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Seaweed Cultivation in India—Present and Future

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Introduction

Seaweeds are used as human food, stock feed and fertiliser in different parts of the world. Apart from these traditional uses, the seaweed extractives of red and brown algae such as agar-agar, algin and Carrageenan, are employed in various industries, especially, food, confectionary, pharmaceuticals and textile industries. Recent studies on seaweeds gave promising results on their role in waste treatment and as potential sources of drugs and bio-energy. These new applications will further increase the demand for seaweeds in the near future.

Though economically useful seaweeds are available along the Indian shores, their annual yield from natural habitats is very low. Special efforts are therefore needed in the country to maximise production and maintain a continuous supply of raw material to the industry by manipulating the natural habitats or by cultivating the useful species on artificial substrata. This paper not only reviews the present status of seaweed cultivation in India but also emphasises the need for their cultivation on a large scale. Details regarding the ecological characteristics of culture grounds and future lines of work to be taken up for successful cultivation of sea weeds are also discussed.

Need for cultivation of seaweeds

Seaweed resources estimated from the coastal areas of Gujarat, Maharashtra, Goa, Tamil Nadu, Andhra Pradesh, Orissa and Lakshadweep (Chauhan, 1978; Chauhan and Mairh, 1978; Chennubhotla *et al.*,

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1988; Mitra, 1946; Dargalkar, 1981 and Subbaramiah *et al.*, 1979a, b; 1987) are shown in Table 1. The total quantity of all types of seaweeds

Table 1. Seaweed resources estimated from the Indian coast

State	Standing Crop (Tons)	
	Wet weight	Dry weight*
Gujarat	446.2	133 9
Maharashtra	278.3	83.5
Goa	2000.0	600.5
Tamil Nadu (Shallow waters)	22044.0	6613.2
Tamil Nadu (Deep waters)	9100.0	2730.0
Andhra Pradesh	7493.0	2247.9
Orissa	5.0	1.5
Lakshadweep	7524.0	2257.2
Total	48890.5	14667.2

*Based on 70 per cent water content.

estimated from different states was 48,980.5 metric tons wet weight, which is approximately equal to 14,662 tonnes dry weight. From the data obtained in these surveys about 30 per cent of total dry seaweeds estimated (that is, 4390.2 tonnes) account for agar-agar and algin-yielding plants. During the last two decades agar-agar and algin industries are well-established in the country and according to Venkatesh Kumar (1980) there are 20 agar-agar and 12 sodium alginate manufacturing units with an installed capacity of 1821 tonnes per year. Due to lack of sufficient raw material, the production of seaweed colloides from these units was far less than the installed capacity. Further a total quantity of about 9,105 tonnes of agar-agar and algin-yielding seaweeds are required to manufacture 1821 tonnes of phycocollides per year (at the rate of 20 per cent yield on dry weight basis). These estimates clearly show the wide gap between supply and demand for seaweeds in the country.

Data on the density of some wild agarophytes from natural habitats (Tamil Nadu coast—Subbaramiah *et al.*, 1979a) and from the culture experiments (Patel *et al.*, 1979; Umamaheswara Rao, 1974 and Rama Rao *et al.*, 1985) are given in Table 2. This information clearly indicates that the rate of production and density of seaweed crop are more in culture grounds than in natural habitats. The above facts on resources and rates of production, emphasise the need for farming the useful species of seaweeds along the Indian shores.

Present status of sea weed cultivation

More than two decades back some preliminary experiments were made

Table 2. Densities of wild and cultured agarophytes

Agarophyte	Density (wet weight)	
	Wild plants (g/m^2)	Cultured plants (kg/m^2)
Gelidiella aceorosa	0.1	0.3*
Gracilaria spp.	1.4	4.4
Hypnea spp.	1.1	11.6

*on the basis of dry weight.

to culture *Sargassum cinctum* in sea water ponds (Thivy, 1964) and *Gracilaria edulis* and *Gracilaria corticata* in aquarium tanks and natural habitats (Umamaheswara Rao, 1968). Later many small scale experiments and pilot plant studies were made by different workers using the rope and net methods and also using substrata like coral stones. Agarophytes like *Gracilaria edulis* were cultivated by Raju and Thomas (1971); Umamaheswara Rao (1974); Krishnamurthy *et al.* (1977) and Chennubhotla *et al.* (1978); *Gelidiella acerosa* by Subbaramiah *et al.* (1975); Patel *et al.* (1979) and Chennubhotla *et al.* (1977) and *Hypnea musciformis* and *Hypnea valentiae* by Rama Rao (1982), Rama Rao and Subbaramiah (1980) and Rama Rao *et al.* (1985). Raju and Venugopal (1971) worked on the settlement and growth of *Sargassum* spp. on artificial substrata placed in shallow waters with a view to increasing the yield by habitat improvement method. Other algae such as species of *Enteromorpha ulva* were cultured by many workers (Ohno *et al.*, 1981; Mairh *et al.*, 1983 and 1986 and Oza *et al.*, 1985 a, b). With the experimental data collected on the cultivation and knowledge of biology of Indian sea weeds available (Umamaheswara Rao, 1987) it would be possible to cultivate the agarophytes and other algae on a large scale using monolines and nets or by placing fresh rocky substrata in the seaweed growing areas.

Ecological characteristics of cultivation grounds

Lagoons of a fringing coral reef near Mandapam and Kavaratti atoll (Lakshadweep), a small shallow bay along the open shore of Visakhapatnam, estuarine part of the Godavari Delta and the salt water Pulicat Lake are shown in Fig. 1 to bring out the differences in the ecological characteristics of some calm and protected areas available along the Indian shores. Though calm and nutrient rich areas with optimum movement of water are suitable for the cultivation of sea weeds, salinity changes and availability of light in these areas play an important role in the growth and development of marine plants. A majority of commercially important seaweeds prefer high salinities ranging from 25 to 35 per cent and seaweed growth will be minimum if the waters are turbid due to the presence of suspended matter. The hydrographical conditions of each area, given in Fig. 1 clearly support

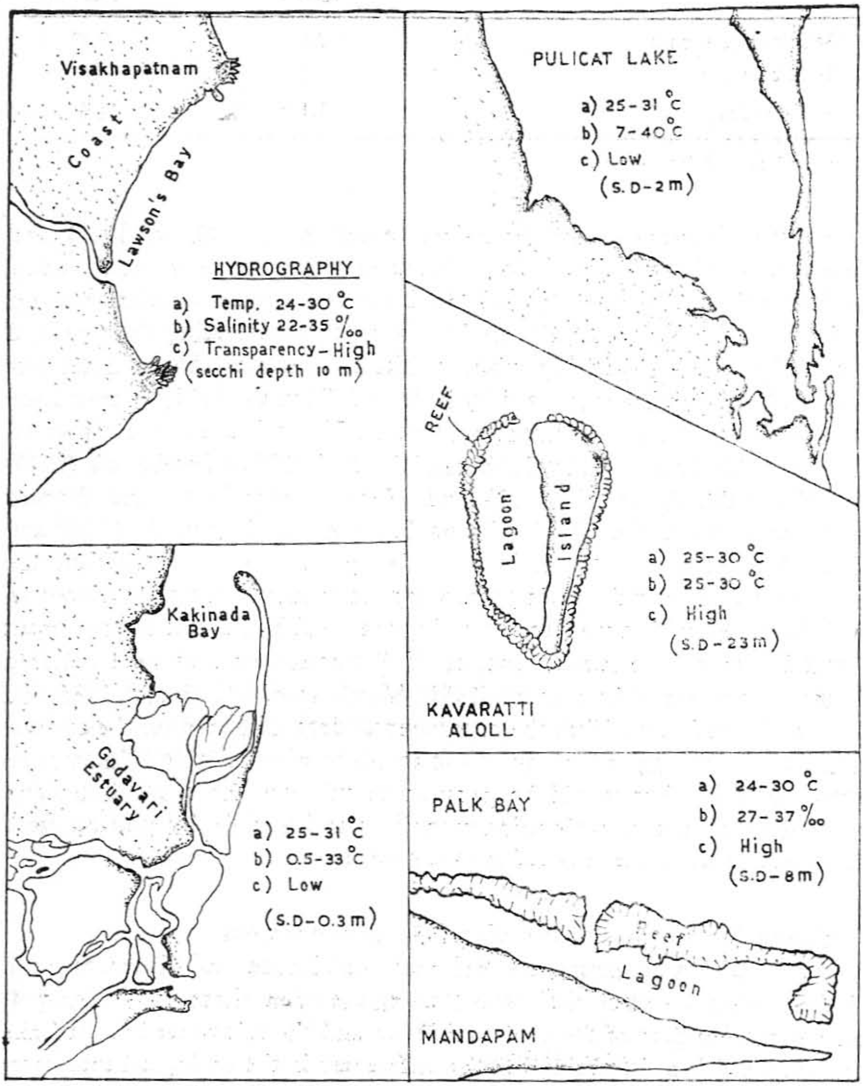

Fig. 1. Some calm and protected areas along the Indian shore

that the river mouths, salt water lakes and backwaters (eg., Cochin back-water), with wide variations in salinity and low light penetration depth are not suitable for cultivation of sea weeds. However in salt water lakes like Pulicat and Chilka it may be possible to cultivate some species of *Gracilaria* growing in these areas, near bar mouths or during summer months, when turbidity of water will be less and salinity will be high. From the above examples it is clear that bays of creeks of the open shores, lagoons of coral reefs on the south-east coast of India, Andaman and Nicobar Islands and atolls of Lakshadweep are suitable for immediately starting the seaweed mericulture programmes.

Future lines of work

Since the seaweed industy has been using indigenous agarophytes and alginophytes top priority must be given to cultivate the agar-agar and algin yielding plants. Considering the chemical and growth characteristics, suitable species of *Gelidiella, Pterocladia, Gracilaria* and *Sargassum* must be selected from the wild populations for cultivation. Simultaneously the following steps must be taken up to start the mericulture programmes in the country:

1) Formation of cooperative societies to seaweed farmers.

2) Starting of seaweed research centres.

3) A national plan on seaweed cultivation.

This national plan on seaweed farming is necessary for coordinating the various efforts:

a) to manipulate the natural seaweed growing habitats;

b) to transplant the selected varieties of agarophytes and alginophytes in coastal areas where they are not growing;

c) to identify the culture grounds along the Indian shores;

d) to transfer the culture grounds on a lease basis to interested sea-weed farmers; and,

e) to provide financial assistance to seaweed farmers.

The research centres to be established along the coastal areas must give training in culture technology to seaweed farmers and also carry out investigations on the following aspects to solve the problems associated with large scale seaweed cultivation:

1) Production, storage and supply of seed material on a commercial scale.

2) Development of high yielding varieties of seaweeds by natural selection or hybridisation and gene manipulation.

3) Protection of cultivated seaweed crops from biological (pests and grazers) and physical factors (environmental conditions).

4) Application of fertilisers to seaweed crops.

5) Socio-economic problems of the seaweed farmers.

The future of seaweed cultivation in the country depends on the combined efforts made by the scientists, cooperative societies, state governments and sea weed industry, and different roles played by these organisations are diagrammatically represented in Fig. 2.

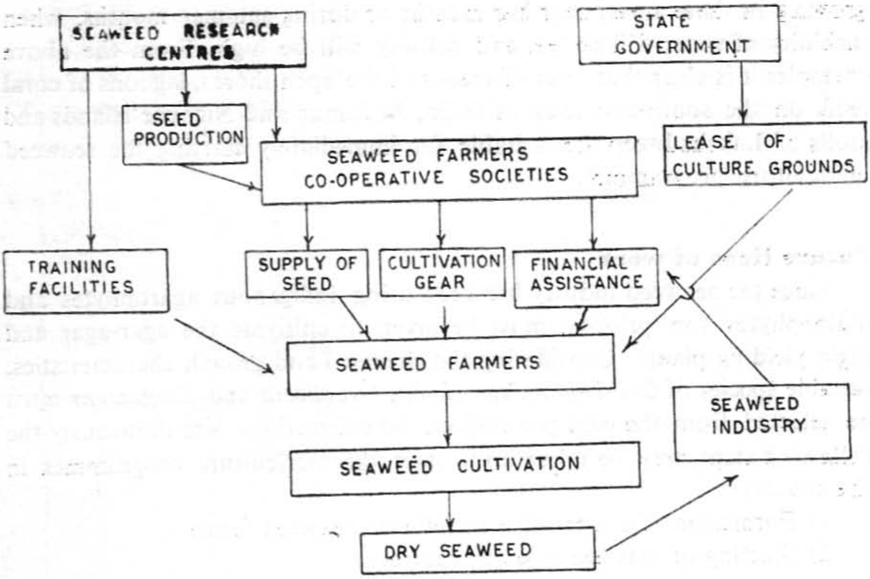

Fig. 2. Diagrammatic representation of the national plan on seaweed cultivation and roles to be played by different organisations

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