

# Blue Economy Policy Brief Indonesia's Seaweed Industry as Key Sources of Growth

PB 0025-01 Jakarta / Vienna / May 2025



The Action Plans for Indonesia's Blue Economy focus on identifying growth opportunities and addressing gaps between the current landscape of Indonesian blue economy development and the international market. Products and sectors covered include seaweed, fisheries, aquaculture, marine biotechnology, marine renewable energy, and marine mining.

Seaweed industry, shrimp industry, and the Pangasius industry arise as key sources of growth in Indonesia, as it holds great potential as a major contributor to the country's blue economy plan, providing livelihoods for coastal communities and generating substantial revenue through exports. As the world's largest tropical seaweed exporter, Indonesia has been and will continue to be a crucial supplier of this marine resource widely used in food and feed additives, cosmetics, pharmaceuticals, and bioplastics, Meanwhile, as the fourth largest shrimp exporter, and a rising Pangasius exporter, the country expects to generate greater productivity to diversity the value-added products, yielding sustainable economic growth.

# **Key Messages**

#### **Constraints to Productivity**

- Limited domestic processing capabilities conditioned by structural problems restrict the industry from moving up the value chain and capturing higher returns from processed products like carrageenan and agar, and entering into innovative markets such as bio-materials and bio-stimulants.
- Unoptimized supply chain lacks a focus on sustainability of the industries, affecting both the quality and reliability of seaweed production and creating inefficiencies that can hinder long-term growth although most of the farming practices are quite sustainable.
- Limited implementation of unified certifications and traceability systems hampers the industry's ability to meet international standards and secure consumer confidence in Indonesian seaweed products.

# Policy Goals for Action Plan

#### **Goal 1: Improve Processing Capabilities**

- Incentivize Investment and Innovation
  in Processing Facilities
- Skill and Technology Development Programs
- Marine-based Integrated Zoning

#### Goal 2: Optimize a Sustainable Supply Chain

- Develop Cooperative Models to advance Climate Adaptive Practices
- Sustainable Certification and and Incentives along the Value Chain
- Build Regional Collection Hubs

#### Goal 3: Establish Unified Certifications and Traceability

- National Certification and Quality Standards
- Digital Traceability System
- Public Awareness and Stakeholder Engagement

# Seaweed Industry

This brief explores the current production levels and key export markets for Indonesian seaweed. While examining the industry's contribution to the country's GDP, it also identifies current challenges in supporting the development of the seaweed industry. It concludes by discussing the emerging opportunities within the sector, including improving production efficiency, market standards, trade and investment policies, and data accuracy. We suggest 9 policy goals for the Indonesian government following case studies from an international context.

## I. Production and Value

Severalstudies(Langfordetal.2023, Bappenas2023, WRI Indonesia 2022) confirm Indonesia's leading position as a globally competitive carrageenophyte and agarophyte seaweed producer. In 2022, for instance, Indonesia produced the largest quantity of Cultivated red seaweed or algae (Kappaphycus spp, Eucheuma spp and Gracilaria spp) worldwide. However, producing the most quantities of seaweed does not necessarily generate the most value as they mainly exported as semi-refined raw material forms. The economic potential of the seaweed industry is closely tied to the export market, which will be analyzed in the trade section. In this section, we will first provide a brief overview of production trends among the world's top seaweed producers. Methods, criteria, and findings are presented below.

**Methodology:** This analysis is based on data from the FishStatJ database by FAO, specifically focusing on the Global Aquatic Production - both by Quantity (2019–2022) and Value (2019–2022). Selected categories of ASFIS species were filtered using the keywords "seaweed" and "algae," including:

- Hizikia Fusiforme (brown algae)
- Other brown algae (Laminaria, Eisenia / Ecklonia)
- Other red algae
- Other seaweeds and aquatic plants and products thereof
- Seaweeds and other algae, fit for human consumption, nei
- Seaweeds and other algae, unfit for human consumption, nei
- Undaria pinnatifida (brown algae)

First, the global marine farmed seaweed industry is highly concentrated: 95% of farmed seaweed globally accounts for just six species. These include three temperate water seaweeds (Japanese Kelp) used to produce kombu, wakame and nori, which are grown in China, Japan, the Democratic People's Republic of Korea, the Republic of Korea, and the tropical species used to produce agar and carrageenan grown primarily in Indonesia, the Philippines and China (FAO, 2023).

China, Indonesia, the Democratic People's Republic of Korea, the Republic of Korea, Japan, and the Russian Federation are the six top producers of seaweedrelated products in terms of quantity. Meanwhile, the statistics show that each country predominantly produces different types of seaweed, suggesting a comparative advantage in these specific varieties.

Indonesia mainly produces Kappaphycus alvarezii (Cottonii), Kappaphycus striatum (Sacol), Eucheuma denticulatum (Spinosum), and Gracilaria. These types belong to the red algae family and are primarily produced into carrageenan and agar. They are used in food and cosmetics for their gelling, thickening, and stabilizing properties, which add value to products that support economic growth.

The global carrageenan market was valued at approximately USD 924.74 million in 2023 and is projected to grow at a compound annual growth rate of 5.4% from 2023 to 2030 (Grand Review Research, 2023). The primary types of carrageenan—kappa ( $\kappa$ ), iota ( $\iota$ ), and lambda ( $\lambda$ )—differ in their chemical structures and functional characteristics, leading

to diverse applications. Kappa-carrageenan holds the largest market share at 67%, followed by iotacarrageenan at 24%, with the remainder from lambda carrageenan, which is not produced in Indonesia. Indonesia is a major supplier of kappa- and iotacarrageenan, supporting a significant portion of the global market through its seaweed cultivation, particularly from *Kappaphycus* and *Eucheuma* species (Eucheumatoid Seaweeds). Therefore, as the largest producer of tropical seaweed, Indonesia is suggested to maintain its competitiveness on the international market.

Currently, Indonesia exports mainly dried seaweed to China, the Republic of Korea, France, and Vietnam, providing further opportunities for raw material processing in these countries. We see considerable efforts from Indonesian local industries which produce agar and carrageenan for exports to Europe and USA and for domestic markets. However, such efforts remain relatively uncompetitive compared to those in China.

Comparatively, Indonesia's production revenue from Eucheumatoid seaweed production has doubled over the past decade, rising from \$122.3 million in 2012 to \$258.7 million in 2022. For Gracilaria seaweed, however, Indonesia lags behind its main competitor, China, which generates \$335.3 million, compared to Indonesia's \$12.3 million. High production volumes do not necessarily translate efficiently into economic value. In Indonesia, the seaweed industry primarily focuses on cultivating raw Eucheuma seaweed, with minimal processing involved. For instance, value-added products like carrageenan and agar are not extensively processed domestically, limiting income potential. Chile, by comparison, illustrates how significant production value can be achieved without large quantities; in 2022, it ranked 5th in production value for Gracilaria seaweeds at \$148.8 million, despite ranking only 13th in production quantity.

The price of seaweed is influenced by various factors, including international market demand and seasonal weather fluctuations, which can affect both supply and quality. Despite these variables, a general upward trend in seaweed prices has been observed across all regions in Indonesia. This consistent increase suggests strong growth potential for the seaweed industry in terms of production expansion and value generation, as Indonesia strengthens its position in the global market. This trend also indicates opportunities for investment in processing and value-added products, which could further enhance economic returns.

### Figure 1. Price for Seaweed in Indonesia in different locations during the past decade



Source: Lanford, 2022

## II. Trade and GDP

This analysis is based on data from the FishStatJ database by FAO, specifically focusing on the Global Aquatic Trade - By Partner Country, both by Quantity (2019–2022) and Value (2019–2022). Selected categories of ASFIS species were filtered using the keywords "seaweed" and "algae," including:

- Hizikia Fusiforme (brown algae)
- Other brown algae (Laminaria, Eisenia /

Ecklonia)

- Other red algae
- Other seaweeds and aquatic plants and products thereof
- Seaweeds and other algae, fit for human consumption, nei (not elsewhere included)
- Seaweeds and other algae, unfit for human consumption, nei
- Undaria pinnatifida (brown algae)

#### Figure 2. Exports of Seaweed and Other Algae by Major Countries of Destination, 2012-2023<sup>1</sup>

Country of Destination	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
					N	et Weight : T	on					
China	123,401.6	143,725.4	150,854.7	151,640.0	152,095.7	150,783.4	158,058.0	157,740.0	151,211.3	177,699.1	198,969.1	220,711.9
Chile	6,376.3	6,452.9	6,855.5	8,172.2	5,150.6	4,874.2	3,825.6	3,951.9	3,438.1	2,870.2	4,234.2	4,899.8
Korea, Republic of	5,815.8	3,492.6	7,298.6	12,059.1	4,641.5	5,770.2	9,459.4	8,942.0	8,116.9	5,192.8	7,813.9	4,259.2
Hong Kong	4,362.4	4,196.8	5,983.7	3,292.6	3,031.4	1,612.3	838.0	532.4	460.8	495.2	500.7	390.1
Philippines	11,211.8	7,852.8	9,123.9	7,633.3	5,114.8	1,508.0	1,529.8	1,325.6	926.7	1,436.9	2,473.4	1,816.8
Japan	865.1	692.2	1,074.8	1,644.7	1,311.6	1,920.7	1,627.1	1,444.7	1,412.7	1,479.4	2,230.0	2,932.6
France	1,240.5	1,720.0	2,596.7	4,007.8	1,617.3	2,012.8	3,329.6	3,566.8	3,297.0	2,470.1	5,820.2	940.1
Denmark	818.2	1,455.9	792.4	1,283.5	1,306.3	1,101.8	666.8	2,152.2	463.1	106.5	105.1	361.2
Vietnamese	6,095.8	1,790.7	6,072.9	6,453.3	1,751.5	4,612.6	7,667.8	6,084.4	6,140.9	9,207.7	6,193.3	9,972.1
Spain	706.1	486.2	1,420.4	1,934.8	1,160.1	1,183.6	2,727.5	2,390.0	2,127.2	1,974.5	1,861.5	2,119.7
Others	7,385.8	4,245.2	8,632.2	8,052.9	7,579.9	8,990.4	10,896.4	7,474.0	3,930.1	5,855.9	7,069.5	2,667.9
Total	168,279.3	176,110.7	200,705.8	206,174.1	184,760.6	184,370.0	200,625.9	195,604.1	181,524.7	208,788.5	237,270.8	251,071.5
					FOE	3 Value : 000	US\$					
China	90,375.7	124,954.1	163,012.7	112,525.6	101,827.1	128,539.0	159,619.1	174,445.1	150,783.8	189,237.7	338,461.4	254,905.5
Chile	5,782.0	7,611.3	11,071.1	9,544.2	4,719.3	6,128.7	6,513.0	8,488.2	5,865.1	4,561.9	4,957.2	4,001.2
Korea, Republic of	5,586.8	3,957.9	9,939.3	8,857.7	3,191.2	5,958.4	13,088.2	9,734.0	9,632.2	5,403.1	15,809.8	5,031.5
Hong Kong	2,176.6	2,847.4	3,884.3	2,325.5	2,273.4	963.0	318.0	296.7	301.9	322.6	403.1	316.3
Philippines	12,306.2	10,866.6	13,169.4	7,384.1	3,482.5	1,498.0	1,636.9	1,409.7	899.4	2,326.5	4,798.7	2,445.3
Japan	590.7	455.9	933.5	1,168.6	1,297.7	1,447.5	1,245.3	993.4	973.6	1,074.9	2,328.4	3,096.6
France	1,022.1	2,299.0	3,566.6	4,023.2	793.0	1,607.6	5,089.0	5,277.1	3,605.7	3,134.9	13,997.0	1,868.1
Denmark	699.6	1,622.3	1,026.0	953.6	631.9	921.0	1,034.3	3,255.8	469.6	83.0	117.0	759.4
Vietnamese	5,022.8	1,235.1	4,645.0	4,010.4	577.1	2,531.8	3,888.6	2,820.0	3,839.1	5,840.0	4,805.9	7,576.3
Spain	1,655.7	1,064.5	2,983.3	1,630.7	498.3	764.2	2,532.4	1,518.0	914.0	1,039.7	1,741.3	1,307.0
Others	8,937.4	5,542.3	11,997.4	7,840.5	4,716.2	8,736.9	13,435.7	9,956.8	5,848.9	10,826.2	13,587.9	3,494.0
Total	134,155.7	162,456.4	226,228.7	160,264.1	124,007.7	159,096.3	208,400.6	218,194.8	183,133.3	223,850.7	401,007.6	284,801.1

## Figure 3. Top 15 Countries by Trade Value in Seaweed and Other Algae Exports, 2022

#### Trade Value by Value (Top Seaweed and Algae Exporters in 2022



<sup>&</sup>lt;sup>1</sup>BPS. Indonesia Statistics of Exports of Seaweed and Other Algae by Major Countries of Destination. Accessed from: <u>https://www.bps.go.id/en/</u> statistics-table/1/MjAyNSMx/exports-of-seaweed-and-other-algae-by-major-countries-of-destination--2012-2022.html





Trade Value by Quantity (Top Seaweed and Algae Exporters in 2022)

Indonesia primarily exports seaweed and algae to China, South Korea, France, and Vietnam. Among these, China receives the largest share of Indonesian seaweed exports, positioning Indonesia as China's top supplier—above other key exporting countries like Chile, Peru, and the Philippines. In 2022, Indonesia led the global market in total export value of seaweeds and other algae (both fit and unfit for human consumption), reaching USD 399 million with a total export weight of 237,040.07 tonnes.

#### Figure 5. Yearly Trends of Average Price in "Exports" for Seaweeds and Other Algae, Fit for Human Consumption, 2012 – 2022





#### Figure 6.

Yearly Trends of Average Price in "Exports" for Seaweeds and Other Algae, Unfit for Human Consumption, 2012 – 2022



While species exported may differ among leading countries, Indonesia consistently exhibits lower average prices for its seaweed exports compared to its main competitors. This can be attributed to Indonesia's export focus on *Gracilaria* and other raw seaweed types, which are primarily used for extracting carrageenan and agar. While both Indonesia and the Philippines export carrageenan seaweed, Indonesia exports larger quantities of Gracilaria, a lower-value variety, compared to the Philippines, which likely contributes to the difference in unit trade values.

Over the years, Indonesia's industries have made significant progress in international cooperation and seaweed processing, evidenced by increased agar production. However, the direct export of fully processed products like agar-agar and carrageenan remains relatively limited compared to the volume of unprocessed seaweed and algae exports (FAO, 2018).

Indonesia's seaweed and other algae exported command significantly lower unit trade value

### **III. Current Challenges**

Indonesia's seaweed industry faces three primary challenges that limit its economic potential and global competitiveness.

First, **limited domestic processing capabilities** conditioned by structural problems restrict the industry from moving up the value chain and capturing higher returns from processed products like carrageenan and agar, and entering into innovative and potentially higher value markets such as biomaterials and bio-stimulants.

Second, an **unoptimized supply chain** affects both

than other countries. For instance, compared to Chile and Peru, which achieve much higher values at \$2,356 and \$1,450 per tonne, respectively, Indonesia exports raw or minimally processed seaweed, accounting for lower value. This disparity highlights an opportunity for Indonesia to enhance its economic gain by investing in processing capabilities and value-added strategies. Given Indonesia's substantial export volume and dominant market presence, such improvements could significantly increase the trade value of its unfit-forconsumption seaweed exports and strengthen its competitiveness in the global market.

With additional data expected in the coming years, we anticipate Indonesia's unit price per tonne could increase, contributing more significantly to GDP growth. Overall, aquaculture exports have maintained a 1.7% contribution to GDP in 2020, with seaweed alone increasing its share from 0.2% to 0.3% (WRI Indonesia, 2022).

the quality and reliability of seaweed production. Inefficiencies can hinder traceability, market stability, and long-term growth, although most of the farming practices are quite sustainable. In absence of standardized climate adaptive practices, productivity and quality of seaweed is threatened due to acidification and raising temperature of seawater.

Third, **limited implementation of unified certifications** and traceability systems weakens compliance with international standards and consumer confidence in Indonesian seaweed products. Addressing these challenges could unlock significant opportunities for Indonesia's seaweed sector, enhancing its global competitiveness.

### 1/Limited Domestic Processing Capabilities

First, Indonesia primarily exports dried raw seaweed as its main product, with market prices influenced by seasonal fluctuations and demand from China. However, the economic potential of processed seaweed products, such as carrageenan, agar, and alginate—which are valuable in food additives, cosmetics, pharmaceuticals, and bioplastics remains largely untapped by local farmers. There are around 50 carrageenan processors and agar processors of seaweed in Indonesia, of which 50 are active and most of which work under their capacity.

One key consideration is how to enhance the processing capabilities of local Indonesian firms for seaweed products. Currently, Indonesian farmers can produce seaweed at lower costs than other countries, giving Indonesia a favorable position in terms of purchasing power on the international market. However, Indonesia's seaweed prices are heavily affected by China's seaweed processing industry, including both facilities within China and Chinese-owned processing companies in Indonesia, such as BLG, Green Fresh, GreenOne, and Fuyuan. Research indicates that these four companies account for approximately 40% of Indonesia's carrageenan processing capacity (45,000 tonnes) and about 50% of the actual utilized output (Siradjuddin & Julianto, 2024). Unleashing the potential of the remaining seaweed processing companies is therefore essential.

Meanwhile, technology transfer from Chinese processing firms in Indonesia to local companies remains limited. Policymakers face a critical processing tension: advancing Indonesia's capacity could enhance value capture but might also destabilize seaweed prices, undermining existing market advantages. This challenge is further compounded by complex licensing procedures, limited access to advanced processing technology, and inadequate infrastructure. To address these issues, policymakers must consider a systematic approach to upgrading processing technologies while fostering collaboration with foreign industry leaders. Enhancing capacity building efforts for Small and Medium Enterprises (SMEs) in this sector may significantly contribute to the independence of seaweed processing capabilities.

## 2/Inefficient and Fragmented Supply Chain

The second major challenge lies in the systematic redundancy within Indonesia's seaweed supply chain, which remains largely labor-intensive and reliant on traditional, manual farming methods (Langford et al., 2023). While seaweed farming is more profitable than many other agricultural activities, this potential is hindered by a complex and fragmented supply chain. A vast network of small farmers, often located in remote coastal areas, creates logistical challenges, making direct access to markets unaffordable and inefficient. The lack of capital investment in mechanization and streamlined processes results in bottlenecks, limiting the scalability and profitability of the sector.

The industry's supply chain is further complicated by numerous intermediaries—collectors, re-dryers, and distributors—whose practices like side-selling, re-drying, co-mingling, and re-packing create inefficiencies and reduce scalability (The Nature Conservancy, 2019). These layers create costly barriers to direct connection between farmers and purchasers, resulting in product quality variability and market instability.

Despite past efforts to scale and commercialize seaweed farming, few reports have examined why these corporatization and commercial expansion attempts have struggled. Notably, there remains a lack of comprehensive global mapping of seaweed value chains: existing studies tend to focus narrowly on trade flows rather than tracing the full journey from production to processing and final markets. To address this gap, strategic initiatives-including the organization of focus group discussions with key ministries, a targeted strategic study on the seaweed sector at the global level, and the development of a flagship report on seaweed value chains-are urgently needed. These efforts would support more informed spatial planning, investment decisions, and policy design to identify the root causes, and to enhance sectoral scalability and resilience.

# 3/ Limited implementation of Certifications and Traceability

Indonesia has developed national standards for seaweed cultivation and processing. However, the extent to which these standards are consistently implemented across regions remains unclear. As a result, farmers are prevented from advancing their cultivation and production practices. Without a standardized pricing system based on carrageenan quality characteristics, farmers have limited incentives to improve quality.

At the same time, international certifications that facilitate access to high-value markets are often prohibitively expensive for smallholder farmers and cooperatives. This financial barrier limits participation in global value chains and discourages compliance with higher-tier sustainability or food safety standards.

To address these vulnerabilities, robust recordkeeping and traceability systems are essential. Tracking records in the upper stream value chain could particularly strengthen transparency, ensure consistent quality, and provide data that could stabilize market pricing, enhancing Indonesia's seaweed industry's resilience and economic potential. Pilot projects like UNIDO's SMART-FISH Programme—delegating Koltiva to manage traceability efforts—offer a promising model that should be scaled in key production regions.

# 4/ Untapped Opportunities in Bio stimulants and Emerging Sectors

Despite rising global demand for sustainable agricultural inputs, Indonesia's seaweed sector remains heavily concentrated on traditional products such as raw dried seaweed and processed hydrocolloids. A significant opportunity lies in the emerging seaweed-based biostimulant market, which is projected to expand substantially-from an estimated USD 1 billion in 2022 to between USD 1.8 and 2.5 billion by 2030, growing at an annual rate of 10-13% (World Bank, 2023; MarketsandMarkets, 2024). Seaweed extracts are increasingly recognized for their ability to enhance crop resilience, reduce fertilizer dependency, and improve soil health, aligning with global sustainability and regenerative agriculture trends. However, without targeted investments in research, product innovation, and technology transfer, Indonesia risks falling behind in capturing these higher-value segments.

At the same time, while seaweed holds promise as a renewable feedstock for biofuels and bioplastics, commercialization remains at an early stage. Macroalgae can be processed into bioethanol and biodiesel, offering future prospects for renewable energy; however, high production costs and scalability barriers continue to limit widespread adoption. In the bioplastics sector, seaweed-derived biodegradable materials—such as edible films and compostable packaging—represent a small but rapidly growing market, valued at approximately USD 0.5 billion in 2022 and projected to nearly double by 2032 (Research and Markets, 2023). Without strategic partnerships and innovation-driven initiatives, Indonesia may be unable to fully capitalize on these emerging sectors and risks being sidelined in the evolving global bioeconomy.

#### 5/Data Discrepancies and Implications

Furthermore, it is worth noting that according to satellite mapping and in-depth qualitative and quantitative research, data discrepancies exist between the official estimation of seaweed production and the actual production (Langford et al. 2022). Satellite mapping and research suggest that Indonesia has approximately 62,000 marine farming households and produces an estimated 2 million tonnes of wet equivalent seaweed annually less than what some official statistics suggest.

Such discrepancies may arise from different data collection methods.

The methodology for calculating seaweed production utilizes the KKP / FAO production database, which estimates the amount of wet seaweed harvested from production areas, applying a conversion factor of 10% from wet to dry seaweed. The BPS and the Ministry of Industry base their data on the amount of dry seaweed that is exported and processed in Indonesia.

We recommend that these ratios could be defined consistently for different seaweed species. Typical wet-to-dry ratios range from 7:1 to 10:1, depending on the species for every kilogram of dry seaweed:

- Cottonii and Spinosum: 7 kg wet to 1 kg dry
- Gracilaria, Sargassum, Ulva: 10 kg wet to 1 kg dry

Accurate and harmonized data is essential for reliable estimates of economic contribution and future planning.

#### Figure 7.

Comparison of total volume of seaweed production estimated by BPS and documented in South Sulawesi

	Tot	tal volume of pr	oduction (tonnes)			
	Nati	onal	South Sulawesi			
	Marine Production	Pond	Marine Production	Pond		
KKP National (BPS 2022b)	8,090,796	1,456,730	3,442,076			
KKP South Sulawesi (KKP 2022b)	-	-	2,431,802	996,975		
Ministry of Industry (Kemenperin 2022)	2,00	8,760	-			
BPS Seaweed Survey (BPS 2022a)	2,907,662 (volume sold)	351,152	868,191 (volume sold)	222,601		

Estimated volume of seaweed production from different sources

# IV. Policy Goals

This section outlines key policy goals and actionable strategies to strengthen Indonesia's seaweed

industry, supported by domestic developments and relevant international case studies

	Key Actions	Foundation for Competitive Advantage Current Status of the Indonesian Seaweed Industry	Global Leadership in Sustainable Seaweed Production International Case Studies				
Goal 1: Imp	Goal 1: Improve Domestic Processing Capabilities						
Policy 1	Incentivize Investment in Processing Facilities	Only 45% of the domestic seaweed processing plants have remained <u>operational</u> since 2016. The Ministry of Industry is preparing for incentive schemes for investment and the replacement of outdated machineries.	The Philippine government provides incentives for seaweed processing plants, such as <u>tax breaks and grants.</u>				
Policy 2	Skill and Technology Development Programs	Vocational Education and Training <b>Programs active</b> in South Sulawesi. Eleven Fisheries Polytechnics are active in Indonesia, with South Sulawesi noted for its achievements. UNIDO has been actively supporting the development of these Polytechnics since 2014.	Norway's Blue Skill Project ( <b>BRIDGES</b> ) focuses on aquaculture training, which improves industry-specific technical skills among <u>workers</u> , <u>research, partnership</u> , and enhanced <u>product quality</u> .				
Policy 3	Marine-based integrated zoning	Integrated Coastal Zone Management is needed to balance the competing use of diverse coastal resources. Current marine protected areas (MPAs), however, face challenges of insufficient funding and training for local projects.	The Minister of Fisheries in Japan conducts annual <u>training</u> <u>sessions</u> to local regions on seaweed restoration and marine zoning.				
Goal 2: Optimize a Sustainable Supply Chain							
Policy 4	Develop Cooperative Models to advance Climate Adaptive Practices	UNIDO supports cooperatives such as the Kospermindo in South Sulawesi and Mina Agar Makmur in Karawang, West Java.	In South Korea, <u>seaweed</u> industry empowers small-scale farmers to pool resources and negotiate better prices, fostering economic resilience and <u>improved quality control.</u>				

Policy 5	Sustainable Certification and Incentives	The ASC-MSC standard does not currently have any certified farms in Indonesia but states that they "have received interest from Indonesian producers, but until an operation formally announces the audit, this information is kept confidential" (P. Bianchi, personal communication, December 2018). Certification costs remain a major barrier, especially for smallholders, and few buyers demand such certification. UNIDO has been attempted to facilitate the development of ASC-MSC Seaweed standard endorsement since 2017.	ASC-MSC standards are globally recognized as a mark of high-quality, sustainably sourced seafood, ensuring adherence to rigorous environmental and social standards.				
Policy 6	Build Regional Collection Hubs	Indonesia Seaweed currently operates two regional hubs in Makassar and Surabaya, serving as key points for distributing dried seaweed exporters and processors.	India's <b>dairy industry</b> employs regional collection hubs to streamline logistics and reduce transportation costs, which can be a model to adapt centralized seaweed collection.				
Goal 3: Establish Unified Certifications and Traceability							
Policy 7	National Certification and Quality Standards	The Standard Nasional Indonesia (SNI) provides criteria for raw dried seaweed and related products. The Global Quality and Standards Programme (GQSP) provides support to National Standardization Agency (BSN) for drafting the SNI Raw Dried Seaweed, ATC and SRC, and has helped MMAF to develop IndoGAP, though implementation has been delayed.	Thailand's "One Standard, One Market"( <b>GAqP standards</b> ) approach for shrimp farming unifies standards across regions, <u>launching initiatives</u> for quality control.				

Policy 8	Digital Traceability System	Platforms like <u>STELINA</u> and Seaweed Trace (developed by UNIDO SMART-Fish and now managed by PT Koltiva) demonstrate progress in digital traceability. Start- up such as <u>Sea Green</u> demonstrate considerable efforts as well.	FAO suggestions encourages blockchain adoption for the industry; The Philippines " <u>Tracy</u> <u>Project</u> " aims to improve traceability in fisheries.
Policy 9	Public Awareness and Stakeholder Engagement	The Indonesia International Seaweed Conference and Expo in Nov 2024, organized by ASTRULI (the Indonesian Seaweed Processors Association) with support from UNIDO, CBI, the Ministry of Industry, the Ministry of Trade, and the Ministry of Marine Affairs and Fisheries, will become an annual event under SIAL Interfood.	The International Seaweed Symposium (ISS) is a triennial global forum for industry stakeholders; The 25th ISS will take place in Canada in May 2025.

To accelerate the growth of Indonesia's seaweed industry, specific action plans should be aligned with three strategic policy goals, building on the country's recent achievements. In 2019, Indonesia launched the Seaweed Roadmap Development Plan with detailed proposed actions. While this roadmap has since been suspended, UNIDO GQSP has been actively engaging with Marves, BAPPENAS, and MMAF to support the roadmap's renewal following the issuance of the new RPJMN by the end of 2024.

For the first goal of improving processing capabilities, Indonesia has made progress by establishing seaweed processing facilities in key producing regions such as Sulawesi and Bali. However, the industry remains dominated by the export of raw or semi-processed seaweed, limiting domestic value addition. Current plans aim to enhance processing capabilities by investing in advanced extraction techniques for carrageenan and agar and adopting modern drying and packaging technologies. Training programs-developed in collaboration with local universities and the Ministry of Industry-are also underway to equip the workforce with specialized skills. These efforts are designed to position Indonesia as a regional leader in premium seaweedbased products and derivatives, increasing export revenues and creating quality jobs.

Regarding the second goal to optimize a sustainable supply chain, Indonesia has achieved notable progress in sustainable seaweed farming by developing community-based aquaculture projects and introducing sustainable practices in regions like East Nusa Tenggara and Sulawesi. These initiatives have reduced environmental impact while supporting the livelihoods of local farmers. The proposed policies build on these achievements by promoting eco-friendly farming practices, such as the use of biodegradable farming materials, introducing guidelines for minimizing habitat disruption, and improving cold-chain logistics to preserve product quality during transport. Partnerships with environmental NGOs and industry groups support these sustainability efforts, ensuring Indonesia's seaweed supply chain aligns with global standards for environmental and social responsibility.

We also propose establishing unified certifications and traceability to achieve the third goal.

Indonesia is active in forging international standard compliance, with the Ministry of Marine Affairs and Fisheries actively promoting sustainable certification for seaweed. Pilot programs in regions like West Java have tested traceability systems that digitally track seaweed from farm to export, though scaling remains a challenge. The current plan aims to expand these certification programs nationally and to establish a unified, government-backed certification recognized by major global markets. This includes partnering with international certifying bodies to ensure Indonesian seaweed meets stringent export requirements. A comprehensive digital traceability system should also be developed, which will enable global buyers to trace the product's origin, processing history, and quality certifications, improving transparency and fostering trust in Indonesian seaweed products.

These targeted actions leverage Indonesia's existing groundwork while addressing critical gaps to build a resilient, competitive, and globally recognized seaweed industry.



## V. Conclusions

In summary, Indonesia's seaweed industry stands at a pivotal moment. With appropriate reforms and sustained investment, the sector can become a central pillar of the national blue economy strategy.

A five-to-ten-year action plan could prioritize establishing partnerships with foreign direct investors to transfer processing and formulation technologies, aiming to produce high-value products. Beyond carrageenan and agar, Indonesia has the potential to explore emerging markets for seaweed-based bio stimulants, biofuels, and bioplastics—products that align with global sustainability trends.

Despite its impressive production volume and incredible potential within the blue economy, the seaweed industry continues to face persistent structural challenges. Inconsistent product quality, insufficient processing capacity, data discrepancies, and fragmented supply chains are key issues that must be addressed. Smallholder farmers—who are the backbone of the sector often lack access to technology, credit, and consistent market opportunities, leaving them vulnerable to price volatility and limiting their ability to scale.

To move forward, Indonesia must invest in infrastructure, streamline supply chain coordination, and support the professionalization of seaweed farming. Empowering coastal communities through training, certification, and access to financing will create more resilient livelihoods. Through these efforts, Indonesia can not only secure a greater share of the global seaweed market but also drive inclusive, sustainable development across its coastal regions—solidifying its role as a global leader in the blue economy.

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Disclaimer: The views and opinions expressed in this policy brief are those of the authors and do not necessarily reflect the policies of UNIDO and referred public and private organizations in Indonesia.

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# Appendix

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