<u>Research Note</u>

APY Analysis Web Tool for Seaweed Cultivation

Introduction

Seaweed cultivation, as a diversification activity in mariculture, has tremendous potential all along the Indian coast. Seaweeds are rich in vitamins and minerals and are consumed as food in various parts of the world and used for the production of phytochemicals, viz., agar, carrageenan and alginate, which are widely employed as gelling, stabilising and thickening agents in several industries of food, confectionery, pharmaceutical, dairy, textile, paper, paint, etc.

In India, seaweeds are used as raw materials for the production of agar, alginate and liquid seaweed fertiliser (LSF). There are about 20 agar industries, 10 algin industries and a few LSF industries situated at different places in the maritime states of Tamil Nadu, Karnataka, Andhra Pradesh and Gujarat[1]. The red algae Gelidiella acerosa, Gracilaria edulis, G. crassa, G. foliifera and G. verrucosa are used for agar manufacture and brown algae Sargassum spp., Turbinaria spp. and Cystoseira trinodis for the production of alginates and liquid seaweed fertiliser. The quantity of seaweeds exploited is inadequate to meet the raw material requirement of Indian seaweed industries. The GoI realising that the farmers have no facilities for production and processing of seaweed, farming of which is done majorly in Tamil Nadu and Gujarat coasts and around some parts of lakshadweep and Andaman and Nicobar islands, proposed a multi-purpose seaweed park to be set up in Tamil Nadu to promote seaweed cultivation as a part of Budget 2021[2].

Seaweeds such as Gracilaria edulis, Hypnea musciformis, Kappaphycus alvarezii, Enteromorpha flexuosa and Acanthophora spicifera can be successfully cultivated in long-line ropes and nets by vegetative propagation method. This activity has a potential to provide income and employment to about 200,000 families. To promote aquaculture and blue economy GoI has passed various policies and helped set up various organisations to impart required education and training to the farmers such as NPMF,PMMSY[3], NETFISH, and training by MPEDA[4]. Along with policies, technology also plays an important role in promoting the Blue Growth Initiative.

Factors affecting yield of cultivation

1. **<u>Water Salinity:</u>** The diversification of species occurs at high salinity levels and only limited species grow at low salinity levels. Very high salinity levels also showed disrupted growth. There exists an optimum salinity between the two extremes. Salinity lying approximately equal or higher to 30 PSU is preferred.The optimal

saline content of inorganic salts is required for the seaweed kinetics and efficient conversion to the total amino acids].

2. **Light Intensity:** In a study done on gracilaria family seaweed, Increasing the light intensity has the effect of increasing the nitrate reductase compound which catalyses the reduction of salts in the water. The reduction of the salts enhances the N:P kinetics which promotes seaweed growth. It is also seen that not only the intensity but light colouring also affects the growth because of varying spectral absorptions of different species.
3. **Temperature:** The study done on gracilaria family species showed that each species exhibits different variations with temperature but the temperature dependence on the optimal yield is high. Temperature, along with light intensity, on variations shows high differences in yields. This strengthens the dependence of seaweed growth on temperature variations.Very high temperatures may cause drying of seaweeds and very low temperatures slows down the metabolism. The temperature of the range of 26 degrees to 30 degrees is optimal for the growth of the prominent species cultivated in IOR.
4. **Skill Assistance:** For the floating bamboo cultivation technology (SRFR), there is a harvest cycle of 45 days, and one production year involves 6 such harvest cycles. For better yields, care is needed and requires one beneficiary to handle one raft per day. The skill assistance provided to the labourers for handling the rafts in harsh conditions and to check the quality of factors also determines the yield.
5. **Water Depth:** In very shallow water during a low tide, the bamboo raft may be exposed to direct sunlight for a prolonged time leading to drying of the leaves and in extreme cases even burning up of the leaves and tissues of the seaweed.
6. **Stocking Density:** The study on *Ulva reticulata* showed that at stocking density of 1 kg/sq. metres the stocking density increased at 3.9% per day while at 3 Kg/sq. metres the stocking density increased at just 1.1% per day. Similar research on *Ulva lactuca* showed that the stocking density of 4 Kg/sq. metres to 6 Kg/sq. metres is seen optimal and yield decreases on both sides. For the gracilaria seaweed family, the highest biomass yield occurs at the stocking density of about 8 Kg/sq. metres.

Opportunities in Seaweed Farming

The prospects on seaweed aquaculture presented by National Cooperative Development Corporation show there is immense opportunity for farmers involved in the aquaculture.

1. **Net exporter:** Currently, India is a net importer of seaweeds, because of not enough supply to cater to the industrial demands but India has the potential to become a major producer because of the long coastline and available manual labor available

for cultivation. With increased production, India can surpass its demands and make way to become a net exporter of seaweeds.

2. **Promote coastal rural prosperity:** The seaweed aquaculture will uplift the economy by providing employment, a commodity to sell, and a sustainable route to bring financial stability.
3. **Revolutionise organic agriculture:** Seaweed acts as a very good natural fertiliser and thus their sustainable nature will help not only to produce valuable products but also can be used extensively in farming as a fertiliser substitute.
4. **Economic growth in the country:** The expansion of seaweed aquaculture will promote technological advancements for production and processing and thus the organisation sees it as a destination for overseas investment.

Technological Interventions of Importance

In open water,The farming area must be well sheltered from very strong waves, current and wind. The bays, creeks, lagoons and coral reefs are suitable areas for the farming of seaweeds. The site should have a rapid water turnover, but not heavy enough to damage the farm. The ground should be stable enough to permit easy installation of stake or bamboo. The soil of the site should be clayey and not of humus sand or mud. Netting must be placed around the units to avoid grazing by herbivorous organisms. Undesirable algae, barnacles or attached sediments must be removed by periodic cleaning[5].

1. **Single Rope Floating Raft (SRFR) method:** A long polypropylene rope of 10 mm diameter is attached to 2 wooden stakes with 2 synthetic fibre anchor cables of 1-2 m and kept afloat with synthetic floats. The length of the cable is twice the depth of the water column (2-4 m). Each raft is kept afloat by means of 25-30 floats. The cultivation rope (1 m long x 6 mm diameter polypropylene) is hung with the floating rope. A stone is attached to the lower end of the cultivation rope to keep it in a vertical position. Generally, 10 fragments of *Gracilaria edulis* are inserted on each rope. The rope is untwisted slowly and the fragments of seed materials are inserted inside the gap and the rope has to be released to tighten the seed material. The distance between two rafts is kept at 2 m[5].
2. **Tube net method:** In this type of culture method seaweeds are cultured using a net tube, which is attached to a bamboo raft. The net tube is made up of 3 m length and 1 m perimeter made of 25 mm mesh size. 30 numbers of such tubes are tied at an interval of 50 cm to a bamboo raft of 15x3 m size. 50 litre water cans are used as floating material to keep the units buoyant. 25 kg of seeding material can be planted in one such unit[5].
3. **Monoline Method:** Four poles of bamboo with 3 m length are fixed and the four sides are tied using a 6 mm rope and the polypropylene seeding rope is attached to

this. One segment (36 m length and 6 m breadth) constitutes 10 monoline units. Seedlings are planted at a distance of 15 cm. 40 seedlings can be planted in one monoline. The total seed requirement is 60-80 kg. HDPE fishing nets can be used for making fencing for avoiding grazing fishes and drifting away from the seaweed seeded nets. Used PET bottles can be tied on each rope for increasing buoyancy[5].

4. **Pond Farming:** In the pond culture, the seed material has to be cut into small pieces and broadcasted uniformly on the bottom of the pond. Seed material introduced on long line ropes and nets can also be cultured in the pond water at subsurface level.In pond culture, water depth has to be monitored and maintained at 30-40 cm. The depth has to be increased to 60-80 cm during summer months to prevent a significant rise in water temperature. Frequent exchange of water (50-75%) is necessary to maintain the optimum temperature of water in the ponds. Fertilisation with either organic or inorganic fertiliser can be done to enhance growth. For pond culture, the site should be located near seawater sources and the bottom of the pond should be at or near zero tidal level[5].
5. **Integrated Multi Trophic Aquaculture (IMTA):** Aquaculture management can be done effectively by integrating seaweeds into aquaculture systems. It is done either by stocking seaweeds along with shrimps, fishes or mussels in optimum stocking density or by recycling the water through a pond supplemented with seaweeds. Integration of *Kappaphycus alvarezii*, the carrageenan yielding red seaweed with green mussels (*Perna viridis*) at Padane, Kasaragod District, Kerala produced a maximum of 20.1 fold increase in yield in 80 days and a minimum of 13.2 fold increase in yield in 40 days. *Gracilaria verrucosa* is an ideal seaweed for integration with shrimp in brackish water ponds which reduces stress on shrimp by utilising excess nitrogenous wastes from the system andalso results in luxuriant growth of G.*verrucosa[5].*
6. **Autonomous Underwater Vehicle (AUV):** AUVs can be deployed into farms to monitor the farming conditions such as water current, turbidity, light intensity, temperature, pH, DO, salinity, nutrients, sedimentation, fouling organisms and predators on a daily basis and can be used to notify the farmer whenever a discrepancy is found. This can be used to measure the length and biomass of seaweed as well.This can also be used to detect onset of disease and control the spread. This will help in reducing labour costs and is only feasible for large farms.
7. **Climate forecast:** It is essential for farmers to know have a prediction of immediate climate change to save their production from damage and losses as well as the climate change in the long run at the site of production so as to take appropriate measures to maintain the site fit for production by controlling the parameters that affect the growth rate (this is essential for inland farms). This can be achieved by satellite imaging.

Policy Interventions of Importance

The GoI has devised various policies to promote aquaculture in the country and boost the Blue Economy to realise its full potential.

1. **Training:** Training the farmers at grassroot levels is important to maintain quality standards as it highly depends on the technique of production, NETFISH is a approved society under MPEDA which caters to this need. The GoI is also providing assistance in terms of money to any such agency which aims to impart training to farmers[6].
2. **Approval of production sites:** GoI must approve use of specific coastal waters for deployment of farms at large scale. Inland cultivation must also be promoted in lakes and ponds such as Chilika lake for sustainability and simplicity.
3. **Quality Control:** Checks to maintain optimum parameters for best growth and yield must be conducted by government officials. Adulteration in aquaculture is something which must be kept in mind while looking towards the growth of it to maintain high standards of quality.

Challenges in further development of the tool

The biggest challenge in further development of the tool is to collect data in a controlled environment for growth rate dependence on different parameters for different subspecies cultivable in India, higher the number of data points we have, the more accurate it will be for the tool to predict the feasibility of a site for production.

Physical sensors along with nodes integrated into a low-cost wireless sensor network is promising option for monitoring the different parameters which affect the growth rate of aqua species of concern[7]. Following are some sensors which can be useful

Sensors	Application
RS-EC-*-2EC	Conductivity Measurement
RS-PH–2-	pH value, H+ concentration index
RS-PM200	Water level/depth
RS-LDO-N01	Dissolved oxygen
RS-SHT-*	Temperature sensor probes
AS EZO-CO2	Detect gaseous CO2
KH-CL-N01-1	Measure Residual Chlorine and Ozone
KH-ZD-N01-1	Turbidity Sensor

ORP	Measure Quality of aquaculture water
KH-COD-N01-1	COD sensor
KH-NHN-N01-1	Ammonia and Nitrogen
RS-GZ*-*-2	Sunlight sensor

Relevant Points

1. **Database Management:** All the stakeholders involved should emphasise on maintaining the accurate data essential for theoretical-based research and analysis using machine learning for the species of interest.
2. **Using Satellites**: Using satellite data for relevant parameters such as temperature, ocean currents, salinity, etc can be is a good option for sustainability of the tool and aquaculture industry[4].
3. **Seaweed Industrial Production and sustainability:** While Seaweed looks promising source of biofuel energy, scientists of "MACROFUEL" mention that maintaining sustainability and reaching industry-level production at the same time is proving to be difficult[4].

REFERENCES

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