sea cage farming, 3 types of nets are essential:

(i) Outer Predator Net

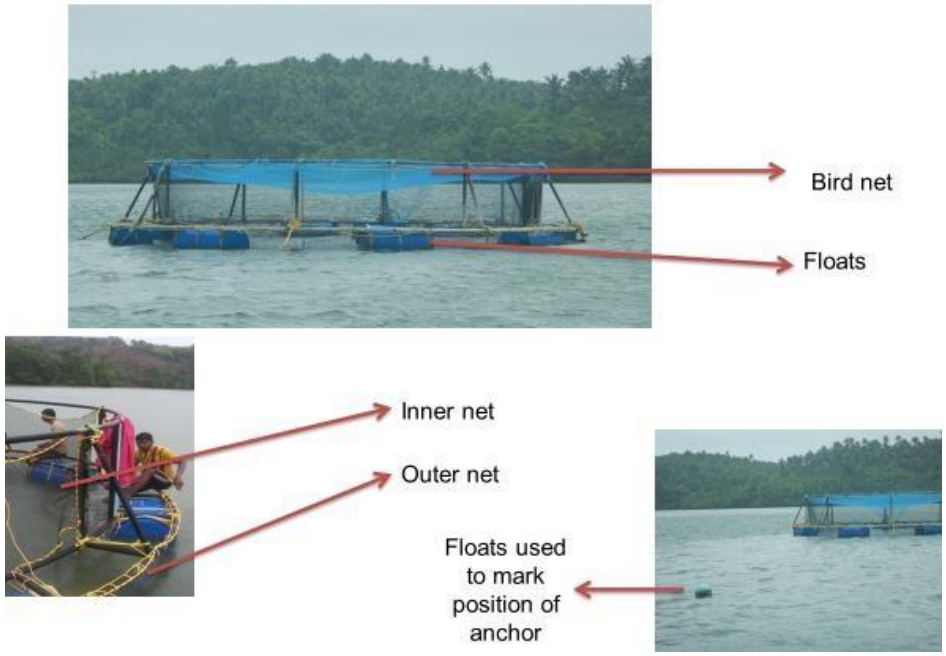
It is essential to prevent entry of predators in sea cage culture. Considering the strength, durability and cost factor, usually braided UV treated HDPE netting of 3 mm thickness and 80 mm mesh size is found very effective and recommended. Dimensions of predator net cage – 7 mdiameter and 5-6 m depth.

(ii) Inner Net

It is the net in which the seeds of desired species of fishes are stocked and cultured. For fabrication of inner fish rearing/grow-out net cage, twisted HDPE netting of 0.75-1.5 mm thickness and 12 - 40 mm mesh size is selected depending on the size of cultivable species. Dimensions of fish rearing net cage – 6 m diameter and 5-6 m depth.

(iii) Bird Net

To prevent predatory birds from preying on fish, a protective birdnet must be overlaid on the cageframe. HDPE or nylon nets of 60 - 80 mm mesh size will be ideal fora bird net.



The ballast pipe is another support system required to maintain the shape and structure of the net bags. Normally 1.5 to 2 inch diameter HDPE ballast pipe with holes at regular intervals, for the free flow of water, is used. Metal lines are inserted inside the pipe for increasing weight so that the ballast remains submerged in water

Mooring

Mooring system is used to hold the cage frame in a suitable position according to the prevailing environmental conditions. A good mooring system is required to keep the cages in a fixed position and to reduce the transfer of excessive forces generated by wind, currents and waves to cages. In well protected bays and seawater sites and freshwater sites, the forces of exerted by environmental factors are less and thus, small mooring system can used. In the case of sea cages, where the cages are exposed to greater environmental forces require more effective mooring systems. Mooring joints the cage with the anchor system. Type of mooring system to be used depends on the type of cage, site where the culture practices will be done, and the requirement for positional precision. Cage and mooring design is "site specific", and careful and combined choice of cage type, nets and most specifically moorings, has a considerable bearing on the ability of fish stocks to survive in major storms, on exposed sites. Good mooring system must be

be strong enough to resist the forces of

- Currents
- Waves and Wind action
- It should withstand and transmit the forces acting on it
- mooring line must have high breaking strength

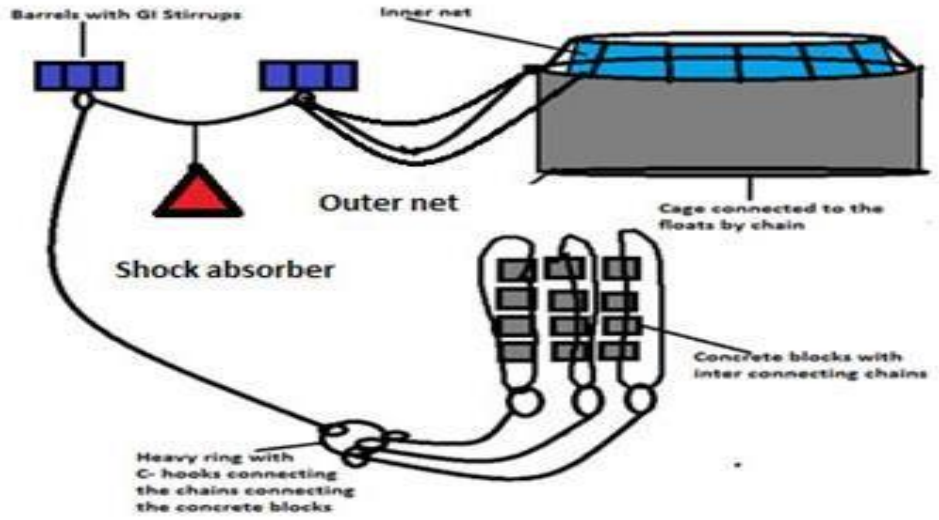
Mooring components

Important components include the anchor or mooring unit on the seabed, the rising line, which connects the anchor to the surface system, and the surface or subsurface mooring grid. The major elements comprise several smaller sub-units – particularly links, shackles, droppers, safety lines, buoys, etc., which in effect are integral in the complete system.

Types of mooring

- Single point
- Multipoint

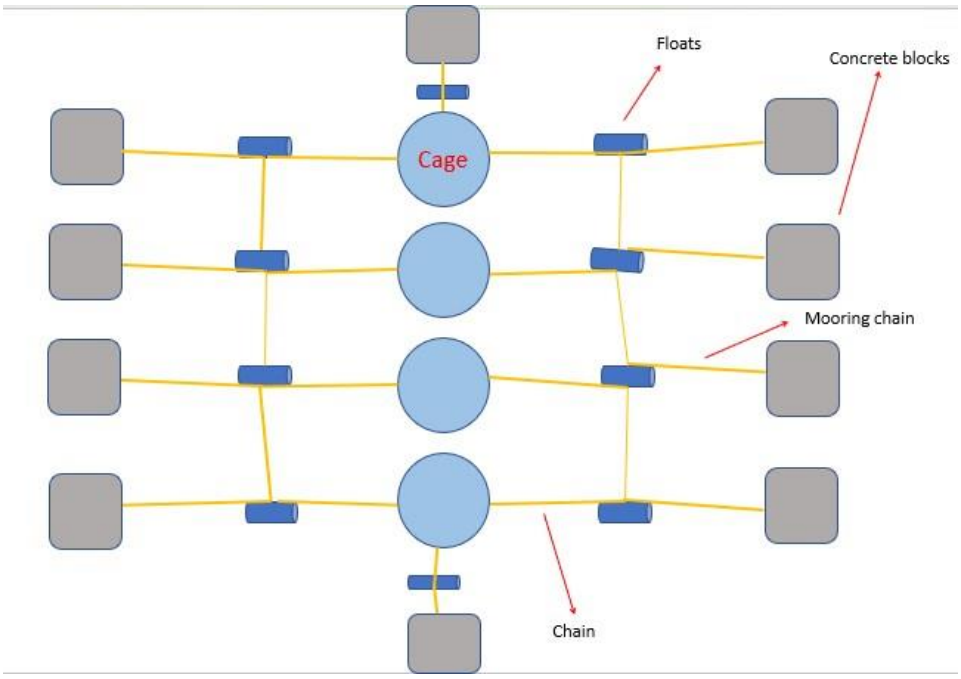
Single point mooring is used with rigid collars/ frames and this system allows the cage to move in a complete circle. They use less cable and chain than multiple point mooring, reduces the net deformation than the conventional mooring. They distribute wastes over a considerably larger area than those secured by a multiple point system. The material used may be either concrete blocks or sand filled bags.



Single point mooring using concrete blocks (Source: CMFRI Handbook on Open Sea cage culture)

Single point mooring using sand filled bags (Gabbion box)

Multipoint mooring is most commonly used mooring system. These systems retain the cages in one particular orientation. These systems use more chains/ropes to adopt the position of cages with least resistance to prevailing wind, wave and current forces. Orientation of cages depends on the nature of the site and group configuration of the cage.



Multi point mooring (Cluster mooring at Karwar)

Stocking

Stocking appropriate size and number of fish seed in cages is very crucial for the success of cage farming. After allowing the hatchery produced spawn to grow for a period ranging from 30 to 60 days, fish seed can be stocked in cages. Nursery rearing of seed is essential for all species and it can be done as a separate activity, in landbased nursery ponds or hapas held in ponds or in floating nursery cages, by individuals or groups at different localities to support sea cage farming with ready to stock fingerlings. Healthy, uniform-sized fingerlings should be procured for stocking in cages.

The fingerling stocking details are given in the table:

Species	Stocking Size (Length/ Weight)	Stocking Density (Nos./ m^3)
Cobia	15 cm/ 35 g	8-10
Pompano	10 cm/ 35 g	30-40
Seabass	10 cm/ 30 g	30-40
Grouper	15 cm/ 40 g	15-20

Feeding

Feed accounts for 60% of input cost in cage farming so are the importance to manage the feeding. Marine fishes need a diet rich in protein (35-40%) for optimal growth. The size of the feed pellet should be adjusted according to the growth of the fish. The usual feeding amount is 10% of body weight for juvenile fish but can be reduced to 3% of body weight as culture progress**.** A feed with an FCR of 1:2 is advisable. Feed should be given as per the recommended ration since overfeeding leads to wastage, economic loss and environment pollution.

Feeding rates, frequency of feeding and time of feeding are important factors to be considered in cage farming. Feeding rates and frequencies are related to age and size of the fish. Fish larvae and fry need to be fed on a high protein diet more frequently.

When fishes grow bigger, feeding rates and frequencies can be reduced. Feeding fish is a labour-intensive activity and the frequency must be adjusted in such a way that it is economically viable. Generally, growth and feed conversion increase with increase in feeding frequency. Feed consumption is also influenced by time of day, season, water temperature, dissolved oxygen levels and other water quality parameters. Moist feeds or pellet feeds can be used based on requirements and availability.

Harvesting the cage farmed fishes

The ease of harvesting cage farmed fish is one of the reasons to choose cage culture. Harvest of fish in cages is less labour intensive and can be done partially or completely based on market demand. Harvesting can begin when a significant portion of the fish reach a size the marketable size. At the time of harvest, it is advised to record the total no of fish harvested and their total weight. The cage farmed fishes are primarily sold through local fish markets or at farm gates and fetch a premium price owing to their superior quality and freshness.

Harvested Asian seabass

Harvest of pompano and snapper

Good management practices in cage farm management

1. Routinely monitor cages for escapement and properly maintain cage nets so as to prevent fish escapes
2. Optimize feeding protocols and to use good quality feeds
3. Use appropriate stocking densities and employ techniques to minimize physiological stress to cultured organisms
4. Growth rates of cultured fishes should be monitored at appropriate time intervals
5. Cage nets should be monitored regularly, and necessary repairs should be done immediately
6. Regular net cleaning and net exchange practices should be carried out depending on the site as well as the season. It usually varies from weekly to monthly duration
7. Periodic monitoring of water quality parameters like water temperature, dissolved oxygen, pH should be carried out
8. Mooring system should be monitored regularly, and any defects should be rectified immediately
9. Health status of fishes should be assessed while feeding
10. Implement cage rotation or fallowing
11. Site facilities in areas with sufficient flow rates and avoid areas that may impact sensitive ecosystems (e.g., coral reefs)
12. Always monitor the effects of cage site on the nearby environment
13. Practice IMTA (integrated multitrophic aquaculture)

References

Gopalakrishnan A, Boby Ignatius and VVR Suresh (2022). Mariculture Development in India: Status and Way Forward. J. Plant Genet. Resour. 35(3): 317–321.

Rao, G Syda and Imelda, Joseph and Philipose, K K and Mojjada, Suresh Kumar (2013) Cage Aquaculture in India. Central Marine Fisheries Research Institute, Kochi.

Loka, Jayasree and Senthil Murugan, T and Suresh Babu, P P and Anuraj, A (2017) Training manual on Open Sea cage culture. ICAR - Central Marine Fisheries Research Institute, Karwar.

Philipose, K K and Loka, Jayasree and Sharma, S R Krupesha and Divu, D, eds. (2012) Handbook on Opensea Cage Culture. Central Marine Fisheries Research Institute, Karwar.