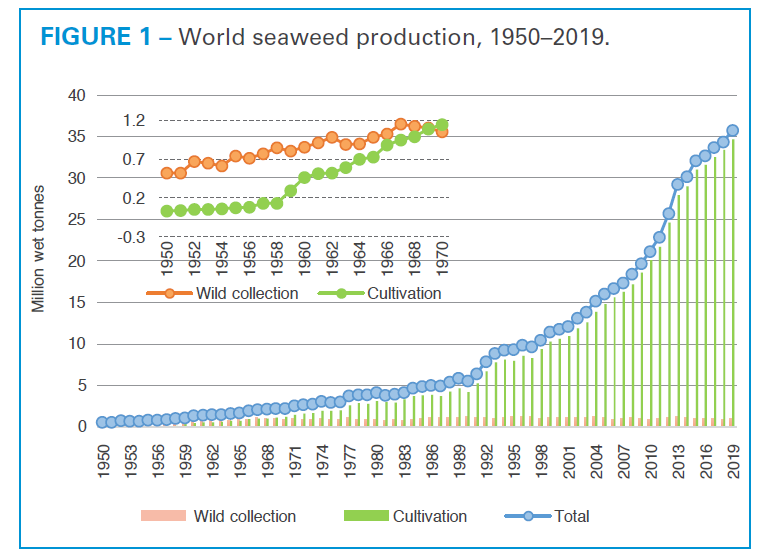
**IDENTIFICATION OF ENVIRONMENTAL PARAMETERS FOR SEAWEED CULTIVATION**

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**INTRODUCTION:**

Seaweed is nothing but marine macroalgae that grow in the intertidal and subtidal zones of coastal areas. Since ancient times, seaweed has been used as food by numerous civilizations around the world. In addition, edible seaweed has been reported to be rich in protein, lipid, and dietary fibre. The high levels of minerals and dietary fibre and low lipid levels characteristic of many seaweed species make seaweed an attractive source of bioactive materials for a wide range of applications. In addition, the protein quality and antioxidant activity associated with the content of polyphenolic compounds and pigments (such as fucoxanthin) make seaweed an interesting source of bioactive substances, especially for use in human and animal nutrition. Seaweed also contains high amounts of vitamin A, K, and B12), protective pigments, minerals, and trace elements essential for the human diet, and many nutrition claims (iron, calcium, iodine, or magnesium) compared to bone health, cognitive function, maintenance of natural metabolism, normal growth and muscle function. Seaweed is also a source of essential fatty acids, and it is the only non-fish source that has polyunsaturated fatty acids (PUFAs), mainly omega-3 and omega-6 fatty acids. Seaweeds are also termed the ‘Medical Food of the 21st Century as they are being used as laxatives, for making pharmaceutical capsules, in the treatment of goitre, cancer, bone-replacement therapy, and cardiovascular surgeries.

According to the statistics by FAO, the world seaweed production was just half a million in the year 1950, that too mostly from the wild collection of seaweed. In 1970, seaweed cultivation has met the wild collection. When people understood the applications and the value of seaweeds, the attention given to seaweed farming has enormously increased over the year. And in the year 2019, the seaweed cultivation itself has raised to nearly 35 million wet tonnes which have a contribution of around 30% of the total global aquaculture production.



Source: *FAO,2021[1]*

Thanks to all these biological activities and potential new uses, seaweed will be a sustainable resource in the future, leading to increased demand for the use of these organisms and their production. The biological productivity of *S. cerevisiae* causes the storage of photosynthetic carbon. This carbon can be sequestered or transported to the ocean depths, leading to CO2 sinks. Harvesting algae and using them to produce biofuels or in other industries (food, feed, pharmaceuticals, fertilizers) can help reduce CO2 emissions. Seaweed can be used as a carbon sink and even as a fuel and can be a sustainable alternative biomass source for the production of fuels as well as chemicals such as bioethanol and biobutanol. In addition, high levels of soluble mineral nutrients such as nitrogen, phosphorus, and carbon are absorbed by seaweed and lead to the growth of algae and help reduce eutrophication in seas and oceans. Seaweeds are part of food webs that provide diverse associated organisms (organisms of conservation and economic importance) from different trophic levels (predators, fishes, invertebrates) with habitat, food, shelter, etc. The hydrodynamic energy generated by the waves and the maintenance of high bed levels in intertidal areas, thereby help to protect intertidal areas from erosion.

Many seaweed-based industries in India are currently unable to produce agar to its full potential due to a lack of raw materials. The existence of a vast marine area suitable for seaweed cultivation reminds seaweed fans of the next "seaweed revolution".

Despite strong management strategies in many sectors, there is a growing consensus that wild resources cannot provide enough seaweed to meet future demand. This is an important way to unlock your potential. However, the sustainable development of seaweed farming faces various problems, limitations, and challenges for policymakers, stakeholders, and experts to work together to deal with or overcome.

**GLOBAL STATISTICS AND INDIA’S STAND:**

|  |  |  |
| --- | --- | --- |
| **COUNTRY/AREA** | **WET WEIGHT IN THOUSAND TONNES** | **SHARE OF WORLD (TOTAL)** |
| World | 32386.2 | 100 |
| **Asia** | **32226.3** | **99.51** |
| China | 18575.7 | 57.36 |
| Indonesia | 9320.3 | 28.78 |
| South Korea | 1710.5 | 5.28 |
| Philippines | 1478.3 | 4.56 |
| Democratic People’s Republic of Korea | 553 | 1.71 |
| Japan | 389.8 | 1.20 |
| Malaysia | 174.1 | 0.54 |
| Viet Nam | 19.3 | 0.06 |
| India | 5.3 | 0.02 |
| **Africa** | **108.5** | **0.34** |
| Tanzania | 103.2 | 0.32 |
| Madagascar | 5.3 | 0.02 |
| **Americas** | **20.7** | **0.06** |
| Chile | 20.7 | 0.06 |
| **Oceania** | **14.04** | **0.04** |
| Solomon Islands | 5.5 | 0.02 |
| Papua New Guinea | 4.3 | 0.01 |
| Kiribati | 3.65 | 0.01 |
| **Europe** | **4.5** | **0.01** |
| Russian Federation | 4.5 | 0.01 |
| **Other Producers** | **21** | **0.06** |

**Table 1:** World Seaweed Production (2018)

From the report submitted by FAO on the State of World Fisheries and Aquaculture (SOFIA,2020) [1], Asia has a contribution of around 99.51% of the Total global seaweed production (32.4 million tonnes). Countries like China and Indonesia are the major contributors to seaweed production in Asia which is then followed by South Korea and the Philippines. Seaweed production more than tripled from 10.6 million tons in 2000 to 32.4 million tons in 2018. Indonesian seaweed production has increased from less than 4 million tons in 2010 to more than 11 million tons in 2015 and 2016, with similar production levels in 2017 and 2018, due to the rise of *Kappaphycus alvarezii* farming in Indonesia.

India produced 5300 tonnes (wet weight) in 2018, which has a contribution of 0.02% of the total seaweed produced from the Asian continent. And it yielded an approximate market value of around 300 crores to 500 crores to the Indian government, which is very much less when compared to India’s potential in seaweed farming.

An all-India preliminary site selection survey suitable for seaweed farming was conducted by ICAR-CMFRI along all maritime states of India. From this survey, a total of 23,970 ha area were identified as potential seaweed farming along the Indian coast. In India, there are 46 seaweed-based industries, 21 for Agar and 25 for Alginate production, but they are not functioning up to their rated capacity, due to the short- supply of raw materials.

Seaweeds are abundant along the Tamil Nadu and Gujarat coasts and around Lakshadweep and Andaman & Nicobar Islands. Rich seaweed beds occur around Mumbai, Ratnagiri, Goa, Karwar, Varkala, Vizhinjam, and Pulicat in Tamil Nadu, Andhra Pradesh, and Chilka in Orissa.

|  |  |  |
| --- | --- | --- |
| **STATE** | **NO. OF LOCATIONS IDENTIFIED** | **PRELIMINARY DEMARCATION OF POTENTIAL SITES (in ha)** |
| Gujarat | 9 | 10316 |
| Diu | 5 | 700 |
| Maharastra | 12 | 2724 |
| Goa | 4 | 120 |
| Karnataka | 14 | 1579 |
| Kerala | 7 | 80 |
| Lakshadweep Islands | 11 | 213 |
| Total West Coast | 62 | 15,732 |
| Tamilnadu | 187 | 5048 |
| Andhra Pradesh | 49 | 1215 |
| Odisha | 14 | 1525 |
| West Bengal | 5 | 450 |
| Total East Coast | 255 | 8238 |
| Total (India) | 317 | 23,970 |

**Table 2:** State-wise distribution of potential sites for seaweed cultivation in India

Source: *Johnson et al.,*2020 [2]

**INDIA’S SEAWEED STATE-WISE TARGET:**

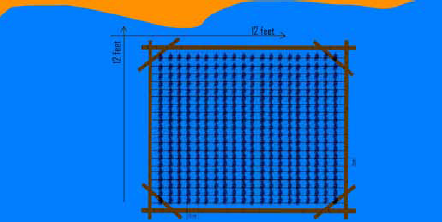
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **State** | **2020-2021**  **(5%)** | **2021-2022**  **(10%)** | **2022-2023**  **(25%)** | **2023-2024**  **(30%)** | **2024-2025**  **(30%)** | **Total**  **(100%)** |
| Gujarat | 0.1 | 0.2 | 0.5 | 0.6 | 0.6 | 2 |
| Maharastra | 0.05 | 0.1 | 0.25 | 0.3 | 0.3 | 1 |
| Goa | 0.01 | 0.02 | 0.05 | 0.06 | 0.06 | 0.2 |
| Kerala | 0.025 | 0.05 | 0.125 | 0.15 | 0.15 | 0.5 |
| Tamilnadu | 0.15 | 0.3 | 0.75 | 0.9 | 0.9 | 3 |
| Andhra Pradesh | 0.075 | 0.15 | 0.375 | 0.45 | 0.45 | 1.5 |
| Odisha | 0.05 | 0.1 | 0.25 | 0.3 | 0.3 | 1 |
| West Bengal | 0.05 | 0.1 | 0.25 | 0.3 | 0.3 | 1 |
| Karnataka | 0.025 | 0.05 | 0.125 | 0.15 | 0.15 | 0.5 |
| Puducherry | 0.01 | 0.02 | 0.05 | 0.06 | 0.06 | 0.2 |
| Lakshadweep | 0.005 | 0.01 | 0.025 | 0.03 | 0.03 | 0.1 |
| Andaman & Nicobar Islands | 0.005 | 0.01 | 0.025 | 0.03 | 0.03 | 0.1 |
| Daman & Diu | 0.005 | 0.01 | 0.025 | 0.03 | 0.03 | 0.1 |
| Total | 0.56 | 1.12 | 2.8 | 3.36 | 3.36 | 11.2 |

**Table 3:** State-wise production target (in lakh tons) in wet weight

The table represents the year-wise plan to improve seaweed production along the maritime states of India. To achieve the target, it is required to understand the ecology of the seaweed and how the environmental and hydrodynamic parameters affect the growth. Among all the states, Tamil Nadu and Gujarat have the most no. of potential sites for seaweed farming in India, and the target production at the end of 2025 is 3 Lakh tonnes and 2 lakh tonnes respectively.

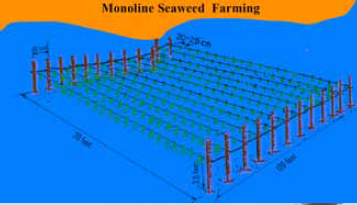
1. **SEAWEED CULTIVATION METHODS: [3]**
2. Bamboo Raft Method:

Floating bamboo raft ideal for shallow and calm waters. The floating raft is made of bamboo and has a main frame of 12 feet by 12 feet and a transom of 4 feet by 4 feet. About 20 twisted polypropylene ropes are used for planting seaweeds on each raft. Along the length of the rope, about 150-200g of seaweed are tied at 15cm intervals. A total of 20 pieces of seaweed are tied to a rope. The total seed requirement per raft is 60 to 80 kg. A 4m x 4m fishing net is tied to the bottom of the raft to prevent herbivorous fish from biting it. In a typical season, clusters of 10 rafts are deployed in adjacent coastal areas in water depths of 1.0-1.5 m using 15 kg anchors. On the other hand, in the harsh season, the same cluster should be installed using two or three anchors.



1. Longline or Monoline Method:

Longline or monoline seaweed cultivation is ideal in areas characterized by moderate wave motion, shallow water depth and low populations of herbivorous fish. A rectangular seaweed growing area that is 120 feet long and 20 feet wide is called a plot. A total of 24 casuarina poles (each 10 feet long and 3-4 inches in diameter) are required to form one piece. 12 casuarina rods 10 feet apart on each side (total length 120 feet). As can be seen in the picture below, at a distance of twenty feet, similar structures have been built in parallel. The legs are connected with a 6 mm rope and the rope of seaweed seedlings is fixed on it. About 150 grams of seaweed are tied at 15 cm intervals, and a rope contains about 40 pieces. The total amount of seed required for one rope is 6 kg. In total, 10 ropes are equivalent to 1 bamboo raft in production. So one section is equal to 10 rafts. The fence is constructed using HDPE fishing nets to prevent drift, and used plastic bottles are attached to each rope to increase buoyancy.



1. Tube Net Method:

The pipe network construction method can be used in areas with high wave motion such as coastal states (Andhra Pradesh and Gujarat). A 25 m long tubular net (diameter 10 cm, mesh size 1.5 cm) is suspended in the subsurface water column using an appropriate number and size of floats at regular intervals. Anchor stones (approximately 30 kg) are used at both ends to stabilize the pipe mesh in the water column. If desired, additional anchors of appropriate size and weight can be fixed between them. Place 15 kg fresh weight of seed material into the tube using a 1.0 or 1.5 m long plastic tube that acts as a funnel or funnel. The diameter of the pipe should be slightly smaller than the net diameter of the pipe for efficient planting. Insert the plastic pipe into the pipe network and pull the entire pipe down until the opening of the plastic pipe is separated from the pipe. Carefully pull the tube netting down from the bottom of the plastic tube so that there are no gaps between the seedlings. This process continues until the entire pipe network is seeded with algal biomass. Both ends of the pipe net are tied with rope to prevent material wastage.



1. **Nutrients:**

Seaweeds are photoautotrophic organisms and are one of the major producers in brackish and brackish waters. They synthesize organic matter with light and CO2 from inorganic nutrients such as soluble inorganic nitrogen (DIN) (i.e. NH3, NH4+, NO2-, NO3-) and soluble inorganic phosphorus (DIP) (i.e. PO43-). The organic matter produced may be eaten by other organisms in the ecosystem or used in food and other products, but the nutritional requirements of seaweeds vary by species and are only known for a limited number of species.

Nutrient uptake and uptake mechanisms link available external resources with demand for growth. However, since the environments in which macroalgae grow are characterized by strong variation in several related factors, including nutrients, macroalgae show a degree of flexibility with respect to resource management and biomass internal composition. They quickly adapt to food conditions. Algae can switch their investment in photosynthetic energy from C to N and P during the day or from summer to winter. Nutrient uptake mechanisms must evolve optimally to meet the nutritional needs of specific species in their environment.

The algal surface area to biovolume ratio (SA:V) is a determining factor in the nutrient uptake efficiency of the seaweeds, especially at low concentrations (*Rees, 2007*) [4]. Even at both low and high nutrient concentrations, the algae with low SA:V show lower uptake efficiency when compared to the algae with high SA:V. (*Hein et al.,1995*) [5]. The nutrient uptake and its use is a three-dimensional phenomenon while light reaching the macroalgae is a two-dimensional phenomenon. For the benthic plants the rates of light absorption to nutrient uptake varies depending on both plant morphology and hydrodynamic conditions. (*Baird and Middleton 2004*) [6]

1. Carbon:

The assimilation dynamics of carbon uptake in aquatic plants have many features with other nutrients. That is, it is essential for the cell, requires photosynthetic energy to use it, has specific transporters on the cell surface, is stored inside the cell, and is used later when other limiting conditions are reduced.

HCO3 are the alternate source for inorganic carbon, and its availability is abundant. These HCO3 can be converted to CO2 to be used by Rubisco by means of both spontaneous or catalyzed dehydration. For most of the algae, the rate of conversion of HCO3 to CO2 is clearly below the photosynthetic demand of it.

The entry of CO2 into the cells of aquatic organisms is generally limited by the diffusion boundary layer (DBL). The thickness and resistance of DBL depends on the speed of water flow around it, as well as the form and volume of macroalgae. Because of these limitations the entry of CO2 itself, cannot support the photosynthetic demands of the algae and thus algae will suffer from carbon limitations. (*Cornwall et al., 2013*) [7]

1. Light:

The pigments developing from the seaweeds depends on the light conditions. Under low light conditions higher pigment content within the thalli was observed as under strong light conditions (*Ramus et al., 1976, 1977*) [8&9].The chance of photon absorption increases with increasing photosynthetic antenna size.

The pigment content in the thalli is higher under low light conditions when compared to high light, due to the increase in photosynthetic antenna size. The chance of photon absorption increases as the increase in photosynthetic antenna size. The content of accessory pigments in the macroalgae varies with respect to different water depths from where it is collected. In low light conditions in the deep-water region, larger antenna size increases the capacity of light absorption where as smaller antenna helps to avoid photodamage and photoinhibition due to over excitation under high light conditions. Under low light conditions the plant invests more energy in the synthesis of light-collecting pigments and in strong light into the synthesis of photosynthetic enzymes, electron chain components as well as photo-protective structures and energy-dissipating mechanisms. The photosynthetic organisms that are closer to the water surface generally don’t suffer from energy shortage, instead they have to invest in proteins and cellular components which protect them from potential damage by excess supply of energy (*Wilhelm and Selmar 2011*) [10]This may cause a reduction in photosynthetic activity in the macroalgae.

1. Temperature

Temperature-dependent effects on performance (e.g., growth, photosynthesis) and temperature tolerance (i.e., survival) are the two principal aspects that determines the biogeographical pattern of seaweeds. The temperature responses of species are often correlated with the local thermal environments, i.e., species are locally adapted, but may vary seasonally or among populations or life stages. The effect of temperature on performance traits, such as growth and photosynthesis, is typically visualized using temperature–response curves.

The rising temperatures and acidifications are both results of climate change and are affecting the global seawater temperatures. Extreme temperatures can be lethal for seaweeds and moderate changes in temperature can lead to reduced growth and reproduction. There has already been described that ocean warming may cause approximately 25% of the seaweeds to die off in the next 60 years (*Wernberg et al., 2011*) [11]. The findings from the study of (*Staehr & Thomsen, 2013)* [12] states that the influence of temperature is not only limited to the growth of seaweeds but as in the light regime and internal composition of it.

1. Salinty

Salinity is a measure of a variety of inorganic salt concentrations in seawater. The salinity level determines the seawater osmotic pressure. For marine algae, the osmotic pressure affects moisture distribution inside and outside of the semipermeable membrane and seaweed absorption of nutrients.[19] The salinity range is also different for different species with different processes of growth and development. The growth, photosynthesis and respiration are strongly affected by salinity changes. Under extreme hypersaline or hyposaline conditions the photosynthesis and respiration are completely inhibited. These are described with the help of growth-salinity relationship curves.

1. **Formulae for determination of seaweed growth rate:**

Several investigators have attempted to develop different formulae for the estimation of growth rates and caused confusion to the readers. In this study,(*Yoong et al., 2013*)[13] accuracy and reliability of the average growth rate formulae were analyzed using geometric progression theory and compared to each other.

The lowest degree of error (0.023 %) and the highest matched point (61.90 %) was achieved by applying [(Wt /W0)1/t−1]×100 % in growth rate determination. This formula has been tested and proven to be the most accurate among all the currently available ones.

Generally, growth rate is defined as the speed of growth over time.

1. **GENERALIZED SITE SELECTION CRITERIA FOR SEAWEED CULTIVATION:**

* Stable seawater with not less than 30 ppt salinity
* Sandy/ rocky bottom with transparent water
* Ideal temperature 26oC-30oC.
* The area should have a minimum 1.0 m water depth during low tide.
* Area with mild water currents is preferred.
* pH = 6.5 to 8.5
* Area free from silt deposits.
* Area away from freshwater runoff and domestic or agro-industrial effluents discharge.
* Area away from fishing harbor/landing center.
* Non-hindrance for existing fishing and other allied activities.

The presence of wild species of seaweed at a site or in adjacent areas not only provides an ecologically sound indicator of a site, but also eliminates seed acquisition problems. The presence of benthic colanders indicates the suitability of the site for Eucheuma in terms of good water movement, high levels of phosphates, silicates, salinity, dissolved oxygen and high transparency. For example, an abundance of soft corals indicates good water movement.

Fishing and ornamental fish harvesting activities damage farms, aquaculture facilities, and the crops themselves and negatively affect seaweed cultivation. Potential sites should be free of such competing activities. Access to roads, markets, government services and aquaculture services should be considered.

A wave current of about 0.2 m/s is considered suitable for seaweed culture. Water movement caused by currents is considered a better form of water motion than wave as it is more predictable and less destructive. Seaweeds have different kind of attachments which is adapted to various types of substrata. The substrata provide mechanical support for its attachment.[14]

1. **Important economic Species of India:**

*Kappaphycus alvarezii, Gracilaria edulis, G. crassa, G. foliifera, G.arcuata, G. corticate, Gelidiella indica, Hypnea cervicornis, Gracilaria tenuistipitata, Gracilaria dura, G.verrucosa, G.vorticata, Gelidiella acerosa, Hypnea valentiae, Sarconema furcellatum, Acanthophora spicifera, Laurencia papillosa, Sargassum wightii, Sargassum myriocystum, Sargassum tenerrimum, Sargassum duplicatum, Turbinaria conoides, Turbinaria ornata, Turbinaria decurrens, Cystoseira trinodis, Hormophysa triquetra, Enteromorpha compressa, Caulerpa racemosa, Caulerpa sertuiarioides, Chaetomorpha unoides, Cladophora fascicularis, Porphyra indica, Hypnea musiformis.*(*N. Kaliaperumal et al.,1995*) [15]

Out of the 33 economic important species of India, the research has been done only on the 10 seaweed species (listed on Table 4).

i) Findings from the literature:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.no** | **Seaweed species** | **Temperature**  **(oC)** | **Salinity (ppt)** | **Additional findings** | **Reference** |
| 1 | *Kappaphycus alvarezii* | 26-28 | 30-33 | Floating cage method is preferred | *Maruf kasim and Ahmad Mustafa,2017* [16] |
| 2 | *Gracilaria edulis* | 24-28 | 27-32 | Cultivation in subtidal region is preferrable | *M. Ganesan et al., 2011* [17] |
| 3 | *G. crassa* | 25 | 35 | - | *Ravi S et al., 2014* [18] |
| 4 | *G. arcuata* | 20 | 30 | - | *S N Raikar et al.,2001* [19] |
| 5 | *G. foliifera* | 25 | 30 | - | *S N Raikar et al.,2001* [19] |
| 6 | *G. corticata* | 25 | 25 | - | *S N Raikar et al.,2001* [19] |
| 7 | *Hypnea cervicornis* | 25 | 25 | - | *Lanping et al.,2013* [20] |
| 8 | *Gracilaria tenuistipitata* | 20 | 20 | pH of around 6.5 gives better growth rate | *Alvaro et al.,1999* [21] |
| 9 | *Gracilaria dura* | 26-31 | 30-36 | Polypropylene net method is preferred | *V.Veeragurunathan et al.,2015* [22] |
| 10 | *Gelidiella acerosa* | 25-33 | 28-38 | Suspended stone method is preferred | *M.Ganesan et al.,2011* [23] |

**Table 4:** Growth parameters of different seaweeds

1. **Research Gaps & Future scope:**

* Leverage the cooperative network and model for propelling the growth of seaweed cultivation.
* Innovations in seeding technology and detailed marine spatial analysis of potential sites for culturing seaweeds along the entire coastline of India.
* For the better nutrient exchange and higher wave action, it is encouraged to have deep sea seaweed cultivation. And the infrastructure to have this system should be supported by the concerned state fishery department.
* Knowledge of sustainable seaweed harvest in the natural seaweed sites has to be addressed.
* Before training and infrastructure distribution to cultivators, seaweed site mapping and pilot study is required.
* Investment should be done in research fields like land-based cultivation of seaweed and pond culture.

1. **Target Beneficiaries:**
2. Farmers in the coastal areas
3. Research institutes like NFDB & CMFRI
4. Entrepreneurs

**Conclusion:**

The expansion of domestic seaweed farming improves the socio-economic status of coastal fishermen/farmers, helps mitigate the adverse effects of climate change, and protects marine ecosystems from ocean acidification and ocean deoxygenation. It is one of the diverse livelihoods for coastal fishermen. Therefore, the Government of India is planning to promote seaweed farming through the Pradhan Mantri Matsuya Sampada Yojana (PMMSY). We intend to provide financial, marketing and logistical support to ensure that small-scale fishers, especially women and fishers, provide income and welfare to the households under their care.

Due to limitations such as marine protected areas, marine national parks and other fauna impact assessment studies, the study of suitable sites for seaweed farming should include experimental agriculture, stakeholders involved in different seaweed farming activities and coastal communities. Detailed and comprehensive analysis required, including community consultation. The specific regional flora, nutrition and breeding sites of protected marine species such as olive ridley turtles along the Orissa coast, as well as natural disasters, are crucial while developing the ultimate model of coastal seaweed farming in India. Considering all the specific aspects of the site it is necessary to prepare a comprehensive plan for the cultivation of seaweed in territorial waters. This should be done through technology demonstration and validation, taking into account existing coastal communities' acceptance of the activity, as well as input from a wide range of stakeholders. Unexplored waters of protected islands should be explored for seaweed cultivation, taking into account all potential impacts on the specific existing and sensitive ecosystems. Wetlands, the shallow, protected areas of the Lakshadweep atolls, are ideal for growing seaweed.

An area of ​​approximately 213.4 ha has been identified in the waters of Lakshadweep (all 11 inhabited islands) and is being studied in the Andaman and Nicobar Islands. It is suggested that 10% of the lagoon area of ​​the island can be used for the cultivation of seaweed due to the geographical and marine climatic advantages. The island ecosystem only encourages the cultivation of native species of seaweed. There is an urgent need to develop analytical tools for spatial management. Therefore, future research can focus on developing spatial management tools that can provide decision makers with objective, science-based tools for sustainable ocean use.

The findings of the study will be helpful in creating a web tool for Area Production Yield analysis of seaweed. To develop an inland offshore cultivation of seaweed it is of utmost importance to understand the growth parameters of the seaweed. The large-scale cultivation of commercially important seaweeds in the coastal waters of maritime States would fill the demand-supply gap of Agar and Alginate producing industry in the country.

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