ICAR-CIBA Extension Series No. 75

Cost effective low volume cage culture model for brackishwater finfish farming in backwater creeks: An alternative livelihood model for coastal tribal and fisher folks of Gujarat

(Under Tribal Sub-Plan)

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Introduction

India is bestowed with number of locally important cultivable brackishwater finfishes for aquaculture such as Asian seabass, Milkfish, Grey mullet, Pearlspot, Spotted Scat, Red snapper, Rabbit fish, Estuarine grouper and Cobia. Diversification assumes significant importance in India with respect to sustainability as coastal aquaculture is limited to the shrimp aquaculture. The brackishwater aquaculture activity from India had been chiefly originates from small stakeholders owning relatively smaller farming areas. Fish has universally consolidated its position as an affordable healthy food and increase in its production for assures income, food and nutritional security. Farming of fish using customized cages in open brackishwater is an ideal option to utilize the untapped water resources for enhancing fish production, and translating these into income generation activity for the stakeholders involved.

Among the brackishwater finfish species, Asian seabass *Lates calcarifer* and Pearlspot *Etroplus suratensis* can be considered as suitable candidate species for open water cage culture practices owing to their desirable characteristics such as euryhaline nature to withstand wid range of salinity, acceptance of pellet feeding and good market demand. ICAR CIBA has successfully demonstrated cage culture of these species with the farmers participation in Kerala, Tamil Nadu and Maharashtra.

In the west coast, the estimated brackishwater resources in Gujarat is around 3,76,000 hectare with the potential area suitable for brackishwater aquaculture is about 83340 hectares. Southern Gujarat is blessed with plenty of open brackishwater resources such as backwater, creeks, swamps etc., which can be utilized effectively for cage farming of brackishwater finfishes. Tidal amplitude of Gujarat coast is higher than other parts of West coast. This natural phenomenon had created vast stretches of marshy and saline lands all along the coast. This will be model for brackishwater finfish production, and livelihood generation in all coastal districts of Gujarat. It would also enable skill development in cage construction, cage setting and carrying out different phases of cage culture such as nursery and grow-out culture to the farmers.

Need for Intervention

Presently, Gujarat is considered as one of the progressive states in shrimp farming in India in terms of higher productivity and export. Major shrimp farming activities are centred in four districts and nearly 95 of state such as Surat, Valsad, Navsari and Bharuch contributing shrimp farmer's population with the potential area of 69,583.91ha (Tandel and Maheta, 2018). Although, the state has brackishwater creeks which is suitable for cage culture but has not been utilized so far. These underutilized brackishwater bodies can be effectively used for brackishwater cage aquaculture to bring out significant differences in species diversification, fish production and livelihood generation at different coastal district of Gujarat state. Since shrimp farming involves the ownership of land, initial capital investment and operational costs, disease related issues etc., small scale aqua farmers may not be able to take up this practice as livelihood income generation activity. Therefore, brackishwater cage culture activity with finfish species is a potential option for overcoming these limitations and has additional advantage due to its easy adoption and higher profits. It is a powerful tool to utilize the untapped water resources for enhancing fish production, productivity and translating these into income for the stakeholders involved.

Therefore, ICAR-CIBA, Chennai has taken initiatives to develop low volume low cost multispecies cage culture of Asian seabass and Pearlspot in brackishwater creeks as an alternative income generation opportunities for coastal tribal and small scale aqua-farmers of Gujarat.

Asian seabass (*Lates calcarifer*)

Asian seabass (*Lates Calcarifer*) known as Bhetki or *barramundi* in India is one of the commercially important finfish species caught from inshore areas, estuaries, backwaters, lagoons and fresh water ponds. Seabass is a fast growing species with ability to tolerate wide fluctuations in environmental conditions and gaining rapid popularity as a candidate species for diversification in coastal

aquaculture in India. Seabass is carnivorous in nature. However, juveniles are omnivores. Seabass is an opportunistic predator, whose diet changes at different ages of various size groups. It feeds mainly on zooplankton in early stages and as they grow changes to feeding on young fishes and shrimps. They show preference for pelagic fish rather than benthic crustaceans as the prey is large. However, juvenile seabass even consume smaller sizes of seabass of the same age group as whole and can cause reduction in the survival rate. It is one of the fastest growing fish, can grow to an average size of 1.5 kg in 10 to 12 months and fetches good price in domestic and international market. It is considered as a potential candidate species for farming in saline or freshwater environments in ponds and cages. The culture of seabass involves nursery rearing in happas, pre growout culture and growout culture in ponds and cages.

Asian seabass *Lates calcarifer*

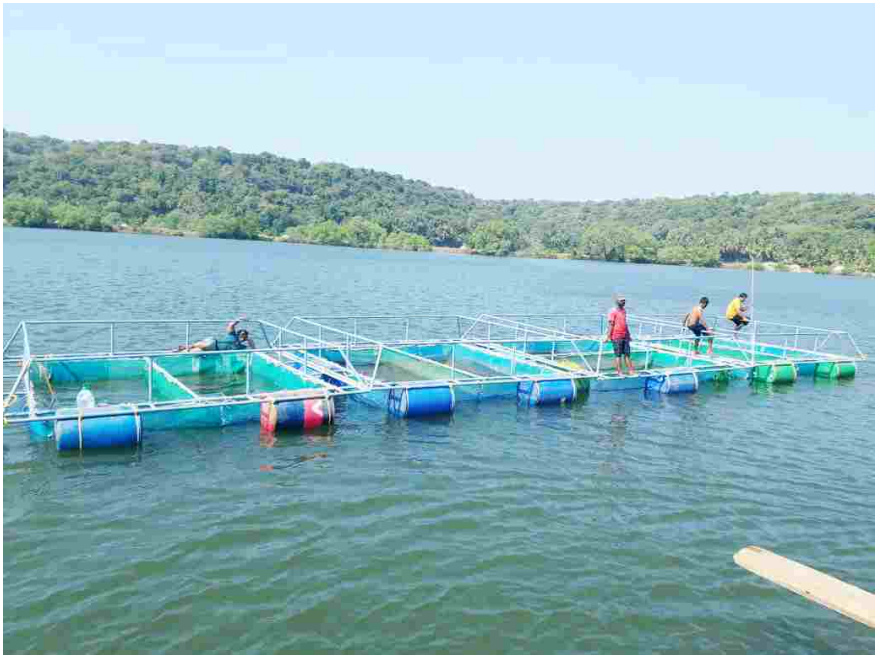
Pearlspot (*Etroplus suratensis*)

Pearlspot *Etroplus suratensis* (Bloch, 1790) is commonly called as green chromide and its popular vernacular names are Karimeen (Malayalam) and Kaalundri (Marathi). It is the state fish of Kerala having high market demand in the west coast. Pearlspot is an economically important food fish having a market value of Rs. 250-500 per kg depending upon the size. It is also an emerging ornamental fish. Pearlspot is adaptable to different culture systems like ponds pens and cages. Being omnivorous in nature, aquaculture of pearlspot is economical and highly suitable for supporting livelihood of small scale fish-farmers. A major bottleneck limiting the expansion of pearlspot aquaculture is inadequate availability of seed for stocking in grow-out systems. Therefore, pearlspot seed costs are relatively high ranging from Rs. 10-15 per unit according to the size of the seed.

Pearlspot *Etroplus suratensis*

Cost effective low volume seabass and pearlspot cage culture

CIBA has developed a comprehensive low volume low cost cage culture technology for sustainable and viable farming of seabass and pearlspot, which can be adopted by farmers.The most important aspects to take up cage culture of fish species is the availability of stock size seed, cost effective feed, cage management and active participation of the farmers. These factors have direct impact on production and sustainability of culture system. Cage culture rearing can be done using Galvanized Iron, PVC or bamboo as cage frames having knotted or knotless cage nets floated with barrels in brackishwater creeks as well as mangrove waters. However, low volume cage culture is a low venture setup which can be adopted in home backyard creek water bodies. The cage culture rearing phase is of 180-240 days depending upon the practice. Production of high value fish using low volume cages in brackishwater bodies can thus be a potential livelihood option to the poor and suck kind of low volume cages even can be fabricated by the farmers themselves. This type of cage culture is gaining importance amongst the small fish farmers, Self Help Groups, tribal communities as livelihood options in Kerala, Karnataka, Maharashtra, Andhra Pradesh, Tamil Nadu, etc.



Cage culture of seabass and pearlspot in brackishwater creeks of Sindhudurgh, Maharashtra

Steps to be followed during cage culture cite selection

Cage culture sites must be free of any kind of water pollution and located away from local sewage discharges etc. Site should have regular water depth of above 3 m and must retain at least 2.5 m of water level during lowest low tide of the year. Wind and wave action should be at moderate level (<1m/s) and must have good water exchange through cages for replenishment of oxygen and removal of waste metabolites. Sites should be such that cages are easily monitored and managed during culture operation Site should not be a regular fishing ground or boat navigation channel. Site should free from any sand mining area as removal of sand from water led to suspension of minute soil particles, inorganic and organic sediments in water column cause clogging of nets cages, fish cages and reduces water exchange and dissolved oxygen levels. Site should be near to shore with boat connections and good approach road for easy access.

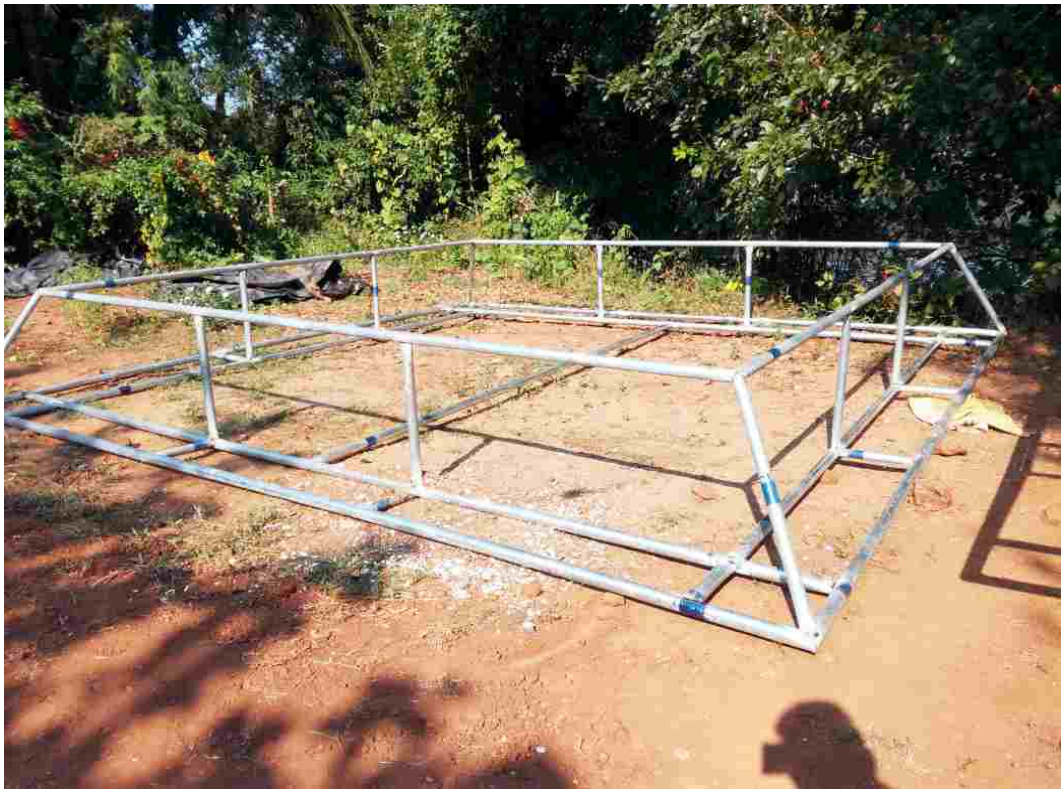
Pollution free creek site for cage culture

Cage frame and structure

The Cage main frame and whole structure can be made of Galvanized Iron (GI) pipes, PVC pipes or Bamboo poles as per the requirement. However, cage frame made of good quality Galvanized Iron (GI) pipes painted with anti-rusted epoxy paint have good shelf life in brackishwater bodies. For fabricating single grow-out cage with the dimension of 4 x 4 x 2m (32 m^2) about twelve nos. of 1.5 inch and six nos. of 1.25 inch GI pipes are required. The cage frames and structures need to be coated with epoxy paint to avoid rusting of the GI pipes in salt water. To keep the whole cage net in vertical position in water column, square shape internal frames of 2 x 2 m size can be made of 1.5 inch GI Pipes are kept inside at the bottom of each cage net compartment. For grow-out net cages frame of 4 x 4 m size are used. The four corners of internal frame are tied with PP rope for quick uplifting of the frame during cage cleaning, changing net, etc.

Cutting of G.I. pipes for making frame

G.I. pipes wielding for cage frame



Wielded cage frame

Barrels and anchors

The whole cage structure kept afloat with the help of six HDPE barrels of 210-250 L capacity. Mild stainless anchors or concrete weight blocks as anchors can be attached to the corners of the net cage at the bottom. The cage structure is anchored at creek muddy or sandy bottom with the help of 85-100 kg steel weight having five legs to withstand the strong water current and to avoid displacement of cage structure during high tide and low tide.

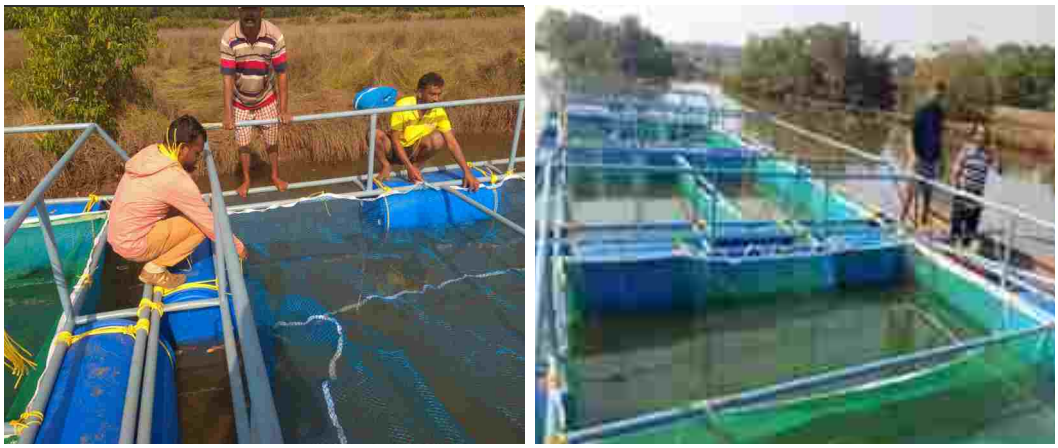
Cage frame installation

Anchoring cage frames

Cage nets

Two types of cage nets can be used for pre-grow out net and grow out culture of seabass for achieving good survival and higher production of the system. In the pre-grow-out cage culture (around 90 days culture period), fingerling size seabass seed (1-5 inch & 2-15 g) are stocked in the cage. In this case, HDPE knotless cage nets of 4 x 4 x 2 m dimension made of 24/36 ply & 12-20 mm diamond /hexagonal shape mesh webbing mounted with 3-6 mm rope and 2000-3000 kg tensile strength are used. In the grow-out culture cages, advanced fingerlings in the size of 50-100 g seabass fish can be stocked. For this purpose, HDPE knotless cage nets of 4 x 4 x 2 m dimension made of 45/60 ply & 25-30 mm diamond /hexagonal shape mesh webbing mounted with 6-12 mm rope and 3000-5000 kg tensile strength are suitable till harvest of the culture period.

Asian seabass is carnivorous fish in nature hence to avoid cannibalism and to improve survival during pre-grow out cage culture, net cages with internal partition to have two internal compartments of 2 x 2 x 2 m can be made. This would facilitate re-stocking of two different size group seabass fishes in each compartment. In the case of Pearlspot culture, such internal partition is not required since they are herbivore fishes.



Partitioned net cages for seabsass pre-grow out cage culture in creeks

All sides of the pre-grow-out and grow-out cage nets are supported with nylon strap of 3 mm width and 1 mm thickness with inbuilt 6 mm and 12 mm polypropylene ropes for tying the nets to the cage main frame. To protect the cultured species from wild crabs and other predatory organisms, each cage should have an outer protection cage net in the dimension of 4.3 x 4.3 x 2.5 m made of nylon knotted net of 36-40 mm mesh size.

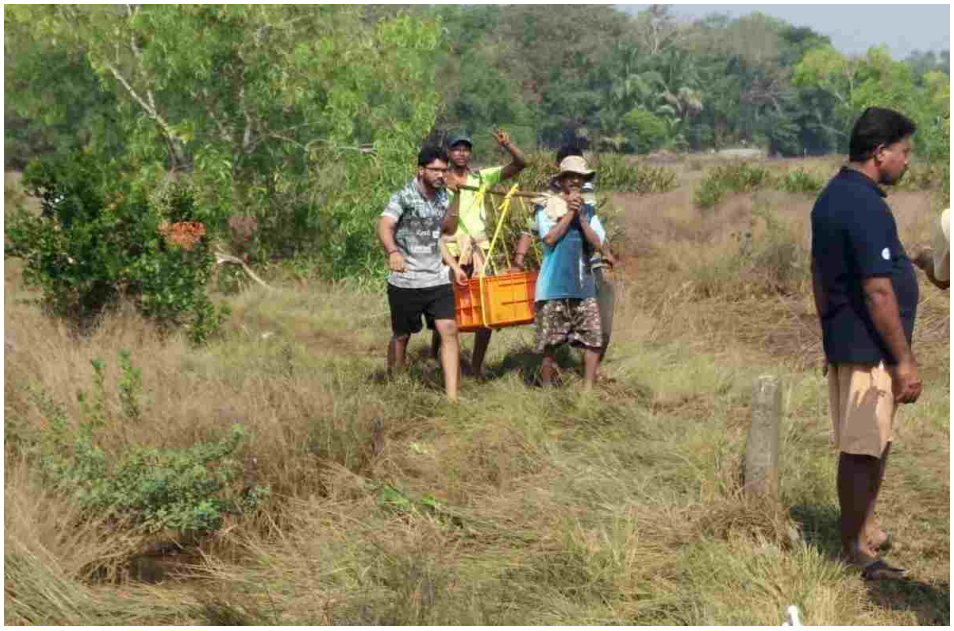
Stocking

Fish stocking density and duration of the culture period are the two important aspects which need to be decided well in advance. Stocking should be done in the early morning hours in between 07:00-11:00 to avoid stress to the fishes. Healthy, injury, stress and disease free seed should be stocked in the cages.

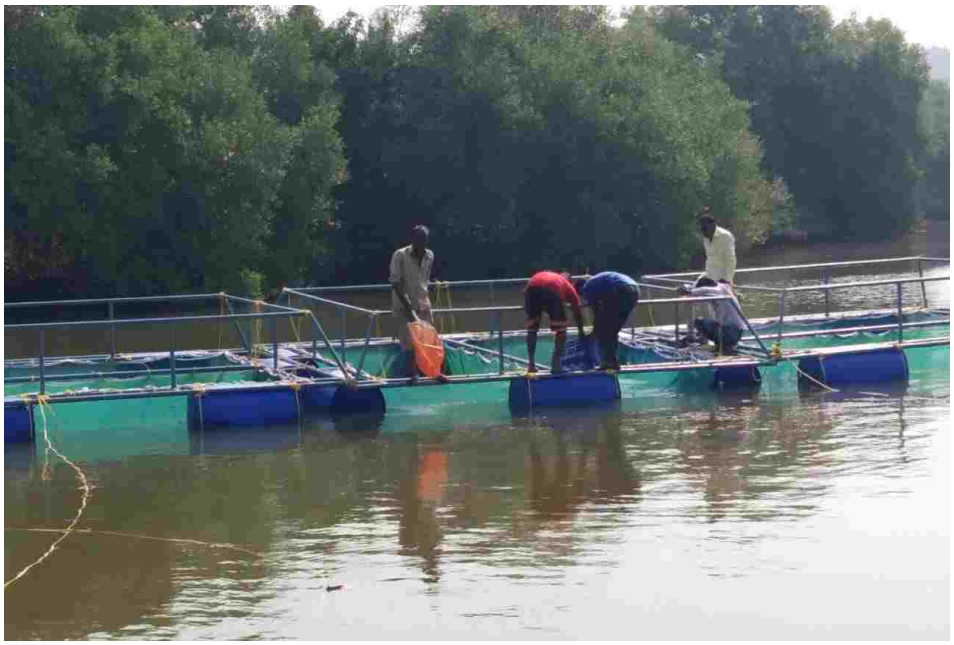
In the pre-grow-out cages, seabass fingerlings with the size of 3.0 to 5.0 inch can be stocked @ 20-30 nos./m^3 i.e. 640-960 nos./cage. Whereas pearlspot seed with the size of 1.0–2.0 inch size can be stocked @ 90-100 nos./m^3 i.e. 2880-3200 nos./cage. The density can be increased depending upon the water quality of the creek and proper feed management should be done. However, higher stocking densities of seed over and above optimal level can lead to stress and infections due to crowding and management problems. Hence optimal stocking density should be maintained in both pre-grow-out and grow-out culture systems.

Asian Seabass fingerlings

Pearlspot fingerlings



Transportation of fish seed for stocking in cages



Seed stocking in cages

Feeding

Supply of quality feed of appropriate size with essential nutritional value is utmost important criteria to yield better productivity. Fishes stocked in the cages can be fed either with extruded/floating or slow sinking pellet feeds. Supply of trash fishes to feed seabass can be avoided since, getting the live or dead trash fishes on regular basis will be a problem and these fish also can carry the pathogens if not processed properly. However, artificial feed have many advantages over trash fishes such as easy as procurement, storage and feeding.

Seabass is carnivorous in nature. However, juveniles are omnivores. Seabass is an opportunistic predator, whose diet changes at different ages of various size groups. They show preference for pelagic fish rather than benthic crustaceans as the prey is large. Since seabass does not prefer to feed on the feed settled at the bottom, while feeding care should be taken the fishes are on sub-surface water column. However, juvenile seabass even consume smaller sizes of seabass of the same age group as whole and can cause reduction in survival rate.

Seabass fish prefers slow sinking pellet feed (2-6 mm) having protein 40-45 % and FCR for pellet feed is claimed to be around 1.5 to 1.8 depending upon the feeding strategies followed by the farmer. Pearlspot is herbivorous fish, which feed mainly on filamentous algae, aquatic macro-vegetation and planktonic organisms. Pearlspot fish also readily accept artificial feed and the FCR is about 1.5 to 1.8. Pearlspot fish prefers floating feed (0.6 -2 mm) with protein requirement of 25-35%.

Sinking feeds for seabass

Floating feed for seabass

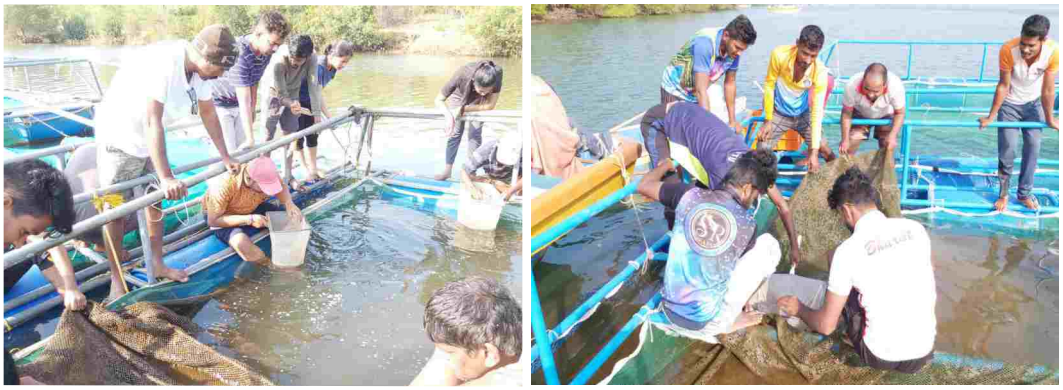
Feeding is done twice a day (morning and evening). The fish should be fed at the rate of 10% of their body weight to start with feed requirement is calculated based on the biomass. Feeding rate vary from 3-10% of total biomass over a period. After four to six weeks, the feeding rate may be reduced to 8%. As the fish grow in size the feeding rate should be gradually reduced to 5%, 3% and even 2% finally.

Artificial feeding to cage cultured seabass and pearl spot by farmers

The total biomass in the cage culture should be fortnightly estimated by random sampling of 15-20 fishes from each cage for adjusting the feed. Over feeding need to be avoided which leads to poor water quality of the culture system and resulting in reduced survival.

Grading

Seabass is highly cannibalistic fish and if proper timely feeding, cleaning and management care is not taken then it affects the survival as well as sustainability of the culture. Hence, size wise grading of farmed fishes is one of the important step during pre-grow out cage culture of seabass. This is very much essential to reduces the cannibalism and improve the percentage survival during cage culture. Fingerlings size grading need to be done at 15-20 days intervals. During the grading, all fingerlings are removed from each cage nets and taken in grading containers where shooters are separated from the small size fingerlings group and kept separately according to their sizes as smaller one in one compartment and larger one (shooter) in other cage compartment. Grading must be done in early morning (07:00-11:00 am) and late evening (16:00-18:00 pm) hrs. At least, 3-4 people are essentially required on each cage for proper grading, cage net cleaning, cage management and to avoid handling stress to cultured fishes.



On site cage cultured seabass grading by farmers

Cage Culture Graded Small Seabass

Cage Culture Graded Seabass Shooter

Pearlspot are not carnivorous species hence fish grading is not required in case of pearlspot cage culture. However, cages need to be checked for chocking with debris if any and cleaning purpose.

Cage management

Since cages are inside the water and exposed to water current, the debris materials drifted may adhere to the cages and clog the mesh restricting the water exchange. The fouling organism will also attach and clog the meshes. Other animals like crab may damage the nets. The cages should be regularly checked for clogs and leaks. Damaged nets should be repaired or replaced. Daily cages need to be cleaned with brushes to avoid clogging of the cage nets. Cage mesh clogging with mud and debris will reduce water exchange, and lead to accumulation of waste products depleting the oxygen causing stress to fishes, affecting feeding and growth.

Cage net repairing by farmers

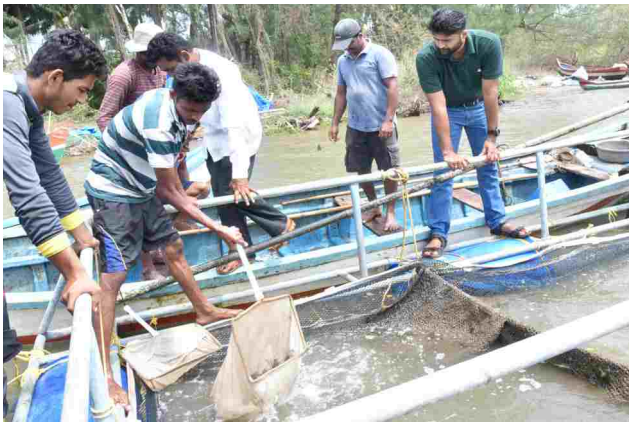
Cage net cleaning by farmers

Water quality

Water quality is crucial part of the cage culture. The selected site should be free of any water pollution to avoid stress on the cultured species. Sites with turbid water must be avoided as most of time they clog net cages and affect fish growth. The selecetd site should have the following water parameter quality such as Dissolved oxygen: >5 ppm, Temperature: 25-33 ^{0}C, pH: 7.5-8.5, water current: 0.1-0.2 m/s, Salinity: 05-35 ppt, Ammonia: <00.25 ppm, Nitrite: <00.05 ppm, Nitrate: <01.00 ppm, Turbidity: 10-30 NTU'.

Harvesting and marketing

Seabass and Pearlspot attain marketable size of 800-1000 g and 200-250 g respectively within culture period of 6-8 months depending upon culture conditions and management. The best harvesting size for seabass is above 1.0 kg as it fetches more price in the market due to consumer preference of this size. Prior to harvesting, feeding is stopped and harvesting need to be done either in morning or evening hours to maintain the freshness and quality of the harvested fish. After harvesting, fishes need to be immediately iced with flake ice @ 1:1 ratio and then transported to the market in the basket. Regular partial harvest and supply of fish in monsoon season even can give more profit to the farmers. The seabass one kg can fetch Rs. 400-600/Kg while 250 g of Pearlspot gets Rs. 250-300/Kg



Fish harvesting from cages

Harvested seabass

Harvested pearlspot

Conclusion

The tribal and coastal fisher communities required an alternative option for livelihood and income generation. Brackishwater areas like creeks, lagoons, estuaries, ponds etc., can be well utilized for taking up cage culture of different candidate brackishwater finfishes. If such type of cage culture technologies is adopted by tribal and coastal fisher communities of Gujarat, then it can effectively enterprise for their livelihood.

Details of the material required for battery of 4 Cages: 1 Unit:

Sr. No	Items	1 Cage	04 Cage
1	G.I.Pipes -1.5 Inch	12	48
2	G.I.Pipes -1.25 Inch	06	24
3	1.5 Inch elbows for two cage frames	08	32
4	Pre Grow out Cage Net of 20 mm mesh	01	04
5	Grow Out Cage Net of 30mm mesh	01	04
6	Outer Cage Net of 40 mm mesh	01	04
7	200 L Air Tight Barrels for floating cage	06	24
8	250 L Feed Barrels	02	08
9	40 Kg Anchor	01	04
10	30 Kg Anchor	01	04
11	15 Kg Anchor	01	04
12	Grading tanks	02	08
13	Platform Wooden Planks	08	32
14	Pigeon Net	01	04
15	Hand Net	02	08
16	3 mm Rope Bundle	01	04
17	Painting Brush	02	08
Common Things for 4 cages-1 unit			
18	Ph Meter	01	
19	Do Meter	01	
20	Refractometer	01	
21	Thermometer	01	
22	Ammonia Kit	01	
23	Nitrite Kit	01	
24	Nitrate Kit	01	
25	Turbidity Kit	01	
26	Weighing Balance	01	
27	6 mm Rope Bundle	01	
28	12 mm Rope Bundle	01	
29	Epoxy Paint	08 litre	
30	Tarpaulin sheet	03	
31	12 Feet Cement Poles for cage land based shed	08	

1. Estimated capital cost and operational cost required for rearing of Asian seabass and Pearlspot fishes in 4 cages-1 unit

S.N.	Item	For 4 cages (Rs. In lakhs)
A Capital cost		
1	G.I. pipes (1.5 Inch: 48 Nos.; 1.25 Inch: 24 Nos)	01.30
2	HDPE knotless 4 x 4 x 2 m pre-growout cage net of 20 mm mesh - 04 nos. HDPE knotless 4 x 4 x 2 m growout cage net of 30 mm mesh - 04 nos. HDPE knotless 5 x 5 x 2.5 m outer cage net of 40 mm mesh - 04 nos.	01.20
3	Cage anchoring, floating structures : airtight barrels-24 Nos., anchors (40 kg, 30 kg & 15 kg) - 04 nos.	00.60
4	Big feed storage 500 L barrels 08 nos. @ Rs. 850/-	00.07
5	Fish grading tanks: 08 nos. @ Rs. 5000/-	00.40
6	Digital weighing balance - 01 (For weighing fish and feed)	00.08
7	Water parameter meters - 01 each (Ph, Temperature, Refractometer, Ammonia, Nitrite, Nitrate, Turbidity Kits etc)	00.20
8	12x18 plastic sheets for false shed - 03 nos. Cement poles - 04 nos. (For feed, cage material storage at site)	00.10
9	Wooden planks - 08 nos. @ Rs. 625/-	00.20
10	Elbows - 32 nos.	00.02
11	Life jackets - 08 nos.	00.08
Total (A)		**04.25**
B Operational cost		
1	Cost of 3000 seabass fingerlings @ 40 Rs. (density 1000 nos./cage)	01.20
2	Cost of 3000 pearlspot fingerlings @ 15 Rs. (density 3000 nos./cage)	00.45
3	Seabass/snapper feed (3-6 mm)-960 kg /cage @ Rs. 90/kg (expected FCR 1:1.5)	02.60
4	Pearlspot feed (0.4-2 mm)-630 kg/cage @ Rs. 50/Kg (expected FCR 1:1.5)	00.32
5	Feed, material & local transportation	00.10
6	Miscellaneous expenses (wielding charges, antifouling paint, ropes, boat charges big fish hand nets, etc)	00.33
Total (B)		**05.00**
C	**Grant total (A+B)**	**09.25**

2. Expected Output: Farmers Employment and Income through Cage Culture/Year

S. N	Particulars	Seabass culture	Pearlspot culture
1	Number of cages (nos.)	03	01
2	Farmers per unit (nos.)	10	
3	Culture duration (days)	240-300	240-280
4	Density/cage (nos.)	1000	3000
5	Fingerlings stocking (nos.)	3000	3000
6	Seed survival (%)/cycle	70	80
7	Expected size of fish at harvest (g)	1000	250
8	Expected production (Kg)	2100	600
9	Fish selling price (Rs./Kg)	400	250
10	Revenue from sale of seabass & Pearlspot fish (Rs. In Lakhs)	08.40	01.50
11	**Total revenue from 4 cages (Rs. In Lakhs)**	**09.90**	

3. Economics & revenue

S. N	Particulars	Amount (Rs. Lakhs)
A	Capital cost*	00.85
B	Operational cost	05.00
C	Total expenditure	05.85
D	12% Interest on total expenditure	00.70
E	Total cost/year (A+B)	06.55
F	Revenue from sale of fish /year	09.90
G	Net profit / Year (E-F)	03.25
H	Net profit / 10 farmer	00.32

*Capital cost is used for five years

Brackishwater aquaculture for food employment and prosperity

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