Economic Evaluations in Mariculture

R. Narayanakumar
Socio Economic Evaluation and Technology Transfer Division
Central Marine Fisheries Research Institute, Cochin-682 018

Introduction

Fisheries sector is an integral part of the Indian economy. It has gained a prominent place in the economic map of the country by its consistent contribution to the GDP and foreging exchange earnings in addition to providing livelihood security to about 14 million people and also a major source of nutritional security. The sector has contributed over Rs. 30,000 crores through sea food export. The estimated value of marine fish landings in India during 2014 was Rs. 31,750 crores at LC level and Rs. 52,360 crores at retail market level. (CMFRI, 2015).

The marine fish landing in the country is stagnating around four million tonnes. The estimated landing in 2014 was 3.59 million tonnes (CMFRI, 2015). The increasing awareness on the nutritive value of fish has increased the demand for fish. When the production (harvest) from marine fisheries reaches a stagnation phase, with limited scope for further expansion, the alternative is to look for augmenting the fishery resources of the sea. Looking into the Sea is an important alternative available in front of us. Among the many alternatives available like sea ranching, artificial reefs, mariculture is one of the potential alternatives, which can be practiced by the fishermen more effectively.

Mariculture systems include in-shore and off-shore and maintain a constant high saline water conditions. In-shore mariculture systems include clams, oysters and other molluscs, which are wild-caught or hatchery-reared seed grown on the sea floor or on suspended nets, ropes, or other structures (Naylor 2001). Off-shore mariculture refers to large intensive fisheries in off-shore fish pens.

Mariculture: The Present status

Mariculture has the potential to augment production and incomes through coastal as well as open sea farming. The global aquaculture production increased by a about 25 times in the last 30 years against only seven times increase in capture fisheries production during the corresponding period (Gopakumar et al., 2007). India has vast areas of suitable coastal waters, lagoons and bays which can be utilized for mariculture. Seed production and culture of marine finfishes has been expanding in the recent past in many parts of the world, but in India, it is only an emerging sector. The potential cultivable candidate finfishes are groupers, cobia, rabbitfish, seabass, pompano, snappers and sea bream. Lack of availability of hatchery-produced seed on a commercial scale is the major bottleneck for large-scale marine finfish farming. The availability of seed from wild is often unpredictable,

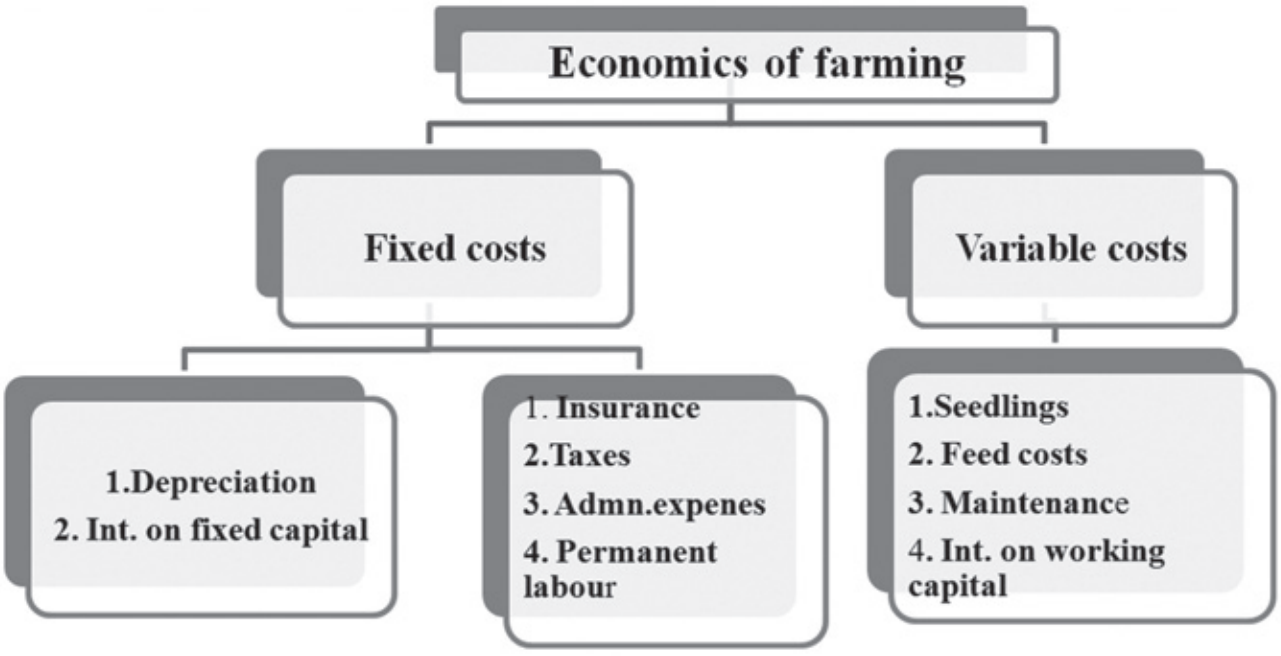
and hence, the development and standardization of seed production techniques for a few commercially important species is receiving research priority.

Why Economic Evaluation

The success of the adoption of any innovation or new technology lies in its economic performance. The rate of return per rupee invested is the economic indicator that guides the investor to choose a particular enterprise or practice. Besides, the analysis of the economic performance serves as an indicator for the investor to allocate his resources in the enterprises. This becomes very much essential, since the resources are scarce and the investor is interested to invest his scarce capital resource in that enterprise that gives the maximum return for his investment.

Components of ecnomic evaluation

The economic evaluation mainly comprises cost of farming and returns of farming,



Indicators of Economic performance

The economic performance of any mariculture activities can be assessed by working out the following cost and return indicators and financial feasibility of any enterprise. (Narayanakumar, 2009, Sathiadhas & Narayanakumar, 2010).

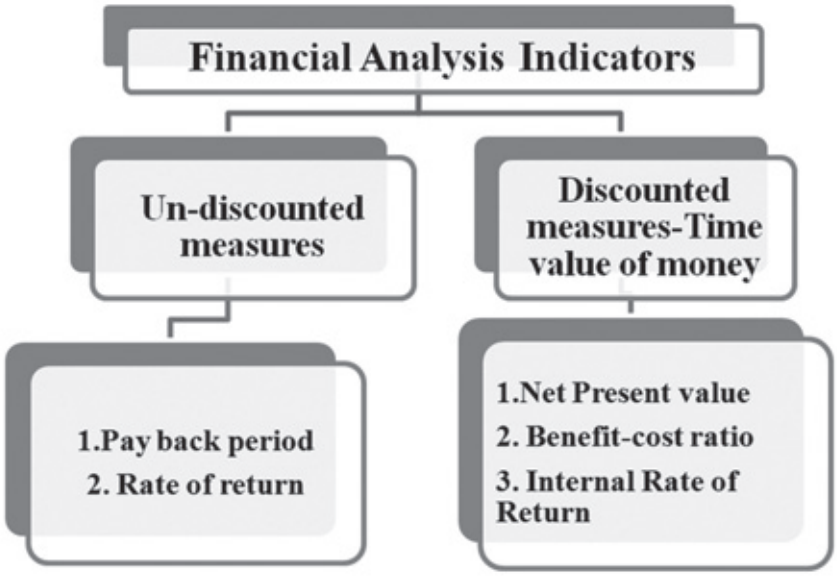
Table 1 Indicators of economic performance of a mariculture enterprise

Sl. No.	Economic Indicators
1	**Initial investment** a) Fixed installations b) Land (if any) c) Major accessories d) Minor Accessorised) Others
2	**Total Investment**
3	**Fixed cost (For crop duration of six months)** a)Depreciation b) Insurance (2% on investment) c) Interest on Fixed capital (12%) d) Administrative expenses
4	**Total Annual Fixed cost (A)**
5	**Operating costs** a) Cost of seedlings b) Cost of feeding and other labour charges c) Interest on working capital (6%)
6	**Total Operating or Variable cost (B)**
7	**Total cost of production [Row(4)+Row(6)]**
8	**Yield of the fish variety (in kg)**
9	**Gross revenue [(8) * Price per kg]**
10	**Net income [(9)-(8)]**
11	**Net operating income [(9)-(6)]**
12	**Cost of production (Rs./kg)[(7)/(8)]**
13	**Price realized (Rs./kg) (9)/(8)**
14	**Capital Productivity (Operating ratio) (6)/(9)**
15	**Rate of return over investment (9)/(2)**

As seen from the table, the different economic indicators of the economic performance of any mariculture enterprise are worked to assess its performance. This will serve as the guidelines to the institutional agencies that are extending the financial support to the enterprise.

Financial performance

The financial performance of an enterprise is analysed by working out various types of indicators as given below.



The financial feasibility analysis is done using the following **capital budgeting techniques** with appropriate assumptions on the duration of the farming, annual days of operation, inflation of costs and returns and related parameters. Three indicators will be estimated namely, **Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Returns (IRR)**

- NPV determines the present net worth of the stream of cash inflows over cash outflows. The cash inflows and outflows are discounted at at particular rate

$$NPW = \sum B_n (1 + d)^{-n} - \sum C_n (1 + d)^{-n} + V_T (1 + d)^T - \sum I_n (1 + d)^{-n} \textbf{..(1)}$$

Where,

B_n cash inflows in period **n**

C_n cash outflows in period **n**

V_T the salvage value realized in the terminal year of the investment

I_n investment made in the year **n**

- **Benefit Cost Ratio** is the ratio of sum total of annual discounted net cash flows over the economic life of the investment to the investment.

$$BCR = \frac{\sum B_n (1 + d)^{-n} - \sum C_n (1 + d)^{-n} + V_T (1 + d)^T}{\sum I_n (1 + d)^{-n}} \quad \textbf{...(2)}$$

- **Internal Rate of Return** is that discount rate which makes the NPW equals to zero. It is that discount rate which equates the net cash flows during its economic life with the initial investment.

$$IRR = \sum B_n (1 + r)^{-n} - \sum C_n (1 + r)^{-n} + V_T (1 + r)^T - \sum I_n (1 + r)^{-n} = 0 \textbf{...(14)}$$

Where,

r internal rate of return

The actual procedure adopted to calculate IRR is by linear interpolation as follows

$$IRR = \text{Lower Discount Rate} + \left\{ \left(\text{Difference between the two discount rates} \right) \left(\frac{\text{NPW at lower discount rate}}{\text{Absolute difference between The NPW's at the two rates}} \right) \right\} \textbf{.....(3)}$$

Case studies

We can see some of the case studies in mariculture conducted by CMFRI to explain the economic considerations in Maraiculture

1. Cage farming in Balasore, Orissa

Farming in open sea cage farms is an alternative practice with great potential to increase production of high value edible finfish and shellfish. In recent years, open sea cage farming is expanding on a global basis. In India, the sea bass was cultured by CMFRI in cage diameter: 6 m; depth: 6 m off Balasore near Orissa in a demonstration project. The cage was launched near Chaumukh beach in Balasore during January, 2009 and was stocked with

4,357 numbers of locally collected Asian seabass juveniles. After about six months, around 3,200 kg seabass was harvested indicating the potential. 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 that this open sea cage farming of sea bass is economically viable (Table 2). (Rao et.al.,CMFRI, 2009).

Table 2 Economic analysis of the experimental cage culture demonstration at Balasore

Sl.No.	Details of cost and returns	Amount (in Rs.)
1	Initial investment for a 6m diameter cage	3,00,000
2	Fixed cost (For crop duration of six months)	
	a) Depreciation b) Insurance (2% on investment) c) Interest on Fixed capital (12%) d) Administrative expenses	30,000 3,000 18,000 3,000
3	Total Fixed cost (A)	54,000
4	Operating costs	
	a) Cost of seedlings	50,000
	b) Cost of feeding and other labour chages	1,75,000
	c) Interest on working capital (6%)	6,750
5	Total Operating cost (B)	2,31,750
6	**Total cost of production (Six months)**	**2,85,750**
7	Yield of sea bass (in kg)	3,032
8	**Gross revenue from 3032 kg**	**5,75,760**
9	**Net income (8)-(5)**	**2,90,010**
10	**Net operating income (Income over operating cost)**	**3,44,010**
11	**Cost of production (Rs./kg) (6)/(7)**	**94.24**
12	**Price realized (Rs./kg) (8)/(7)**	**189.89**
13	**Capital Productivity (Operating ratio) (5)/(8)**	**0.50**

2. Cage farming in Visakhapatnam

Table 3 Initial investment of the cage culture farm of 1061 m^3

Sl.No.	Items	Investment (in Rs.)	% to total	Economic life (in years)
1	HDPE Cage frame	4,00,000	27.12	10
2	HDPE nets	3,00,000	20.34	10
3	Galvanized Iron Chains	80,000	5.42	10
4	Mooring equipments	60,000	4.07	10
5	Stone Anchors	1,50,000	10.17	50
6	Floats	1,50,000	10.17	10
7	Shock absorbers	25,000	1.69	10
8	Ballast	35,000	2.37	10
9	Ropes-HDPE	35,000	2.37	10
10	One time launching charges	2,40,000	16.27	
	Total Initial Investment	**14,75,000**	100.00	

Table 4 Details of Annual Fixed cost

Sl.No.	Details	Amount (in Rs.)
1	Depreciation	1,16,000
2	Insurance premium (5% of investment)	73,750
3	Interest on fixed capital	1,77,000
4	Administrative expenses (2%)	29,500
	Total fixed cost	**3,96,250**

Table 5 Details of Annual Variable cost of cage culture (for a crop duration of seven months)

Sl.NO.	Details	Cost	% to total
1	Feeding	2,24,000	14.02
2	Seedling	1,50,000	9.39
3	Feed cost	9,00,000	56.32
4	Net cleaning	75,000	4.69
5	Underwater inspection	50,000	3.13
6	Net mending and Maintenance	25,000	1.56
7	Post crop overhauling	20,000	1.25
8	Security	1,00,000	6.26
9	Interest on working capital @6% for one crop duration	54,040	3.38
	Total	**15,98,040**	100.00

Table 6 Economic indicators of the cage culture of *Lates calcarifer, Visakahapatnam*

Sl.NO.	Details	Amount (in Rs.)
1	Annual fixed cost	3,96,250
2	Annual Variable cost	15,98,040
3	Annual total cost	19,94,290
4	Gross revenue (after harvesting from 5th to 7th month)	37,50,000
5	Net operating income	21,51,960
6	Net income (profit)	17.55,710
7	Capital Productivity (Operating Ratio)	0.43
8	Annual Rate of return to capital (%)	119%

Thus it is seen from the above results that the economic analysis of the experimental cage culture farm has worked out successfully with higher net operating income and net income in a crop period of seven to nine months. It is to be noted that once the practice is further expanded to many areas and farms, the cost will decline due to the economies of scale of operation. Thus it could be concluded that the open sea cage farming is a viable alternative and economically & financially feasible mariculture operation for the stake holders to make use of in the developing countries.

Mariculture: A potential source of employment

The mariculture has proven to an economically viable alternative to augment the biomass production from the seas in situations wherever the fishery resources are harvested beyond the sustainable limit. Looking into the seas, is the key word for increasing the fish production from the sea as well as improving the livelihood of the million people who depend on the sector.

The mariculture activities provide adequate employment opportunities for the fishers to sustain their livelihood. An estimate by Syda Rao and Gopakumar (2010) indicated that the open sea cage farming of a species provide 1,040 man days of work; open sea lobster farming, 496 man days; mussel culture -52,000 man days; oyster farming-30,000 man days and seaweed culture 3.06 lakh man days. Narayanakumar and Krishnan (2013) estimated that with current development projections targeting 5,000 families in the near future , the seaweed sector could generate around 765 thousand man-days of employment in the Ramanathapuram district. It has been estimated that India can produce one million tonnes of dried seaweed and provide employment to 200 thousand families with annual earnings of around Rs. 0.1 million per family. From these estimates, the scope of commercial mariculture can be understood.

Conclusion

Mariculture and research in mariculture is in different stages of development in different countries. The increasing awareness of the consumers on the shell fishes like clams, oysters & mussels and increasing interest for the cultured high valued fin fish can be capitalized by adopting and investing on taking up mariculture practives. This will help the commercial mariculture to develop to greater heights besides contributing to the food security of the country and providing consistent remunerative livelihood to the fishing community.

It is also equally important to see that the fishermen are given rights to farm in the open sea and its legal implications. There should be a strong policy back up for the establishment of such enterprises to enable the fishers to carry on their mariculture activities. A comprehensive policy framework to patronize the mariculture enterprises is the most essential step in promoting mariculture in any country. This supported by a systematic research programme on mariculture will help the country interested in developing mariculture to reach greater heights in the field.

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