The Failed Science Diplomacy of "Lab to Land" in the Culturing of Macroalgae and Food Security

Parth Arora, PhD

Abstract

The developing of macroalgae as a potential source of nature-based solution to provide ecosystem services such as food security, coastal protection, carbon offsetting, and breeding ground for varied flora and fauna has been going on especially in the backdrop of the impact of climate change in the coastal ecosystem. However, the acceptance and accessibility to such resources are not easy, as it seems to be and is far from projected success stories. Currently the global demand of cultured macroalgae, about 80% is being supplied by only two nations, China and Indonesia. This has led to sole dependence for macroalgae and its components to few nations, on one hand, making its sustainable supply chain unreliable and on the other hand its global demand has led to overexploitation of natural stocks leading to declining ecosystem services of macroalgae, prompting a chain of events leading to subsequent overexploitation. The advancing technique of commercially harvesting macroalgae has not seen a positive growth trajectory leading to a negative mood of investors. Though the macroalgae industry has huge application and "food delicacy" demand across the globe, it has not found an industry booming examples, except in two leading nations. Numerous literature and scientific studies have been conducted, showcasing the significance of macroalgae cultivation as a viable low-cost alternative for food security, developing ecosystem services and refreshing depleted fishery stocks. Having a significant push globally, in form of subsidies and technological transfer to provide an alternate source of livelihood for the coastal communities and as a nutritional source and food alternative, the culturing of macroalgae has failed significantly from the "lab to land" and "policy to product" approach. The acceptance and accessibility to such scientific and policy advancement has failed to produce viable options among the coastal communities of varied geography. Such scientific and societal aspect of food security is very crucial for Island nations or nations with high coastal population but has been majorly neglected by the concerned stakeholders. The underlying factors of such negligence needs to be assessed and a framework shall be developed leading to global food security, supply chain resilience, alternate livelihood, economic stability and eventually climate security.

Situation

The world today is battling with the impact of climate change in form of extreme events. These extreme events in form of coastal inundation, storm surges, cyclones, flooding and coastal erosion have disrupted the lives of coastal communities. The coastal communities are the direct and most affected communities since they depend on the coast for their food and livelihood. For example, 60.7% of Indian fisherfolks are involved in fishing and fish seed collection.[1] The coastal ecosystem through its natural resources has been serving as a subsistence for the communities directly related to it. These natural resources offer direct services in form of fishery resources, timber, recreational grounds to name a few and certain indirect benefits in form of carbon offsetting, air and water filtration, rejuvenation of stocks of flora and fauna. However, the increase in frequency of the extreme events occurring and the human activities have put the coastal ecosystem under great stress. The human activities in form of overexploitation, land diversion for other purpose for example aquaculture, real-estate development have greatly put the coastal ecosystem under stress leading to its degradation. For example, over 8,00,000 tonnes of wild macroalgae are being actively harvested annually from natural beds across 32 countries.2 These activities have led to human made disaster, by endorsing the stress caused due to climate change. In this regard, the coastal states across the globe have been raising voice against their vulnerability towards climate change. Few countries in the Asia-Pacific have also adopted resolutions at the United Nations (UN) reaffirming their commitments to protect the planet and its people. However, things have taken a sharp jump when the UN General Assembly adopted by consensus the resolution spearheaded by a Pacific Island Nation Vanuatu against climate crisis in March last year. There has been therefore a growing concern over the solutions required to be built against climate crisis. Positively, there has been a growing literature on the alternative solutions to such crisis with the nature-based solutions among the top viable low-cost solutions. The major natural ecosystems such as mangroves, coral reefs, seagrasses, macroalgae including kelps at varied latitude and at varied depths along the coast have been proposed as a viable solution for coping with the impact of climate change. They perform varied ecosystem services that are required

for a "healthy" ecosystem. The recent development in science and technology have allowed for the immediate and viable alternative by investing in nature-based solutions. These nature- based solutions are proposed for their holistic services that have multiple "spokes". They have a higher advantage as compared to artificial infrastructures. For example, seawalls, dikes, dams whose cost of construction and maintenance can run into millions of dollars have also known environmental ill effects. Such huge investments are not a viable alternative for island states or other coastal states. Therefore, the adoption of alternate multi-result-oriented solutions would not only have regional but global implications in other coastal nations and especially island states who have limited livelihood and food security opportunity and are most vulnerable to the impact of climate change and subsequent food security.

Subheading

The nature based-solutions are the natural, viable, and environmentally accepted secure alternative for coping with the impact of climate change. For example, the macroalgae culturing has improved the water quality as seen in the case of China, where there was large scale nutrient removal from the coastal waters with the help of macroalgae aquaculture.[3] Therefore macroalgae being a "food delicacy" in various countries, having proven scientific nutritional content, and ecosystem services are one of the most suitable nature-based solutions. Such solutions can have community acceptance and investors interest when projected and implemented holistically. Currently, the global trade of macroalgae and other algae fit for human consumption is about 1.076 billion US $ with about 208 million US $ of trade deficit.[4] While, the macroalgae market is projected with a potential growth of up to $11.8 billion by 2030.[5] The global demand for macroalgae has resulted in harvesting of natural wild stocks, leading to destruction of wild species and resulting ecosystem services loss. Interestingly, the global current demand of cultured macroalgae and its associated by-products of about 80% is supplied by China and Indonesia alone.[6] The supply demand is therefore limited to very few nations and can have global supply chain fluctuations in time of geopolitical crisis leading to global imbalance and supply demand challenge. Therefore, macroalgae emerges as not only cost-effective source for food and nutritional security but also a viable alternate source of livelihood and in contributing to infrastructural and climate adaptation measures. Despite its potential, the community success of macroalgae culturing globally is hindered by various challenges, necessitating strategic interventions to ensure successful food and infrastructure resilience.

Possibilities

The macroalgae having a huge market potential and global imbalance of supply chain is an opportunity for communities, stakeholders and nations across the globe to utilise this market gap. Macroalgae farming has swiftly evolved into a global industry, spanning 48 million km2 across 132 nations, with active participation from 37–44 countries.[7] However, it has not achieved its sustainable culturing potential and is majorly limited to two nations as already seen. Further it's a clear failed "Lab to Land" approach. For example, there has been technical advancement in the commercial harvest of macroalgae species in countries like China, Philippines, Japan, and India with established guidelines but has not been able to replicate it on ground through community participation. For example, in India, a recent report by National Fisheries Development Board on 100 success stories from Indian fisheries found only five success stories related to macroalgae cultivation. In this case the availability of technology but no interested stakeholders either due to their negligence or due to their unawareness or due to their accessibility is a point of concern. Another aspect is the latency in "policy to product" approach, where there has been low acceptance of the macroalgae products among the community. Further, the community's sole dependence on wild fishery resources limits their opportunity for other livelihood opportunities thus creating livelihood and food insecurity.

Parallelly, there are various global and national initiatives for the coastal communities to become resilient from the climate change in form of training and provision for providing an alternative source of livelihood. Subsequently, such initiatives would provide other social benefits, for example, it would help to reduce the gender biasness in livelihood earning in the coastal areas, by increasing women participation. The culturing would therefore allow for robust fisheries management framework and fishers' welfare.

Recommendations

To unlock the full potential of macroalgae and enhance the food resilient infrastructure, strategic interventions are imperative. There is a need to understand the coastal community's perspective to macroalgae farming. The government agencies need to identify the

gaps in meagre acceptance and accessibility of macroalgae as a source of alternate livelihood through perspective understanding of the local communities and social structure of the community using "bottom up" approach. The Self-Help groups and entrepreneurs should be trained and clustered to produce global and domestic market relevant macroalgae raw material and products. The Commerce department should promote the certification of macroalgae products and recipes through organising cultural programme and highlighting the traditional use of macroalgae. Creating of "macroalgae parks" as zones of "Blue Revolution" in areas that are degraded to rehabilitate coastal zones with the help of NGOs and college students. Providing community insurance schemes and health insurance for the farmers involved in the macroalgae cultivation.

There is need to improve the understanding of regional food and livelihood security among the coastal communities. The health department should incorporate awareness drives for the nutritional benefits of the macroalgae. The food safety certificate and environmentally friendly macroalgae products should be streamlined. Macroalgae processing plants should focus on easy-to-use products that can be used as a substitute in diet.

Finally, there is an urgent need for creation of a "nature-based" framework. Research should focus on projects, understanding the change in water quality in the areas where macroalgae cultivation is taking place, report of revival of various species due to culturing activities, enhancement or deterioration of any ecosystem services in all phases of macroalgae cultivation. Understanding the vulnerability of macroalgae farms from potential emerging diseases, abrupt or drastic changes due to extreme events.

Calculating the threshold of the maximum sustainable yield of macroalgae farming through scientific studies and social surveys. Development of shipment route, logistics availability, and regional technology transfer feasibility studies are to be done. Ultimately there is a need for creation of track 1.5 dialogue and workshops to understand the concern of various stakeholders.

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