



Seaweed Aquaculture: Revolutionizing Coastal Livelihoods and Sustainable Growth

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Abstract

Marine microalgae known as seaweeds flourish in shallow coastal waters and around rocky shorelines. Used in several sectors like cosmetics, pharmaceuticals, food, agriculture and with great variety, they have various uses. Rich in nutrients and with therapeutic qualities, seaweeds are referred to as the “*Medical Food of 21st Century*”. Along the shores of Tamil Nadu, Gujarat and the islands of Lakshadweep and Andaman & Nicobar, seaweed resources are plentiful. The possibilities of seaweed farming, site selection criteria, production trends, cultural approaches and economic influence are investigated in this paper.

Keywords: Agar, Alginate, Carrageenan, Seaweed

Introduction

For conventional fishing, seaweed farming is a sustainable, financially feasible and environmentally friendly choice. These sea plants produce required chemicals including agar, carrageenan and alginates. Overharvesting and restricted agricultural methods cause seaweed demand in India to outstrip its supply. Encouraging marine algae farming could provide more cash for coastal towns, hence guaranteeing a consistent supply of raw materials for businesses. The Government of India is supporting the cultivation of marine algae to promote production and improve coastal livelihoods through various agencies.

Production Trend

FAO (2022) estimates that global aquaculture in 2022 generated 36.505 million tonnes of algae; out of which, 20.379 million tonnes were red algae (55.8%), 15.985 million tonnes were brown algae (43.8%), 28 thousand tonnes were green algae (0.1%), 20 thousand tonnes were unidentified algae (0.1%) and 102 thousand tonnes were cyanobacteria (*Spirulina*) (0.3%). India made just 34,000 tonnes of seaweed in 2021, or 0.01% of the total for the world. The Central Marine Fisheries Research Institute (CMFRI), though, projected that India might yearly produce as much as 9.7 million tonnes of seaweed. The Indian government aims to

raise seaweed production to 1.12 million tonnes by 2025 in order to benefit from this possibility (CMFRI, 2024).

Seaweed Distribution in India

India contains 844 species of seaweeds, with a production of 58,715 tonnes (wet weight). The major seaweed rich regions include:

- Tamil Nadu and Gujarat
- Lakshadweep and Andaman & Nicobar Islands
- Other Locations: Mumbai, Ratnagiri, Goa, Karwar, Varkala, Vizhinjam, Pulicat and Chilka Lake

The three primary categories of seaweeds found in India are:

1. Red Algae (434 species): Agar production (e.g., *Gelidiella acerosa*, *Gracilaria edulis*, *G. verrucosa*).
2. Brown Algae (194 species): Alginate and liquid fertilizers (*Sargassum*, *Turbinaria*).
3. Green Algae (216 species): Less commonly used for industrial applications.

Potential of Seaweed Farming

While natural supplies are always running out, the need for seaweed products is rising fast. Ensuring appropriate supplies and generating money for coastal communities, sustainable seaweed farming is the only answer. Figure 1

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illustrates the process of tying seedlings onto a bamboo raft, while Figure 2 depicts the harvesting stage.

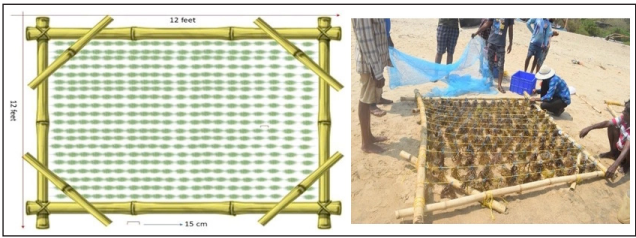


Figure 1: Tying seedlings on bamboo raft



Figure 2: Harvesting

Benefits of seaweed farming include:

Low Investment and High Returns: Requires less infrastructure and has a short crop cycle (45-60 days).

Eco-Friendly Cultivation: Fertilizers or pesticides not needed.

Employment Generation: Provides an additional income, especially for fisherwomen and Self-Help Groups (SHGs).

Site Selection for Seaweed Farming

Ideal locations for seaweed farming must meet the following conditions:

- **Salinity:** At least 30 ppt.

- **Water Clarity:** Sandy or rocky bottom with good transparency.

- **Temperature:** Optimal range of 26-30 °C.

- **Water Depth:** Min. 1 m during low tide.

- **Water Currents:** Mild currents preferred for steady growth.

Good spot finding is the responsibility of a site selection committee of specialists from the State Fisheries Department and CSIR-Central Salt and Marine Chemicals Research Institute (CSMCRI) in Bhavnagar, Gujarat. While CSIR-CSMCRI is the technological partner, the National Fisheries Development Board (NFDB) funds to assist.

Seaweed Farming Techniques

With rafts a common method, especially for species like *Gracilaria edulis* and *Kappaphycus alvarezii*, seaweed culture techniques include raft culture (floating or fixed), longline culture and bottom planting (Figure 3). Different techniques applied in seaweed farming are shown in table 1.

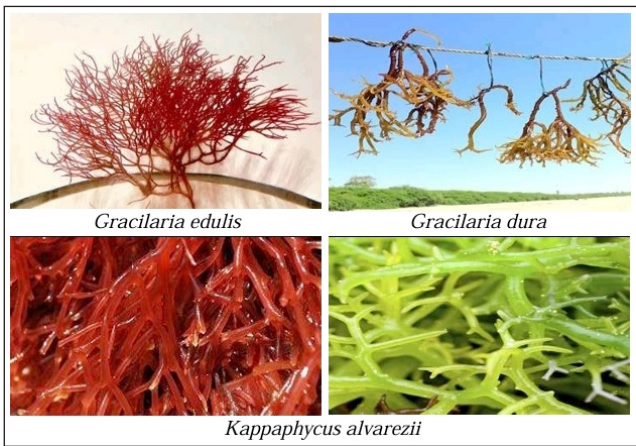


Figure 3: Commercially important species

| Table 1: Different methods used in seaweed cultivation | | | |
|--------------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------|
| Steps involved in culture | Bamboo raft method | Longline method | Tube net method |
| Suitable for | Calm, shallow water. | For moderate wave action. | For strong wave action. |
| Structure setup | 12 ft × 12 ft bamboo raft with polypropylene ropes. | Rectangle segment (120 ft × 20ft) using 24 casuarina poles. | Floating tube nets (10 cm dia, 25 m length) with mesh size of 1.5 cm. |
| Anchoring | 15 kg anchor (2-3 in rough conditions). | Pet bottles (Floatation). | 30 kg stones at each end. |
| Seeding process | 150-200 g seaweed fragments, tied 15 cm apart on ropes. | 150 g seaweed fragments, tied 15 cm apart on ropes seaweed fragments. | 15 kg seaweed seedlings loaded using a plastic pipe funnel. |
| Protection | 4 m × 4 m fish net to prevent grazing. | HDPE fishing nets prevent drifting. | Nets tied at both ends to prevent seed loss. |
| Yield | 1 raft requires 60-80 kg of seedlings. | 1 segment = 10 rafts in production. | |

Targeted Seaweed Species for Cultivation in India

The most appropriate species for farming are *Gracilaria edulis*, *Gracilaria dura* and *Kappaphycus alvarezii*.

Opportunities and Sustainability of Seaweed Farming for Coastal Communities

Seaweed farming opens up new chances for people living

on the coast, as more folks want products made from seaweed. India needs a lot of agar, alginate and carrageenan each year: about 400 tons, 1000 tons and 1500-2000 tons, respectively. The country buys most of these materials from other places. When you dry it out, India wants 4,000 tons of seaweed to make agar, 5,000 tons to make alginate and 4500-6000 tons to make carrageenan every year (Johnson

and Ignatius, 2021). As more people want these useful materials, harvesting wild seaweed is no longer sufficient. So, cultivating essential seaweed varieties through propagation has become the main way to get raw materials for seaweed businesses.

People living on the coast fish to earn money, but there aren't as many fish now because of uncontrolled fishing. Seaweed farming provides women and young people in rural coastal areas another way to earn for a living. It can bring in good income and create many jobs (Krishnan and Narayanakumar, 2010). The Indian government has allocated

Rs. 640 crores under the Pradhan Mantri Matsya Sampada Yojana to increase seaweed cultivation and depend less on gathering it from the wild. This project seeks to encourage seaweed farming as a sustainable and feasible source of income for rural coastal areas.

Applications of Seaweed

From animal feed and food supply to fertilisers, cosmetics, medicines and bioremediation, seaweeds have many applications. They also serve for extracting industrial chemicals and gums. Table 2 provides few examples illustrating the application of seaweed.

Table 2: Applications of seaweed

| Category | Application | Description |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Food | Edible seaweed | Kelp and Nori among seaweeds are eaten straight or incorporated into salads, soups and sushi. |
| | Seaweed-based Snacks | Healthy snacks including chips, crackers and seasoning are made from seaweed. |
| | Seaweed as a thickening agent | In food items like jellies and ice-creams, seaweed extracts such as agar-agar and carrageenan serve as gelling and thickening agents. |
| | Seaweed in health Supplements | Rich in nutrients (e.g., iodine, vitamins, minerals), seaweed is included in nutritional supplements. |
| Cosmetics | Skincare products | Cremes, lotions and facial masks contain seaweed extracts for their hydrating and anti-aging qualities. |
| | Haircare products | Shampoos and conditioners include seaweed for its advantages in strengthening and nourishing hair. |
| | Exfoliation | Its natural abrasiveness and skin-softening qualities make seaweed a common ingredient in exfoliating scrubs. |
| Pharmaceuticals | Medicinal properties | Seaweed is rich in bioactive chemicals that have been researched for anti-inflammatory, antiviral and antioxidant properties. |
| | Iodine supplementation | A natural source of iodine, seaweed is crucial for thyroid function and goitre prevention. |
| | Wound healing | Used in wound care, seaweed extracts help to prevent infection and encourage recovery. |
| | Laxatives | Some varieties of seaweed are included in herbal treatments for digestive health because of their gentle laxative properties. |

Conclusion

Seaweed farming offers a chance to generate income and help the environment at the same time. It provides a steady income for people living on the coast, fishing families and women. With proper training, smart site selection and backing from the government, this type of farming can boost many people's lives. By applying scientific techniques, India has the potential to ramp up its seaweed production. This effort could meet the rising demand and make India a key player in the worldwide seaweed market.

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