

# Challenges and Opportunities through Seaweed Cultivation in Korea

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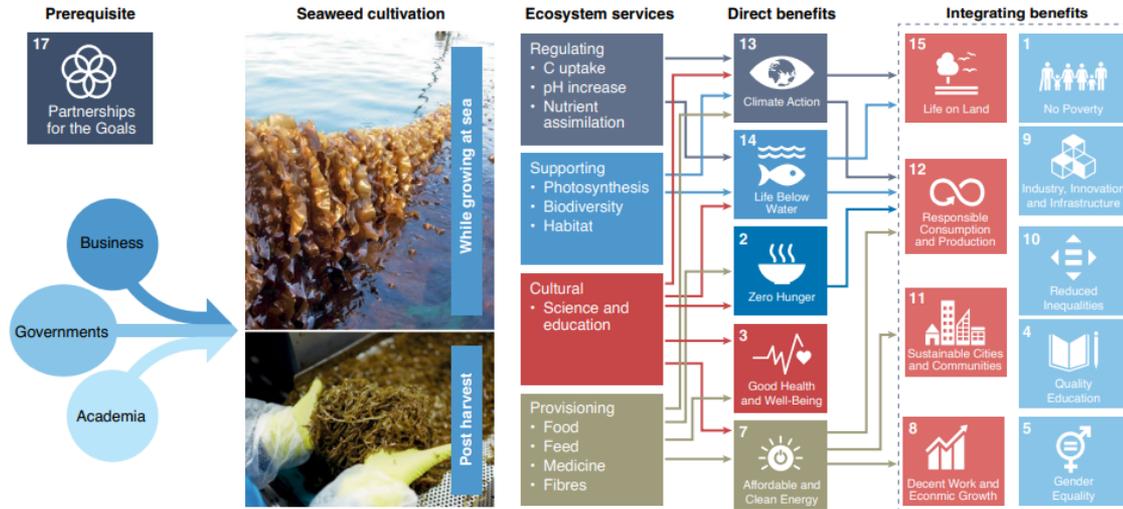
**Seaweed Research Institute**  
National Institute of Fisheries Science

# 01 | Introduction : Seaweed & UN SDGs

Duarte et al. 5(3):185-193, 2022

## PERSPECTIVE

## NATURE SUSTAINABILITY



**Fig. 3 | Seaweed production and utilization contributes to advancing a number of UN SDGs, which provide integrative benefits contributing to additional SDGs.** Credit: Teis Boderskov (top photo) and Colourbox (bottom photo). Logos reproduced from <https://www.un.org/sustainabledevelopment/news/communications-material/>.

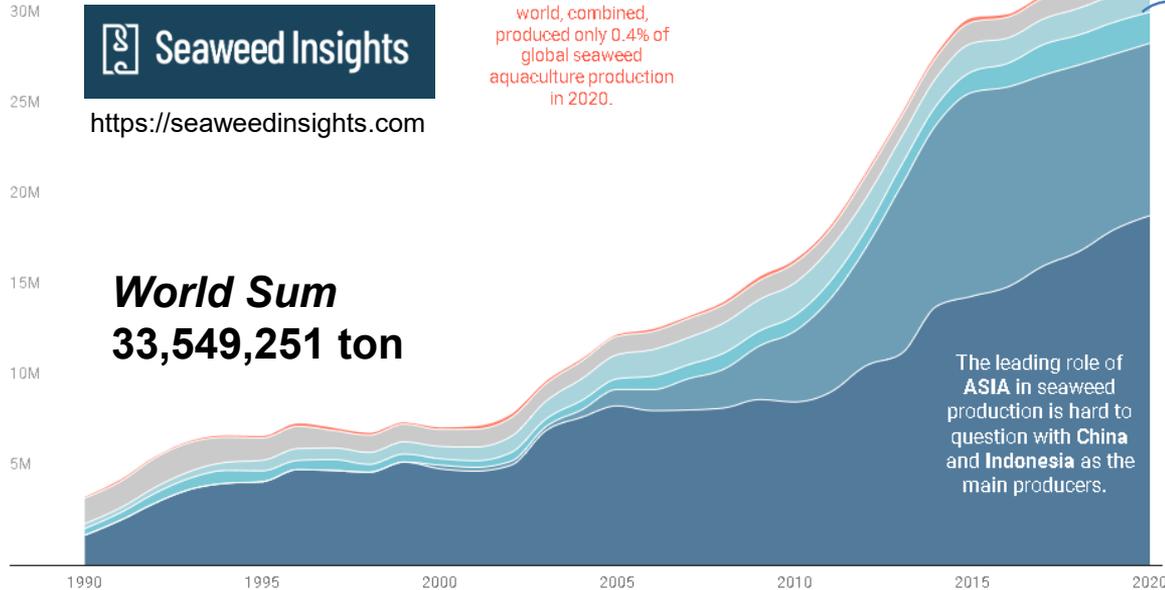
- Seaweed farming is becoming important as a source of jobs and economics.
- Ecosystem services provide food and natural products across a range of industries
- Nature-based solution for climate change mitigation and adaptation for counteracting eutrophication and biodiversity crisis
- Seaweed contributes to providing additional benefits as well as ecosystem services that directly benefit the UN SDGs come true.
- Scaling up seaweed aquaculture is an imperative to accommodate more than 9 billion people in 2050 while advancing across many of the UN sustainable development goals (SDGs)

# 01 | Introduction : World Seaweed Production (FAO 2020)

## Global Production Volumes 1990-2020 by Country (in Tonnes Wet Weight)

Global Production Volumes by Country based on 2020 Annual Figures

■ China ■ Indonesia ■ South Korea ■ Philippines ■ Other Asia ■ Other



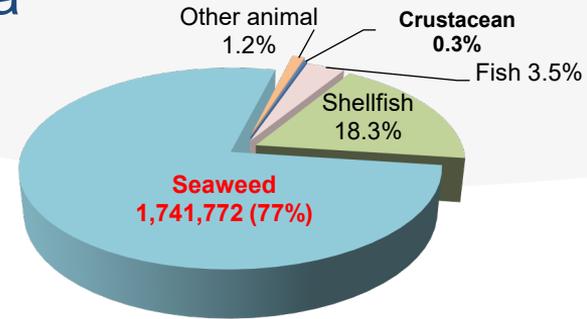
- Seaweed aquaculture accounts for 51.3% of global mariculture production
- Grows at 6.2% y<sup>-1</sup> between 2000 and 2018 (Duarte et al. 2022)

# 01 | Introduction : Seaweed Farming in Korea

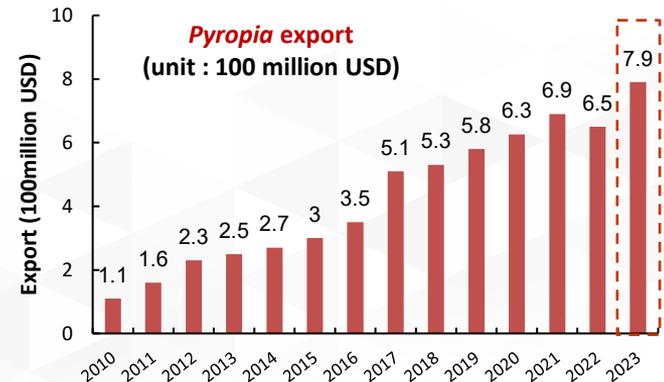
- Korea is the 3<sup>rd</sup> producer of the world seaweed production
- Seaweed resources : 1,006 species (Green 133, Brown 206, Red 667; NIMBRME 2022)
- Production and value of major seaweed species in 2023

Species	2023			
	Production (Ton)	Ratio(%)	Value (USD1,000)	Ratio(%)
<i>Saccharina japonica</i>	595,931	34.2	78,829	12.0
<i>Undaria pinnatifida</i>	566,564	32.5	71,700	10.9
<b><i>Pyropia spp.</i></b>	533,249	30.6	<b>485,303</b>	<b>73.7</b>
<i>Sargassum fusiforme</i>	17,710	1.0	7,093	1.1
<i>Ulva spp.</i>	8,287	0.5	3,891	0.6
<i>Codium fragile</i>	7,594	0.4	2,902	0.4
<i>Ecklonia stolonifera</i>	6,243	0.4	1,537	0.2
<i>Gacilariopsis chorda</i>	3,087	0.2	970	0.1
<i>Capsosiphon fulvescens</i>	2,745	0.2	5,469	0.8
<i>Sargassum fulvellum</i>	362	0.02	649	0.1
<b>Total</b>	<b>1,741,772</b>	<b>100</b>	<b>855,847</b>	<b>100</b>

Data from the Ministry of Oceans & Fisheries, wet wt.



2022 Aquaculture production in Korea



2030 Goal is Exports of 1 billion USD

# 01 | Introduction : Seaweed Farming & Government's guideline

"Convenience & Economy"

Culture Method	Species	Technology
 <p>Fixing pole</p>	<p><i>Pyropia</i>, <i>Ulva</i>, <i>Capsosiphon</i></p>	<ul style="list-style-type: none"> <li>- Artificial seeding : <i>Pyropia</i></li> <li>- Natural seeding : <i>Ulva</i>, <i>Capsosiphon</i></li> <li>• 1 Unit (Check) : 1.8~2.2X40m</li> <li>• Distance between culture farms : 200m</li> <li>• Permissible range of culture farm area : 5~18% per ha</li> </ul>
 <p>Floating net</p>	<p><i>Pyropia</i>, <i>Ulva</i></p>	<ul style="list-style-type: none"> <li>- Artificial seeding : <i>Pyropia</i></li> <li>- Natural seeding : <i>Ulva</i></li> <li>• Distance between culture farm : 200m</li> <li>• Permissible range of culture farm area : 5~18% per ha</li> </ul>
 <p>Long-line</p>	<p><i>Undaria</i>, <i>Saccharina</i>, <i>Costaria</i>, <i>Ecklonia</i>, <i>Sargassum</i>, <i>Codium</i>, <i>Gracilariopsis</i></p>	<ul style="list-style-type: none"> <li>- Artificial seeding : <i>Undaria</i>, <i>Saccharina</i>, <i>Costaria</i>, <i>Ecklonia</i>, <i>Sargassum</i>, <i>Codium</i></li> <li>* Regeneration : <i>Sargassum</i>, <i>Gracilariopsis</i></li> <li>• Distance between culture farm : 100m</li> <li>• Permissible range of culture farm area : 5~20% per ha</li> </ul>

- For sustainable production
- Restriction of density for cultivation facilities (5-20% per ha)
  - Management through farm environment rating system
  - Monitoring for food safety (heavy metals – As, Cd, Pb, Hg)

# 01 | Introduction : Korean Seaweed Production

## Recent Changes of Seaweed Industry in Korea

Hwang & Park 2020, Algae



Species diversity increased

- Same 3 major species
- Various species included



Cultivation technology developed

- To maximize natural productivity
- To reduce labor costs



Automation facilities proliferated

- To support fisheries communities
- To help aging & declining population



Specialized & large-scaled companies

- Scale up of seed companies
- Separation of seed, aquaculture & process

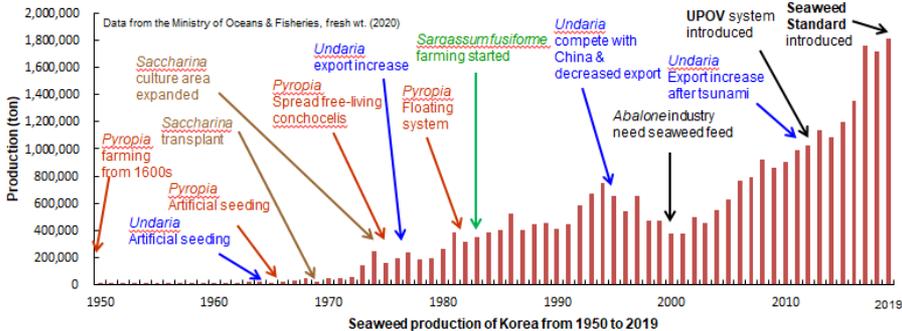
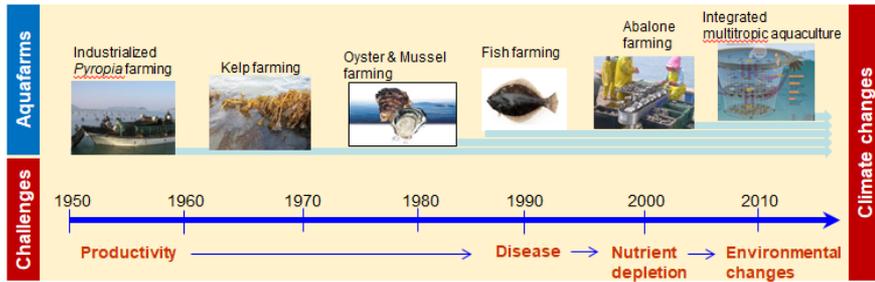


As awareness of sustainable farming

- Sustainable development goals (SDGs)
- Obtaining ASC-MSC certification

# 02 | Old & New Challenges in Seaweed Cultivation

## KEY CHALLENGES



## KEY OPPORTUNITIES

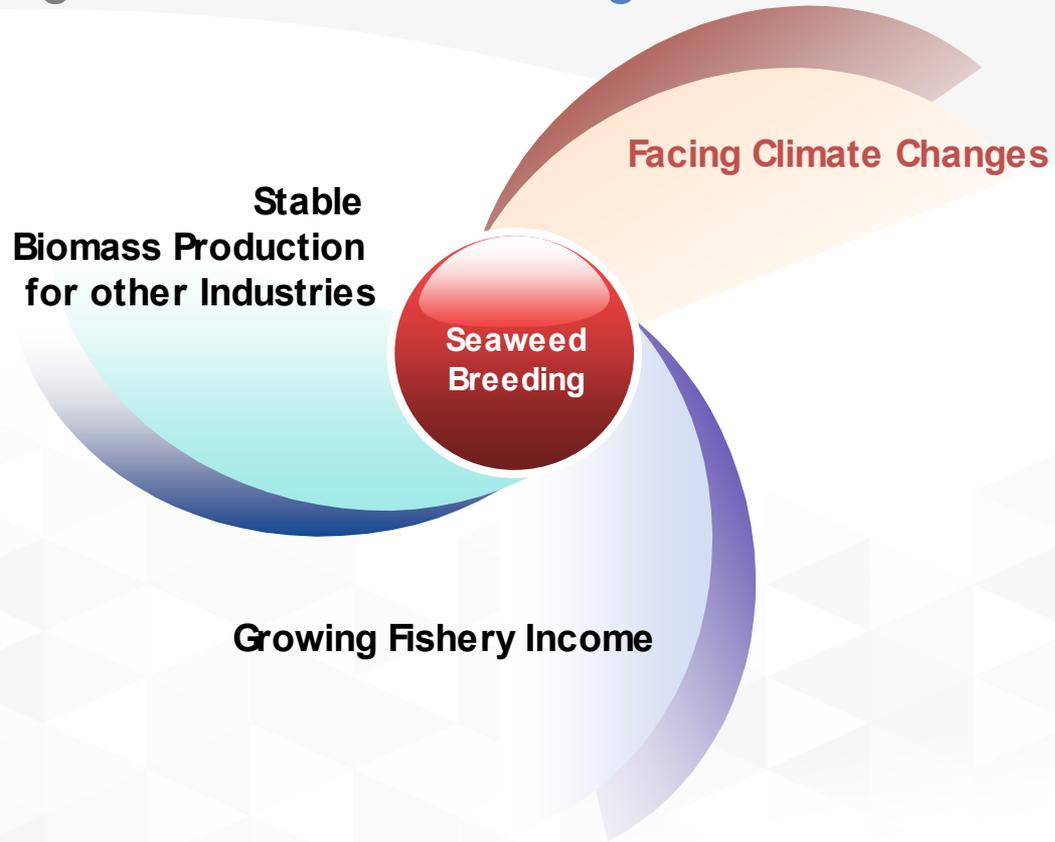
- ✓ Selection of target species suitable for environment
- ✓ Domestic technology and know-how for each stage of seaweed seedling, aquaculture production and processing
- ✓ Government's policy & legislation for sustainable seaweed industry

- Act on Conservation & Management of Marine Ecosystems
- Act on Securing, Management & Use of Marine & Fisheries Life Resources
- Fisheries Resources Management Act, Aquaculture Industry Development Act
- New Plant Varieties Protection Act (2013)
- Fisheries Seed Industry Promotion Act (2016)

*Fisheries Seed : aquatic animal (semen, eggs, fry,...) & aquatic plant(seeds, spores, propagules,...)*



## 03 | Challenges: Seaweed Breeding



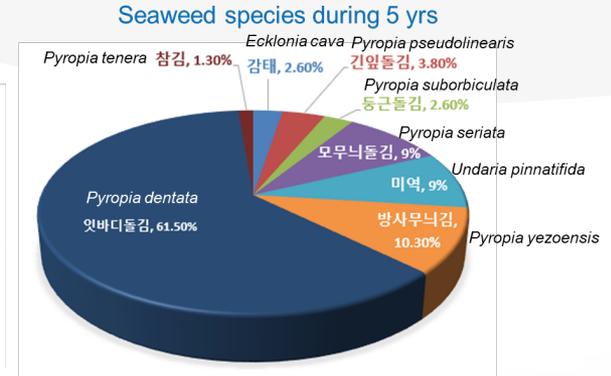
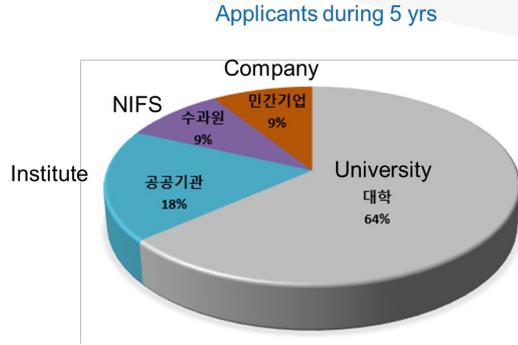
# 03 | Challenges: **BIOBANK** (Material Supply for Seaweed R&D)

## 7 Seaweed Biobanks in Korea

- NIFS is the largest biobank
- Maintenance (labor-intensive)



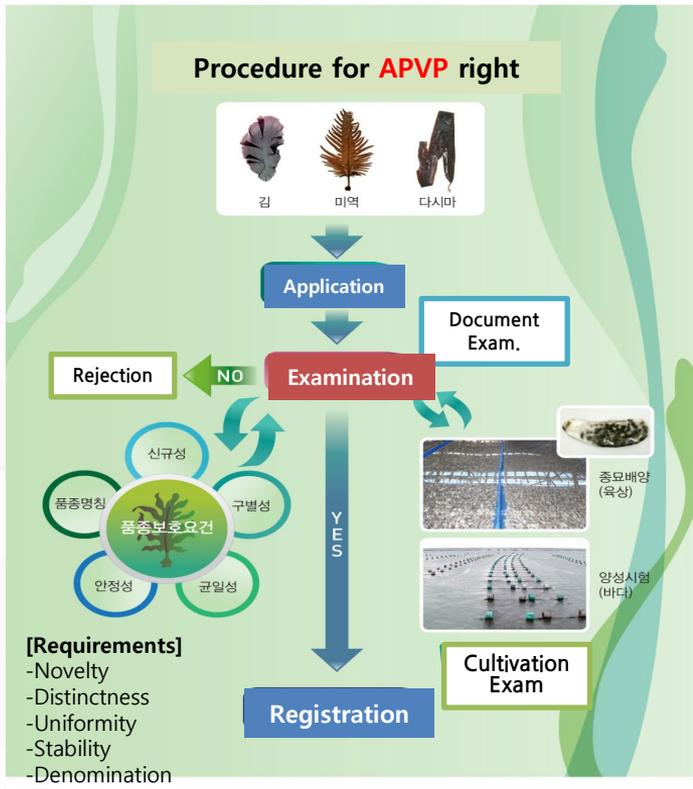
Seaweed Culture Collection



Research for  
Molecular biology, Aquaculture, Breeding,  
Physiological ecology, Marine ecosystem  
conservation, Bioactive substances ...

# 03 | Challenges: **Introduction APVP in Seaweed (2012~)**

Procedure of gaining **APVP** registration



**Aquatic Plant Variety Protection in Korea**

**Strain development ~ Application : 3~5 yrs**

- 2 years of field cultivation test
- Documents for application
- Name a breed



**Application ~ Registration : 2 yrs**

- 2 years of field test for Examination

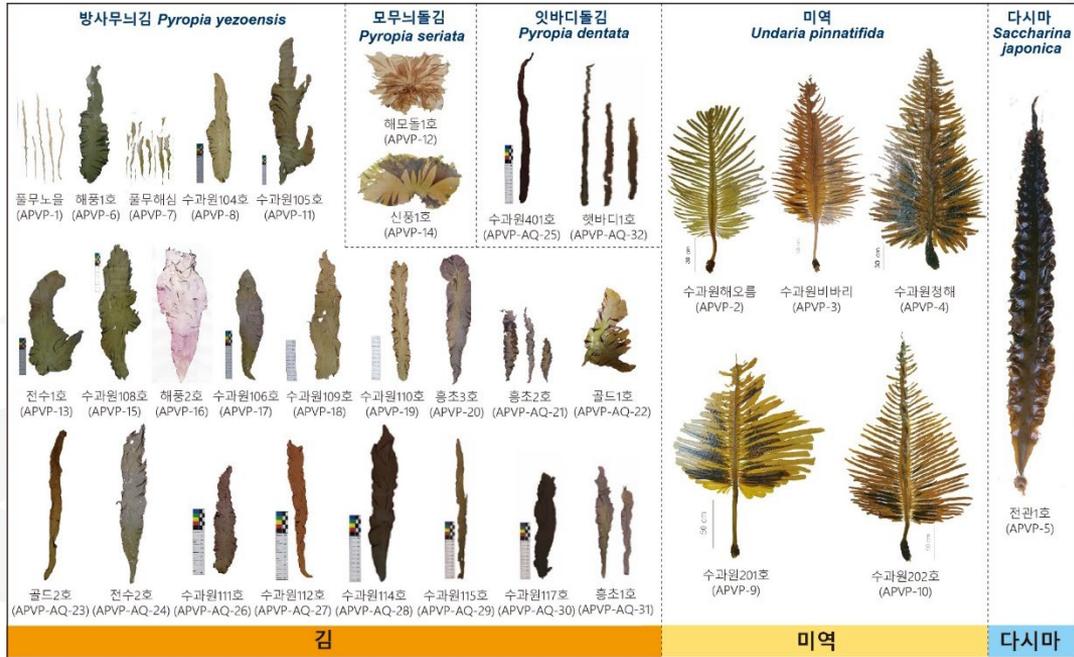


**Sale to farmers with Protection**

- Application of Intellectual Property Protection System

5~7 yrs

# 03 | Challenges: Increase Domestic Seaweed Cultivars



Registered Seaweed Cultivars in Korea (2012~2023)

32: 26 *Pyropia*, 5 *Undaria*, 1 *Saccharina*

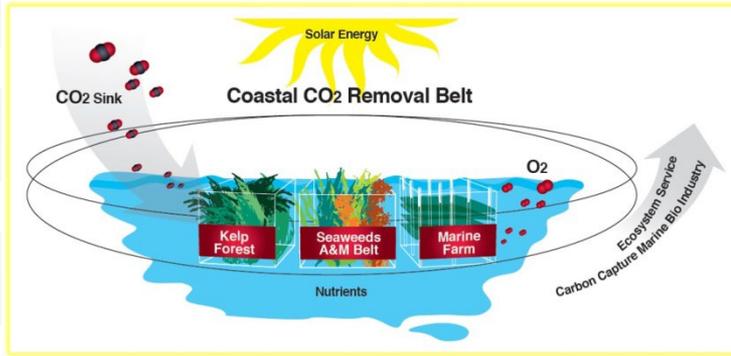
- No. Registered Seaweed Cultivars in 2023 : Korea 32 > China 24 > Japan 15
- Replace from foreign to domestic cultivars : 60% in 2010 → 95% in 2022



Establishment of Seaweed Cultivar Sovereignty

# Breeding Programs for Edible Seaweeds in Korea

- Produced various seaweed varieties
- Contribute to production increase of seaweed
- Established the coastal CO<sub>2</sub> removal belt (C CRB) via marine forests (~10 t of CO<sub>2</sub>/year/ha) for mitigation & adaptation against global warming



→ Government's Zero Carbon Policy in 2050

## R&D Projects



### Golden Seed Project

- 2013~2021 [Agriculture & Fisheries (*Pyropia*)]
- Selective, cross & mutation breeding



### Breeding & Cultivation tech. of Brown & Green Seaweeds

- 2012~ (*Undaria*, *Saccharina* spp. & *Capsosiphon*)
- Selective or cross-breeding/Cultivation technology



### Various utilization for other industries

- (Traditional uses) Food, Feed & Fertilizer
- (New) Health functional, Food additive & Cosmetics

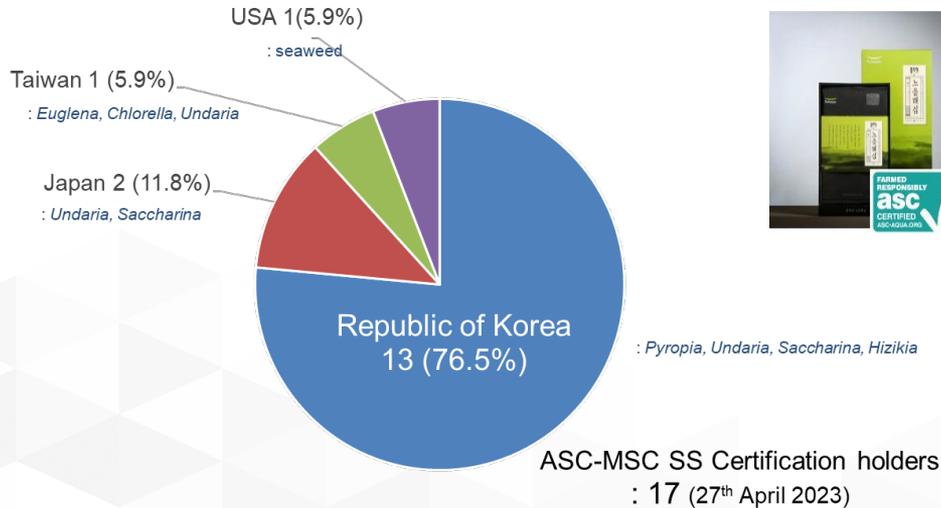
## 03 | Challenges: Policy Insurance



- Policy Insurance operating for aquaculture & fishery disaster insurance
- Natural disaster by typhoons, tsunamis(storm surges/tsunamis), storms, red tides & abnormal environment (temp, salinity, DO, nutrients...)
- 50% of insurance premium is being subsidized
- 4 major seaweed species: *Pyropia*, *Undaria*, *Saccharina* and *Sargassum fusiforme*

**Reducing Damage to Fishermen through  
Implementation of the Insurance**

## 03 | Challenges: ASC-MSC Seaweed Standard



- **ASC-MSC Seaweed Standard:** A joint standard for environmentally sustainable and socially responsible seaweed production
- **5 principles:** *Sustainable wild populations / Environmental impacts / Effective management / Social responsibility / Community relations and interactions*
- The number of seaweed certification holders in Korea is gradually increasing accordance with the government's eco-friendly aquaculture policy

# 04 | Take home message is...

- ✓ Seaweed can contribute directly or indirectly to realization of 14 UN SDGs
- ✓ Korea's successful experiences with seaweed industry
  - ✓ Increase No. high-income seaweed fishermen exceeding 73,000 USD y<sup>-1</sup>
  - ✓ Seaweed Biobanking Services: 7 Banks
  - ✓ Has the largest No. of Registered Seaweed Cultivar: 0 in 2011 → 32 in 2023
  - ✓ Increased proportion of domestic seaweed cultivars: 60% in 2010 → 95% in 2022
  - ✓ Increased export of seaweed(laver)
    - : 100 million in 2010 → 790 million USD in 2023 → *1 billion USD in 2030*
- ✓ Korean government support to seaweed industry's growth
  - ✓ Legislation to foster sustainable seaweed industry, preparation of APVP system to protect seaweed variety protection rights, and promote R&D
  - ✓ Financial support for each industrial stage (Seed, Cultivation, Process, Export)
  - ✓ Direct payment system: Enhancement of eco-friendly aquaculture
  - ✓ Promotion of R&D: Biobanking, Cultivation Tech., Farming equipment tailored to fishery households ...
  - ✓ Disaster insurance: Policy insurance tailored to fisherman since 2008 (50% is being subsidized)

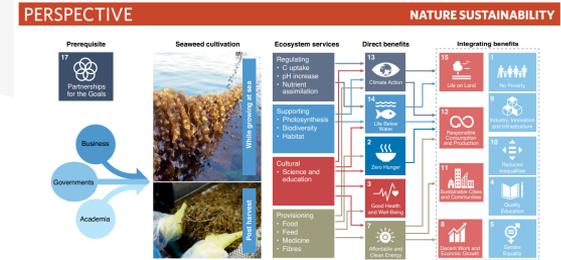
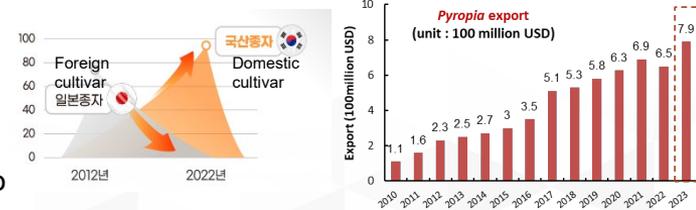


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**K-laver export over 110 countries**  
**2030 Laver Export Goal is 1 billion USD**

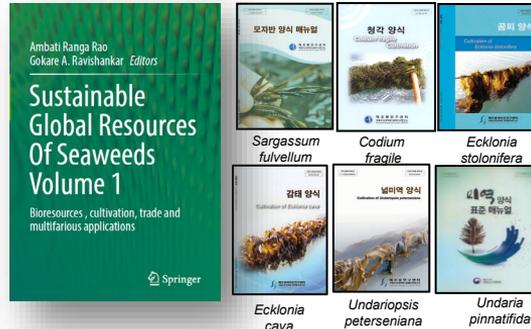


# Thank you

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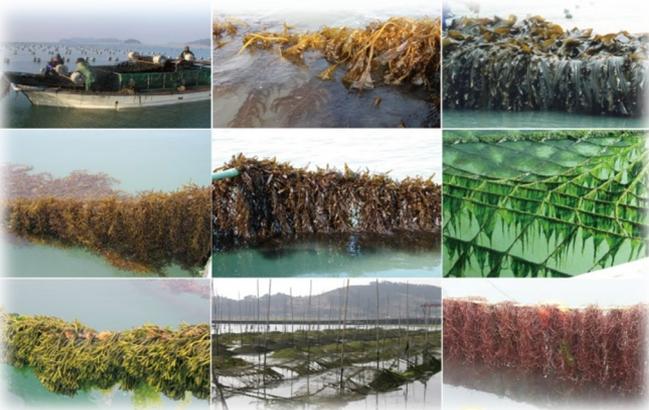
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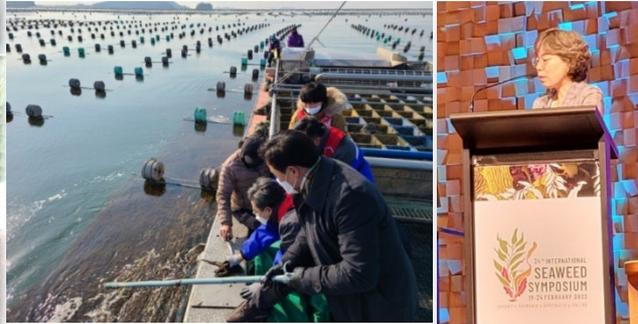
Publication of seaweed manual books



FAO Seaweed Aquaculture Policy Dialogue (2022)



**Farmed seaweed species in Korea**  
Hwang et al. 2020 in *Botanica Marina*



Diagnose and solve the cause of seaweed farm

24<sup>th</sup> International Seaweed Symposium in Australia (2023)



World Bank (Christopher Brett...) visit Seaweed Research Institute, NIFS (2023)