Seaweed Cultivation

1. Introduction

Seaweeds are macroscopic algae growing in the marine and shallow coastal waters and on rocky shores. Seaweeds are wonder plants of the sea, the new renewable source of food, energy, chemicals and medicines with manifold nutritional, industrial, biomedical, agriculture and personal care applications. Seaweeds are also termed as the 'Medical Food of the 21st Century' as they are being used as laxatives, for making pharmaceutical capsules, in treatment of goiter, cancer, bone-replacement therapy and in cardiovascular surgeries.

The major industrial applications of seaweeds are as a source of agar, agarose and carrageenan used in laboratories, pharmaceuticals, cosmetics, cardboard, paper, paint and processed foods. In India there are 46 seaweed-based industries, 21 for Agar and 25 for Alginate production, but they are not functioning up to their rated capacity, due to short- supply of raw materials.

2. Resources

Seaweeds are abundant along the Tamil Nadu and Gujarat coasts and around Lakshadweep and Andaman & Nicobar Islands. Rich seaweed beds occur around Mumbai, Ratnagiri, Goa, Karwar, Varkala, Vizhinjam and Pulicat in Tamil Nadu, Andhra Pradesh and Chilka in Orissa.

3. Status and Potential

Around 844 species of seaweeds have been reported from Indian seas, their standing stock is estimated to be about 58,715 tonne (wet weight). Out of the 844 seaweed species, India possesses around 434 species of Red Algae, 194 species of Brown Algae, and 216 species of Green Algae. The Red Algae *Gelidiella acerosa, Gracilaria edulis, G. crassa, G. foliifera and G. verrucosa* are farmed for manufacturing Agar and Brown Algae *Sargassum* spp., *Turbinaria* spp. and *Cystoseira trinodis* for the production of alginates and liquid seaweed fertilizer. The quantity of seaweeds available currently is inadequate to meet the raw material requirement of Indian seaweed industries.

Seed stock of seaweeds is traditionally collected from sea bed in shallow waters along the southeastern coast of Tamil Nadu. Further, continuous, indiscriminate, and unorganized harvesting has resulted in depletion of natural resources. Seaweed cultivation is a highly remunerative activity involving simple, low cost, low maintenance technology with short grow-out cycle.

4. Project Location and Implementation

A. Beneficiaries: Coastal fisher-families, especially fisher-women, their societies/ SHGs, and farmers/ entrepreneurs. The project is to be implemented in a cluster model with each cluster consisting of a minimum of three beneficiaries. Project will be implemented by the beneficiary with technical support from Department of Fisheries of the State Govt.

B. Selection of Site for Seaweed Cultivation: Seaweed cultivation would be undertaken in shallow coastal waters of maritime States, wherein Bamboo-Rafts or Tube-Nets would be held in clusters. A committee comprising of representatives from State Fisheries Department and CSIR-Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavnagar, Gujarat, would identify and select the area for development of seaweed cultivation. CSIR- CSMCRI would be the technology partner, Department of Fisheries of Coastal States would be the Implementing Agency and NFDB would provide financial assistance.

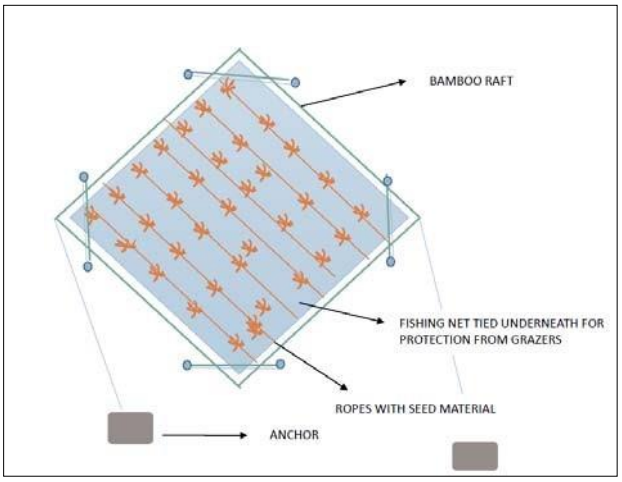
Suitable sites for seaweed cultivation will be selected based on the following criteria:

- Stable seawater with not less than 30 ppt salinity
- Sandy/ rocky bottom with transparent water
- Ideal temperature 26-30 ^{o}C.
- The area should have minimum 1.0 m water depth during low tide.
- Area with mild water currents are preferred.

5. Project Components

A. Raft Preparation and Installation: Each raft measures a minimum of 3×3 m (made of bamboo poles having 7.5 to 10 cm diameter). Rafts may be free floating or fixed.

Each SHG/ Society having at least 3 persons will be provided a minimum of 135 rafts (45 x 3 = 135) in 1 cluster and an individual will be provided a maximum of 45 rafts.



Tying Seedlings of Seaweed on a Bamboo Raft

B. Targeted Seaweed Species: The Red Algae *Gracilaria edulis*, *Gracilaria dura* and *Kappaphycus alvarezii* are highly suitable for cultivation on floating Bamboo Rafts or Tube-Nets held in the sea.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Gracilaria edulis</td><td>Gracilaria dura</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">Kappaphycus alvarezii</td></tr>
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C. Seaweed Stocking and Yield: Although stocking densities should be determined by species requirements and operational considerations, the influence of stocking densities on growth and production has been determined empirically. The indicative stocking and harvest details are as follows:

- Crop Duration: 45 - 60 days
- No. of Rafts/Beneficiary: 45 nos.
- Total Number of Rafts per Cluster: 135 rafts
- Seed Material Required Per Raft: 50 – 60 kg/ raft
- Total Seed Material Required/Cluster: 6,750 kg
- Seaweed Harvested from 1 Raft: 250 kg/ raft
- Net Produce from 1 Raft (after deducting seed material): 200 kg/raft
- Total Production per Cluster per Cycle:135 rafts x 200 kg = 27,000 kg
- Annual Seaweed Production per Cluster: 27,000 kg x 6 cycles = 1,62,000 kg

D. Maintenance of Rafts and Harvesting: Maintenance of rafts would be done by the beneficiaries themselves, i.e. SHGs/ Fisherman Society, fish farmers. One person/beneficiary can handle a single raft in a day. Seaweed cultivated on rafts can be harvested every 45-60 days. Seaweed removed from the rafts will be dried on a clean surface and marketed to the seaweed processing industries.

Harvesting Seaweed from Bamboo Rafts

E. Comparing Cultivation of *Gracilaria edulis* with *Kappaphycus alvarezii*

Component	*Gracilaria edulis*	*Kappaphycus alvarezii*
Floating Raft Dimensions (made of bamboo poles having 7.5 to 10 cm diameter)	3×3 m	3×3 m
Crop Duration	45 -60 days	45 days
Quantity of planting/seed material required/raft	5-6 kg	50-60 kg
Biomass harvested/raft	40-50 kg	240-260 kg
States where Seaweed Cultivation is prevalent	Tamil Nadu, Gujarat	Tamil Nadu, Gujarat
Stability in Rough Sea	More sensitive	Less sensitive

6. Probable Unit Cost

Sl. No.	Components	Cost/Unit
1	Cost of One Bamboo-Raft (3 m × 3 m) or Tube-Net, and Inputs Costs	Rs.2,000
2	No. of Bamboo-Rafts or Tube-Nets per beneficiary	45 nos.
3	Total No. of Rafts per Cluster (3 beneficiaries)	135 nos.
4	Crop Duration per Cycle	45 days
5	Training & Skill Development: 3 days, 50 persons per batch	Rs.1.25 lakh

7. Production Economics

(A) Estimated Output

SL. No.	Particulars	Amount/ Quantity
1	No. of beneficiaries per cluster	3
2	No. of rafts per beneficiary	45
3	Total no. of rafts/cluster	135
4	Harvest cycle (period in days)	45
5	No. of raft(s) handled/ person/ day	1
6	Total seaweed harvested from 1raft (kg)	250
7	Total seed stock required for re-plantation of 1 raft (kg)	50
8	Net produce from1raft after deducting seed stock (kg)	200
9	Annual seaweed production (after retaining 50 kg seed stock for next crop; total seaweed production from 135 rafts; 6 cycles) (wet weight in kg)	1,62,000
10	Total dried seaweed production (from 135 rafts; 6 cycles; @ 10% of wet weight) (dry weight in kg)	16,200
11	Price of dried seaweed (Rs. per kg)	35
12	Gross Revenue (Rs.)	5,67,000

(B) Estimated Project Costs & Returns

SL. No.	Particulars	Amount in Rs.
1	Capital Cost (for 135 rafts) @ Rs.1500/- per raft	2,02,500
2	Recurring Cost for 1st Cycle (for 135 rafts, including seed stock cost) @ Rs.500 per raft	67,500
3	Recurring Cost from 2nd to 6th Cycle (for 135 rafts, excluding seed stock cost)	1,68,750
4	Total Cost [Sl. No. 1+2+3]	4,38,750
5	Gross Revenue [Table A, Sl. No. 12]	5,67,000
6	Net Revenue in 1st year [Sl. No. 5-4]	1,28,250
7	Net Revenue from 2nd year onwards [Sl. No. 5-(2+3)]	3,30,750
8	Net Income per person/month in a cluster (2nd year onwards) [Rs.3,30,750 in12 months for 3 persons]	9,188

8. Project Monitoring Unit (PMU)

The Technology Partner CSIR-CSMCRI would constitute a PMU, and the Project Monitoring Indicators would broadly include:

- Training to the beneficiaries.
- Supply of seedlings to the State Fisheries Departments.
- Formation of local level people-institutions (Cooperatives, SHGs, etc.).

9. Expected Outcomes

- Mass production of Spores: An approach to vigorous seed development for commercial farming of *Gracilaria edulis* by CSIR-CSMCRI MARS, Mandapam, Tamil Nadu.
- Farming of Red Seaweed *Gracilaria dura* on Gujarat Coast for promoting inclusive economic growth in coastal rural settings by CSIR-CSMCRI, Gujarat, through participation of coastal fisher population.
- Large-scale cultivation of commercially important seaweeds in the coastal waters of maritime States would fill the demand-supply gap of Agar and Alginate producing industry in the country

10. Further Reading

Ineke Kalkman, Isaac Rajendran, Charles L. Angell, 1991. Seaweed *(Gracilaria edulis)* Farming in Vedalai and Chinnapalam, India. Bay of Bengal Programme, Madras, India, BOBP/WP/65, 1991, pages 1-16.

Gulshad Mohammed, 2016. Current trends and Prospects of Seaweed Farming in India. *In* Imelda Joseph and Ignatius Boby (eds.), 2016. Winter School on Technological Advances in Mariculture for Production Enhancement and Sustainability. Course Manual, Central Marine Fisheries Research Institute, Kochi, 2016, pages 78-84.

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