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SEAWEED FARMING

Potential and reality in Andhra Pradesh coast

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Introduction

Global aquatic plant production in 2016 was 30.1 million tonnes valued at USD 231.6 billion. Seaweeds were the most farmed aquatic plants, with a much smaller production volume also obtained from microalgae. Seaweeds are macrophytic algae; a primitive type of plant, lacking true roots, stem, leaves and generally growing in the shallow waters. Rapid expansion in farming of tropical species of seaweeds (*Kappaphycus alvarezii* and *Eucheuma* spp.) has taken place in countries such as China and Indonesia. Recently, attention is being increasingly focused on the nutritional value of several seaweed species, because of their high protein, vitamin and mineral content. Use of seaweeds has considerably increased for direct consumption (*Undaria pinnatifida, Porphyra* spp. and *Caulerpa* spp.), as well as for use in animal feed, fertilizers, pharmaceuticals, cosmetics and other applications. The major portion of seaweeds is industrially processed for extracting thickening agents such as alginate, agar and carrageenan. However, seaweed as raw material for carrageenan extraction has also been the major contributor to the growth of farmed aquatic plant production in the recent past, in several countries. Moreover, seaweed is also the only non-fish source of natural omega-3 long-chain fatty acid, and has therefore, attracted major attention among different category of population for inclusion in diets.

Apart from direct use by humans, seaweed plays an important role in coastal mariculture development through integration of seaweed culture with cage farming. Seaweeds are extractive species, producing food by photosynthesis using dissolved nutrients absorbed from the seawater. Integration of seaweed culture with food fish culture is bound to benefit the environment, as the seaweeds take up the nutrient load in the surrounding environment. Culture of extractive seaweed species with food fish species at the same mariculture site is encouraged for aquaculture planning and development and zoning for cage culture activities. Hence, understanding the importance on the potential use of seaweeds in human nutrition, health care, mariculture development and economic upliftment of small-scale fishermen, a thrust has been provided in seaweed culture on pan-India basis by the Government of India.

Status of seaweed production in India

India with a total coastline of 7517 km across its coastal states and islands harbours about 844 species of seaweeds. Estimates on the potential production of seaweeds from Indian waters reveal that 30 million tonnes could be produced utilising 0.30 million ha area along the coastline at an estimated productivity of 100 tonnes/ha/year. However, apart from Tamil Nadu and Gujarat, wherein commercial scale farming is presently carried out, seaweed farming in other maritime states is still at the initial stages of development, mostly on research and demonstration mode. Different research surveys had estimated India to harvest approximately 870,000 tonnes of seaweed every year, but in 2016, the farmed seaweed production from the country was only 3000 tonnes (wet weight), which was less than 0.1% of the global seaweed production for the same year. Despite the presence of a large number of sheltered bays and lagoons suitable for mariculture, commercial large-scale farming of seaweed has not commenced in the country. The dependance is more on natural collection from marine areas and at present, there are about 25 actively operating seaweed-based chemical industries in India. However, due to lack of raw material, all industries are presently working at half of their capacities, and are mostly importing seaweeds from other countries. Available information indcates India to have good potential for seaweed culture, however, a huge gap exists between resource available and produced. In this backdrop, scope for increasing seaweed production in the country is huge and this necessitates active participation from different coastal states of India.

Seaweed potential in Andhra Pradesh

The coastline of Andhra Pradesh extends from Tada, Pulicat Lake on south to Domkura, near Kalingapatnam on the north with a length of 970 km. The coastal stretch is mostly of sandy or muddy in nature and only in some selected pockets, rocky substratum is found. Around 78 species of seaweeds have been reported to be present along the entire AP coast. Also, the coast offers an ideal environment for marine algal communities by the influx of two major rivers, Godavari and Krishna, opening into the Bay of Bengal, where the release of nutrients forms highly productive mangrove habitats in the river deltas. The four northern districts (East Godavari, Visakhapatnam, Vizianagaram and Srikakulam) are abundant in algal resources than the southern counterparts. Seaweed resources in the coast were surveyed by Central Salt and Marine Chemical Research Institute (CSIR- CSMCRI), in collaboration with the Department of Fisheries, Government of Andhra Pradesh during 1979–82 across three sectors. The survey estimated an average of 7500 tonnes (fresh weight) of standing crop per year with important resources being of *Ulva fasciata, Enteromorpha compressa, Chaetomorpha antennina, Sargassum species, Padina* sp, *Gracilaria corticata, Gelidium* sp., etc. There are also studies, wherein the seaweed culture production potential from the coastal waters of the state was estimated at 100,000 tonnes per year.

Status of seaweed culture – Andhra Pradesh

Cultivation technologies for important seaweeds under agarophytes and carragenophytes have been developed and standardised in different places of the country. Adopting it, an initial field cultivation trial was conducted by a multitude of research institutions for different seaweed species (*Gracilaria corticata, Gracilaria verrucosa* and *Hypnea valentia*) in the Visakhapatnam coast, albeit with limited success due to high wave and wind action. Subsequently, Central Marine Fisheries Research Institute (ICAR-CMFRI),

Fig 1. Net tube based integrated seaweed (K. alvarezii) culture in Visakhapatnam coast

Visakhapatnam Regional Centre had experimented the culture of *Gracilaria corticata, Gracilaria edulis* and *Sargassum vulgar*, but could not progress further in the culture of these native seaweed species due to several issues. Later, different research organisations had again initiated the culture along Visakhapatnam coast, but their efforts could not be scaled upto the commercial level required, mostly as the native species experimented failed to withstand the rough sea conditions and also due to its poor growth. Though, the native seaweed species experimented were hardy and had good market demand, the farming attempts were plagued with the issues of low growth/yield, long culture duration (complete recuperation takes 4 - 8 months depending on the species) and less harvesting frequencies (maximum of twice in a year). A study reported that G. acerosa required eight months for complete recuperation in partial harvest method and also the harvesting was possible only twice in a year (July – August and January – February), whereas, in case of G. edulis, recuperation was found to be in 3 - 4 months and harvest was preferably twice a year (April and July). Therefore, inspite of posessing good market demand, culture method could not be established for some of the native seaweed species in Andhra Pradesh.

In India, cultivation of *Kappaphycus alvarezii* was initiated at Mandapam during 1995-1997, which was popularized by PepsiCo during 2002. Since then, commercial scale production of the species has started in different states (Tamil Nadu and Gujarat) and the average production varied from 120 – 1500 mt/year in dry weight basis. In India, the demand for this species is more than 5000 mt/year (dry weight) for producing alginate-based products, but production has always been less than 2000 mt/year through farming. After commercial success in Tamil Nadu and Gujarat, the PepsiCo group had done extensive survey along Andhra Pradesh coast during early 2000 to find the culture feasibility for the species. Subsequently, a raft-based culture trial of *K. alvarezi* was carried out during 2004 in open sea in Prakasam district and during 2007 in Krishna backwaters, Krishna district. The culture trials failed at both the locations due to

Therefore, we surmise that for each state, culture system for seaweeds needs to be modified and tailor-made to suit the topography and the environment of the culture sites in the respective states.

Fig 2. Drying of seaweed harvested from net tube-based culture method

rough waves in open seas and wide salinity fluctuations in backwaters. Later, in the year 2015, the Aquaculture Foundation of India, Chennai had initiated the culture under demonstration mode with funding support from National Fisheries Development Board (NFDB), Hyderabad at different coastal villages in the nothern districts of Andhra Pradesh: Visakhapatnam district (Mangamaripeta village) and Vizianagaram district (Mukkam, Y.M. Palem and Neelagaddapeta villages). In these locations, monoline culture was practised, which showed encouraging growth till 100 days, but could not be harvested due to the prevailing rough weather conditions. However, it was reported that the water quality in the selected sites were conducive for seaweed farming, but, due to the mooring system being not strong enough, the culture units failed to withstand the rough sea conditions.

Advent of open-sea cage farming has further helped to ascertain the possibilities of seaweed culture in Visakhapatnam coast, near R.K. Beach. After carefully considering the previous bottlenecks associated with seaweed culture in this coast, ICAR-CMFRI, Visakhapatnam Regional Centre had attempted an integration of seaweed culture with marine cage farming of finfishes using the available cage mooring. The seaweed (*Kappaphycus alvarezii*) was cultured using net bag and net tube-based methods. During the initial culture trial, seaweed was seeded into the net bags and the net tubes and was cultured inside the cages using the support from the base pipes of the cages, which showed encouraging results for the two months culture duration. Later, a square shaped (3x3 m) HDPE raft was prepared and floated with support of its own buoyancy and also with the support of air tightened plastic cans at the four corners. This frame was attached to the outer base pipes of the cage through ropes, and then, the seeded net bags and net tubes were suspended across the area of the frame. The seaweeds were allowed to grow for two months,

and the culture showed encouraging results with seven times increase in production, thereafter, the culture was harvested. This observation showed the prevailing sea condition to be favourable for seaweed culture using the above methods, and also seawater quality to be conducive for its growth. Therefore, we surmise that for each state, culture system for seaweeds needs to be modified and tailor-made to suit the topography and the environment of the culture sites in the respective states.

Bottlenecks in seaweed farming in Andhra Pradesh and way forward

The state is bestowed with good resources for seaweed culture, but inspite of this, seaweed farming has not picked up at the commercial level. Several issues which are impeding seaweed culture and its further expansion are as follows:

- Unavailability of basic information on seaweed culture due to inconsistent research efforts by different government and non-government organisations along this coast.
- Coastal sea bottom topography and prevailing rough sea weather conditions lead to hardship in day to day operations.
- High investment on anchoring the culture units.
- Lack of awareness among the coastal populations on the benefits of seaweed culture.
- Low returns, unlike other aquaculture sectors such as shrimp and fish farming, which has demoralised the aqua entrepreneurs venturing in this sector.
- Absence of a transparent government mariculture policy.

An initiative was taken by ICAR-CMFRI, Visakhapatnam Regional Centre for promoting K. alvarezii farming in the Visakhapatnam coast of Andhra Pradesh. Subsequently, a brainstorming session was conducted on seaweed culture involving different stakeholders and the listed issues were thoroughly discussed. Issues on zootechnical aspects of seaweed farming were discussed in detail and it was decided to adopt culture methods suitable for the coast. Taking a cue from past experience and reviewing literature, net tube and net bag methods were found to be most suitable for the rough sea conditions. This necessitated the culture operations to be performed a little away from the sea shore with active participation from fishermen. Anchoring of the seaweed unit is a major bottleneck. Again, using the mooring innovations associated with open sea cage farming, effective mooring mechanisms have been devised, which are found to be cost-effective and are able to withstand the rough seas conditions. Marine cages are also used for growing seaweed adopting IMTA (Integrated Multi-Trophic Aquaculture Systems), in which the cage frame is used to hold the seaweed culture units around the cages. This integrated approach helps in improving the returns, both from fish and seaweeds and also reduces the cost by avoiding mooring systems for seaweed culture.

Presently, the biological aspects of seaweed farming are managed by the constant research efforts of research institutions; it is the social and the economic related issues which need more attention from Government and non-Government organisations

Presently, though the biological aspects of seaweed farming are managed by the constant research efforts of research institutions; it is the social and the economic related issues which needs more attention from Government and Non - Government Organizations. A steady and consistent return needs to be achieved from seaweed farming and the same should be thoroughly explained to the coastal population and other associated stakeholders for better adoption of the technology. Coastal unemployed youth interested in seaweed culture should be appropriately trained with respect to the various activities necessary for effective management of the culture and its units. More importantly, active involvement of the seaweed processing industry under their Corporate Social Responsibility (CSR) activity needs to be ensured. The policy aspects on seaweed farming have been incorporated in the National Mariculture Policy, which is under consideration of the Government of India. The listed guidelines in the policy document would encourage and provide a platform for the private entrepreneurs to venture into seaweed farming all along the coastline of the country in a massive scale and by this, hope to increase the seaweed production in the near future.

References are available upon request from the authors