CMFRI

Course Manual

Winter School on

Recent Advances in Breeding and Larviculture of Marine Finfish and Shellfish

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SEAWEED CULTIVATION IN INDIA

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Seaweeds are macroscopic marine algae attached to solid substratum, growing in the shallow waters of sea. They are important marine resources exploited for their commercial value as the source of phycocolloids such as agar, agarose, algin and carrageenan, besides their use as food, source of enzymes, dyes, drugs, growth promoters *etc*. In India, seaweeds are harvested from the natural beds along the Tamil Nadu and Gujarat coasts since 1966. The southeast and northwest coast of India and the Andaman-Nicobar and Laccadive archipelagoes harbour a variety of seaweeds with rich biomass and species diversity. The standing stock of seaweeds in India is estimated to be 2,60,876 tonnes. It is estimated that seaweed resource of India comprise 6% agarophytes, 8% carrageenophytes, 16% alginophytes and the remaining 70% green and other non commercial seaweeds. Indian coastline has 624 species of marine algae belonging to 215 genera and 64 families, of these nearly 60 species only are commercially important. However, in a revised checklist 844 species of marine algae have been reported from India, comprising 216 species of Chlorophyta, 191 species of Phaeophyta , 434 species of Rhodophyta and 3 species of Xanthophyta indicating a considerable increase in the species of seaweeds of India . Seaweeds are exploited for commercial purposes only from southeast coast of India, especially from Vedaranyam to Kanyakumari coast which resulted in the depletion of standing stock and species diversity. The major seaweed species exploited from the natural beds are *Gelidiella acerosa, Gracilaria edulis, G. crassa, Sargassum wightii, S. myriocystum, S. ilicifolium, Turbinaria conoides, T. deccurens* and *T. ornata.* and *Cystoseira trinodis*. The first report available on the seaweed exploitation from Pamban, Periapattnam and Kilakarai.

Data on seaweed landings at the southeast coast of India collected by CMFRI from 1978 – 2001 showed a pattern of inconsistency of commercially important seaweeds. This prompted the CMFRI to formulate a time frame for the harvest of these species from the seaweed beds of Gulf of Mannar and Palk Bay in Tamil Nadu. However, this timeframe and the conservation measures were not followed by the local people who were engaged in seaweed collection as it affected their livelihood .

In India mariculture of seaweed was attempted by the CMFRI, Central Salt and Marine Chemicals Research Institute and the National Institute of Oceanography. In 1964 seaweed culture experiments were conducted for the first time in ponds at Porbunder by attaching small plants of *Sargassum* to coir (palm ropes) net . The plants of *Sargassum* grew to height of 15 to 52 cm in 40 days. This experiment revealed good possibilities for cultivation of *Sargassum* and other seaweeds in India. Agar yielding seaweed *Gracilaria edulis* was first cultured by long line rope method in a sandy lagoon on the eastern side of the Kurusadi Island (Rameswaram). Since then, the R & D organizations of Govt. of India are engaged in the experimental mariculture of seaweeds such as *G. acerosa, G. edulis, S. wightii, Gelidiopsis variablis, Acanthophora spicifera, Hormophysa triquetra, Hypnea valentiae and Ulva lactuca.*

Cultivation of seaweeds is carried out by two methods: vegetative propagation using fragments from mother plants and reproductive method by different kinds of spores such as carpospores, zoospores and tetraspores. In the vegetative method, the fragments are inserted between the twists of ropes (Coir/ HDP) and cultivated in the near shore area of the sea. In the reproductive method, the spores are transplanted to the sea after a brief period of nursery rearing.

In India commercial scale mariculture of seaweeds is yet to be taken up by entrepreneurs. According to the estimates by the FAO (1997), world production of brown seaweeds through aquaculture is 4.9 million metric tonnes. The green and red seaweeds contribute 0.03 mt and 1.7 m t respectively. The main contributors are China, Japan, Korea, Chile, Canada, Norway, Indonesia, Phillipines, Thailand and other countries, while the share from India is nil.

From this it is evident that, the landing of agarophytes is considerably low compared to that of the alginophyte. However, the demand for agarophytes by the Indian industry has increased significantly resulting in overexploitation from the natural beds. This has prompted to resolve restoration measures through rational harvesting and mariculture. For the mariculture of agarophyte *Gracilaria edulis* is considered to be the important species because of its high regenerative capacity and cosmopolitan distribution.

Mariculture of agar yielding seaweeds in Indian waters experiences certain constraints such as;

- Grazing of cultivated seaweeds by fishes, crabs, turtles etc
- Vagaries of sea during the SW and NE monsoon due to which culture period is restricted to November to March
- Low returns to the seaweed farmers due to low price of raw materials (Rs.3–4/ Kg) hence fisher folks are not enthusiastic to undertake seaweed cultivation.
- Non availability of seaweed seed stock with high yield of colloids.
- Seaweed culture sites are felt as a hindrance for fishing activities

With the participation from local people from Pamban, Vedalai, Seeniappadarga and Rameswaram villages around Mandapam, *G. edulis* is being cultivated on large scale and the technology is disseminated to the participants under the transfer of technology programme financed by the DBT, New Delhi. Introduction and culture of carrageenan yielding seaweed, *K. striatus* from the Philippines by CSMCRI is considered as a boon to seaweed cultivation in India. Presently this species is acclimatized and cultivated extensively along the Mandapam coast (east coast) and on Diu coast (west coast). *K. alvarezii* is an exotic species successfully cultivated and domesticated in Indian waters. The species has been brought to India 10 years ago during 1995 by Central Salt and Marine Chemical Research Institute Bhavnagar. After 9 years of laboratory experiment, and experimental farming in Saurashtra coast (Mairh *et al*.1995) the species was first introduced in Gulf of Mannar for commercial farming. Introduction and culture of carrageenan yielding seaweed, *Kappaphycus alverezii* from the Philippines by CSMCRI (Mairh *et al.,* 1995) can be considered as an asset to seaweed wealth of India.

Place of cultivation	**Type of cultivation**	**Yield of Carragenan**	**DGR &CGR**	***Author/s /Year***
The Philippines	Fixed bottom line	54.6%	4.68%	Trono,1992
The Philippines	Raft culture	-	4.4-8.9%	Dawes *et al.,* 1994
Indonesia	High density planting (920-30 thallai/sq.mt)	30%	3.5%	Luxton, 1993
-do-	Fixed method,	30%	3.5%	Adam & Parse, 1987
Vietnam	cold season	40%	9-11%	Ohno *et al*., 1996
	Monoline	51.5%	7-9%	-do-
Japan	Raft culture	27-42%	5%	-do-, 1994
India (east coast)	Long line	-	3.19%	Eswaran *et al. 2002*
India (westcoast)	Raft culture	50%	12 g/day	Reeta J, .2001

It was also understood that all farming method of *Kappaphycus* are profitable having returns on investment 115% on in single raft and 984% fixed off bottom method. While comparing *Kappahycus* farming with other aquaculture species, it was observed that the pay back period was very low compared to milk fish, mud crab and tiger shrimp. (Aqua Farm News,1998).

Before going in to the details of *Kappaphycus* farming and its impact on environment and on the domestic species in India, some important points need to be discussed regarding the particular species.

Species	Total investment	Net income ha/year	Return investment	Pay back period
Kappaphycus	18.750	187.896	1.003	0.10
Milkfish	18.688	14.694	79	1.10
Mud crab	88.201	58.585	66	1.17
Tiger shrimp	32.906	11.686	36	2.10

- There are more than 150 species of marine algae including *Kappaphycus* introduced through ballast waters throughout the World (Russel per.commn)
- *Kappaphycus,* which is not a native species of Phillipines introduced from Japan was cultivated in the Phillipines during 1960. Now Phillipines became a leading supplier of *Kappa* carrageenan constituting 80% of global carrageenan market.
- Species was introduced in Hawaii in 1970, Western Samoa in 1975, from Hawaii to Fanning islands during 1977
- Federal state of Micronesia from Pohmpei, Material from Pomphei also transported to Majuro lagoon of Marshall island in 1990
- Tuvalu in 1977. *E.denticulatum*. Along with spores of *Acanthophora spicifera, Dictyota, Hypnea* and *Ulva* were also transported
- Cook Island in late 1980 taken from Fiji, from Fiji to Solomon islands during 1987
- Tonga in 1982
- India during 1995

Annual commercial production has increased from less than 1000 t dry weight when first began to approximately 100,000 t worldwide in recent years (Ask & Azanza, 2002). The market for carrageenan has been growing exponentially at a rate of 5% annually for the last 25 years (Bixler, 1996). In the Philippines seaweed production further increased to 84,000 million t (1997) to 118460 million t (2001) and 127693 million t (2003). Similarly the area of cultivation increased from 43,306 ha (2001) to 58,420 ha (2003)

If we look into the export detail of the Philippines carrageenan

- The price of carrageenan ranged between US$ 11-18 where as the price of raw material ranged between US$ 1-2. Export price of raw seaweed in 1999 US$ 860/MT. The country exports carrageenan to USA, Great Britain, Japan, Canada, Italy, Spain and Australia.
- Buying price of *Eucheuma cottoni* from Phillipines ranged from p 10.44 (1997) to p 37.50 (2004)
- Chinese carrageenan processor buying raw seaweed in 2002 from the Philippines with high price of p 50/kg against prevailing price p 30/kg.

COUNTRY	**1971**	**1979**	**1984**
Philippines	500	14,000	25,000
Canada	6,000	5,700	5,000
Chile	4,000	6,000	6,000
Indonesia	4,000	3,500	3,000
Others	5,500	4,500	4,500
Total	**20,000**	**33,700**	**43,500**

India has got the potential to cultivate seaweed *Kappaphycus alvarezii*. Presently this species is acclimatized and being cultivated extensively along the Mandapam coast (Harish, 2002). Pepsi food limited has enter into large scale contract farming of this carrageenan yielding seaweed.

This is cultivated in an area of 100 ha, 10 km from sea front on the Palk Bay side at Mandapam, Tamil Nadu with the technical guidance and

seed material from CSMCRI, Bhavnagar with permission from the Government of Tamil Nadu. (Harish, 2002). It has also set up an extraction unit of carrageenan at Paramakuddi near Madurai expected an export value of 20 crores by 2003 (Bussiness line,2002).

Further, due to the query raised by some of the NGOs for cultivating the exotic species in the natural Biosphere of Gulf of Mannar which has got a wide diversity of natural flora and fauna, Pepsi food limited were asked to shift their area of cultivation to the Palk Bay. Now they have taken 2 km area on lease for Rs.2 lakhs and initiated cultivation of *Kappaphycus* from Pamban to Akkamodam, Kovilwadi near the Thonithurai bridge and Oliakuda near Rameswaram. It is understood that the seaweed cultivation near Oliakuda is not very successful and the area of the northern side of the islands and the mainland near Pamban is found to be very suitable for the cultivation of *K. alverezii*. Research on the fragment culture of *Kappaphycus* in west coast of India also showed a very good yield (CGR 12 g/day) with 50% yield of crude carrageenan.

Even after four long years of commercial cultivation many queries are yet to be answered.

- Whether any export market is open up for raw material of the cultivated seaweed of *Kappaphycus* and semi processed and processed carrageenan.
- Whether Government has taken any initiative to fix up the price of raw material, processed and semi processed carrageenan in domestic market considering its potential of producing 35-50% crude carrageenan on dry weight basis.
- In the present scenario, Pepsico has fixed up a buy back price from farmers @ Rs. 8.50/- per kg dry weight, which is very low compared to the international market price despite the fact that initial investment for cultivation of *Kappaphycus* is very low in southeast coast of India.
- Whether Government has taken any initiative for leasing water bodies for cultivation of *Kappaphycus* and giving any subsidy for the farmers?
- There are queries from the farmers such as, If we cultivate, who will be takers? At what price? What will be price for fresh and dry material? What will be the price for semi processed material? Whether there will be any profit in these activities?

All these can be answered if Government can take up commodity price fixation in both in domestic and international market. There is good prospect for cultivation in India provided the following are taken before commercializing the exotic variety in India

- Quarantine measure of the exotic variety in Indian water
- Environmental impact assessment before and after cultivation
- Impact on fisheries and the natural resource of seaweeds
- Formation of fisher folk cooperatives for seaweed cultivation
- Demarcation of area for seaweed farming either by lease or as Govt. support to the coastal fisher folk
- Cultivation as a rural infrastructure for the upliftment of the coastal fisher folk
- Fixation of price for the dried material, processed and semi processed material by the government
- Proper regulation for domestic and export market.

Conclusion

In view of the good scope for seaweed cultivation in India, there is urgent need to address the above problems by the concerned agencies like National Research Institutes involved in seaweed research such as CMFRI, CSMCRI, CIFT, MPEDA, State fisheries Department of Tamil Nadu, Kerala, Andhra Pradesh, Diu, some Universities, NGO, Aquaculture Foundation of India and industrialists like PEPSICO, Marine Chemicals and Snap Alginate, with the active involvement of the coastal fisher folk of different areas.

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