Case Study

Climate Change Adaptation through Livelihood Development- Small Scale Cage Farming of Fish

1. Introduction

1.1 Uppunda village in Kundapura taluka of Udupi district borders the Arabian Sea on its western side, and more than a quarter of its total 2160 families are engaged traditionally in capture fishery. Ravindra, like menfolk from most of the families living along the Sumana River estuary; would go for fishing on their wooden artisanal boats. Times were good when they were initiated into the vocation during their younger days, and they used to land with a boatful of fish at the end of a day's fishing. There were catches of high value estuarine fishes using cast nets and stationery gears, also adding in good measure to their income. But over a period of time, Ravindra and other fellow fishermen found that their catches were dwindling and it was becoming increasingly difficult to make both ends meet. Little did they realise that they were falling prey to the global phenomenon called 'global warming' and the deleterious effects of climate change confronting our planet.

2. Climate Change issue

2.1 Heat trapped by increasing atmospheric greenhouse gas levels, is absorbed (as much as 90%) by ocean; causing ocean temperature to rise. The major implications of global warming and consequent rise in ocean temperature in addition to ocean acidification, are sea level rise caused by the melting of polar ice and the thermal expansion of water, and alteration in distribution of stock due to mass movement of fishes to favourable environmental conditions.

2.2 The surface waters of the sea and shallow areas are more subjected to rise in temperature. Hence the fish species normally inhabiting the coastal regions tend to migrate to deeper waters in search of favourable conditions. This results in depletion of fish stock in the coastal waters depriving the artisanal fishermen who undertake traditional fishing in near coastal areas.

2.3 Although there are many challenges in anticipated sea level rise, the most pronounced is that even a small increase in sea level causes a dramatic impact on the coastal environment. Saltwater- freshwater interface moves further inland causing the reduction and extinction of estuarine associated habitats and ecosystems. The estuaries are becoming more saline due to the slow process of climate change inflicted sea level rise, which makes most of the estuaries of India remain more and more saline water dominated over a period of time. There is also the issue of low influx of fresh water from Catchment Rivers due to anthropological interventions of diverting fresh water for irrigation and domestic and industrial use. This poses a very serious livelihood issue for the coastal population, depending on the estuarine fishery, and many of them are on the lookout for alternate livelihood activities for survival in the changing scenario.

3. The solution

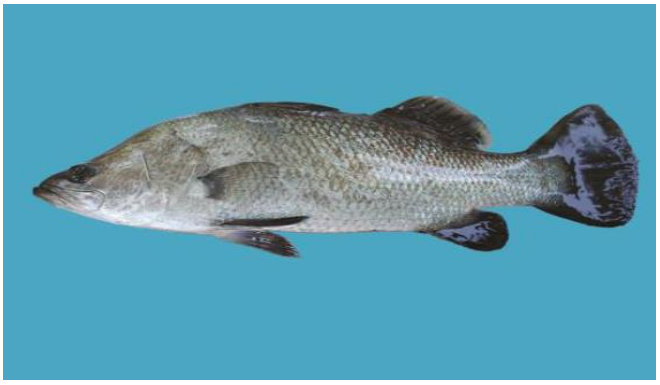
3.1 To address the livelihood issues of coastal fishermen of Uppunda village, Mangalore Research Centre of Central Marine Fisheries Research Institute (CMFRI) initiated fin fish culture demonstration in the saline creeks and estuaries. It was found that in the south-west coat of India covering the state of Karnataka, where tidal amplitude is less than 2 m, there is good scope for undertaking cage farming of brackish water fin fishes by traditional fish farmers.

3.2 Cage farming of fish

Cage culture of fish originated in the Far East, and was later adopted in several countries. Small scale cages in estuaries were experimented in India for many fin fishes like Red snapper, Rabbit fish, Groupers and Seabass. But lack of seed production techniques limited the progress in estuarine cage farming. However, new developments in seed production for fin fishes has made the activity popular, and has been taken up as a family avocation in several places. Seed can be procured from hatchery or from the wild, and is stocked in indigenously built cages. The cages can be placed close to the home of fish farmers living adjacent to the backwaters, creeks and open bays and can be easily managed by individual families to rear a variety of locally available species. The activity provides year round occupation, alternate livelihood and source of income for the families engaged.

3.3 Selection of species for culture

The species to be cultured should be suited to local climate extremes and/ or should be native to the area. Established and reliable rearing technology should be available for the intended species. The natural life cycle of the fish should be considered so that its biological needs can be met (tolerance to salinity and crowding and acceptance of artificial diets). Lates calcarifer, known as Seabass in Asia, is a large euryhaline member of family Centropomidae that is widely distributed in the Indo-West Pacific region from Arabian Gulf to China, Taiwan province of China, Papua New Guinea and Northern Australia. It is a relatively hardy species that tolerates crowding and has wide physiological tolerences. The high fecundity provides plenty of scope for hatchery production of seed and is relatively simple. Seabass feeds on pelletised feed and juveniles can be easily weaned to pellets. It grows rapidly, reaching harvestable size



(350 gms to 3 kg) in 6 months to 2 years. Presently most of the production is from small coastal cage farms either singly or along with groupers and snappers.

4. The awakening

4.1 Ravindra's casual interaction with scientists of the Krishi Vigyan Kendra (KVK) at Brahmavara, kindled the idea of taking up an alternate avocation to supplement the income from fishing. CMFRI, a premier research organisation under the Indian Council of Agricultural Research (ICAR) was exploring the possibility of exploiting the aquaculture potential of coastal water bodies along the 300 km long coast line of Karnataka and its pristine unpolluted saline creeks and estuarine areas of about 8000 ha. Taking into consideration the dynamic seasonal hydrographic conditions in the creeks and estuaries, as well as with an aim to provide the coastal fisher families an alternate year- round profitable livelihood option, research on cage designs for culturing fin fishes was initiated by CMFRI, Mangalore Research Centre in 2008. The basic cage design was tested and modified to improve its stability, durability and to optimise the use of locally available fabrication materials. After initial field trials, CMFRI along with KVK, Brahmavara planned the implementation of the project through volunteering fishermen groups. As the spirit of the project was to provide alternate income to fishermen whose catches were affected by climate change impacts, Uppunda was selected as the initial project site, and fishermen desirous of undertaking the activity in cluster mode were preferred.

4.2 Participation in group mode

Working in group mode has obvious advantages to both promoting institutions and the beneficiaries. The group members derive the benefit of pooling resources, sharing efforts and spreading risks, while promoting agencies needs to devote less time and rsources to cover more number of entities. Further the group dynamics helps in ensuring greater effectiveness and genuineness in the activity undertaken. Understanding the importance of working together for greater impact and mutual help, Ravindra along with 4 other fellow fishermen formed a Joint Liability Group (JLG) for sharing the works and monitoring farming activity with a long term objective of sharing collateral in case of availing bank loan. A Joint Liability Group is an informal group comprising preferably of 4 to10 individuals coming together for the purposes of availing bank loan either singly or through the group mechanism against mutual guarantee. The JLG members would offer a joint undertaking to the bank that enables

them to avail loans. The JLG members are expected to engage in similar type of economic activities. The management of the JLG is to be kept simple with little or no financial administration within the group.

4.3 Cage farming of fish

Several factors favoured selection of Sumana River Estuary as an ideal location for setting up cage culture units. These were as follows:

1. Cages are required to be situated in sheltered areas protected from strong wind and waves.

2. There should be sufficient depth under the cage in order to maximise water exchange, avoid oxygen depletion, accumulation of unconsumed food, faeces and debris, disease infection, silt accumulation which could prevent water exchange, and build-up of some noxious gases. Location of cage should be such that a clearance of at least 2 to 3 m is available at the lowest water level of spring tide. On the other hand, the maximum depth of floating cage should preferably be less than 20 m to optimise investment and maintenance costs.

3. The required physical/ biological criteria are current movement of 10 to 50 cm/ sec and not exceeding 100 cm/ sec, turbidity not exceeding 10 mg per litre, areas unfavourable for growth of fouling organisms (reasonable current velocity, moderate temperature and salinity and less turbidity), and less nutrient loading (from farm wastes and effluents) to avoid red tide blooms.

4. Culture site should be near a shore preferably with a jetty for boat connection with farms and near a good road for land transportation. Good accessibility helps in easy availability of farm products, feed, fingerlings, fuel, farm equipment, supplies and other necessities. This facilitates proper monitoring of the project also, and lower risk of poaching.

5. Availability of healthy seed is a critical factor in success of cage farming. Seabass fry (45 to 55 mm size) could be procured from hatcheries in east coast, packed at stocking density of 175 to 250 no.s per bag, and transported to place of rearing. Fish seed is also available plenty in creeks, river mouths, low lying areas and ditches near the sea, and can be collected from nature with little efforts and less expenses. After 30 days, nursery reared seabass is released to cages for further rearing.

4.4 Designing of cages, fabrication and mooring

Success of cage farming depends on rigidity and stability of cages, cost advantages, ease of operation and economic viability. Central Marine Fisheries Research Institute, Mangalore had carried out continous research on the design, fabrication and installation of small scale fish farming cages from year 2008 onwards and have adopted the final prototype in year 2011. Cages of 6m x 2m x 2m size fabricated using 1.5 inch GI pipes as cage frames with a middle rib support to keep stability and shape is found to be an ideal model. Netlon material is used as outer net for protection from predators and large fishes. Nylon net of varying mesh size is used as inner net, and can be fabricated according to size of seed stocked. Hapa was provided when fishes are reared from juvenile size. Inner cages can be tied to cage frame in corners with

provision to remove anytime. PVC pipes are used as floats for suspending the cage in water. Additional flotation can be given by tying empty oil cans. Mooring of cages can be done according to depth, nature of substratum and speed of current. Mooring can be achieved by tying sand bags with nylon rope at two points on the two side panels of the cage. The cages are slipped into water with a simple lever mechanism using iron rods, pipes or wooden logs

4.5 Feeding, maintenance and harvesting of fish cages

Adequate supply of nutrients is essential for growth of fish. Feed can be dry feed, moist feed and semi-moist feed, and are readily available in market or can be prepared. Feeding can be done at 5 to 10% initially and reduced to 3 to 4% of body weight per day. Cages should be cleaned regularly to prevent bio fouling, siltation and clogging; smaller mesh size nets more frequently. The cages are also vulnerable to destruction by aquatic animals such as crabs, otter etc. and should be repaired or replaced. Dead fishes should be removed promptly and disposed.

Seabass grows to an average size of 50 cm in 10 months with average weight of 1.20 Kg. The fishes reach 2 Kg (60 cm) in 12 months and 3.30 Kg (75 cm) in 18 months. Harvesting is by removing the fish from cage using a dip net. Planning the harvest during trawl ban (June to July) could fetch maximum price for fish.

4.6 Economics of cage fish farming (Cage size of 6m X 2m X 2m)

Capital and input costs

No.	Items of expenditure	Amount (Rs.)
1	GI pipe frames (6 m) 1.5 inch dia- 10 bars	20,000
2	Netlon material (25 m) for outer cage wall	15,000
3	Inner net (12 kg)	10,000
4	Ropes	5,000
5	Fabrication and mooring cost	15,000
6	Floats	5,000
	Total cost of construction and mooring	70,000
7	Rearing cost for one year	1,60,000
	TOTAL COST	2,30,000

Benefits

Fish production in one year	1000 kg
Average price per kg (Rs)	400
Benefit in one year (Rs)	4,00,000
Profit in one year (Rs)	1,70,000

5. Linkage support

5.1 Capacity Building:

- Fish farmers were provided 3 days exposure visit to Central Institute of Brackish water Aquaculture (CIBA), Chennai to learn about farming of sea bass
- Objective oriented training programmes conducted, in different location of the project area (each of one day duration)
- All farmers were trained in KVK, Brahmavara by scientists from CMFRI with emphasis on hands-on training
- Subsequent trainings were conducted by lead farmers at field conditions

5.2 Availability of seeds:

Fish seed was available in plenty in creeks, river mouths, low lying areas and ditches near the sea, and were collected from nature with little efforts and less expenses. Fry is collected using dip nets, scoop nets, seines, drag nets and traps. The collected fry

were transported to culture site either under closed system (plastic bag partly filled with water and oxygen) or open system in water filled containers with aeration.

5.3 Availability of feed

During nursery rearing the fishes were fed twice with compounded feed at the rate of 8% body weight and slowly weaned to local palletised feed. Once transferred to the cages after 50 days, they can be fed trash fishes and fish/ chicken waste. This is easily available from local markets and by-catches of fishermen.

5.4 Marketing support:

There was no problem in marketing the fish due to high demand. Fish is sold at the farm sites itself to wholesalers/ agents on cash payment basis. As harvesting is strictly as per demand, there is no distress sales or need to transport to outside markets. Prices are generally stable, and is as mutually agreed on by the fish farmers and buyers.

6. Project Achievements

The project was operationalised from year 2008 and Ravindra and his fellow fishermen in the JLG were one of the first beneficiaries. The initial cages were fabricated under supervision of CMFRI and provided to fish farmers for demonstration. After finalisation of the cage design in the year 2011, large number of fish farmers have joined and set up cages with own funds and also bank finance. As the initial capital expenses are comparatively low, dependence on bank loans is less. The cumulative progress is as under;

- Total fish farmers covered : 310
- Number of cages set up : 400
- Total fish production per year : 380 tonnes
- Total income per year : Rs. 1520 lakh
- Total net income per year : Rs. 646 lakh

7. Impact of the Project

The project helped the traditional fishermen of Uppunda village in adapting to the deleterious effects of climate change. They have been more than compensated for the loss of income on account of dwindling fish catches. A fish farmer, owning a cage of 6mx 2mx 2m could now get a net income of about Rs. 2 lakh per year. Suitable modification of management practices has helped the farmers in getting higher incomes also. Further, cage farming has brought the much needed cushion against natural shocks and higher prices during trawl ban period. Fishermen now have a livelihood activity ensuring a stable income, and have the luxury of harvesting at any time of the year when prices are at a peak level. Moreover, cage farming does not require attention all the time, and fishermen are able to also pursue their capture fishing activity in the sea while other family members or any one member of the JLG takes care of feeding the fish stock and monitoring of cages.

The young un-employed/ under-employed youths have started taking up this activity. With rise in the family income, there is also improvement in social indicators like more balanced diet, cleanliness of surroundings, better education to school going children, pucca houses and amenities etc.

Task for Participants

i. What was the climate change issue involved in the case?
ii. Who were the key actors and what were their contributions?
iii. What were the factors that led to formulation of the project?
iv. What was the dominant extension model in the project?
v. How the various linkages were facilitated for the project beneficiaries?
vi. What were the impacts of the project?
vii. What are the measures necessary to mainstream such a project?
viii. Any learning from the project in respect of the initiative for augmenting farmers' income?
ix. What are the possibilities for replication of the model through bank credit?

Trainers' Note

i. What was the climate change issue involved in the case

- Major implications of global warming due to climate change and consequent rise in ocean temperature, are sea level rise caused by the melting of polar ice and the thermal expansion of water and alteration in distribution of fish stock.
- The surface waters of the sea and shallow areas are more subjected to rise in temperature. Hence the fish species normally inhabiting the coastal regions tend to migrate to deeper waters in search of favourable conditions. This results in depletion of fish stock in the coastal waters depriving the artisanal fishermen who undertake traditional fishing in near coastal areas.
- Due to sea level rise, the saltwater- freshwater interface moves further inland causing the estuaries to become more saline water dominated over a period of time. The resultant impact on the coastal environment poses a very serious livelihood issue for the coastal population depending on the estuarine fishery.

ii. Who were the key actors and what were their contributions

- A committed organisation like CMFRI which has the capability to develop suitable technology and ability to establish linkages
- KVK, which had provided interface with the farmers and played a major role in technology transfer
- CIBA, as a trainer on culture practices for lead fish farmers
- Progressive farmers, who took initiative in undertaking the farming practice and creating the institutional framework through forming JLGs

iii. What were the factors that led to formulation of the project

- The phenomenon of climate change which resulted in changes in the coastal environment causing reduction in fish catches of traditional fishermen
- Need for an alternate income for the fishermen
- Availability of a suitable conditions in the form of a sheltered estuary with tidal amplitude of less than 2 m facilitating safe installation of cages
- Sea bass, a suitable species of fish which is eurihaline and can tolerate a wide range of salinities, grows fast and has high commercial value
- Progressive young fishermen who were ready to adopt a new technology

iv. What was the dominant extension model in the project

- Technology Transfer extension model, was adopted in the project. The initial efforts in developing the technology was made by CMFRI, and the same was extended to field through the intervention of KVK. Backward linkages were also provided through institutional support.

v. How were the various linkages facilitated for the project beneficiaries

- Construction of cages and farming technology were imparted by CMFRI
- Initial training of lead fish farmers on the biology and culture aspects of sea bass was provided by CIBA, Chennai
- Objective Oriented training programmes were conducted, in different location of the project area by scientists/ field extension staff of CMFRI
- All farmers were trained in KVK with emphasis on hands-on training
- Subsequent trainings used to be conducted by Lead farmers at field conditions
- Input linkages were established by farmers through collective action of JLGs
- Marketing arrangements were established by farmers through support from CMFRI and the Department of Fisheries

vi. What were the impacts of the project

- Adaptation to the climate change problem- deleterious effects of high salinity of estuaries was overcome through culture of a eurihaline fish like sea bass
- Dwindling catches of fish and decrease in income solved through supplementary income from cage farming
- Uncertainty in income from capture fishery overcome through establishment of a livelihood activity with assured income
- Gainful employment for unemployed rural youth
- Greater cohesion among fisher folk through undertaking a group activity and functioning under institutional framework of JLG
- Improvement in social indicators like more balanced diet, cleanliness of surroundings, better education to school going children, proper dwelling etc.

vii. What measures are necessary to mainstream such a project

- Exposure visit of key & primary stakeholders to the project area
- Identification of the problems in proposed area and possible solutions
- Drawing up an implementable action plan, with clear roles & responsibility for planner, financier, implementer, executor, beneficiaries
- Identification of various support services required
- Time frame for each activity
- Monitoring/ evaluation of each project activity

viii. Any learning from project in respect of the initiative for augmenting farmers' income

- Identification of a livelihood activity acceptable to farmers
- Identification & assessment of add-on activities, woven around core activity
- Care to be taken, to identify such add-on activities, which farmers are comfortable at and never to thrust upon any activities on farmers.
- Adequate income generation from the activity in reasonable period and long term sustainability of income
- All activities, ideally should be complementary to each other
- Extension services should evolve & percolate from among the farming community
- Arrangement for bulk purchase of raw material and bulk sale of produce, may be ensured

ix. What are the possibilities for replication of the model through bank credit

- Bankers, at various levels (senior, middle & field), need to be sent for exposure visit to this type of project
- A potential areas may be identified for replication of the model
- Demand for the project may evolve from prospective beneficiaries itself through awareness creation on the problem
- Problem tree analysis and objective tree analysis, to be attempted involving all stakeholders
- Log frame analysis, to be attempted in a clear & precise manner
- Roles & responsibilities, especially in respect of mobilization, extension service, credit, training, loan recovery etc, may be delineated among stakeholders
- Institutional mechanism for monitoring & review, may be evolved.

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