CAGE CULTURE: TECHNOLOGY OF THE MILLENNIUM FOR THE INCREASED PRODUCTION OF PURE ORGANIC FINFISHES

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1. INTRODUCTION

Fish can be cultured in any of the four prevailing culture systems like ponds, raceways, recirculating systems or cages. A cage or net pen is a system that confines the fish or shellfish in a meshed en¬closure and allows it to grow in its natural environment.The cage aquaculture initiated in Norway during 70s got developed into a high tech industry in many countries all over the world for high valued fishes. Cage culture is accessing and expanding into new untapped open-water culture areas like reservoirs, lakes,rivers and coastal brackish and marine inshore and offshore waters globally.Cage culture can be established in any suitable body of water, including lakes, ponds, mining pits, streams or rivers with proper water quality, access and legal authority. This flex¬ibility makes it possible to exploit un¬derused water resources to produce quality fish.The main advantage of fish culture in cages is the fast growth rate, effective utilization of feed, good water quality parameters of the natural systems and easy harvest on demand compared to the pond culture. Factors such as increasing consumption of fish, some declining wild fish stocks, and a poor farm economy have produced a strong interest in fish production in cages.

In India though the cage culture is in the initial phases due to the successful and easily operating technology and plenty of open water bodies it is expanding very rapidly.Cage aquaculture is an active mode of fish cultivation prevalent in many states of India including Kerala. Now it has been marked asone of the attractive and important means of livelihood as well as profit making ventures.Cage culture has gained great popularity not only among people who depend traditionally on fishing but also among those who do not even have any previous experience in fishing. There are some particular reasons why people are attracted towards cage aquaculture. The most important reasons are the durability of the cage, easy maintenance and high profit. The new cage design and efforts of Central Marine Fisheries Research Institute (CMFRI) during the last decade has considerably boomed the cage fish farming in Kerala especially in Ernakulum, Thrissur and Alleppey districts. Fish culture in Cage have several advantages over other methods of culture as it is done in existing open natural water bodies require comparatively low capital outlay and use simple technology, they are popular with farmers, extension workers and development programmes. Cages can be used not only for grow-out of fish to market size, but also for broad stock development of major marine finfishes.It is an aquaculture production system made of a floating frame, net materials and mooring system (with rope, buoy, anchor etc.) with a round or square shape floating net to hold and culture large number of fishes and can be cultured in reservoir, river, lake or sea.Of the estimated one million tons of marine fish cultured in Asia, probably 80-90 % is from cage farming. Cage culture is presently undergoing great innovations in response to globalization and the growing demand for aquatic products. It has been predicted that the fish consumption in developing and developed nations will increase by 57 % and 4 %, respectively over the coming years is expected to full fill through the increased production from cage aquaculture.

SIGNIFICANT ADVANTAGES OF CAGE CULTURE

- Many types of water bodies can be used (open sea, brackishwater, estuaries, reservoirs, lakes, rivers etc. which

could otherwise not be harvested) for cage culture

- Good water quality parameters as the water is flowing
- Relatively low initial investment
- Easy operation and management
- Ideal for poor and landless people especially for fishers
- Effective utilization of Feed
- Fast growth and higher production of quality fish
- Production of fish in its natural conditions
- Reduced culture period (1-2 crops/ year)
- Production of high quality fish
- Easy and harvest

2. WHAT IS CAGE CULTURE?

Cage culture involves growing fishes in existing water resources while being enclosed in a net cage which allows free flow of water and with optimum feeding for fast growth and high production. It is an aquaculture production system made of a floating frame, net materials and proper mooring with anchor/ pole, rope, buoy etc.in an open water body. Economically speaking, cage culture is a low input farming practice with high economic returns. In view of the high production capacity in cage culture systems, it can play a significant role in fish production of the country and the income generation of the farmer.

3. CAGE STRUCTURE AND MOORING

Cage fabrication

1. CAGE FRAME

Indijenously fabricated high-density polyethylene (HDPE) cage

measuring 6 m diameter with catwalk and hand rail with provision for connecting different nets was used in the marine cages. Whereas GI frames can be of any measurement like 4 x 4, 6 x 6 or 9 x 4 according to the area or nature of the water body or our requirement; it can be square, rectangular or round (for sea)

Fig.1 HDPE round cage with blue inner and green outer nets 2. GI cage (4 m2) frame after welding and painting 3 GI cage (6 m2) in open water system in operation

Round GI pipes of 1 ¼– 1 ½inch diameter are usually using for cage fabrication; the required number of pipes (13 nos for 4 x 4, 18 nos for 6 x 6 and 22 nos for 9 x 4) has to be procured from the market cut according to the measurements as marked in the fig. It can be welded as a single unit or demandable types fitted with nuts and bolts and can be welded at the culture sites or any locations; while welding care has to take to do the welding without any holes to avoid water entering into the pipes. After welding the whole welding areas have to be covered with m-seal before painting.The whole structure has to be painted with marine epoxy primer & paint and allow dry properly before mooring.

3. 2. NETS

Two nets are required at a time for a cage to hold the fishes while doing grow out culture both in sea as well as open water systems. The design of net cage is as follows in marine cages:HDPE outer predator (braided 60 mm mesh) and inner grow-out (40 mm mesh) nets with a net depth of 6 m were used. A bird net (80 mm mesh) was used to protect the stock from birds. A 6 m diameter HDPE ballast pipe (63 mm diameter) at the bottom with holes for the free flow of the water was used to maintain proper shape of the nets.Where as in other open water systems no need of any braided nets which are usually costlyand the outer and inner net is made of twisted HDPE of 28 – 40 mm mesh and 18 – 24 mm mesh respectively based on the size of the fish seeds. Ballast pipe is according to the size of the inner net. It can be made with PVC or GI. Here also a bird net of 60 – 80 mm mesh is used to protect the fish from the attack of birds and ballast pipe to maintain the shape of the net is required. While making cage nets square mesh is a must instead of diagonal mesh to avoid escape and gilling of undersized fishes.

3.3. FLOATS

Drums for flotation: Minimum 8 numbers of 500 l plastic drums (used) are required for a single cage for floatation; and it has to be tightly sealed and tied to the frame as shown in the picture.

3. 4. MOORING SYSTEMS

Single mooring system:As the name implicates in single mooring systems the anchoring is only at one point. It is mainly used in the open sea conditions and the cage can rotate 360 o;resultant of the currents or wave actions and mooring is done either by anchor or gabion box with granite pieces.This reduces the stress of the mooring chains in sea conditions.

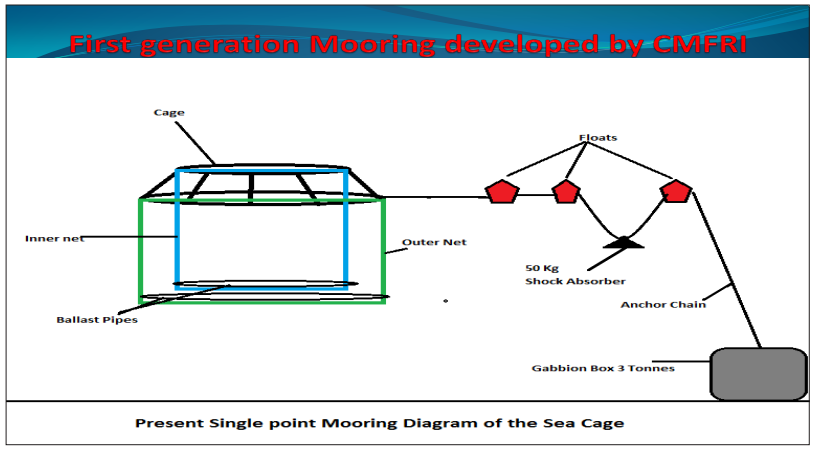

Fig. 2 Diagrammatic picture of the single mooring system

Double Mooring system: It is generally used in lakes, rivers or back waters where two directional water flows prevails. It uses poles in shallow areas; whereas anchors in deeper waters. Mooring will be on both the sides; so that cages will keep in place while the water flow in both the directions happens consequently mainly due to the tidal influx. Here the cages cannot move much except the vertical movements due the tides; a little side wise movement is also possible depending on the length of the ropes tied between the poles and the cages.

3. 5. SITE SELECTION

Selection of a suitable site is most important factor in the case of any culture especially in the open sea cage

culture because it determines investment, running cost and mainly the ultimate success. A calm bay or inbound sea with good water flow and sandy or rocky bottoms should be selected as an ideal culture site. In the case of cage culture, most cage sites have been placed in relatively sheltered waters but there are a finite number of such suitable sites. But most of the times such an ideal area may not be available in most of the places. However, the future is in the open sea cage culture is likely to be further offshore, as the coastal waters limitations when the same develop as an industry and scarcity of water bodies. For site selection, a pilot survey has to be conducted prior to the commencement of cage farming. Different criteria must be addressed before site selection for cage culture The first is primarily concerned with the physicochemical conditions like temperature, salinity, oxygen, currents, pollution, algal blooms, water exchange etc. that determine whether a species can thrive in an environment. The water and sediment quality parameters of the proposed sites should be determined prior to the culture to meet the standard requirements. Other criteria that must be considered for site selection are weather conditions, shelter, depth, substrate etc. Finally legal aspects, access, proximity to hatcheries or fishing harbor, security, economic, social and market considerations etc. are to be taken care.So we can take the factors one by one and find out the most suitable area in our locality.

1. The depth should be sufficient to keep the nets clear off the sediment and allow water exchange beneath the nets. Otherwise we have to adjust the length of the nets according to the depth of the water column.
2. Good water exchange is also important in cage culture to replenish oxygen and flush away wastes.

3. Tidal amplitude is found to have great role in making daily water currents and pulling effects on the cages will be very high especially during the full and new moons. The ideal is 1 – 1.5 m or less than that.
4. Knowledge of the wave action at a potential site will help for the selection of a proper cage and mooring technology for the site.
5. The wind velocity of the site must be less than 30 km h-1 during culture period.
6. Water quality factors such as temperature, salinity, pH, suspended solids and the presence of algal blooms can potentially influence the growth and survival of the cultured fish.
7. Bottom characteristics also have some role in the site selection as sandy and rocky bottom is good than muddy.
8. Sources of pollution which can negatively impact on water quality.
9. Weather is also another important factor in determining the suitable site for cage culture as they can impact on both the cage structure and enclosed fish.

6. DIFFERENT SPECIES IN CAGE CULTURE

Candidate Species

Fast growing and high value species are the best suited species for marine as well as open water cage culture. A number of species are already grown commercially in cage culture overseas and notable examples are rainbow trout, brown trout and Atlantic salmon. Cobia Rachycentroncanadum, groupers and Asian sea bass Latescalcarifer and juvenile lobsters are the potential fish

species for India due to its high market demand, better growth rate and seed availability. In brackishwater cages, common species used for culture include Sea bass, Snappers especially red snapper, Pearl spot, Etroplus surratensis, mullet (Mugil sp.), milkfish (Chanoschanos), and other carangids like T. blochii, T. mukalee,C. ignobilis, C. sexfaciatus etc. The major species used for culture in marine cages are Cobia, Pompano, Groupers, Sea bass, Sea bream, Rabbit fishes, and lobsters.

Hatchery technology is available for sea bass, cobia, pompanoand Groupers and in the case of lobsters the juvenile fishery is prevalent in the Indian coast as it fetches high price; and these fishes are the main candidate species used for the cage culture at present. The prospect of developing commercial interest in lobster farming in India seems bright due to the substantial increase in price consequent upon heavy demand from export market as well as due to the juvenile fishery. Fattening of lobster juveniles in the sea cages is very advantageous as the juveniles will get a chance to grow, mature and spawn in the cages. As its fishery is in live condition a better co-ordination can increase production and it helps in the conservation of the species at the same time. A variety of ornamental fishes, shrimps and mollusks can also form candidate species for cage aquaculture.

7. STOCKING

Grow out of the fish culture in cages starts as it transfers to the cages from the nurseries, usually the nursery reared juvenile fishes of 8 – 10 cm fishes with a minimum weight of 80 – 100 g are preferable for stocking in cages in case of sea bass. However, the size and stocking varies with the species and the major factor to be noted is that the seeds stocking in the cages has to be retained in the inner net, they

should not pass through its mesh. The stocking densities of species in cages are highly variable and the optimum density for many species is not known. Stocking in cages are usually two types i.e. high density/ low volume or low density/ high volume. Low density/ high volume stocking (2-20 fish/m3) are recommended for species like Cobia for which harvest size is several kilograms; high density/ low volume stocking (50-250 nos/m3) are good for those fishes target harvest is 1 kg or less. Stocking density depends on the size and type of the fish selected for mariculture, however generally depending on the production target of up to 25 – 30 kg per m3 stocking can be done.

Fish stocking in cages

The minimum recommended stocking density for common carp, tilapia, and catfish is 80 fish /m3. A recommended maximum stock density for beginning farmers is the number of fish that will collectively weigh 150 kg/m3 when the fish reach a predetermined harvest size (Schmittou, 1991). The smallest recommended fingerling size for stocking is 15 g. A 15-g fish will be retained by a 13-mm bar mesh net. Larger fish can also be stocked into cages. Survival rates in well-placed and well-managed cages are typically 98 to 100 %. Unless greater mortality is expected, no adjustment is needed to calculate stocking density.

An example of how to calculate the number of fish to stock per cage follows: Assume that a farmer wants harvest fish weighing 500 g from a 1-m3 cage.

Total fish weight at harvest	=	150 kg/m3
Number to stock	=	300 fish (300 x0.5kg)
Desired average fish weight	=	0.5 kg at harvest

Production = 150 kg/m3

For a harvest of fish averaging 200 g, the number of fish to stock would be:

Number to stock = 750 fish/m3

0.2 kg x 750 = 300 kg/m3

Juveniles of sea bass reared in the nurseries of size 10 - 15 cm in length (25 – 50 g) can be transferred to the cage for the grow-out. The stocking density in the cages varies from 20 – 25 kg/m3 in the final harvest time. So with a final weight of expectation of 1 kg fishes in harvest time after a period of 6 – 8 months; from the cages the stocking density varies from 25 – 30 fishes / m3 for the sea bass. Care must be taken to avoid handling stress and other physiological stresses as maximum as possible while transport and stocking.

8. GENERAL MANAGEMENT

The growth and thereafter production is the resultof proper management of the various culture activities. The various factors to be taken care in cage management are:

1. Feeding

In any aquaculture especially in cage aquaculture, the most important factor is feed and feeding as the fishes in the cages are totally depended on the feeds what we are feeding.A cost- effective feed of good quality and acceptance determines the production. The nutritional requirement is dependent on the species and its stage of development; juveniles usuallyrequirehigh protein good quality feeds. Feeding is also a vital function and includes many biological, water quality, and economic factors. The direct influence of growth rate in terms of feeding intensity, feeding time, food rations are important and the farmer has

to give more attention. The feeding characteristics of each species vary in feed intake, digestion, feeding frequency and conversion efficiency and these has to be addressed. Feed has to store properly if it is pelleted feed; if feeding with trash fish the chance of rapidspoil and has to be carefully managed. Feeding should be done throughout the culture period at varying levels depending on the growth rate and natural feed availability. Feeding trays or feeding rings can be used based on the type of feed used.Use of floating feed is vital for cage-farm operations.Feeding should be scheduled in such a way to ensure that feed wastage is kept to a minimum.

2. Net cleaning and net exchange

Cage nets may be checked weekly for cleaning, which is to be done more frequently if clogging is more during cage culture. Small tears may be repaired at the site itself, while major repairs should be done on shore only. Net exchange has to be done periodically to avoid fouling and for good water exchange. Mesh size should be carefully selected at each stage of growth the nest has to be changed according to the growth and size of the fishes cultured. The frequency of net change varies depending upon the site location,materials used, season and management of cage. Net cleaning can be done physically or by using mechanical pumps. Physical cleaning involves removing and scrubbing the net and drying. Similarly cage frames are also cleaned in situ using a hand brush both above and below the water line to dislodge weed and accumulated debris.

3. Water quality management

Cage-farm wastes are usually in the form of uneaten feed and fecal matters of the fishes. Mooring cages in deep waters, leaving 1-2 m bottom space and good current

flow results in cage wastes being easily flushed away, thereby avoiding organic build up under the cages.Routine monitoring of water quality is essential; by this we can avoid losses caused by lethal changes in water quality. It is essential for estimation of optimum stocking and feeding requirements, to evaluate the general condition of stock, so that if stressed, can avoid handling. It is essential to evaluate site and configuration of cage. Information of long term changes in water quality at a site is very important for the sustainability of the industry and the variation in production may be properly evaluated.Health management is essential to maintain a good health status, assuring optimum production and the avoidance of diseases. In aquaculture, the economic risk associated with diseases is highand treatments are often initiated too late and are therefore rarely effective. Thus, aquatic animal health management must be aims to prevent diseases before they occur.

4. Periodic maintenance of the cages, moorings, anchors, and related accessories

Irrespective of the damage that can be caused by climatic changes, predators, drifting objects, poachers, all materials used in construction of cages have a definite life span. Cages, nets and moorings therefore must be checked at intervals for signs of damage and wear and tear and repaired or replaced if necessary is a must. Mooring must be checked regularly.

9. HARVEST

Harvesting in a cage culture system is a simple processand less labour intensive compared to that in ponds. Harvesting can be done in a single lot or in batches based on demand and market price. No sophisticated harvesting

technology is required cages can be towed to a convenient place and harvest can be carried out according to the needs. Also based on demand, partial or full harvest can be done.Preservation and processing of cultured fish will be an essential part of the culture industry when aquaculture is further developed.

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