SEAWEED PRODUCTION, TRADE AND MARKETING STATUS IN SRI LANKA

By J.Y.V. Sumanarathna

Seaweed exports from Sri Lanka supply the fertilizer and food industries mainly in Europe, followed by Asia, with India being the single largest importing nation in the region. Initiatives are being taken to expand the industry but there are some crucial hurdles to address, including adverse climatic conditions, lack of robust parental strains, inadequately-regulated purchasing systems, predators and technical barriers. The potential of seaweed in contributing to livelihood development and empowerment of women in Sri Lanka could be greatly enhanced through technological approaches, ongoing assistance from the government, awareness and promotion sessions, investments and the creation of a "one-stop-shop approval" system.

Credit: National Aquaculture Development Authority of Sri Lanka

Food and Agriculture Organization (FAO) 2021 data revealed that global seaweed production illustrated significant growth from 2000 to 2019 from 118 000 tonnes to 358 200 tonnes (Perumal et *al.*, 2023)[1]. The main seaweed-producing continent in the world is the Asian region which contributes 97.38% of the total production in the world. China is the biggest seaweed producer with 56.82% followed by Indonesia, amounting to 28.6% of the total Asian production. Almost all (99%) of the total seaweed production in Asia comes from farms (Zhang et *al.*, 2022). The European region also farms large amounts of seaweed and according to the Centre for the Promotion of Imports from developing countries (CBI), France, Spain, and the Netherlands are recorded as major producers in the industry.

Seaweed are defined as a category of photosynthetic organisms known as macroalgae which do not produce flowers and thrive in marine environments. They are rich in a biologically-active substance that plays a major role in social, economic, and ecological arenas in the world (Zhang et *al.*, 2022)[2] and grow successfully in both freshwater and marine environments without the need for application of antibiotics or pesticides (Durairatnam, 1961[3]; Somasundaram et al., 2014)[4]. Seaweed also has a significant position in the global food system while holding a vital regulator role in the impact of climate change, and contributing to blue carbon strategies (Farghali et *al.*, 2022)[5].

Oarweed *(Laminaria digitata),* tangle *(Laminaria hyperborean),* and rockweed or knotted kelp *(Ascophyllum nodosum)* are the main seaweed varieties in demand in the EU while non-EU countries tend to focus on kombu *(Saccharina* and *Laminaria),* nori *(Pyropia yezoensis* and *Pyropia tenera),* and wakame *(Undaria)* (CBI, 2022)[6].

According to a recent World Bank report, high potential growth has been identified in ten emerging seaweed markets in the world. Trade in the industry could reach USD 11.8 billion by 2030 based on the importance of seaweed as a carbon sink, women-led business generator, marine biodiversity supporter, and in the opening up of value chains (The World Bank, 2023)[7].

Uses of seaweed

Possessing unique biological, physiological and chemical characteristics, seaweed is used in a wide range of applications, making them a valuable and versatile resource.

It is important as food for direct human consumption besides being processed into edible additives, nutraceuticals, and animal feeds. In Asian cuisine, seaweed is consumed in fresh, dried, flaky, and flour forms and as a vegetable. Notably, red seaweed *(Porphyra),* commonly known as nori, is rich in valuable edible protein and is used as an outer wrapping for sushi, either uncooked or lightly baked. Brown seaweed, *Undaria spp,* is widely used in culinary preparations, while dried Laminaria species are incorporated into various dishes.(Pereira R. et *al.*, 2008)[8].

Nutritional-rich seaweed species are also used in the pharmaceutical industry to produce tablets and capsules especially *Chlorella, Spirulina,* and nutritional supplements, while some *Spirulina spp (Spirulina platensis)*

[1] *Pitchurajan Krishna Perumal, Chun-Yung Huang, Chiu-Wen Chen, Grace Sathyanesan Anisha, Reeta Rani Singhania, Cheng-Di Dong & Anil Kumar Patel (2023) Advances in oligosaccharides production from brown seaweeds: extraction, characterization, antimetabolic syndrome, and other potential applications, Bioengineered, 14:1, DOI: 10.1080/21655979.2023.2252659*

[2] *Zhang, L., Liao, W., Huang, Y. et al. Global seaweed farming and processing in the past 20 years. Food Prod Process and Nutr 4, 23 (2022). https://doi.org/10.1186/s43014-022-00103-2*

[3] *Durairatnam, M., 1961. Contribution to the study of marine algae of Ceylon. Bull. Fish. Res. Stn. Ceylon, No. 10: 5–117.*

[4] *Somasundaram, Sutharsan & Vathshalyan, Nishanthi & Srikrishnah, Shanmugalingam. (2014). Effects of Foliar Application of Seaweed (Sargassum crassifolium) Liquid Extract on the Performance of Lycopersicon esculentum Mill. In Sandy Regosol of Batticaloa District Sri Lanka. American-Eurasian J. Agric. & Environ. Sci.. 14. 1386-1396. 10.5829/idosi.aejaes.2014.14.12.1828.*

[5] *Farghali, M., Mohamed, I.M.A., Osman, A.I. et al. Seaweed for climate mitigation, wastewater treatment, bioenergy, bioplastic, biochar, food, pharmaceuticals, and cosmetics: a review. Environ Chem Lett 21, 97–152 (2023). https://doi.org/10.1007/s10311-022-01520-y*

[6] *CBI, The European market potential for seaweed, 2022; CBI, Growing appetite for seaweed, 2022*

[7] *"World Bank. 2023. Global Seaweed: New and Emerging Markets Report, 2023. © Washington, DC: World Bank. http://hdl.handle.net/10986/40187 License: CC BY-NC 3.0 IGO."*

[8] *R. Pereira, C. Yarish, 2008, Mass Production of Marine Macroalgae, 2236-2247, ISBN 9780080454054, https://doi.org/10.1016/B978-008045405-4.00066-5. (https://www.sciencedirect.com/science/article/pii/B9780080454054000665)*

are used to produce food additives. (Andrade et *al.,* 2018; Batista et *al.,* 2017; Martelli et *al.,* 2020; Somasundaram et *al.*,2014). They have been identified as a good source of carotenoids and bio-active compounds such as iodine, bromine, vitamins, and pigments, and may be used as a medicine for cancer patients. This is mainly practiced by Chinese cancer patients who use extracts of *Laminaria* and *Sargassum* species (Kariyawasam, 2016).

With regard to the culture of fish and shrimp, Danish researchers are reportedly planning to utilize residual nutrients and CO_2 from land-based shrimp and fish farming to produce sea lettuce, a green protein and valuable high-fibre seaweed species for human consumption (INFOFISH, 2023)[9]. The project aims to use the sea lettuce to absorb and convert emissions from land-based aquaculture into a high-value product. Among other things, the seaweed will be used for dietary supplements that can prevent diabetes and for sustainable foodstuffs innovations. In addition to capturing emissions that would have otherwise been emitted into the atmosphere and aquatic environment, the seaweed produced is both healthy and rich in umami flavour. Seaweeds are also a cost-effective source for the synthesis of metallic nanoparticles; in this regard, silver nanoparticles (AgNPs) may be used as prophylactics and therapeutic agents against bacteria and viruses affecting cultured shrimp.[10] Meanwhile, some findings suggest that seaweed extracts may enhance the nutritional content, production, and growth of plants (Durairatnam, 1961[11]; Somasundaram et *al.,* 2014).

In addition, seaweed has a significant impact on global carbon, oxygen, and nutrient cycles through photosynthesis (Chung et *al.*,2013, 2017). Balancing CO_2, and facilitating, fossil energy and decreased eutrophication are other major contributions of seaweed. (Krause-Jensen et *al.,* 2016; Jagtap et *al.,* 2023[12]).

Seaweed cultivation in Sri Lanka

Over the past years and by the end of 2023, remarkable growth in the sector has been reported with the assistance of relevant authorities, encouraged by increasing global demand, and there is clear potential for more expansion. The cultivation of seaweed is gaining popularity as a sustainable livelihood activity in the coastal areas of Sri Lanka, where around 320 species are being cultivated (Durairatnam, 1961; Somasundaram et *al.,* 2014). The seaweed industry also acts as a catalyst for generating employment opportunities and improving the living standards, particularly for women, in coastal regions (Crawford, 2002; Narayanakumar et *al.,* 2011[13]; Ginigaddara et *al.,* 2018[14]).

According to the National Aquatic Resources and Development Authority (NAQDA), there are 191 recorded seaweed farms in Mannar, 72 in Jaffna, and 28 in Mannar. However, the seaweed production in the northern region experienced a slight decline in 2021 and 2022 due to the global COVID-19 pandemic and economic setbacks in the country. In 2023, production is expected to rebound with the active involvement of NAQDA, which is conducting continuous training, monitoring, water quality management, and disease management.

Northern seaweed annual production (tonnes)			
2020	2021	2022	2023 (up to October)
422	218	200.6	1410

(Source: NAQDA)

Gracilaria edulis and *G. verrucose,* commonly referred to as Ceylon moss, are predominantly found in the Northern region, specifically in Kalpitiya, Trincomalee, and Mannar. (Durairatnam, et *al.,* 1955; Ginigaddara, 2018); in addition to other species and seaweed beds which have been identified around the island. FAO reports that the seaweed is collected from Mannar, Kalpitiya, Trincomalee and Puttalam for commercial purposes and various locations in Sri Lanka have been identified as commercial seaweed beds, including Mannar in the Northern Province, Kalpitiya in the North-Western Province, Negombo and Beruwala in the Western Province, Hikkaduwa and Hambantota in the Southern Province, and Trincomalee in the Eastern Province (FAO, 1990)[15]. The seaweed included *Ulva spp., Enteromorpha spp, Caulerpa spp, Sargassum spp, Padina spp, Gracilaria spp, Laurencia spp, Gelidiella spp, Hypnea museiformis, Padina spp, Gracilaria edulis, Caulpera spp, Codium spp, Acanthophora delile, Noospora spp, Cheaetomorpha spp* and *Lorencia spp.*

The seaweed is cultured mainly through the single rope method, raft method, and pond culture (Kariyawasam, 2016[16]).

Due to a lack of essential and comprehensive scientific data on seawater salinity, temperature, biodiversity, tides, wave action, currents, and geographic conditions, Sri Lankan commercial seaweed cultivation is still considered to be in the pilot stage and experimental initiatives are still being conducted (FAO, 2021). Research in 2018 indicates that the availability of information about employment opportunities, financial viability, personal satisfaction of stakeholders, and product viability is vital when developing seaweed cultivation as a sustainable industry to uplift livelihoods.

Rising trend in seaweed exports

Sri Lanka primarily exports seaweed-related products to the European region, with Sweden being the largest export destination, followed by Germany, Belgium, Lithuania, France, and Denmark. As an individual nation, India is the primary importer of Sri Lankan seaweed products, together with several non-EU countries, including Hong Kong, the United Kingdom, Switzerland, the United States, New Zealand, the Maldives, and Norway, which maintain a good trade relationship with Sri Lanka.

[9] *INFOFISH, 2023, Fishing Technology Digest, A newsletter on Fishing Technology, Gear and Methods, Vessels and Equipment, April-June 2023*

[10] *Nida Khan, K. Sudhakar, R. Mamat, 2023, Seaweed farming: Perspectives of genetic engineering and nano-technology application, Heliyon, 9(4),e15168,ISSN 2405-8440, https://doi.org/10.1016/j.heliyon.2023.e15168. (https://www.sciencedirect.com/science/article/pii/S2405844023023757)*

[11] *Durairatnam, M. and J.C. Medcof, 1955. Ceylon moss - a marine resource. Fish. Res. Stn. Ceylon, 16(2): 19-28.*

[12] *Jagtap, Ashok & Meena, Surya. (2022). Seaweed farming: A perspective of sustainable agriculture and socio-economic development. 10.1016/B978-0-12-822976-7.00022-3.*

[13] *Narayankumar, R., & Krishnan, M. (2011). Seaweed mariculture: an economically viable alternate livelihood option (ALO) for fishers. Indian Journal Of Fisheries, 58(1), 79-84.*

[14] *Ginigaddara, G., Lankapura, A., Rupasena, L., & Bandara, A. (2018). Seaweed farming as a sustainable livelihood option for northern coastal communities in Sri Lanka. Future of Food: Journal on Food, Agriculture and Society, 6(1), 57-70. Retrieved from http://www.thefutureoffoodjournal.com/index.php/FOFJ/article/view/11*

[15] *FAO. 1990. The Status of Culture and Utilization of Seaweeds in Sri Lanka. Report of the Regional Workshop on the Culture & Utilization of Seaweeds. Cebu City, Philippines.*

[16] *Kariyawasam, Isuru. (2016). Seaweed Mariculture: A Potential "Multi-Million Dollar Industry". SATH SAMUDURA; Healthy Oceans; Healthy Planet; ISSN: 2279-3208; Marine Environment Protection Authority, Sri Lanka. 2016. 44-49.*

Despite the presence of identified seaweed beds in Sri Lanka, export quantities of seaweed and related products remain relatively low. Insufficient production levels, lack of proper processing technologies and a limited range of value-added products have led to diminished export values.

Table 1: Value of seaweed exports (various forms) from Sri Lanka (in USD)

Code	2019	2020	2021	2022	2023
H.12122900				11 020	164 444
H.12129900	34	2 741	98 792	96 541	114 535
H.12122100	88 595	60 275	71 153	62 775	94 231
H.12122990		23 566	39 971	51 102	18 143
H.12122910		3			1 799
H.26219090	1 020	979	93	7	
H.26219010			44		
Total	**88 629**	**86 585**	**209 916**	**221 439**	**393 151**

Source : Sri Lanka Customs

In early 2023, approximately 600 000 kg of seaweed were recorded as exported, with this figure showing an upward trend over the past five years, as indicated by Customs records (Table 2).

Table 2. Volume of seaweed exports from Sri Lanka, 2019 -2023 (in kg)

Year	2019	2020	2021	2022	2023
Quantity	61 829	149 963	197 990	270 128	594 307

Source : Sri Lanka Customs

Currently, only a few exporters are engaging in seaweed cultivation and exportation. Most of their farms and establishments are based in the northern areas. According to the 2023 Customs records, around USD 165 thousand worth of seaweed was exported in the year up to September, mainly to India (USD 43.52 thousand) followed by Hong Kong for manufacturing fertilizers. The Republic of South Korea is a major destination for seaweed meant for human consumption; exports to that market were valued at USD 50.71 thousand in 2023 up to September (Table 3).

Processed seaweed *Credit: Global Seafood (Pvt) Ltd*

Constraints for seaweed cultivation in Sri Lanka

A scientific survey conducted in the northern region in 2018 revealed that seaweed cultivation is a good option to address unemployment in coastal communities. However, the absence of a well-established buying and selling system and the significant impact of predator attacks are crucial obstacles for seaweed farmers, in addition to other factors affecting the industry (Ginigaddara et *al.*, 2018). Overuse of the existing seaweed stock is one of these major constraints in the industry, creating raw materials with low biodiversity and vigour (Kariyawasam, 2016).

Since seaweed cultivation takes place in an uncontrolled environmental setting, unexpected weather conditions may affect seaweed cultivation. As mentioned above, the current practice of the industry is to use planting materials from previous generations which has led to the gradual deterioration of their genomic quality. Furthermore, any transition from traditional to commercial cultivation is severely affected by the lack of technological knowledge at the nursery stage, reduction of post-harvest losses, appropriate drying techniques, and value-added production to meet international standards. A general lack of awareness regarding the potential value of the industry among officials also leads to unexpected delays in the processing and export process.

The way forward

Due to over-harvesting of Gracilaria spp in Chile, Buschmann et *al*[17] proposed in their report to shift from captured seaweed to cultured seaweed. In Sri Lanka, which similarly sees a lack of captured seaweed, cultivation practices assume more importance in meeting rising world market demand. However, seaweed cultivation is still an under-tapped area in Sri Lanka (Sunjoyo, 2023).

Most of the farm activities are conducted by family members and through contracts with nearby farmers. These arrangements often provide additional socio-economic benefits, reflecting the potential for the Sri Lankan seaweed industry to be a financially viable livelihood option for coastal communities. The expansion of seaweed cultivation will also create more opportunities for Sri Lankan women to uplift their lifestyles and reduce financial difficulties.

Despite the presence of abundant seaweed beds in Sri Lanka's marine areas, various natural and logistical constraints affect seaweed production. Enhancing technical know-how and implementing effective monitoring throughout the cultivation and post-harvest processes, are critical for the success of commercial seaweed cultivation. In comparison to other aquaculture industries, seaweed farming is relatively straightforward from a technical perspective, allowing farmers to learn through practical experience to improve their practices.

[17] *Alejandro H. Buschmann, Carolina Camus, Javier Infante, Amir Neori, Álvaro Israel, María C. Hernández-González, Sandra V. Pereda, Juan Luis Gomez-Pinchetti, Alexander Golberg, Niva Tadmor-Shalev & Alan T. Critchley (2017) Seaweed production: overview of the global state of exploitation, farming and emerging research activity, European Journal of Phycology, 52:4, 391-406, DOI: 10.1080/09670262.2017.1365175*

Table 3. Volume and value of seaweed exports from Sri Lanka to major markets, 2021 – September 2023 (in USD & kg)

Code	Description	2021		2022		2023 (January To September)	
		Quantity	Value	Quantity	Value	Quantity	Value
H.12122900					**11.02**		**164.44**
	India			30 146	11.02	423 940	164.43
	Hong Kong					3	0.01
H.12129900			**98.79**		**96.54**		**114.54**
	United Kingdom	43 824	72.46	46 536	50.21	33 780	61.38
	Sweden	6	0.03			1 579	33.64
	Belgium			16 000	35.71	9 040	19.26
	Germany			12	0.17	36	0.14
	Switzerland			4	0.06	14	0.12
	Saudi Arabia	1241	3.9	2 975	10.4		
	Lithuania	2 398	21.71				
	Italy	216	0.46				
	United States	32	0.24				
H.12122100			**71.15**		**62.78**		**94.23**
	Republic of Korea	16 000	20.25	8 000	23.63	32 000	50.71
	India			9 500	9.54	38 830	43.52
	Japan	24 553	50.9	18 587	29.6		
H.12122990			**39.97**		**51.1**		**18.14**
	India	109 582	39.85	138 340	51.1	48 985	18.14
	China	8	0.12				
H.12122910							**1.8**
	India					6 100	1.8
H.12129300			**0.03**				**0.82**
	Maldives					1 000	0.82
	UAE	40	0.03			10	...
H.26219090			**0.09**		**0.01**		
	Australia	15	0.01	11	0.01		
	China			17	...		
	New Zealand	50	0.06				
	Denmark	5	0.02				
H.26219010			**0.04**				
	Viet Nam	20	0.04				
H.26211000							
	Total :		**210.08**		**221.45**		**393.97**

Source: Sri Lanka Customs

More women should be encouraged to culture and process seaweed as a means to strengthen their incomes

The introduction of new value-added technology and greater availability of investment opportunities for the seaweed sector in Sri Lanka is a must, particularly during this current economic depression. In this regard, a one-stop approval process for potential investors, including from overseas, may lead to revitalization of the sector. In addition, as financial difficulties in the initial stages and during cultivation are critical limiting factors, Government intervention and assistance is important.

Government and stakeholder interventions are also important in:

- identifying culture sites. Seaweed has a super adaptability to grow under a diverse range of environmental conditions even in the desert (Zhang et al., 2022); thus it is crucial to identify the optimal locations for cultivation in Sri Lanka and to execute the cultivation accordingly;
- establishing a proper purchasing system is imperative to support existing farmers. This is because research findings from the study on "Seaweed farming as a sustainable livelihood option for Northern coastal communities in Sri Lanka" in 2018 have highlighted the challenges related to the purchasing system for seaweed in the northern area of Sri Lanka;
- the introduction of advanced technological approaches to industrial-scale cultivation, seed production using tissue culture, integrated aquaculture systems, automated harvesting techniques, and post-harvest technologies; and
- enhancing knowledge on seaweed and related activities. Currently not many officials and communities know enough about the sector, which may create difficulties for the smooth production of seaweed pertaining to approvals and investments. A series of steps should be taken by the government and other responsible organizations to further develop the seaweed industry including awareness workshops, seminars, extension services, demonstration projects, pilot-scale farms, and processing units targeting university students, farmers, processors, investors, and exporters.

Other references

1. *Crawford, B.R. and M.S. Shalli. 2007. A Comparative Analysis of the Socio- Economics of Seaweed Farming in Two Villages along the Mainland Coast of Tanzania The Sustainable Coastal Communities and Ecosystems Program. Coastal Resources Center, University of Rhode Island and the Western Indian Ocean Marine Science Association. 9p*

2. *DeAngelo, J., Saenz, B. T., Arzeno-Soltero, I. B., Frieder, C. A., Long, M. C., Hamman, J., Davis, K. A., & Davis, S. J. (2023). Economic and biophysical limits to seaweed farming for climate change mitigation. Nature Plants, 9, 45–57. https://doi.org/10.1038/s41477-022-01305-9*

3. *FAO. 2022. The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO.*

***J.Y. V. Sumanarathna** is Export Promotion Officer at the Sri Lanka Export Development Board (EDB) in Colombo, where she has been working for over six years. Prior to this, she was an Investigator at the Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI). She has a BSc Agriculture (Special) degree from the Rajarata University of Sri Lanka and is currently pursuing an MSc in Food Science and Technology at the University of Peradeniya, Sri Lanka.*