Capture based aquaculture of spiny lobster in sea cages

A new livelihood opportunity for the 'Sidi' Adivasi tribal people in Gujarat, India

Suresh K. Mojjada*, Gyanaranjan Dash, Mohammed Koya K., Sreenath, K.R., Swatipriyanka Sen, Mahendra D. Fofondi, H.M. Bhint, S. Pradeep, P. and G. Syda Rao.

Veraval Regional Centre of Central Marine Fisheries Research Institute, Matsya Bhavan, Bhidia Plot, Veraval 362269, India, email: sureshkumar.mjd@gmail.com

A view of lobster farming cages off somnath, Gujarat.

Global marine fish production is approaching a standstill due to declining marine capture fisheries, and India's situation is not much different than the rest of the world. Most of the wild fisheries resources have already been over exploited or are on the edge of it. Problems include overfishing of reproductive females or during the breeding season, overexploitation of juveniles and undersized fish, over exploitation of keystone species causing ecosystem disruption and destructive fishing practices, which damage habitat. Other causes of habitat destruction, anthropogenic pollution and climate change are further aggravating the situation and adversely impacting on the ecosystem.

In a country such as India, where the marine fishery resources are under an open access regime and a huge population depends upon the sector for their exclusive livelihood, it is very difficult to achieve ecological goals while jeopardising social goals. Therefore, the sustainability of marine resources in this context is another black box which is yet to be deciphered. However, despite of all these setbacks, sustainability can still be achieved if alternative methods of increasing production from the marine ecosystem system can be found, and one such alternative is mariculture.

In India the first attempt for cage culture was initiated in 2007 at Vishakhapatnam coast by the Central Marine Fisheries Research Institute (CMFRI). Subsequent to this many successful trials have already been made to standardise and demonstrate the technology to encourage adoption by coastal community. Milestones in open sea cage farming by CFMRI have included the successful demonstration of sea bass farming at Balasore[1], Chennai[2] and Karwar[2] districts; lobster farming at Kanyakumari, Tamilnadu[3], cobia farming at Mandapam, Tamilnadu[4], pearl spot farming at Cochin, Kerala[5] and pompano farming at Vethalai, Tamilnadu[6] .

However, mariculture has its own set of advantages and disadvantages. Unlike the coastal aquaculture of shrimp, open sea mariculture is less vulnerable to anthropogenic pollution and sudden fluctuation of hydrographical parameters but at the same time it is a capital intensive venture and maintenance of the cultured animals is a real challenge for the farmer. Similarly, getting the required number of seeds is another such impediment as the seed production technique for most esteemed marine fish species is still in the laboratory trial stage.

Gujarat is one of the most important maritime states of the country having the longest coast line of about 1,640 km and a very broad continental shelf. The state has been bestowed with highly productive and diversified ecosystems and considered as one of the leading marine fish producing states of India, with fisheries providing livelihoods for more than 400,000 people directly and indirectly. However, over the last few years the marine fish production of the state has been relatively static at around half a million tonnes and has been showing signs of being fully exploited. However, as the state has a wide continental self it also has significant potential for mariculture. Owing to the economic importance and availability of seeds of spiny lobster, an open sea cage culture demonstration of *Panulirus polyphagus* was carried out involving Sidi tribes as a major stakeholder.

The 'Sidi' tribe: Early adopters for mariculture

'Sidis' are a unique tribal group that has African ancestry and lives in South Asia. They are mainly found in three Indian states: Gujarat, Karnataka, and Andhra Pradesh. According to the latest census their total population size is about 250,000 with the majority living in Gujarat. Since 1956, the Sidis of six districts in Rajkot Division of Saurashtra have been designated as Scheduled Tribe (ST) and many live below the poverty line, suffering from food insecurity and malnutrition, and often being reliant on a starch-based diet.

As a single source of livelihood, traditional farm incomes on limited holdings are not enough to meet even subsistence needs. However, with adequate technology transfer and proper support, it is possible for tribal farmers to improve their incomes and thereby increase their access to food and improve their nutritional status. To improve the livelihoods of farmers, a demonstration of lobster farming in open sea cages was initiated, with the crop entirely managed by a Sidi cooperative society.

Capture based aquaculture: a new dimension in mariculture

In a multi species fishery where a wide variety of fishing gears are used, it is difficult to control the catch, whether deliberately targeted or incidental bycatch, of juveniles of economically important species. While undersized fish fetch a very small price in the market, the impact of their loss on the future sustainability of the fishery can be significant. Quite often these juveniles are sold for fishmeal production, which represents a poor return on a potentially much more valuable resource.

Capture based aquaculture is a conservative aquaculture practice in which wild caught juveniles of high value fish are grown to marketable size, thereby gaining a much better market price. As the controlled breeding and seed production techniques for most marine fish are still at an early stage, capture-based aquaculture can be a viable step towards fully closed-cycle mariculture. Unlike land based aqua-

Cage farm maintainance and under water inspection.

Cage installations.

culture, mariculture has the advantage of comparatively stable environmental parameters, continuous waste removal, lower exposure and vulnerability to pollution and a much greater scope for future expansion. Usually, floating cages are used for mariculture as they are easy for day to day management and maintenance. CMFRI in collaboration with Indian institute of technology (IIT), Kharagpur, India has developed a prototype circular cage considering the hydrodynamics of Indian seas. The prototype was further refined and presently the 6th generation of cages are being tested for their sea worthiness and ease of management.

Open sea cage farming in Gujarat

Considering the necessity and immense scope for mariculture in Gujarat, the present demonstration of open sea cage culture was conducted by the Veraval regional centre of CMFRI to create a new awareness among coastal fisherfolks. The demonstration was conducted under a co-management regime involving the Bharat Adim Juth Matsyadyog Mandali, which is a registered co-operative society of Sidi tribes under Talala Patan, Gujarat. The infrastructure and technical inputs were provided by the institute whereas the entire grow out operation was managed by the co-operative society.

Candidate species selection and seed collection

Lobsters form one of the most important natural resources of Gujarat. The mud spiny lobster species has been found to have a very good growth rate and survival in open sea grow out conditions7. In terms of seed availability, pueruli and early post-pueruli spiny lobsters are abundantly available in near shore waters along the Saurashtra coast in the post-monsoon months (mainly September to January). Undersized lobster juveniles regularly form an incidental catch in the trawl net and also in stake nets locally called as ‘wada’. As they are below the minimum legal size for export, undersized lobsters are sold at a very low price in the local market, a very low return on the resource and a missed opportunity for the economy. In constrast, the adults of these lobsters

are quite expensive, fetching a price depending on size from Rs. 600 to Rs. 1,100/kg in the domestic market and US$13.30 to 30.00/kg in international markets. Due to its high availability, good survival and growth rate and high market price this species was selected for the open sea cage culture demonstration. Lobster seeds from trawl net bycatch were collected from the Veraval landing centre, Junagadh District, Gujarat. Lobster seeds caught by stake nets were also collected from Mahua, Bhavnagar District, Gujarat. The juvenile lobsters were transported on moistened sand trays wrapped in gunny bags moistened with sea water, dampened at one hour intervals to prevent drying. With this method, around 96 % survival was observed during the transportation period. The seeds thus transported were continuously stocked in the early morning hours to arrive at a final stocking density of 1,500 lobsters per cage.

Site selection

Regular surveys were carried out to select ideal site for the cage culture. Water and substrate samples were collected at regular intervals and analysed in the fisheries environment monitoring division (FEMD) laboratories using standard analytical procedures. Two sites in the sea off Prabhash Patan were selected as physico-chemical parameters were found to be in the ideal range for the culture of lobster. The detailed physico-chemical parameters of two selected sites have been mentioned in table 1.

Grow out operation

Two circular 6th generation HDPE cages of 6 metre diameter and 4 metre depth were used for the grow out operation. The bottom of each cage was modified considering the behaviour of the lobster. As the lobsters are bottom dwelling in nature, a thin meshed net made up of thick twine with two cross pipes was fitted at the bottom to keep it flat. This particular modification was provided to increase the cage surface area as lobster utilises the bottom rather then the water column. Hide outs made up of PVC pipes were fixed on the bottom of the inner net to prevent cannibalism during moulting. Two cages were installed at each site with 220 m between them to avoid collisions due to change in current direction and wave action. Lobster juveniles with a mean individual weight of 80 g were stocked at around 1,500 juveniles per cage. The entire grow out operation were managed by the Bharat Matsyadyog Adim Juth society. Tray feeding was used to observe feed consumption. The daily ration was divided into two parts: 25 % of feed was given in the early morning (07:00) and the remaining 75% was given during evening (19.00). Growth rate and survival were recorded by periodic sampling at weekly intervals.

Dignitaries observing the open sea cage lobster farm harvest.

Table 1: Physico-chemical parameters of two selected sites (mean ± standard deviation)

Parameters	Site 1	Site 2
GPS coordinates of sea cage farm	20°53'22.78"N 70°23'20.06"E	20°53'17.95"N 70°23'25.89"E
Depth at low tide (m)	9 ±1.2	9.4±0.7
Tidal amplitude (m)	4.5	4.5
Bottom	Rocky	Rocky
Salinity (ppt)	32.8±0.20	33.2±0.39
pH	7.9±0.1	8.2±0.15
Temp (oC)	29.2±1.7	28.9±1.03
Dissolved oxygen (mg L^{-1})	4.22±0.16	4.99±0.25
Total suspended solids (mg L^{-1})	0.521±0.006	0.499±0.004
Ammonia (ppm)	0.024±0.003	0.029±0.005
Nitrate (mg L-1)	3.9±0.15	3.4±0.13
Phosphate (mg L^{-1})	0.068±0.005	0.051±0.002

Nets were also checked frequently to remove fouling and repair any damage due to wear and tear. After a culture period of 110 days, an average of 272 kg of lobster was harvested per cage. During the culture period, the lobsters grew to a mean size of 203 g with an overall survival of 93 %.

Future prospects

This successful demonstration offers new horizon for sea farming and will motivate fishermen of the region to adopt the technology for a sustainable lobster fisheries. This will create a new avenue for alternative livelihood opportunity for the coastal fisherfolk. With a sound policy for utilising the inshore waters and creek areas for marine fish farming and institutional support from the state administration, the state of Gujarat has immense potential to enhance its fish production bringing in additional revenue to the economy. Sidi tribal people who are presently working as marginal fishery workers may be able to gain a more profitable and sustainable livelihood opportunity and this will greatly help in improving their socio-economic status.

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Grading of lobsters after harvest.