

RURAL EMPOWERMENT THROUGH SUSTAINABLE OPEN WATER CAGE CULTURE IN KERALA, SOUTH WEST COAST OF INDIA

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Aquaculture plays a major role in providing quality and healthy nutrition through production of several species of finfish and shellfish. Rural development involves sustainable development of the rural population by means of income, employment and standard of living along with its many other dimensions. In India and many Asian countries, aquaculture is mostly a rural occupation involving the people of lower strata of the society and therefore through proper intervention of technology and input management, it can bring rural development in many underdeveloped villages.

Rural empowerment is an important strategy, enabling coastal communities to contribute to production and development. Rural empowerment in this context is about enabling people to develop their individual and collective potential as contributing members of the society. The present study provides a model of rural empowerment through sustainable open water cage culture in Kerala, along the south west coast of India. The study demonstrated that the Kerala model of rural empowerment through cage fish farming could be emulated in other states for developing cage aquaculture industry in India.

Cage culture of fish in at Malayattoor river in Kerala



Achievements in rural development through cage farming in Kerala

Improvement in household food security and nutrition: Increased consumption of fish and its addition to the diets of low-income population offers important means for improving food security and nutrition. The bio availability of fish protein is approximately 5 - 15% higher than that from other

sources. Fish contains several amino acids essential for health; especially lysine and methionine. The fatty acids in fish are unique, with many potential benefits for adult health and child development. The cage farmed fishes are mostly high valued and the farmers may not be consuming it directly; but since they have got the purchasing power with the income they earn; they are able to procure and consume other nutritious food.



Red Snapper



Asian Seabass



Tilapia



Pearl Spot



Caranx



Green Mussel

Various aquatic species cultured in cages in Kerala



ENHANCING RURAL EMPLOYMENT THROUGH CAGE FARMING: THE SUCCESS STORY OF DINIL IN KANNUR DISTRICT

Dinil, a young and dynamic cage farmer, hails from Kannur district in Kerala. He worked in the Indian Army for 6 years and later quit the job to pursue his passion in farming. He holds an Industrial Training Institute (ITI) certificate in mechanical trade. In his search for innovative farming practices, he came across the YouTube videos on cage farming by ICAR-CMFRI. Though he couldn't undergo any formal training in cage farming, with the wholehearted support and involvement of Scientists and technical staff from CMFRI, Kochi, Dinil could start cage fish farming in 2018 as a beneficiary of the NFDB funded project of CMFRI. Within four years of initiating the cage farming, he could successfully expand his farming activities to 7 cages in his village Pinarayi. Apart from successfully undertaking cage farming, Dinil could emerge as an entrepreneur by diversifying the activities in cage fabrication, distribution of seed and feed, and a seed production unit of *Etroplus*. He also provides technical assistance to fellow farmers in the locality for all farming activities from stocking till harvest. With his own investment, in 2019, he has started an AQUAONE CENTRE in Pinarayi, providing goods and services related to cage farming.

Economic benefits

Dinil could obtain an average production of 750 - 1000 kg from a single cage of 48 m³ within a

farming period of 7 months and the fishes were sold at the rate of Rs.500/kg. Currently he undertakes cage farming with seabass, pearl spot and tilapia in his seven cage farms. Under the Integrated Multitrophic Aquaculture System (IMTA), he also cultures green mussel, which has got huge demand in the Malabar area. He could obtain a harvest of 1000 kg mussels in single crop from 200 mussel ropes in his cage farms. The mussels provided additional revenue of Rs.2.5 lakhs from the cages. Apart from ensuring a regular income for himself, today he is able to provide employment to 5 more persons in the locality in cage farming, cage fabrication, seed production and feed distribution activities.

Recognitions

Dinil received recognition as a progressive youth farmer by the local bodies and the local NGOs. He is at present member of the standing committee of the District Panchayat for promotion of fish farming activities in Malabar area.

According to Dinil, cage farming could be undertaken as a successful venture by the youth and feels that the farming needs to be promoted for livelihood enhancement of the unemployed youth with adequate financial and technical backup by various institutional agencies in the state.

THE SUCCESS STORY OF SMIJA: A MODEL FOR WOMEN EMPOWERMENT THROUGH CAGE FARMING

Smija, a progressive woman fish farmer from Ernakulam district holds a diploma in Computer Engineering and is employed as a workshop instructor in a private engineering institute in Ernakulam. Being a member of the family of fish farmers, Smija was passionate about fish farming at a very young age itself. Smija got attracted to cage fish farming after she got an opportunity to attend a training programme at CMFRI, Kochi. As a beneficiary of the NFDB sponsored cage farming project, Smija initially undertook cage farming at Kunjithai in Ernakulam district. She had to face severe crop loss during the 2018 floods, but that didn't undermine her motivation for resuming the farming activities and achieving tremendous success in farming in the subsequent years. Smija, who is a mother of two kids says she is able to manage her multiple responsibilities as instructor and as home maker along with successfully managing her cage farms. As most of the leisure time of the family is spend in the cage farms, cage farming turned out to be a hobby for the entire family apart from an income generating activity.

Economic benefits

In her seven cage farms installed in North Parur, Smija cultured Seabass, Tilapia, Carangids, Pearl spot and Red snapper. She could harvest 3 tonnes of fish initially from her three cages in a single crop, which encouraged her to undertake cage farming in 7

cages in the current season. The sales are undertaken through wholesale agents and retail markets and she is able to sell the fish at a rate of Rs.450/ kg in wholesale and Rs.500/ kg in retail markets. Smija revealed that the additional income earned through cage farming benefitted her immensely to support her family's financial needs when her husband was not having a regular income.

Recognitions

Smt. Smija was honoured by ICAR-CMFRI as a progressive women farmer on International Women's Day of 2020. She has also got much popularity through a YouTube channel programme of a cine celebrity on her farming activities. Smija's success in cage farming is a real motivation to several women farmers who approach her for technical guidance. According to Smija, the cost of production in cage farming could be brought down to a large extent through supply of seeds at low cost in the local markets, which requires development of local hatcheries. She also added that diversification of fishes cultured in her farms helped her to evade the constraints in marketing. She suggested that with adequate financial back up and involvement of organisations like Kudumbashree mission, cage farming could be scaled up as a successful venture for economic and social empowerment of women in the state.



Development of rural entrepreneurship: Small-scale, subsistence aquaculture might not be feasible in the long run in terms of food security and nutrition and to achieve it medium-scale commercial enterprises will be more successful. Farmers in Kerala started homestead and backyard units of cage farms, which have now been turned out as family enterprises thus leading to entrepreneurship and empowerment. Cage farming also enabled development of rural entrepreneurship. Some farmers have evolved as entrepreneurs in cage fabrication, net mending, feed/seed supply, and marketing.

Enhancing rural employment: Most of the farmers who own small scale/ backyard type cage farming systems are those that requires less capital and more labour, so many are employed in the farms. Women also are engaged in cage farming by involving in nursery rearing, feeding, marketing etc. Farmers/ fishermen are not only directly employed in cage farming, but also in alternative occupations like net making, marketing of fish feed/seed, fish produced etc.

Capacity building/ Skill development: It is the process of developing and strengthening the skills, instincts, abilities, processes and resources that organizations and communities need to survive, adapt, and thrive in the fast-changing world. The farmers and the families have attained skill development through institutional programmes in every aspect of cage farming. Most of them are provided with valid certificates from CMFRI/ KVK in cage farming and related activities. The empowered youth were trained as forces who can attend to all requirements in cage farming right from cage fabrication to harvesting and marketing of fishes from cages.

Utilization of local resources in farming perspective: Use of local resources is very crucial in enhancing fish production in a sustainable manner. About 65,000 ha of open water coastal resources remain underutilized in Kerala. The majority of the population in Kerala are non-vegetarians who prefer fish in their daily meals. So, utilizing at least a portion of these resources would be helpful in meeting the ever-increasing demand for fish in Kerala. The entire cage farmed fish are marketed in the domestic sector at a very premium price (Asian seabass @US\$ 5.0 - 6.5/kg). Due to cage farming, pollution in the water bodies is checked to a certain extent.

Empowerment of women and weaker sections: Since government schemes encourage women and weaker sections with more subsidies; self-reliance and self-help among the communities has increased. Involvement of rural women in cage farming activities and capacity development programmes have enabled them to improve their self-confidence and self-esteem and achieve social and economic empowerment. Making a significant contribution to sustainable development at local and national levels, helped them to get recognized at both levels.

Economic upliftment and Improvement in standard of living: Among the various dimensions of empowerment, economic empowerment is of prime importance as it enables the individuals to improve their income, household consumption, savings and reduce indebtedness. With cage farming as a family enterprise, the farmers have improved their standard of living with more income coming to the family. The children are sent to good schools and for higher education (Graduation in Engineering etc.)

Institutional intervention

ICAR-Central Marine Fisheries Research Institute (CMFRI)

Apart from carrying out technology development and technology transfer to farmers, CMFRI is also involved in capacity development programmes for the officials of the fisheries departments for efficient dissemination of various technologies. Technologies either transferred or developed for transfer to the fish farmers/ entrepreneurs include: hatchery technology for seed production, post-hatchery rearing/nursery rearing and Grow-out culture technologies including cage farming. CMFRI provides technical guidance and assist with start-up costs through institutional schemes or by preparing projects for submission to financial institutions for availing soft loans. CMFRI is also supporting farmers with technical know-how in cage fabrication, net specifications for different grow-out stages including nursery rearing, regular cage maintenance, net change, water quality assessment and in emergencies when requested by farmers.

Indigenous and cost-effective cage and net designs: A cost-effective, durable and indigenous square cage using galvanized iron (GI) was designed

by CMFRI, which got widely accepted by the farmers. The ideal measurement recommended is 4 m x 4 m x 3 m, where 3 m is the net depth ideal for optimum production. In coastal waters of Kerala, it is difficult to obtain areas with more than 4 m depth. Therefore, farmers have made their own alterations especially in depth of net which ranged from 2 m to 4 m. Some farmers have experimented with 6 m x 4 m, 6 m x 6 m or 8 m x 4 m for the GI cage frames. However, the most feasible and easy to operate dimension for a coastal cage is 4 m x 4 m x 3m. HDPE nets of varying mesh sizes and twine strength, net cages were designed by CMFRI depending on the size and shape of cage frame. MATSYAFED (Kerala) is the only supplier of net cages to many farmers. However, some farmers are fabricating nets for cage farming as a homestead activity along the coastal villages in Kerala.

Farmers are also able to obtain funding support through central schemes of the National Fisheries Development Board (NFDB), Hyderabad as well as from the State Fisheries Department of Kerala. Rural empowerment in several villages of Ernakulam, Kollam, Alappuzha, Thrissur and Kannur is very pronounced.

A Pearl Spot cage farm in Kannur with assistance from CMFRI



A cage farm in Kerala with CMFRI designed cost effective cages of 4 m x 4 m x 3 m dimensions



A fish cage farm established by Dinil in a quarry



The villages have been turned out into a hub of cage farms during 2015 - 21. Over 1000 families in these villages are involved in cage farming.

Techno-economic feasibility assessments

The techno economic feasibility of coastal cage farming has been assessed for various types of cages and varieties of fishes suitable for growing in

the cages. Based on the participatory cage farming demonstrations and field level assessments, cages of 48m³ (4 m x 4 m x 3 m) size was recommended as the most feasible for farming in the coastal waters of Kerala by ICAR-CMFRI. The economic viability assessment indicated that growing Asian seabass (*Lates calcarifer*) along with Pearl spot (*Etroplus suratensis*) in 48 m³ cages yielded a gross revenue of ₹6.26 lakhs and net profit of ₹3.27 lakhs in a culture period of 7 months (Table 1). These types of cages also showed

Table 1. Indicative economics of cage culture of seabass with pearlspot in a 48m³ cage

	Particulars	Amount(₹)
I.	Capital investment	
1.	Cage frame (1.25-inch B glass pipe with ISI)	25000
2.	Mooring and Floats (8 nos for each cage)	15000
3.	Nets	25000
4.	Freezer and accessories	20000
5.	Sub Total	85000
6.	Depreciation (20%)	17000
7.	Interest on FC (12%)	10200
8.	Annual Fixed cost (A)	27200
II.	Operational costs	
9.	Licence fee	1500
10.	1400 seabass seeds @ ₹30/seed	42000
11.	Pearlspot seed @ 500 nos. @ Rs. 15/seed	7500
12.	Nursery rearing(Hapa)	2000
13.	Feed (Trash fish/ floating feed) 6000 kg @ ₹25/kg and 134 kg pellet feed @ ₹50/kg	156700
14.	Labour 2 hrs/day @ ₹100 for 7months	42000
15.	Harvesting and miscellaneous expenses	20000
16.	Total operational cost (B)	271700
17.	Total cost (A+B)	298900
III.	Returns	
18.	Production (1500 kg seabass and 67 kg pearlspot)	1567kg
19.	Gross revenue (@ ₹400/ kg of fish)	626800
20.	Net profit	327900
21.	Cost/ kg of fish (₹)	191
22.	Price/ kg of fish (₹)	400
23.	Operating ratio	0.43
24.	NPV	6,35,760
25.	BCR	1.55
26.	IRR	90%

(Source: Aswathy et al., 2020)

high operational efficiency in terms of easiness in cage maintenance. Growing *Etroplus* along with Asian seabass enhanced returns and facilitated cleaning of nets.

Impact of Institutional interventions

ICAR-CMFRI was in the forefront for introducing and popularising coastal cage farming in Kerala. Apart from developing and standardising cage designs and farming protocol for coastal cage farming, technical assistance to farmers was given through various capacity development programmes organised at the institute as well as field level programmes.

A total of 6000 farmers were trained through these programmes. The scientists and technical staff of the institute also assisted the farmers at the field level for site selection, assessing water quality parameters as well as for maintenance of cages and in marketing activities. In addition, harvest melas, exhibitions, live fish sales and sales through online portal were arranged for

market promotion of cage farmed fishes. Financial support was provided through various schemes of NFDB and TSP and SCSP (Tribal SubPlan and Scheduled Caste SubPlan) programmes implemented by the institute. The institute has also conducted sensitisation workshops for bankers including NABARD (National Bank for Agricultural and Rural Development) which has ensured institutional credit support through various cooperative and commercial banks. The institute also collaborates with officials of state fisheries department and various subsidy assistance schemes for cage farming by the department under the technical guidance of CMFRI. Institutional interventions in terms of technical and financial support have resulted in wide spread adoption of the technology in the state. Currently 5000 cages are installed in the coastal waters of Kerala providing an aggregate economic benefit of ₹100 crores to 1000 families. The estimated annual employment generation in cage maintenance alone is 2.62 lakh man-days (Table 2). The technology has also resulted in emergence of several entrepreneurs

Table 2: Estimated employment and earnings through coastal cage fish farming in Kerala

Particulars	in ₹ Cr
Total no of cages: 5000 GI Cages	
Fish production @800 kg /cage: 4000 tonnes	
Gross revenue @Rs.400/kg fish	160
No of families benefitted: 1000	
Direct economic benefit: Net profit @ ₹2 lakhs/cage	100
EMPLOYMENT GENERATION	
Employment in cage maintenance (@ one person for 4 cages): 2,62,500 man-days	
Labour income earned @ ₹600/ man-day	15.75
Employment in cage fabrication @10 man-days/cage: 50000 man-days	
Labour income earned in cage fabrication @₹600/ man-day	3
Total employment in cage fabrication and maintenance: 312500 man-days	
Total labour income earned in cage fabrication and maintenance	18.75

Over 5000 cages have been established in Kerala with the support of CMFRI

in the cage farming value chain, thus contributing indirect economic benefits to people involved in cage fabrication, distribution of seed, feed and marketing of fish.

Constraints in cage farming at village level

Constraints in seed supply: For 50 cages of dimensions varying from 4 m x 4 m to 8 m x 6 m, in each cycle 1,00,000 nos. of 30 g size Asian seabass/or 1,00,000 nos. of 10 - 20 g pearl spot/ or 2,00,000 nos. of tilapia seeds are required. There are about 200 cages in each village. To supply the seed, there should be continuous seed production and supply. What the farmers face at present is the involvement of middlemen or the so-called local suppliers, who charge higher rate for seeds in every farming season. Production of quality seeds at local level need to be encouraged through establishment of hatcheries and nurseries with public-private participation to ensure adequate supply of seeds and to eliminate the exploitation by middle men.

Lack of cost-effective pellet feed: At present the farmers procure pellet feed at comparatively higher price (₹ 80 to 130/kg). For seabass, bycatch or low value fish are used as feed which is a constraint until

proper cost-effective feed is available. Especially in the present scenario of covid pandemic, availability of trash fish gets hampered due to lockdowns and restriction in free movement of people. Priority needs to be given for the development of cost effective pellet feeds using indigenous technologies for supply of low-cost feeds in the local markets.

Lack of alternative natural resources for feeding fish: At present few cage farmers are using different natural resources as feed. For example, vegetable wastes, food waste, weeds, kitchen left over etc. for omnivores like pearl spot and tilapia. However, the availability of any of these items is not as much as to sustain the feeding for the entire culture period.

Unexpected discharge of industrial effluents: In Ernakulam district, a major hub of coastal cage farming in the state, majority of the industries are located in the banks of river Periyar, and majority of the cage farms installed in the district are in water bodies connected with Periyar. When the industrial effluents are discharged occasionally by these industries (without any information to the local bodies), mortality in cage farmed fishes has been observed. However, it is not a major issue since site selection for cage farming strictly adheres to areas away from pollution.



The author Dr. Imelda Joseph at Dinil's farm in Kannur