Task Force 6
Accelerating SDGs: Exploring New Pathways to the 2030 Agenda

SEAWEED CULTIVATION AS A MEANS TO REALISE THE G20'S AGENDA FOR SUSTAINABILITY

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Abstract

This policy brief proposes promoting seaweed cultivation as a potential solution to address the many socioeconomic and environmental challenges facing the world today. Indeed, seaweed has many applications, including as a food source, and in fertilisers, biofuels, plastic alternatives, animal feed, pharmaceuticals, cosmetics, and sequestering carbon. Furthermore, seaweed is one of the major components of primary biomass production in coastal marine ecosystems and plays an integral ecological role as a habitat and a substratum for invertebrates, fish, mammals, and birds.

As such, the G20, which accounts for around 84 percent of the global economy and has access to nearly half of the world's coastline, can catalyse a paradigm shift in seaweed cultivation through a concerted and coordinated strategy. This alternative could also have a positive impact on several Sustainable Development Goals[a] if strong policy interventions are made by the group's members.

a Including SDG-1 (no poverty), SDG-2 (zero hunger), SDG-8 (decent work and economic growth), SDG-10 (reduced inequality), SDG-11 (sustainable cities and communities), SDG-12 (responsible consumption and production), SDG-13 (climate action), and SDG-14 (life below water).

The Challenge

1

There is a high degree of consensus about the key issues that plague the planet today. Whether one refers to the United Nations Global Challenges[1] or the Sustainable Development Goals (SDGs), ensuring holistic and sustainable development is an area of convergence. Curtailing climate change, reducing poverty, offering job opportunities (especially to women), ensuring food security, and conserving biodiversity both above land and below water are the areas that require urgent attention if the 2030 Agenda for Sustainable Development is to be implemented.[2]

The global scarcity of freshwater, the unavailability of arable land for agriculture, and the tremendous stress on aquifers for irrigation suggests the need for alternatives to tackle the challenge of addressing malnutrition and ensuring food security for all. Historically, humankind has looked towards the oceans to provide what the land could not. Almost three-quarters of the global population lives within 50 kilometres of the oceans.[3] Booming populations—and providing for their sustenance—have turned these once-abundant regions into areas with depleted marine biodiversity. Climate change and marine pollution compound this problem further.

The oceans and the thriving life within them lie on the verge of irreversible change and require a concerted effort by all countries to consider and adopt a model that charts out the foundations of a more sustainable 'blue economy.'[4] Seaweed could provide the answer.

Seaweed are marine macroalgae that grow in shallow and rocky coastal waters. The term is a misnomer as weeds are generally plants that harm the habitat in which they grow. But as miracle plants with extraordinary properties, these algae are used for a wide variety of applications, including food, cosmetics, pharmaceuticals (also called "medical food of the 21st century"[5]), and agriculture, and as a possible renewable energy source. Seaweed can be of multiple types, depending on their pigmentation:

- **Brown Seaweed (Phaeophyceae):** The most suitable ones are generally found in cold waters in both hemispheres. They are usually large in size and can grow up to 20m. Some examples are

the genera Laminaria, Undaria and Hizikia.[6]

- **Red Seaweed (Rhodophyceae):** They are majorly found in the cold waters of Chile and Nova Scotia (Canada), in the more temperate waters of Morocco and Portugal, and in the tropical waters of Indonesia and the Philippines. They are usually smaller in size, growing from a few centimetres to about a metre. Some examples are Porphyra *and* Dulse.[7]

- **Green Seaweed (Chlorophyceae):** They are commonly found in freshwater and marine waters, and are similar to red seaweed in size. Grass Kelp and Sea Lettuce are some examples.

Ranging from microscopic phytoplankton to giant 'forests' of kelp, marine algae (of which only a few thousand species have been identified) also produce close to half of the earth's oxygen.[8] These underrepresented marine florae hold the potential to help address a wide range of global issues, positively impacting SDGs 1 (eliminating poverty), 2 (ending hunger), 8 (decent work and economic growth), 10 (reduced inequalities), (sustainable cities and communities), 12 (responsible consumption and production), 13 (climate action) and 14 (life below water).

Seaweed cultivation has many benefits. These include:

- **Food source and supplement:** A variety of seaweed has for years been consumed as a food source (such as Nori, Kombu and Kelp; and Dulse, a nutrient-rich red seaweed found along the northern coasts of the Atlantic and Pacific, was served as a primary staple during famines that hit these regions in the late 19th century).[9] Further, seaweed cultivation has a low environmental footprint compared to other forms of food production as it does not require land, freshwater, or fertilisers.

- **Fertiliser:** Seaweed can be processed into a natural fertiliser that is rich in nutrients, such as nitrogen, phosphorus, and potassium. This can help improve soil quality and promote plant growth. Further, its use as a fertiliser could reduce a country's dependence on inorganic

fertilisers, for instance, in the case of India. To meet the demands of the fertiliser industry, India relies on imported chemicals like urea and muriate of potash. These chemicals not only negatively impact soil health and crop productivity, but also raise the import bill.

- **Bioplastics:** Due to its high levels of cellulose and other polysaccharides, companies are exploring the potential to use seaweed as a sustainable alternative to traditional plastics. This will also have significant implications on the packaging industry, which heavily relies on single-use plastics. This paves the way towards responsible consumption and production (SDG-12), in addition to climate action (SDG-13).[10]

- **Animal feed:** Owing to its nutrient-rich profile, seaweed forms a good supplement in animal feed for cows, pigs, and poultry. Moreover, emerging research suggests the introduction of seaweed in cattle feed may help reduce methane emissions by livestock substantially and prove to be more cost-effective and a healthier option for the animals.[11]

- **Pharmaceuticals:** Seaweed contains a variety of bioactive compounds (such as phlorotannins, carotenoids, alginic acid, and fucoidan) that have potential applications in medicine. Some compounds found in seaweed have been shown to have anti-inflammatory, antioxidant, and anti-cancer properties.[12]

- **Biofuel:** New research suggests that seaweed is a suitable raw material to produce biogas and bioethanol.[13] This has the potential to be a sustainable alternative to fossil fuels.

- **Cosmetics:** Seaweed has been used as an ingredient in many cosmetics and personal care products due to its high levels of vitamins and minerals. Often used in anti-ageing creams, shampoos, and soaps, seaweed-based products can help moisturise and nourish the skin and hair.[14]

These are some of the direct applications of seaweed. But for policy recommendations, it is important to assess the impact of seaweed farming on parameters that extend beyond direct application. These include:

- **Biosequestration of carbon dioxide (SDG-13):** Seaweed farming is a carbon-negative crop. Further, as a part of ecosystem services, it has the potential to be a potent source of carbon sequestration, perhaps more than any other marine plant.[15]

- **Nutrient pollution reduction (SDG-13):** Seaweed aquaculture can remove large quantities of nitrogen and phosphorous, helping stabilise coastal ecosystems to prevent eutrophic conditions and associated conditions such as hypoxia.[16]

- **Increased habitat for coastal aquatic species (SDG-14):** Using an asymmetrical before/after control impact design, studies have showcased seaweed aquaculture's positive effect on certain environmental parameters with limited negative effects on the environment.[17] This demonstrates the potential for large-scale aquaculture interventions while minimising the concern of unforeseen environmental impacts of such interventions.

- **Reducing ocean acidification (SDG-13 and SDG-14):** A study along a latitudinal range in China suggests that seaweed farms could serve as a low-cost adaptation strategy to ocean acidification and deoxygenation, and provide important refugia from ocean acidification.[18] In comparison to mangroves or eelgrass, seaweeds can pull more greenhouse gases from the water than the combined biomass of the former, thus, reducing the local impact of oceanic acidification.[19]

- **Potential for providing sustainable livelihood (SDG-8):** With such a wide plethora of applications, along with the potential to help with the fight against climate change, a mature industry centred around macroalgal cultivation has the potential to provide a sustainable livelihood to large communities

(especially women).[b] Furthermore, it will create economic opportunities for the local communities that thrive along the coastlines, whose employment prospects have been hindered by reduced demand.

The net potential for the positive contribution of seaweed cultivation to SDG-13 and SDG-14 is so significant that one Intergovernmental Panel on Climate Change report recommended "further research attention" on seaweed farming as a mitigation tactic. [20]

b An important example is Tanzania, particularly the island of Zanzibar, which has been cultivating seaweed since the 1930s. Various policy interventions by the government have led to improved living standards for the Zanzibari communities and improved economic returns for the farmers. The growth of seaweed farming has also contributed to the empowerment of women in terms of their financial independence. For more details, see, Flower E. Msuya, "The impact of seaweed farming on the socioeconomic status of coastal communities of Zanzibar, Tanzania," World Aquaculture, (06 September 2011), http://www.marineagronomy.org/sites/default/files/seaweed%20in%20Tanzania.pdf; Georgia de Jong Cleyndert et al., "Adaptation of Seaweed Farmers in Zanzibar to the Impacts of Climate Change," *African Handbook of Climate Change Adaptation*, (21 May 2021), https://link.springer.com/content/pdf/10.1007/978-3-030-45106-6_54.pdf. In the case of India, see: https://pib.gov.in/PressReleasePage.aspx?PRID=1778816

The G20's Role

2

The G20 represents over 65 percent of the world population and contributes almost 84 percent to the global economy. At the same time, the member nations are responsible for 79 percent of the world's carbon emissions.[21] Furthermore, the G20 enjoys representation from both the Global North and South, encompassing a wide range of topographies, economies, cultures, ethnicities, flora, and fauna. Interestingly, member countries share another common attribute—the presence of a coastline (when European Union countries are considered as a bloc), and therefore understand the concept of a marine-based economy. Moreover, the ocean economy is projected to reach US$3 trillion annually by the end of the decade.[22]

Except for certain landlocked nations within the EU, the G20 member countries represent 45 percent of the world's coastline,[23] suggesting that the potential for seaweed cultivation is significant. At the same time, it is estimated that 60 percent of the world's major marine ecosystems are degraded, severely undermining the ecosystem services offered by them.[24] Reducing marine litter and establishing marine protected areas are some G20 interventions that are already underway to alleviate the pressure on the maritime environment.

Utilising the development working group model,[25] which aims to strengthen G20 coherence and coordination, a concerted push can help facilitate seaweed adoption and successful scaling.

Recommendation for the G20

3

Recent calls to arrest the irreversible effects of runaway climate change add to the urgency to explore alternative approaches—such as seaweed cultivation—that may pave the way for a more sustainable tomorrow. By leveraging the G20 platform, it is possible to rapidly grow this industry using measures that may be easily localised to account for regional nuances. Broad policy interventions centre around the following interventions:

- Developing national policies and frameworks that promote sustainable seaweed production and consumption.
- Investing in research and innovation to improve seaweed quality, productivity, and value addition (commercial use cases).
- Enhancing cooperation and coordination among stakeholders at the local, national, and international levels.
- Ensuring public participation and educating communities on the benefits of seaweed for health, the environment, and society.
- Integrating seaweed cultivation into climate change mitigation and adaptation strategies.

Still, seaweed cultivation may involve many underlying complexities and raise the potential for regulatory roadblocks that can hinder the growth and adoption of this industry. While it is difficult to provide pointed interventions that can be applied without contextualising the nuances of each G20 member nation, it is possible to provide a framework that serves to identify the broad areas that require intervention. These underlying challenges can benefit from policy interventions at the local, national, and international levels.

- **Site selection:** A technical, ecological, and economic feasibility study should be performed by state agencies also taking into consideration the governance and social aspects before the sites are identified for offshore seaweed aquaculture.
- **Site leasing:** Given that cultivation may be performed on coastal and/or deep-water sites that are beyond the purview of private ownership, there is a need for a leasing policy to provide site locations by way

of efficient permits to individuals/ corporations for their cultivation activities. Inspiration may be sought from state laws around the aquaculture use zone system adopted in Florida, US, or the lease process for ocean farmers adopted in Alaska, US.[26]

- **Site protection:** Unlike farmers on the land, ocean farmers have available vast areas of unclaimed waters with tremendous growth potential. However, since their farm sites are in public water, they must contend with other ocean users, including the military, shipping companies, recreational boaters, and commercial and recreational fishers. State agencies are required to identify locations where these ocean farmers can coexist with other ocean users with the assurance that activities that are catastrophic to their crop (such as dredging) are not performed.

- **Community education and participation:** Given that seaweed aquaculture has the potential to generate significant employment opportunities, whether through direct participation (ocean farming) or via ancillary industries (for instance, for the further processing of seaweed), participation from local communities is essential for the success of such interventions. Education modules that shed light on the health and environmental benefits as well as interventions by the state to encourage the involvement of coastal communities will go a long way in increasing overall awareness and adoption.

- **Marine aquaculture institutes:** G20 member nations should establish institutes to further the promotion of this industry. Suggested areas of study can include the creation of nurseries and other propagation methods, the identification of suitable microalgae, increasing quality and productivity, research on additional commercial use cases (examples include biofuel extraction and bioplastic generation), and innovation in installation and harvesting methods.

- **Financial incentivisation and line of credit:** While large-scale commercial ocean farming operations may have easy access to capital and credit, the same cannot be said for marginalised and vulnerable communities, especially

in developing nations. Easy access to credit and fiscal incentivisation may help spur interest and the adoption of ocean farming and provide a means of livelihood to communities. Studies conducted in India suggest that self-help groups (SHGs) can be formed for community participation and the pooling of capital. Such SHGs may receive official recognition, allowing them easy access to credit/grants.[27] This incentivisation model may be aggressive in the beginning to support the cost of equipment and maintenance of the crop, as market forces will bring down the cost of these activities once the industry scales.

- **Development of ancillary industries/market:** To ensure the holistic development of the industry, G20 member nations must promote the development of ancillary industries that utilise the seaweed produced, providing ocean farmers access to markets. This may entail the establishment of local processing plants (such as for food processing, fertiliser generation, animal feed, or cosmetic industries) or a unified market where farmers from the G20 countries may trade their crops frictionlessly.

- **Access to carbon markets:** Given that state agencies shall be tasked with leasing land parcels to farmers, crop harvests may be monitored and reported. Since seaweed has tremendous potential for carbon sequestration, member nations may provide farmers with a mechanism through which they may seek carbon credits. This can help create a big push for adoption in the early years of carbon cultivation, creating a fiscal incentive while ancillary industries are developed. This may be further extended to recognise the potential for sequestration of other nutrients (such as nitrogen and phosphorous) or reduction of ocean acidification.

Attribution: Nupur Bapuly and Nikhil Sharma, "Seaweed Cultivation as a Means to Realise the G20's Agenda for Sustainability," *T20 Policy Brief,* May 2023.

Endnotes

1 United Nations (UN), "Global Issues," UN, Accessed 25 March 2023, https://www.un.org/en/global-issues

2 Organization for Economic Co-operation and Development and United Nations, "G20 Contribution to the 2030 Agenda," OECD and UN, 2019, https://www.oecd.org/dev/OECD-UNDP-G20-SDG-Contribution-Report.pdf

3 Douglas Broom, "Only 15% of the World's Coastlines remain in their Natural state," World Economic Forum, 2022, https://www.weforum.org/agenda/2022/02/ecologically-intact-coastlines-rare-study/

4 The Intergovernmental Panel on Climate Change, "Synthesis Report of the IPCC Sixth Assessment Report (AR6)," IPCC, Accessed 8 May 2023, https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_LongerReport.pdf

5 Ministry of Science & Technology, Government of India, https://pib.gov.in/PressReleasePage.aspx?PRID=1778816

6 Food and Agriculture Organization, "Introduction to Commercial Seaweeds," FAO, Accessed 31 March 2023, https://www.fao.org/3/y4765e/y4765e04.htm

7 "Introduction to Commercial Seaweeds"

8 National Ocean Services, National Oceanic and Atmospheric Administration, US Department of Commerce, Government of the United States of America, "What is Seaweed?," 2023, https://oceanservice.noaa.gov/facts/seaweed.html#:~:text=%22Seaweed%22%20is%20the%20common%20name,Marine%20Sanctuary%20and%20National%20Park.

9 "Sea Vegetables: The Science of Seaweeds," The University of Maine, Cooperative Extension, Accessed 22 May 2023, https://extension.umaine.edu/4h/stem-toolkits/the-science-of-seaweeds/

10 Silvia Lomartire et al, "An Overview of the Alternative Use of Seaweeds to Produce Safe and Sustainable Bio-Packaging," *MDPI* (18 March 2022), https://doi.org/10.3390/app12063123

11 Diane Nelson, "Feeding Cattle Seaweed Reduces their Greenhouse Gas Emissions 82 Percent," *College of Agricultural and Environmental Science, UC Davis*, March 17, 2021, https://caes.ucdavis.edu/news/feeding-cattle-seaweed-reduces-their-greenhouse-gas-emissions-82-percent

12 P. V. Subba Rao and Chellaiah Periyasamy, "Biodiversity, Conservation and Medicinal uses of Seaweeds: The glimpses," *Springer-Link*, (4 April 2020), https://link.springer.com/chapter/10.1007/978-981-15-1636-8_2

13 Karuna Nagula et al., "Biofuels and bioproducts from seaweeds," *ScienceDirect*, (2022), https://www.sciencedirect.com/science/article/pii/B978032388427300012X

14 Leonel Pereira, “Seaweeds as Source of Bioactive Substances and Skin Care Therapy—Cosmeceuticals, Algotheraphy, and Thalassotherapy,” *MDPI*, November 22, 2018, https://www.mdpi.com/2079-9284/5/4/68

15 Carlos M Duarte et al., “Can Seaweed Farming Play a role in Climate Change Mitigation and Adaptation?,” *Frontiers in Marine Science*, April 12, 2017, https://www.frontiersin.org/articles/10.3389/fmars.2017.00100/full

16 Phoebe Recine, et al., “A case for seaweed aquaculture inclusion in U.S. nutrient pollution management,” *ScienceDirect*, July 2021, https://www.sciencedirect.com/science/article/pii/S0308597X21001172

17 Wouter Visch et al., “Environmental impact of kelp (Saccharina latissima) aquaculture,” *ScienceDirect*, June 2020, https://www.sciencedirect.com/science/article/pii/S0025326X20300801

18 Xi Xiao et al., “Seaweed farms provide refugia from ocean acidification,” *ScienceDirect*, July 1, 2021, https://www.sciencedirect.com/science/article/abs/pii/S0048969721002588

19 NOAA Fisheries, National Oceanic and Atmospheric Administration, US Department of Commerce, Government of the United States of America, “Seaweed Aquaculture,” 2020, https://www.fisheries.noaa.gov/national/aquaculture/seaweed-aquaculture

20 N L Bindoff et al., “Changing Ocean, Marine Ecosystems, and Dependent Communities,” IPCC Special Report on the Ocean and Cryosphere in a Changing Climate, Accessed 3 April 2023, https://www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL.pdf

21 Rosamond Hutt and Timothy Conley, “What is the G20?,” *We Forum*, 2022, https://www.weforum.org/agenda/2022/11/g20-summit-what-you-need-to-know/

22 “OECD Work in Support of a Sustainable Ocean,” OECD, 2022, https://www.oecd.org/environment/2022-OECD-work-in-support-of-a-sustainable-ocean.pdf

23 “G20 Agenda,” *We Forum*, Accessed 1 April 2023, https://www.weforum.org/ocean-20/g20-agenda

24 “G20 Contribution to the 2030 Agenda”

25 “G20 Action Plan on the 2030 Agenda for Sustainable Development,” G20 2016 China, Accessed 28 March 2023, http://www.g20.utoronto.ca/2016/g20-action-plan-on-2030-agenda.pdf

26 Alex Brown, “Seaweed Farming has vast Potential- (But good luck getting a permit),” *Stateline*, March 7, 2022, https://stateline.org/2022/03/07/seaweed-farming-has-vast-potential-but-good-luck-getting-a-permit/

27 Department of Fisheries, Government of India, “Seaweed Cultivation,” https://dof.gov.in/sites/default/files/2020-07/Seaweed_Cultivation.pdf

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