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Sustainable Capture Based Aquaculture in India: Status and Prospects

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Introduction

India is the fourth largest producer of fish in the world and the total fish production is around 7.5 million tonnes per year and its share in the GDP is around 1.4 per cent. The marine fishproduction was 3.2 million tonnes for the year 2008 which form 42.7 per cent of the total fish production. With continued human pressure on marine fisheries and ocean resources, aquaculture has become one of the most promising avenues for increasing marine fish production in the future. On a global scale, the decline of fish stocks has been a motivating factor for expanding the role of aquaculture. It is well known that the ready availability of seed in adequate quantities is one of the major constraints in the development and expansion of mariculture. In this context, the concept of capture based aquaculture/mariculture is considered as a viable option for augmenting production of high value species.

Categories of finfish farming include hatchery-based rearing from egg to adult ("closed cycle aquaculture" or "true aquaculture") and capture-based aquaculture (CBA), which involves capturing seed material from the wild, then growing it to marketable size in captivity, using aquaculture techniques (FAO, 2004). CBA is an interface between capture fisheries and true aquaculture and provides an alternative income for local coastal communities in developing and several industrialized countries. It has been estimated that CBA accounts for about 20 percent of the total quantity of food fish production through aquaculture, which is about 7.5 million tonnes per year, mostly molluscs. The production of finfish, especially carnivorous species (including milkfish, groupers, tunas, yellowtails and eels), through CBA, is currently receiving the most attention. CBA has developed due to the market demand for some high value species for which seed production technology is not yet standardized. Many of the environmental concerns associated with the grow-out of juveniles produced in hatcheries like transfer of diseases

and genetic pollution of wild stocks are not encountered in CBA. As CBA potentially generates higher profits than other aquaculture systems, the market demand for the products and species cultured is high and it is likely that efforts to promote this activity in future will increase significantly.

Species selection

Potential marketability, economic value, growth rate, performance under captive conditions etc. are the main criteria to be considered for species selection in CBA. Most species farmed under CBA are carnivores. CBA is practiced for finfish (eels, groupers, bluefin tuna, yellowfin tuna, yellow tail etc.), molluscs (oysters, mussels, scallops) and crustaceans (shrimps, crabs). Eels, groupers, yellow tail and tunas are of special significance due

to their fast growth and high market demand.

The Indian scenario

Irrespective of its vast potential, the marine/ brackishwater culture production in India is only about 80,000-1,00,000 tonnes annually, which is almost entirely from shrimp production. Even though many Asian countries are leading in mariculture, India is yet to make an impact in this sector. Constraints are many in this line. However, it is time that India should focus on these issues and make a change in the present scenario of mariculture production. Commercial level seed production techniques are to be standardized for many species except Asian seabass. In many non-selective gears, and shore seines juveniles of high value fish are caught which are either discarded or sold at nominal prices. If suitable measures are followed, these juveniles could be used for CBA for resource conservation as well as for increased seafood production.

Research & Development on CBA in India

The spiny lobsters Panulirus homarus, P. polyphagus, P. ornatus, P. pencillatus, P. longiceps and sand lobster Thenus orientalis are available in India for farming or fattening. Farming/ fattening of sand lobster T. orientalis has been demonstrated by CMFRI but the technology has not been raised up to commercial level. Spiny lobster P. polyphagus fattening is being experimented by some NGO's in Gujarat using wild caught juveniles. CBA of lobster has potential in India because of its high value and demand in export market.

Mussel farming

Perna indica and P. viridis are the two mussel species suitable for farming in Indian waters. CMFRI, National Institute of Oceanography (Goa), Konkan Krishi Vidyapeeth,(Ratnagiri) and Central Agricultural Research Institute (CARI), Port Blair, have implemented research programmes on mussel farming. From early 1970s itself, CMFRI has developed grow-out structures suitable for open sea farming, seeding method and farm management measures. The first commercial mussel farm in the country was set up at Padanna, Kasaragode, Kerala in the year 2000. Mussel culture in India is entirely based on CBA and the total production of farmed mussels for the year 2005-06 was 10,600 tonnes.

Initiatives in cage farming in India

Central Marine Fisheries Research Institute (CMFRI) has initiated open sea cage farming as an R&D effort during 2006-07 with support from Ministry of Agriculture, Government of India. An indigenous cage of 15m diameter was launched at Visakhapatnam with primitive mooring techniques and stocked with 9000 nursery reared seabass seed of 50 g size. After 45 days the cage developed technical problems, drifted and hit the coast, and most of fish escaped into the sea. However, the cage and nets were salvaged and analysed for several related issues. The juveniles retrieved had reached 150-350 g size which indicated good growth.. With this valuable "setback" a new cage with modifications in design and mooring was launched in December 2007. Considering the previous experiences, importance was given to structural stability and safety of the cage. In this endeavor, the Indian Institute of Technology (IIT), Kharagpur, West Bengal was consulted, which collaborated in engineering aspects of the cage.

As a consequence of the above and for easy maneuvering, recently 6 m diameter cages were designed mostly to cater to the needs of small farmers. The mooring and other aspects were also suitably modified. The volume of each cage is about 175 m3 and production potential is about 4-5 t of fish.

Further impetus was given by the participation of National Fisheries Development Board (NFDB) in the demonstration of open sea cage framing by sponsoring 6m cages, one cage Sutrapada in Gujarat, 2 at Vasai in Maharastra, 2 at Mangalore in Karnataka, 2 at Cochin in Kerala, 2 cages at Pulicat in Tamil Nadu, one each at Nellore, Kakinada and Baruva in Andhra Pradesh and one cage near Balasore in Orissa, thus totaling 14 cages. Apart from these, there are 12 cages including one with 15 m diameter, three each at Visakhapatnam in Andhra Pradesh, Mandapam in Tamil Nadu, Karwar in Karnataka and Vizhinjam in Kerala.

The demonstrations covering almost all the maritime states, spreading different environmental and social conditions are in progress at the above places. For demonstration in some places, non- availability of seed hampered the work and stocking was delayed. In places where the cages were stocked, some teething engineering and social problems encountered and the operation was restarted after the current monsoon season.

At Veraval the spiny lobster Panulirus polyphagus seed stocked in January 2009 were harvested in May 2009 with very good survival and growth rate. At Vizhinjam and Pulicat, P. homarus seed were stocked in January/February 2009 and harvested in May 2009. At Vizhinjam lobsters reached up to 300-400 g size and the harvest was about 250 kg and sold at the rate of Rs1000/kg. Similarly 6000 seed of sea bass of 10 g stocked in December 2008 reached 750-1200 g by May 2009 with better survival. These demonstrations convinced many farmers/fishermen the potential benefits of cage culture and they came forward in many places to undertake cage culture with their inputs except cages, in the ensuing season. This is the most welcome social awareness that would go a long way in making further progress in open sea cage farming. After overcoming the engineering and social problems the biological issues like seed and feed are very important.

CBA seed resources

Several studies and observations by CMFRI indicated that dol nets of Gujarat and Maharshtra, shore seines of east coast, thalluvalai of southeast coast, Chinese dip nets of Kerala etc which are mostly operated between 2-10 m depth, land juveniles/seed of high value species. These mostly fetch very low price and are dried. The species include seerfish, pomfrets, mackerel, koth, shrimps etc. Also, there exists a good fishery for live juveniles of different species of lobsters but very little are used for fattening. It is estimated conservatively that about one million of seerfish juveniles of 7-10 cm and two millions of mackerel juveniles of 5-8 cm land by shore seines in the month of April alone along the stretch of Visakhapatnam-Kalingapatnam. This is only an approximation and studies are initiated by CMFRI to estimate the juvenile availability.. If such a small fraction of these seed/juveniles are brought in live condition, they form very good source of CBA without affecting the ecosystem and livelihood of fishermen. It will be more lucrative for the fishermen at the same time contributing to several fold increase in mariculture production. Juvenile yellowfin tuna are available in plenty in and around Lakshadweep waters which can be used for farming in cages, for which reasonably viable cage technology is available with CMFRI.

Feed

As on today there is no indigenous scientifically developed marine finfish feed. The development of feed is also very complicated and needs to consider nutritional balance for carnivorous fish, conversion and cost effectiveness. The imported feeds for seabass are sold at Rs 80/kg. Under these circumstances CMFRI and CIFT under NAIP project have launched a feed "cadalmin-sailo feed" prepared from the non-edible parts of tuna but are mostly discarded. The final cost is around Rs30/kg and the feed is well accepted by sea bass,

cobia, red snapper, lobsters, tiger shrimp, rainbow, trout etc. Large scale field trials are in progress to evaluate and improve the efficiency of the feed. CMFRI has also scientifically developed an exclusive feed for sea bass which may cost around Rs 45/kg. Field trials are in progress to evaluate and improve this feed too.

Broodstock development

Taking advantage of the fast growth and high market value of marine finfish, CMFRI has initiated programmes on breeding of finfish such as the cobia (Rachycentron canadum), pompano (Trachynotus sp), red snapper (Lutjanus sp) and groupers (Epinephelus spp) at different CMFRI laboratories.

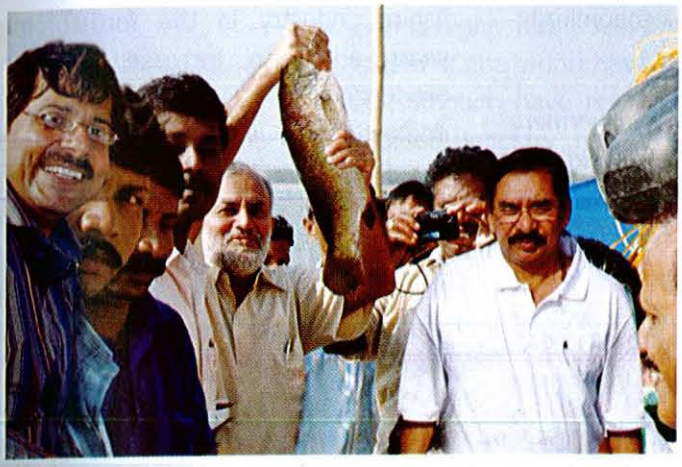
Economics of Cage culture: Case study in Baleswar (Balasore), Orissa

The coastal districts in Orissa are Balasore, Cuttack, Puri and Ganjam. These have a coastline of 480 km in length which is about 8% of the total coastline of India. Balasore is characterised by an extended continental shelf, tidal areas and extensive river deltas. The mangrove biodiversity in Balasore and Cuttack with around 60 varieties of mangroves constitutes the second largest mangal formation in India. District-wise analysis of fishermen families in Orissa shows that the largest number of fisher folk families live in Balasore district (55%) The fishermen in this area are very poor and need proper technological upliftment for gaining better opportunities in the society to improve their standard of living. The place suffers from poor communication and infrastructure facilities too. With the funding from National Fisheries Development Board (NFDB), Hyderabad, the Central Marine Fisheries Research Institute (CMFRI) has selected Balasore as one of the locations for demonstration of open sea cage culture. The site selected was at Chaumukh, about 70 km from Balasore town. The cage site was well protected from direct wave action and mooring was done at two sites, one in the open sea and another in the nearby lagoon. During rough weather, cage was de-linked from the mooring system and relocated at the protected lagoon. This has helped in saving the cages as well as the stock during the devastating cyclone "Ayila" which hit Orissa coast during May 2009.

The indigenous cage installed at Chaumukh was designed and fabricated to suit Indian conditions with cost effectiveness. The HDPE cage frame measuring 6 m diameter has connecting HDPE outer predator (braided 60 mm), inner grow out (25 mm) and bird nets (80 mm) with a net depth of 6m. A cat-walk and hand rail is provided for the safety of the workers, and thus the routine cage management is made easy. The bottom HDPE ballast filled with weight (150 kg) kept the nets in shape and volume. The mooring system includes a cost effective gabion box in place of expensive anchors, filled with about 3 tonnes of stones to which the mooring chain (12 mm) is connected. The swivel connected to the chain rotates the entire cage, by mooring only at a single point. Tension on mooring cable is maintained by HDPE floats connected with a shock absorber of 100-150 kg, which in turn resists any pressure on the cage.

The cage was launched near Chaumukh beach in Balasore in January, 2009 and was stocked with 4357 numbers of locally collected Asian sea bass juveniles weighing 55-85 g. The fish were fed ad libitum thrice a day with chopped trash fish. The monitoring of the cage was carried out by CMFRI staff from Visakhapatanam Research Centre.

The fish harvest at Balasore cage was conducted successfully on November 10, 2009 in the presence of Dr. S. Ayyappan, DDG (FY), Dr. G. Syda Rao, Director, CMFRI, Kochi, Dr. C. Vasudevappa, Senior Executive Director, NFDB, Hyderabad, Professors



Dr. S. Ayyappan, DDG (FY), holding a fish harvested from the cage at Balasore

from Indian Institute of Technology (IIT), Kharagpur, dignitaries from DST and TIFAC and other central and state government officers. In total, 3472 numbers of fish were harvested with an average weight of 872 g. The survival rate was 79.6% and the production was 3031 kg. The maximum size caught was 1.3 kg and the minimum was 560 g. The rearing of the fishes and safety of the cage was achieved with the help of Orissa State Government Fisheries Department and local fishermen societies.

Economic performance of cage culture of sea bass at Balasore

The initial investment for a 6 m diameter cage was Rs.3,00,000/. The fixed costs for the culture period of six months were Rs.54,000/. The variable costs of the culture operation worked out to Rs.2,31,750/. Thus the total cost of production to the participants worked out to Rs.2,85,750/. The yield was 3.03 tonnes of sea bass at the end of six months, thus earning gross revenue of Rs.5,75,760/- to the participants. The culture of sea bass earned a net operating income of Rs.3,44,010/- at the end of six months and a net profit of Rs.2,90,010/- at the end of the same period. The cost of production per kg of sea bass worked out to Rs.94.24/- against the value realization of Rs.189.89 per kg. The capital productivity measured through operating ratio worked out to 0.80. These economic parameters indicate

Table 1 Economic performance of cage culture of sea bass at Balasore

Sl. No.	Details of cost and returns	Amount (Rs)
1	Initial investment for a 6m diameter cage	3,00,000.00
2	Fixed cost (For crop duration of six months)	
	a)Depreciation	30,000.00
	b)Insurance (2% on investment)	3,000.00
	c) Interest on Fixed capital (12%)	18,000.00
	d) Administrative expenses	3,000.00
3	Total Fixed cost (A)	54,000.00
4	Operating cost	
	a) Cost of seed	50,000.00
	b) Labour charges including cost of feeding	1,75,000.00
	c) Interest on working capital (6%)	6,750.00
5	Total operating cost (B)	2,31,750.00
6	Total cost of production (6 months)	2,85,750.00
7	Yield of sea bass (kg)	3,032.00
8	Gross revenue from 3032 kg	5,75,760.00
9	Net income (5)-(6)	2,90,010.00
10	Net operating income (Income over operating cost)	3,44,010.00
11	Cost of production (Rs kg-1) (6)/(7)	94.24
12	Price realized (Rs kg-1) (8)/(7)	189.89
13	Capital Productivity (Operating ratio) (5)/(8)	0.50

that open sea cage farming of sea bass is economically viable.

The next culture is entrusted with the local fishermen society and 5000 numbers of Asian seabass seed weighing 20-25 g were handed over to the fishermen along with the cage and nets with an agreement that CMFRI will monitor the progress of the culture once in a month.

The open sea cage farming is expected to attract more entrepreneurs and fishermen and has opened up a new horizon in marine fisheries and mariculture in India.

Conclusion

The open sea mariculture is thus having a vital role to play in the development of the fishing sector in the days to come. The motivating success in Balasore and earlier at Visakhapatnam will inspire the stakeholders to invest in such opportunities. The seed supply is the most significant input or the component of this open sea cage farming. IF we succeed in establishing a sustainable source of supply of seed, no doubt, open sea cage farming is going to rule the fishing industry in the forthcoming years and also increase the fish production to meet the increasing domestic and international demand supply gap. Hence concerted efforts are needed from the scientific community to develop a comprehensive package of practices for different varieties of fish that can be reared in cages to attain full success.

Figure Seabass catch in Balasore Cag

Figure A new horizon for fishermen at Chaumukh too: Seabass seed distribution by DDG (Fy.), ICAR and Director CMFRI