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Economic viability of cage farming of Asian seabass in the coastal waters of Kerala

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Abstract
Development of low cost cages, seed production techniques for high value finfishes and promotional activities by institutional agencies paved the way for wide spread adoption of cage farming in the coastal waters of Kerala. Cage farming offers tremendous scope for enhancing fish production in the state in the context of dwindling marine catches. The economic viability of cage farming in the coastal waters of Ernakulam District in Kerala state was analysed for enabling investment decisions at micro level. The micro level economic assessments enable macro level policy decisions for boosting fish production and income through promotion of cage farming activities. Financial viability analysis indicated internal rate of return of 21% for sea bass culture in Gothuruthu to 47% in Pizhala fishing village.

Keywords: cage farming, economic viability, sea bass, internal rate of return (IRR)

1. Introduction
Kerala state contributed an average marine fish production of 5.4 lakh t in 2016 which was 15% of the total marine fish production in the country [1]. Even though the state is endowed with abundant coastal and inland water resources, its contribution to the total fish production in the country is only 7% [2]. Majority of the population in the state are fish eaters and the annual per capita consumption of fish in the state is 18.5 kg when compared to the national average of 5 kg [3]. The state is also a major contributor of marine exports from the country. Even though the state was a leading producer of marine fish in the country in the 90s, there was a continuous drop in fish landings in recent years [4, 1]. As more than 90% of the population are fish eaters in the state, the declining catches also resulted in price escalations of marine fishes and dependence on neigh bouring states for meeting the domestic demand in the state [5]. Hence there is an urgent need to enhance the fish production through aquaculture to meet the domestic consumption demand as well as exports.

The Government of Kerala had taken several proactive measures for augmenting fish production in the state through promotion of fish farming in the marine, brackish water and inland areas of the state. There is an estimated 1.26 lakh ha area of coastal water resources comprising 0.65 lakh ha of brackish waters, 0.46 lakh ha of backwater canals and 0.13 lakh ha of prawn filtration fields in the state [3]. More than 70% of these brackish water areas are currently left unused. The fish farmers in Kerala practiced culture of prawns under the traditional pond culture system along with other commercially important fishes such as Milk fish (*Chanos chanos*), Mullet (*Mugil* sp.) and Pearl spot (*Etroplus suratensis*) [6, 7].

Cage farming of high value finfishes gained widespread popularity after the introduction of low cost cages in the coastal areas and development of seed production techniques for high value finfishes [8]. Cage farming activities were initiated in Kerala in 2007 with the introduction of sea cages at Munambam in Ernakulam District by the ICAR-Central Marine Fisheries Research Institute (CMFRI). The successful front line demonstrations of cage farming by the CMFRI in 2009 in the coastal waters led to its wide spread adoption in the brackish water areas too. Cage farming is currently spreading fast in the coastal Districts of Ernakulam, Alappuzha, Kollam, Thrissur and Thiruvananthapuram with increased local demand for high value fishes and promotional activities by institutional agencies. The major fish species cultured were Asian sea bass (*Lates calcarifer)*, Pearlspot (*Etroplus suratensis)*, tilapia (*Oreochromis sp.*), mullet (*Mugil* sp.), red snappers and caranx. Since there was a large scale adoption of cage farming of seabass by the fish farmers in the coastal areas of Ernakulam

District, the study was conducted in selected villages in Ernakulum District. The economic and financial indicators were developed based on the data on costs and revenues collected from the cage farms. The economic and financial indicators act as decision making tools for investment decisions at microlevel and enables macro level policy decisions in the aquaculture sector.

2. Methods

The economics of brackish water cage farming in Ernakulam district (9.9816^0 N and 76.299^0 E) in Kerala state was analyzed by collecting data from fish farmers involved in participatory cage farming. Pizhala and Gothuruthu were the major fishing villages in Ernakulam District where a sizabale number of farmers had adopted the technology and hence these two villages were selected for the study. The sample size in the selected villages were; Pizhala (10 farmers) and Gothuruthu (30 farmers). The data in each of the selected villages were classified based on cage dimensions predominant in each locality and the economic performance indicators were calculated. All the selected respondents in Gothuruthu villages and a few respondents in Pizhala village were beneficiaries of state Govt. schemes. The farmers in Pizhala were supported by the cooperative bank in the locality through supply of formulated feed at subsidized rates and most of the farming activities from feeding to harvest were undertaken by the farmers through collective effort. However the economic analysis considered the actual costs and revenues incurred in cage farming irrespective of subsidies. The economic and financial performance of cage farming was analysed using various indicators like Net profit, operating ratio, Net Benefit-Earnings ratio, Net Present Value (NPV), Internal Rate of Return *(*IRR) and Benefit-Cost Ratio (BCR).

Net profit = Gross revenue minus all costs including operational cost, depreciation and interest on fixed capital

Operating ratio = Operating costs/ Gross revenue

Net Cash Flow (NCF)/Total Earnings (TE) ratio expresses the NCF or net benefit as a percentage of TE. A ratio of more than 10% can be considered as good [9, 10].

The profitability of investment was measured by using NPV, BCR and IRR

BCR is the ratio of present discounted benefits to the discounted cost.

$$BCR= \{\sum_i Bi/ (1+r)^i\}/ \{\sum_i Ci/1+r)^i\}$$

Where Bi is the total revenue earned at year i, Ci is the total costs at year i, i is the average number of years of operation of fishing units and r is the discount rate.

IRR of an investment is the discount rate at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment.

$$NPV= \sum_i Bi/ (1+r)^i-\sum_i Ci/1+r)^i=0$$

Where NPV is the net present value and r is the internal rate of return. BCR and IRR were calculated at a discount rate of 15%.

3. Results and Discussion

3.1 General particulars of cage farms in the selected locations

The dimensions of cages used by the selected respondents varied from 2 x 2 x $1.5m^3$ to 8 x 4 x $2m^3$. The survival rate varied from 80-90% in different locations. The average fish weight at the time of harvest reported by the respondent farmers varied from 1-1.5 kg. The stocking density varied from 200 nos for seabass in cages of dimension 2m x 2m x1.5m to 1000 nos for cages of dimension 8m x 4m x 2m. The respondent fish farmers in Pizhala village in the study area practiced composite culture of seabass along with pearl spot.

Table 1: General particulars of sample cage farms in Ernakulam District

Particulars	Pizhala	Gothuruthu
Species cultured	Seabass with Pearl spot	Seabass
Cage dimensions	8 m x4 m x2m (64m3)	2mx 2m x1.5m (6m3)
Culture period	7months	8 months
Stocking density (nos. / cubic m)	16	30
Survival rate (%)	80-90	80-90

3.2 Economic viability of cage farming

The average investment varied from ₹15000-20,000 for 2mx2mx1.5 m cages to ₹60000-70,000 for 8mx4mx2m cages including cage structure, nets and floats. The other items of fixed cost consisted of accessories such as freezer for keeping fish feed, plastic crates for storage and transportation of fish/feed. The annual fixed cost was calculated based on depreciation on cage structure and accessories and interest on fixed capital (12%). The depreciation was calculated using straight line method. The depreciation for cage structure was calculated for an expected life of 7 years for cages of dimension 8mx4mx2m in Pizhala and 4 years for cages of dimension 2mx2mx1.5 in Gothuruthu. The expected life of accessories was assumed as 5 years. Costs of seed and feed were included under the major operational cost components. Seabass was fed with chopped shrimp in the first month and chopped fish in the subsequent period. The unit cost of fish seed varied from ₹35 -₹43 for seabass and ₹10 for Pearl spot. The average survival rate varied from 80-90% in different locations (Table 1).

In Pizhala the yield per cage varied from 804 kg for seabass and 6.25 kg pearlspot. The selling price was Rs.500/kg. Comparative economic performance in the selected locations indicated that for cages of dimension 2x2x1.5m3, the net profit varied from ₹28,833 in Gothuruthu and in Pizhala the gross revenue realized was ₹4 lakhs. Yield and price/kg of seabass at Gothuruthu was 192kg@ ₹500/kg respectively.

Syda Rao [8] reported a net operating income of ₹3.44 lakhs at the end of six months and a net profit of ₹2.90 lakhs for experimental demonstration cages in Balasore, Odisha for sea bass at stocking density of 4,357 numbers in 6m diameter cages. The operating ratio varied from 0.57 in Gothuruthu to 0.58 in Paizhala. The operating ratio is used to measure the operational efficiency of an enterprise and a ratio of less than 0.8 is considered desirable for accepting a project for investment. The operating ratios for seabass in seacage demonstrations in Visakhapatnam (15 m dia cage) and Karwar (6m dia GI cage) were 0.43 and 0.20 respectively [11].

The financial performance was analysed using NPV, IRR and BCR at 15% discount rate. The financial analysis was done for a culture period of 4 years 7 years respectively for 2x2x1.5 m3 and 8x4x2 m3 cages based on the expected life of cage structure. The benefit- cost ratio of more than one in the selected locations indicated the financial feasibility of cage farming. The BC ratio for seacage farming demonstration in

HDPE cages of 15 dia in Vizakhapatanam (2007) was 1.99 [11]. The Internal rate of return varied from 21% in Gothuruthu to 47% in Pizhala which indicated that cage farming in bigger sized cages was more profitable than small sized cages (Table 2). The various economic and financial indicators revealed that cage farming in the coastal waters of Ernakulam District in Kerala as an economically viable enterprise.

The results of the study when compared with previous reports on conventional fish farming indicates that cage framing is profitable than conventional fish farming. Juliet and Sathiadhas [12] reported the net profit per ha for polyculture of finfishes in conventional pond farming at ₹2.02 lakhs with an average yield of 5.6 t ha^{-1}. Shyam S.S [13] reported a net profit of ₹2.60 lakhs per ha for monoculture of pearl spot. The high productivity per unit area in cage farming and remunerative prices for the cultured species offer tremendous scope for raising the income of fish farmers in the state through cage farming. Currently cage farmed fishes find a better market in the local areas itself owing to the huge demand for quality fishes. However large scale production of finfishes through cage farming may lead to market failures or distress sales unless the entrepreneurial capabilities of farmers are improved.

Table 2: Cost-benefit analysis of cage farming in ₹

Particulars	Gothuruthu (cage dimension:2x2x1.5m3)	Pizhala (cage dimension:8x4x2m3)
Annual Fixed cost	12267	26467
License fee	1500	1500
Labour cost	24000	36000
Seed cost	8000	40500
Feed	11400	145500
Miscellaneous expenses	10000	10000
Operational cost	54900	233500
Total cost	67167	259967
Gross revenue	96000	404500
Net profit	28833	144533
Net benefit-earnings ratio	30.03	35.01
Operating ratio	0.57	0.58
NPV	8612	317929
BCR	1.04	1.26
IRR	21%	47%

4. Conclusion

Cage farming in the coastal waters of Kerala offer tremendous potential for increasing the farm income and fish production in the state. Cage farming of Asian sea bass adopted by the farmers in the selected fishing villages in Kerala proved to be an economically viable enterprise and showed better productivity and profitability when compared to conventional culture methods. Large scale expansion of cage farming in the state by way of public and private investment and promotional activities by state and central government agencies and sustaining fish prices will certainly aid in enhancing the fish farmer's income in the state.

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