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Seaweed mariculture: an economically viable alternate livelihood option (ALO) for fishers

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ABSTRACT

Seaweed mariculture offers an economically sustainable livelihood option for fisherwomen, who, with little effort can contribute significantly to the household income. Ealier in India, seaweeds were collected from natural stocks only. Later due to the indiscriminate collection from the natural stock and consistent demand from industries for high quality seaweeds, research on seaweed farming was initiated by Central Salt and Marine Chemicals Research Institute (CSMCRI) and Central Marine Fisheries Research Institute (CMFRI) in the 1960's. Today, seaweed farming techniques have been standardised, improved and made economically viable. The present paper makes an attempt to evaluate the economic performance of seaweed farming, including the employment generated in Ramanathapuram District of Tamil Nadu. The average annual net income for the three-year farming period (Rs. 6.76 lakh) was higher than the initial investment (Rs. 5.97 lakh), indicating a payback period of lesser than a year. The estimated net present value (at 20% discount rate) was Rs. 1.30 million (implying an IRR, >100%) while the benefit-cost ratio was 1.70. All these indicators substantially establish the economic and financial feasibility of seaweed farming in Tamil Nadu. The employment potential of seaweed farming at Ramanathapuram District has been estimated at 7,65,000 man days with current development projections benefiting 5,000 families in the near future.

Keywords: Economic viability, Employment generation, Financial feasibility, Livelihood option, Seaweed farming

Introduction

Seaweed mariculture is a profitable livelihood option for fisherwomen, who can earn a substantial income for the household with little effort. India possesses 434 species of red seaweeds, 194 species of brown seaweeds and 216 species of green seaweeds. (CMFRI, 1987). The seaweed production potential in India is estimated at 1,005,000 t distributed in six states of India (Modayil, 2004) comprising 250,000 t in Gujarat; 250,000 t in Tamilnadu; 100,000 t in Kerala; 100,000 t in Andhra Pradesh; 5,000 t in Maharashtra and 300,000 t in Andaman and Nicobar islands. However, a significant progress in organised seaweed farming was not made till the beginning of the 21st century due to various reasons.

In India, traditionally, seaweeds have been collected from natural stocks. However, the need for farming of seaweeds arose from the unsustainable harvesting of the seaweeds and the increasing demand for high quality and adequate quantity of raw material from the seaweed processing industries. Accordingly, the Central Marine Fisheries Research Institute (CMFRI), the Central Salt and Marine Chemicals Research Institute (CSMCRI) and related organisations began the experimental cultivation of agar yielding seaweeds *Gelidiella* and *Gracilaria* in 1964 in credit to develop suitable technologies for the commercial scale cultivation of raw material for the agar industries and for preparation of different products (Kaliaperumal *et al.,* 2004). Besides, seaweed industry has a potential export market mainly due to its diverse uses. Today, seaweed cultivation techniques have been standardised, improved and made economically viable. Corporates backed by institutional and financial support led to the expansion of seaweed (*Kappaphycus alvarezii*) farming through Self Help Groups (SHG) model (mostly women), starting in a small scale in Ramanathapuram District of Tamilnadu in 2000, which now gradually has spread to neighbouring coastal districts like Tuticorin, Pudukottai and Thanjavur (Krishnan and Kumar, 2009). Seaweed mariculture has now become a potential employment generating and income earning activity, which is practised by more than thousand members of SHGs in Ramanathapuram District alone and marching ahead in the other coastal districts of the country with the support of private investments, industries, financial institutions like NABARD (through scheduled commercial banks), National Fisheries Development Board (NFDB) and NGOs led by Aquaculture Foundation of India.

The present paper attempts to evaluate the economic performance of seaweed farming in Ramanathapuram District of Tamil Nadu including the employment generated by seaweed farming.

Materials and methods

The data on cost and returns of seaweed farming was collected from the 49 SHGs who have adopted this practice in Mandapam and Rameswaram region of Ramanathapuram District of Tamil Nadu (Fig. 1).

Aquaculture Foundation of India (AFI) provided seaweed seedlings and other materials to farmers in the region.

Tools of analysis

Conventional tabular and percentage analysis were employed to calculate the economic indicators like operating costs, cost of production and net income.

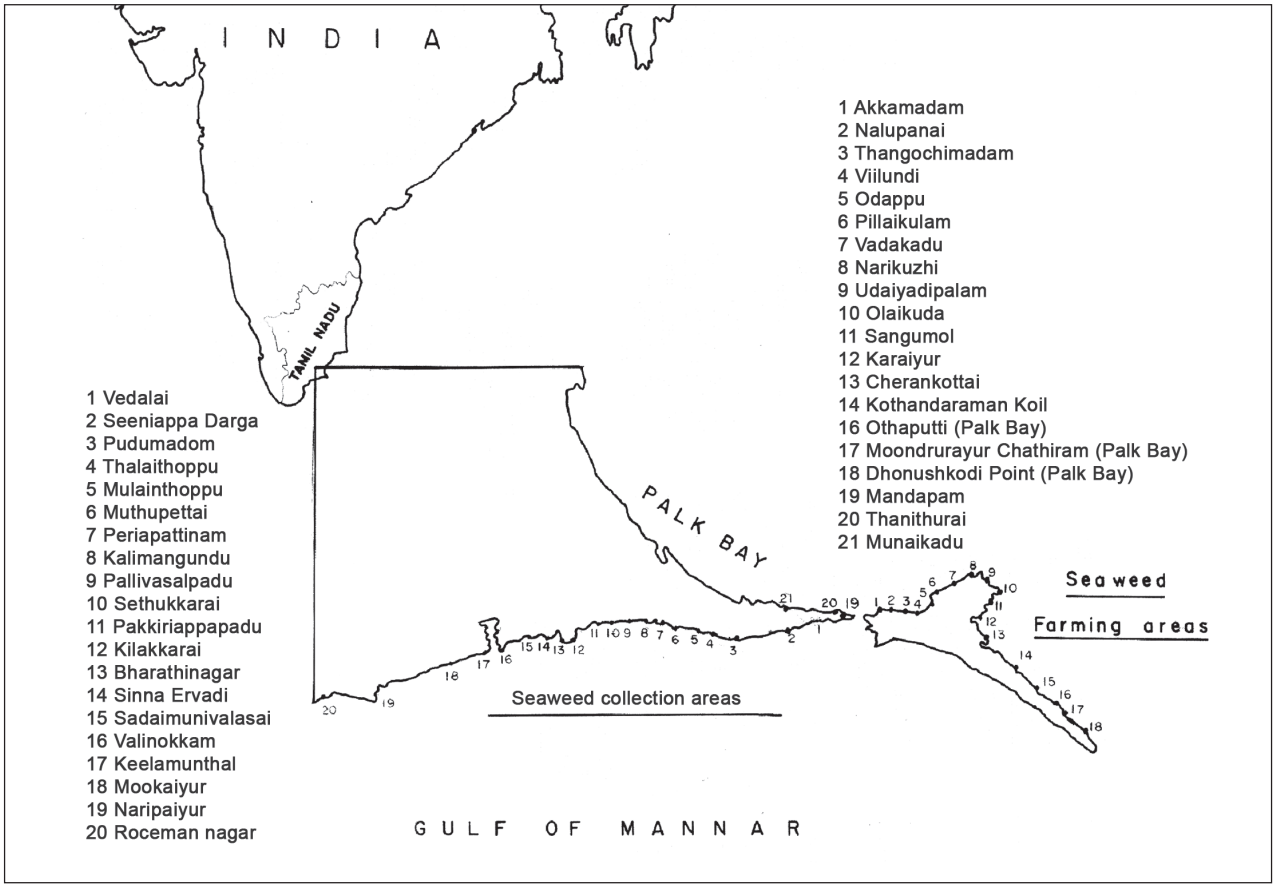

Fig. 1. Map of the study area

The population of organised SHG seaweed farmers at the time when the survey was conducted was estimated at 1,000. The sample respondents were from Vedalai, Umiyalpuram, Munaikadu, T. Nagar, Meenavar colony and Thonithurai villages in Mandapam region and Pamban, Akkalmadam, Nallupanai, Ariyankudu, A.Vadakadu, Parvatham, Sambai, Mangadu and Olaikuda villages in Rameswaram region**.**

The earliest groups in the selected locations have been formed in 2006. The SHGs were predominantly formed by women, even though a few of the SHG consisted exclusively of men and some other SHGs were mixed. Each SHG consisted of five members. The agencies most actively engaged were the Department of Biotechnology (DBT), Ramanathapuram Rural Development Agency (RDDA) and Tamil Nadu Department of Fisheries (TNDoF). The

Financial feasibility

The financial feasibility of seaweed cultivation practice was studied through investment evaluation techniques using both undiscounted (pay back period, rate of return to investment) and discounted methods. Net Present value (NPV) and Benefit cost Ratio (BCR) to ascertain the investment worthiness of the enterprise Tisdell, 1972; Shang, 1981; Gittinger, 1982). However, while the undiscounted measures like pay back period and rate of return to investment give quick evaluation report, they have the disadvantage of not accounting for the time value of money (Tisdell, 1972; Firdausy and Tisdell, 1991, Rao and Kumar, 2008; Sathiadhas *et al*., 2009).

Similarly in the discounting method, the choice of the discount rate is most important to expect a reasonable appraisal

or evaluation. In this analysis the discount rate of 20% is selected, which is higher than the interest charged by the commercial banks in India for all the development projects. The annual cash flow statement was also worked out for a project cycle of three years. Subsidy is not taken into account for calculations. The mathematical equations for estimating the financial feasibility indicators are given below.

a) Pay-back period (years) = Investment / (Average annual cash flow) (1)

b) Rate of return to capital = (Average annual cash flow/Investment) X 100 (2)

c) Net Present Value (NPV) :

$$NPV = \sum_{n=0}^{T} B_n(1+d)^n - \sum_{n=0}^{T} C_n(1+d)^n + V_T(1+d)^n - \sum_{n=0}^{T} I_n(1+d)^n \quad (3)$$

d) Benefit cost Ratio (BCR) :

$$BCR = \frac{\sum_{n=0}^{T} B_n(1+d)^n - \sum_{n=0}^{T} C_n(1+d)^n + V_T(1+d)^n}{\sum_{n=0}^{T} In(1+d)^n} \quad (4)$$

e) Internal Rate of Return (IRR) :

$$IRR = \sum_{n=0}^{T} B_n(1+d)^n - \sum_{n=0}^{T} C_n(1+d)^n + V_T(1+d)^n - \sum_{n=0}^{T} I_n(1+d)^n = 0 \quad (5)$$

where,

B_n : Cash inflows in period n

C_n : Cash outflows in period n

Table 1. Annual costs and returns of 1 ha seaweed farm : raft culture (900 rafts)

	Unit	Quantity (Rs.)	Price per unit (Rs.)	Total value (%)	Share (in years)	Economic life
A. Initial investment						
Seedlings	kg	54,000	1.75	94,500	16	
Bamboo poles	feet	57,600	3.30	1,90,080	32	3
Anchorage weight	kg	1,350	42.00	56,700	9	10
Nylon ropes, 3-mm PP twisted	kg	405	115.50	46,778	8	3
Nylon - Braided ropes	kg	148.5	126.00	18,711	3	3
Raft framing ropes	kg	585	115.50	67,568	11	3
HDPE fishing nets	kg	1,017	78.80	80,140	13	3
HDPE net tying rope	kg	81	115.50	9,356	2	3
Anchoring rope	kg	81	115.50	9,356	2	3
Raft lining rope	kg	90	115.50	10,395	2	3
Labour charges for installation	raft	900	15.00	13,500	2	
Total Initial Investment	Rs.			5,97,084	100	
B. Fixed costs						
Depreciation	Rs.			1,48,400	75	
Interest on investment (7%)	Rs.			41,800	21	
Insurance at 1.2% of investment	Rs.			7,100	4	
Total fixed costs	Rs.			1,97,300	100	
C. Operating costs	Rs.					
Braider twining charges	Rs.			1,08,000	22	
Transportation	Rs.			93,600	19	
Raft maintenance	Rs.			2,84,400	57	
Miscellaneous	Rs.			10,800	2	
Total operating costs	Rs.			4,96,800	100	
D. Total cost of production	Rs.	(B+C)		6,91,400		
E. Gross revenue (four production cycles in first year)	Rs.			1 1,52,000		
F. Net income	Rs..	(E-D)		4,57,900		

Note: Based on data from the 2008-2009 production year.

V_T : Salvage value realised in the terminal year of the investment

I_n : Investment made in the year n

D : Discount rate

N : Number of years of economic investment

T : Terminal year

Results and discussion

Annual costs and returns of seaweed farming

The annual costs and returns for 1 Ha seaweed farm using the raft culture technique is presented in Table 1. The average initial investment amounted to Rs.5, 97, 084/-. The different types of nylon ropes required for planting, tying, mooring and anchoring the rafts accounted for the maximum share of investment (41%) followed by the bamboo poles (32 %) and seedlings (15%). Seedlings were sourced from the harvest of the earlier crop.

The annual total cost of production was estimated at Rs. 6,94,100/- comprising a fixed cost of Rs. 1,97,300/- (28% of the total cost of production) and an annual operating cost of Rs.4,96,800/- (72 %). The annual fixed cost included depreciation on capital investment, interest on capital and insurance premium while operating costs included labour expenses, transportation, and raft maintenance.

The annual gross revenue was estimated at Rs. 11,52,000/-, leading to an annual net income of Rs. 4,57,900/-. The estimation of gross revenue assumed a yield of 280 kg of fresh seaweed per raft after a growout period of 45 days, a 10:1 ratio of fresh to dry weight, and a market price of Rs. 16 per kg of dry seaweed. The complete set of assumptions made for working out the gross revenue per hectare is presented in Table 2**.**

Economic and financial viability

Indicators of economic and financial feasibility for 1 Ha seaweed farm were estimated. The following assumptions were made: i) each cultivation cycle has a duration of 45 days; ii) four cycles are carried out in the first year; iii) six cycles are carried out in the second and third years; iv) after three years of operation, a new set of investments needs to be made; and v) interest on investment is charged at 7 % per annum, based on the guidelines provided by the commercial banks.

The average annual net income for the three year farming project (Rs. 6,76,300/-) was higher than the initial

Table 2. Estimated gross revenue of 1 Ha seaweed farm (900 rafts) with assumptions

Details of harvest	Unit	Value
Average harvest of fresh seaweed per raft after 45 days of culture	kg	280
(Less) allocation of seedling for the subsequent crop	kg	60
Balance of fresh seaweed kept for drying	kg	220
Quantity of dry seaweed produced from 220 kg of fresh seaweed at 10:1 ratio of fresh to dry weight	kg	22
Dry seaweed available for sale per raft after allowing for impurities	kg	20
Market Price	Rs./kg	16
Average revenue per raft per preduction cycle (45 days)	Rs.	320
Average revenue per raft in the first production year (four cycles)	Rs.	1 280
Average revenue per ha (900 rafts) in the first production year	Rs.	11,52,000
Average revenue per hectare (900 rafts) in the second production year (six cycles)	Rs.	17,28,000
Average revenue per hectare (900 rafts) in the third production year (six cycles)	Rs.	17,28,000

Table 3. Economic viability and financial feasibility indicators for 1 Ha seaweed farm (project cycle of three years)

Indicators	Unit	Year I	Year II	Year III	Average
Gross investment	INR(thousands)	597.10	N/A	N/A	597.10
Total cost of production	INR(thousands)	694.10	942.50	942.50	859.70
Gross returns	INR(thousands)	1 152.00	1 728.00	1 728.00	1 536.00
Net income	INR(thousands)	457.90	785.50	785.50	676.30
Net Present Value (20% discount rate)	INR(thousands)		1,300.00		
Benefit Cost Ratio (20% discount rate)	Ratio		1.70		
Return on investment	Percent		113.26		
Payback period	Years		0.9		
IRR	Percent		>100		

investment (Rs. 5,97,100/-), indicating a payback period less than a year (Table 3). The estimated Net Present Value (at 20% discount rate) was Rs. 1.30 million (implying an IRR higher than 100 %) while the Benefit-Cost Ratio was 1.70. All these indicators provide strong evidence of the economic and financial feasibility of seaweed farming in Tamil Nadu. The estimated high rate of return on investment is consistent with the findings of Padilla and Lampe (1989), who calculated an IRR of 78 % for seaweed farming in Philippines; Shang (1976), who estimated an IRR of 56% for *Gracilaria* cultivation, and Tisdell (1991), who reported an IRR of 123% in Bali. Seaweed farming has thus emerged as one of the most profitable livelihood options for coastal fishing communities in various locations of the Asian continent.

The annual cash flow stream for the first three years of the farm is presented in Table 4. The net cash flow is much lower in the first year (Rs. 58,000/-) because of the initial investment; however, net cash flow increases to Rs. 983,000/- in the second and the third year. These high values are indicative of the overall profitability of seaweed farming and corroborates findings from earlier studies (Padilla and Lampe, 1989; Tisdell, 1991).

Employment generation

An estimate of the total employment (man-days per year) generated in seaweed culture in the Mandapam and Rameswaram regions have been presented in Table 5. Assuming that two members in each household are engaged in seaweed farming during 144 and 161 days in an year at Mandapam and Rameshwaram, respectively, the sector would be providing 1,48, 896 and 1,55 ,526 man-days of employment per year in the two regions (this estimate assumes a total of 1,000 families engaged in seaweed farming in the Ramanathapuram District). The various development programmes in the region are currently planning the involvement of a total of 5,000 families in seaweed farming, which would translate into 7,65,000/- days of employment in the district (at an average employment of 153 days per person per year). It has been argued that, seaweed farming could provide employment to 2,00,000/- families in the country, with annual earnings of about Rs. 0.10 million per family (Aquaculture Foundation of India, 2008).

Policy implications

Seaweed farming is an economically viable and financially feasible alternate livelihood option, providing adequate income to the fishers. However, seaweed farming needs adequate and assured institutional financial support. The financial institutions should formulate a productive lending policy to support the seaweed farming through their annual district plans prepared by the lead bank in the district. Considering the employment potential of seaweed farming, the Government can draft appropriate policy measures to encourage more fishers in general and fisherwomen, in particular to form SHGs and take up this avocation as a successful alternate livelihood option to contribute a sustained income to their families. The seaweed farming can be taken up only in the potential areas identified in other states with the help of the expertise developed in Tamil Nadu and suitably supported by the research and financial institutions. There is an emerging need for drafting appropriate open sea leasing policy by the respective maritime state Governments to avoid the social conflicts,

Table 4. Annual cash flow stream for a 1 ha seaweed farm (900 rafts) (Rs. In thousands)

Year	Cash outflow		Total cash outflow	Annual cash inflow	Annual net cash flow
	Investment	Annual cash outflow			
1	597.10	496.80	1 093.90	1 152.00	58.10
2	0	745.20	745.20	1 728.00	982.8
3	0	745.20	745.20	1 728.00	982.8

Table 5. Estimation of employment generation in seaweed farming in Ramanathapuram,

Area	(1) Number of sample households	(2) Average number of family members engaged in seaweed farming	(3) Days of employment in seaweed farming per person per year	(4) Days of employment in seaweed farming per year for sample households (1)x(2)x(3)	(5) Proportion of (1) to total sample size (437) (percent)	(6) Total number of families (N = 1 000)	(8) Mandays per year in seaweed farming (2)x(3)x(6)
Mandapam	226	02	144	65 088	51.7	517	148 896
Rameswaram	211	02	161	67 942	48.3	483	155 526

which are likely to be faced, as seaweed farming expand across the country.

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