

# Sea of Opportunity: Supporting Seaweed Farmers in Papua

Unmet Needs Report

November 2024

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# EXECUTIVE SUMMARY

## BACKGROUND

Indonesia is the world's second-largest producer of seaweed, accounting for over 38% of global production and exporting approximately 200,000 tons annually. This industry is thriving due to rising demand for seaweed-based products in food, cosmetics, pharmaceutical and bio-packaging sectors.

While the Indonesian government has made seaweed as one of its focus industries, seaweed has yet to reach its full potential, with less than 1% of the available area being cultivated, and 65% of the seaweed being sold in its raw or dried form, which leads to missing out on additional value creation.

Kopernik has launched an initiative to support smallholder farmers in Papua to cultivate seaweed and benefit from its socio-economic, and environmental opportunities. This research highlights key insights gained from the implementation process, additional interviews and research involving 45 institutions, including seaweed companies, government bodies, researchers, MSMEs, community farmers, and logistics providers across Papua and beyond.

## THE CHALLENGES

The research revealed 11 key unmet needs affecting the seaweed value chain in Papua: 1) Lack of access to high quality seedlings, 2) Substandard cultivation methods, 3) Lack of variety in seaweed being cultivated, 4) Lack of knowledge on seaweed VAPs, 5) Limited access to tools and materials, 6) Difficulty in obtaining certification, 7) Nascent seaweed markets in Papua, 8) Lack of proper storage, 9) Limited number of buyers, 10) Lack of immediate financial reward to sustain motivation of farmers, 11) Papua's remote location, posing challenges to access wider markets.

## POTENTIAL SOLUTIONS

The Kopernik team has developed 28 potential ideas to address these challenges - with many of these being closely interconnected and overlapping. These potential solutions span across five critical areas, that include: cultivation, value-added products (VAPs), trading, farmer motivation and blue carbon pathways. In order to streamline implementation, ideas were further categorized and prioritized into three stages: early, developing, and establishing.

Of the 28 ideas, 14 have been identified as particularly promising for pilot testing and experimentation. These include, but not limited to, Seedling Nursery, Integrated Multi-Trophic Aquaculture, Seaweed Academy, Seaweed Festival, Improved Storage, Farmer-Buyer Mutual Learning Visits, Portofolio of Quick Wins, Bridging Subsidies of Shipping Cost, as well as Early Participation in Blue Carbon Experiments.

## CALL TO ACTION

Through this Unmet Needs research, Kopernik aims to highlight both the challenges and the vast opportunities within the seaweed value chain in Papua and beyond. In addition to raising awareness, we hope this report sparks a lively dialogue around key issues that demand greater attention.

Kopernik looks forward to partnering with interested institutions to transform these ideas into action, paving the way for a sustainable and prosperous future for coastal communities in Indonesia. Building on these findings, we also hope to explore and experiment with seaweed buyers, investors, organizations, and policymakers, and develop and test additional ideas and innovative interventions that can effectively address the needs of seaweed farmers.

# DEFINITION AND GLOSSARY

## Definition

### Carrageenan

An additive made from red seaweed, used to thicken, emulsify, and preserve foods and drinks

### Agar

A gelatinous substance derived from red algae, commonly used as a medium in microbiological cultures and in food production as a gelling agent.

### Thallus

The body of a plant-like organism, such as algae, that is not differentiated into leaves, stems, or roots, and performs all functions of the organism, including nutrient absorption and reproduction.

### Alginate

A naturally occurring polysaccharide derived from brown algae, used as a thickening, gelling, and stabilizing agent in various industries, including food, medicine, and textiles.

### Vegetative cycle

The phase in the life cycle of a plant or algae that involves growth and asexual reproduction, typically marked by the production of vegetative cells (non-reproductive cells) that contribute to the organism's growth and spread.

### Hydrocolloids

A group of substances that form gels or colloidal solutions when mixed with water. These are commonly used in food, pharmaceuticals, and cosmetics as thickening, gelling, or stabilizing agents (e.g., agar, alginate, xanthan gum).

## Glossary

### VAP

Value Added Product

### KKP

*Kementerian Kelautan dan Perikanan*

### BPOM

National Agency of Drug and Food Control (*Badan Pengawas Obat dan Makanan*)

### MSME

Micro, Small, Medium Enterprises

### GD

Geographical Disadvantage

### FM

Financial Motivation

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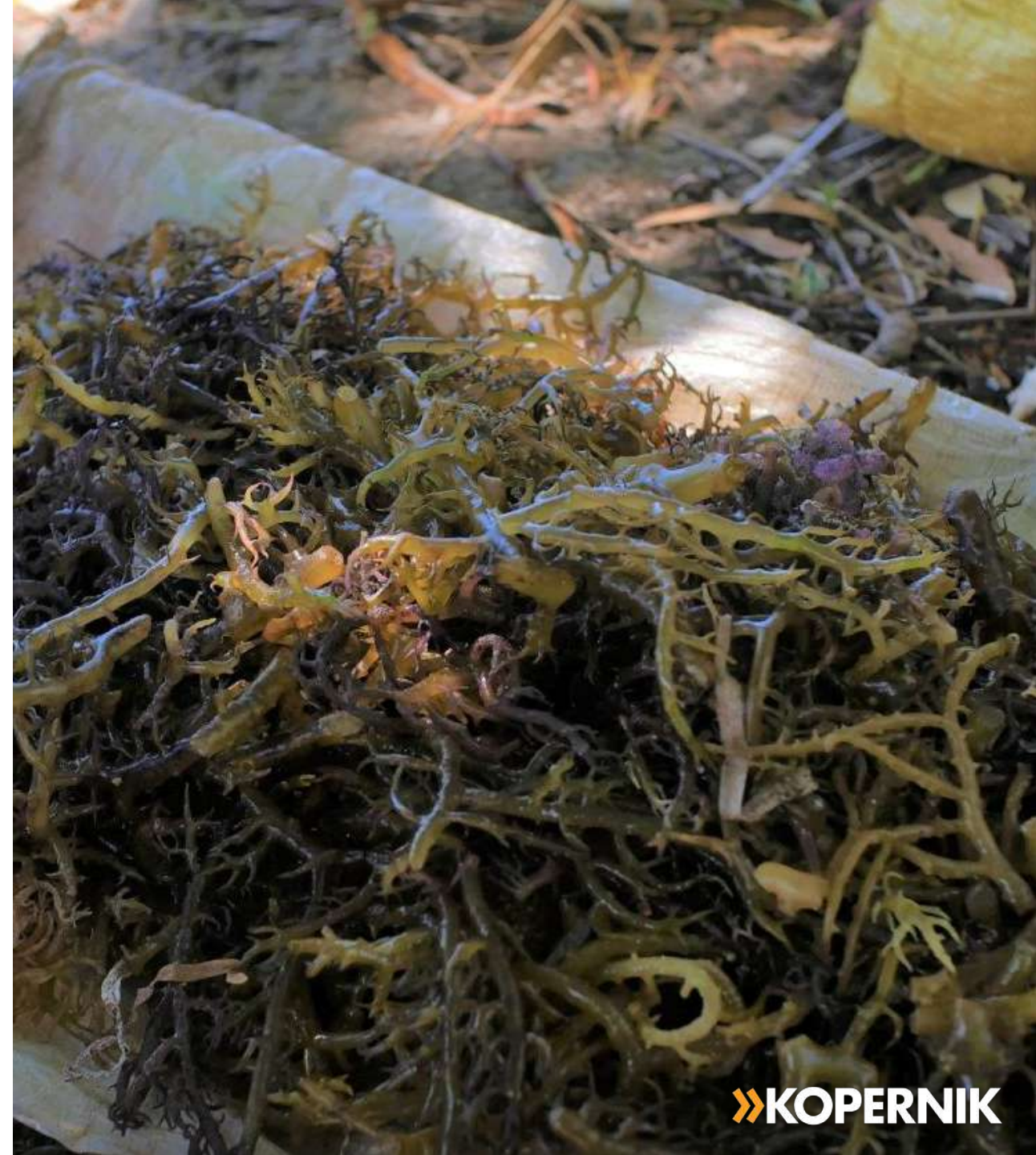
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**Seaweed cultivation offers various socio-economic and environmental opportunities, including food security, income generation, marine habitat protection, and carbon sequestration.**

<b>Social</b>	<b>Economic</b>	<b>Environment</b>
<b>Nutritional Security</b>	<b>Employment Opportunities</b>	<b>Carbon Sequestration</b>
<b>Food Security</b>	<b>Income Generation</b>	<b>Marine Habitat Protection</b>
<b>Empowerment of Coastal Communities</b>	<b>Economic Diversification</b>	<b>Marine Water Quality Improvement</b>

*Source: United Nations Conference on Trade and Development (UNCTD), 2024*

As a result, growing attention is being paid to the potential of seaweed farming.



nature  
sustainability



UN trade & development

Home / News / Seaweed holds huge potential to bring economic, climate and gender benefits

### Seaweed holds huge potential to bring economic, climate and gender benefits

30 April 2024

The ocean crop can significantly improve sustainable livelihoods for small-scale farmers and harvesters and empower women in coastal communities, particularly in Asia and Africa.

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Perspective | Published: 07 October 2021

## A seaweed aquaculture imperative to meet global sustainability targets

[Carlos M. Duarte](#) , [Annette Bruhn](#) & [Dorte Krause-Jensen](#)

[Nature Sustainability](#) 5, 185–193 (2022) | [Cite this article](#)

9779 Accesses | 385 Altmetric | [Metrics](#)

## These 4 start-ups are using seaweed to help save the planet

May 25, 2021



Source: United Nations Conference on Trade and Development (UNCTD), 2024; Nature Sustainability (2021); World Economic Forum (2021)

Seaweed is categorized into three main groups: red, brown, and green. Among these, red (52.6%) and brown (47.29%) seaweed dominates the global seaweed cultivation landscape.

### Global seaweed cultivation volume (2021)

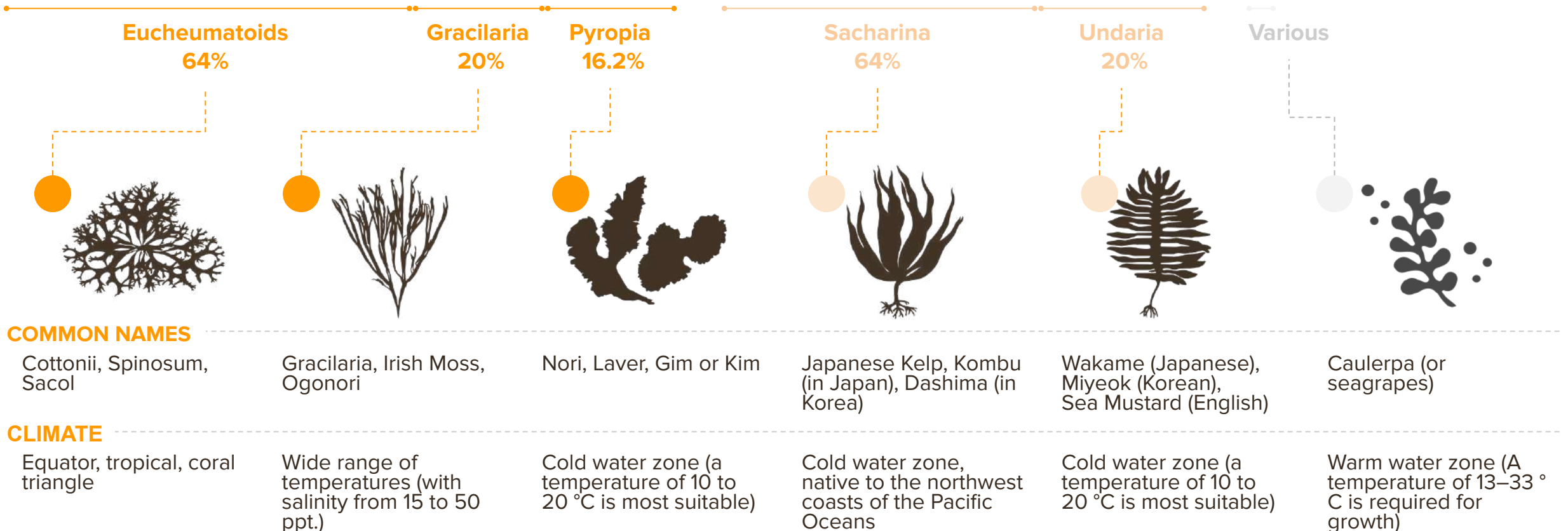
in %

Red seaweed (52.6%) ●

Brown seaweed (47.29%) ●

Green seaweed\* (0.11%) ●

TOTAL: 34,657 MT/YEAR

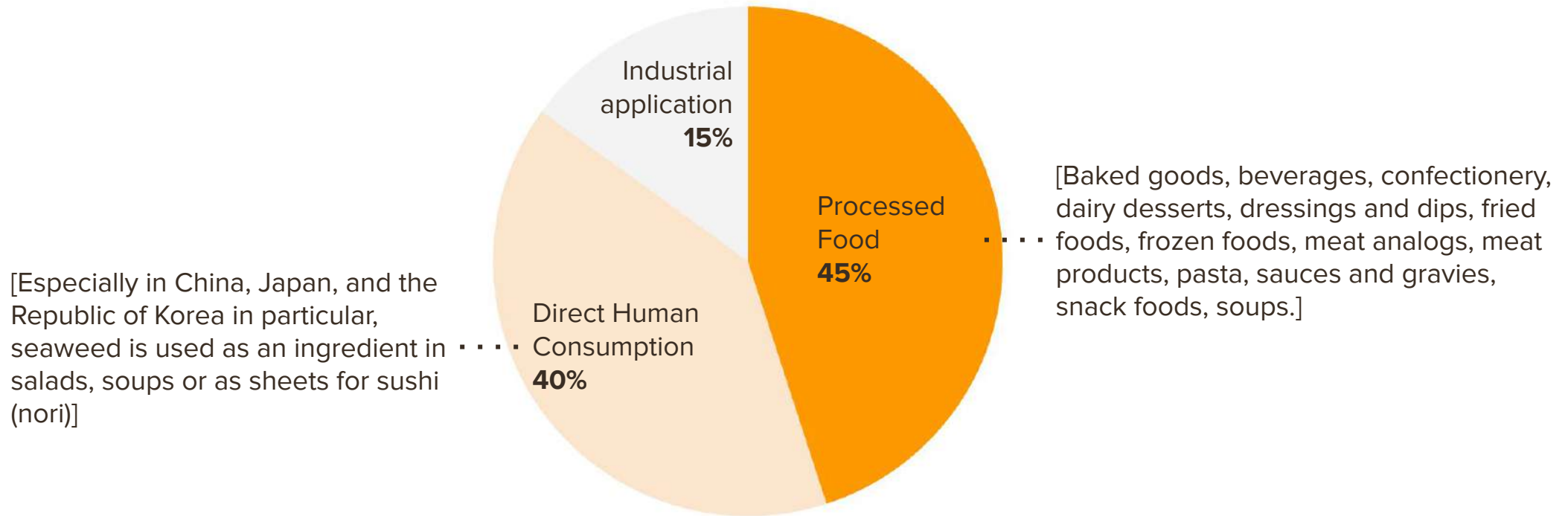




**Processed food accounts for 45% of global seaweed consumption, while direct human consumption accounts for 40%. The remaining 15% is used for various industrial applications.**

### Share of highest cultivated seaweed species globally

in %



Source: Food and Agricultural Organization, 2018

A diverse range of **products** is **derived** from **red, brown, and green seaweed**, depending on the level of processing (i.e. complexity).



**Carrageenan**, for example, is used as a thickening, stabilizing, and gelling agent in food, cosmetics, and pharmaceuticals.

### Food



Cake



Ice cream



Milk



Processed meat products



Noodles



Jelly

### Cosmetics



Soaps



Shampoos



Toothpaste



Moisturizers



Lotions



Serums

### Pharmaceuticals



Tablets and capsules



Wound coatings

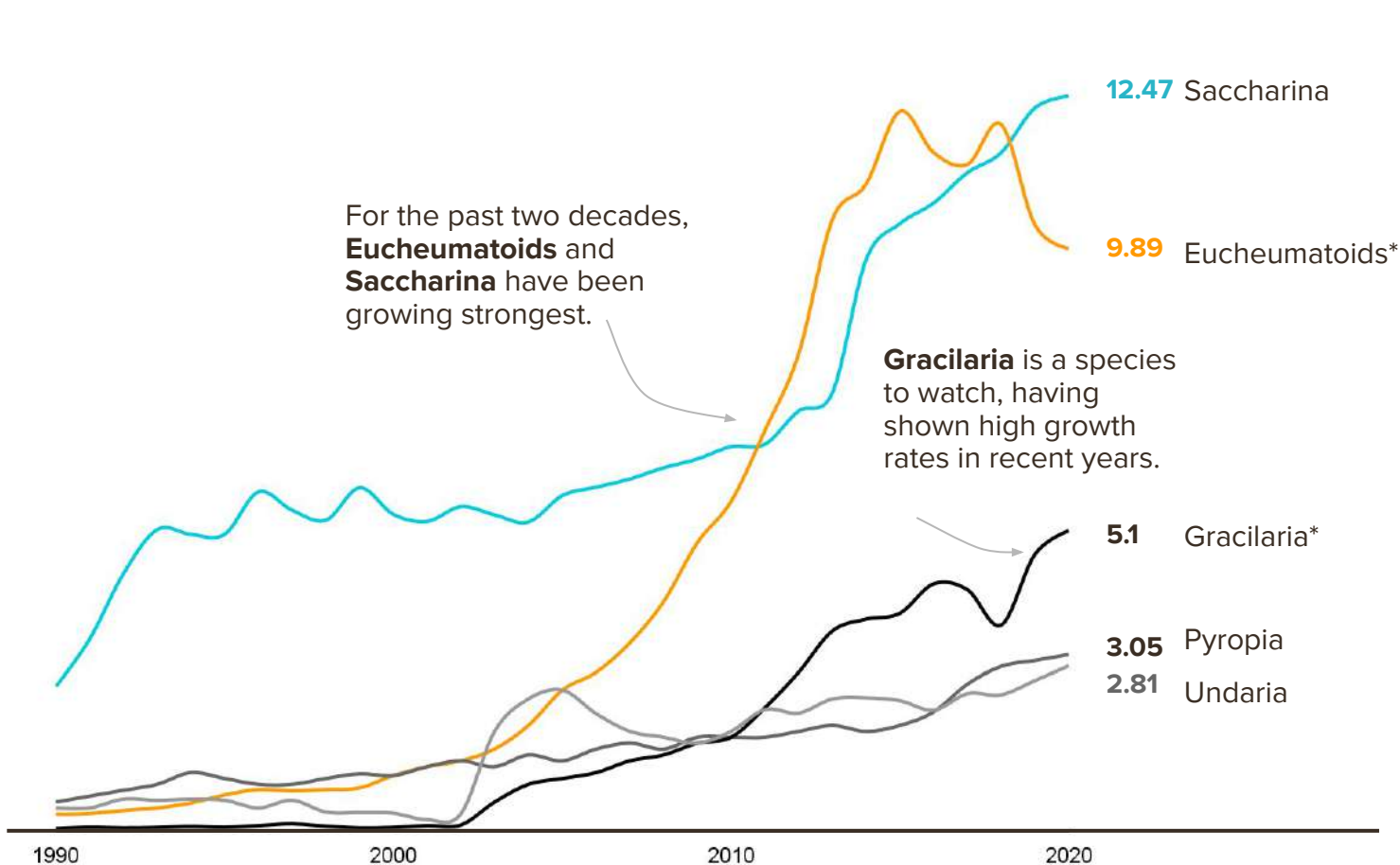


Syrups

# The global seaweed production has surged in the past decade, with Gracilaria leading the way with over a 200% increase since 2010.

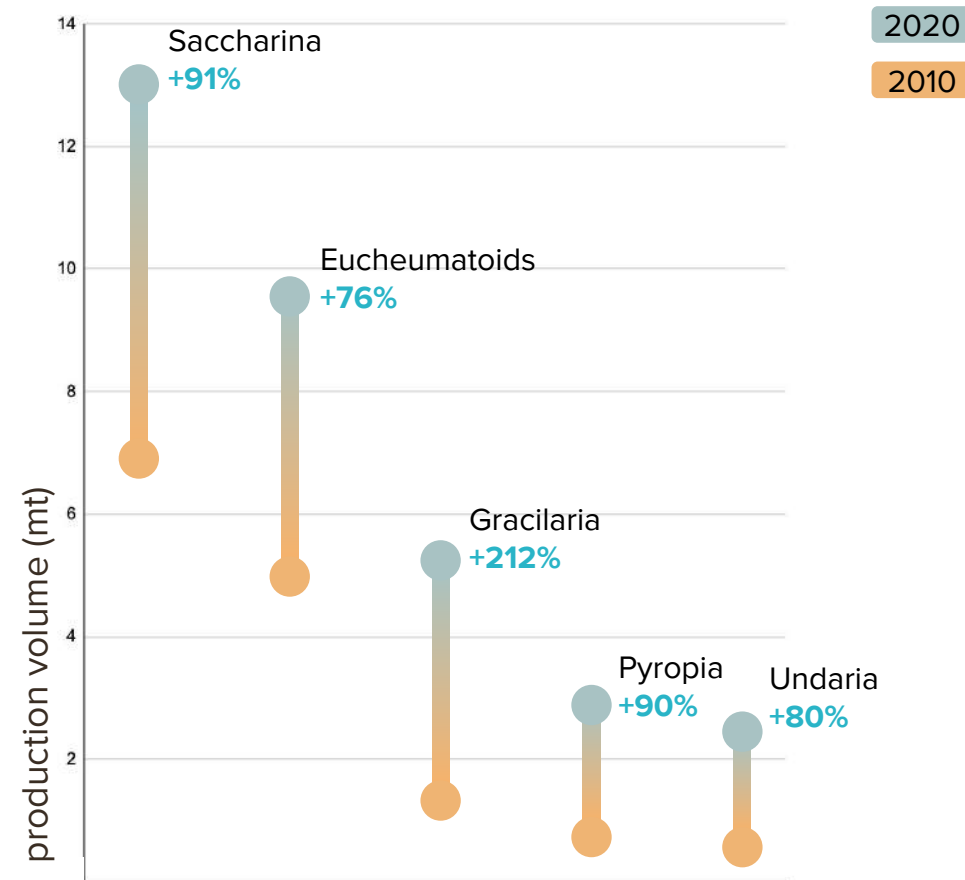
## Comparison of production volumes

by species, 1990-2020, in tonnes



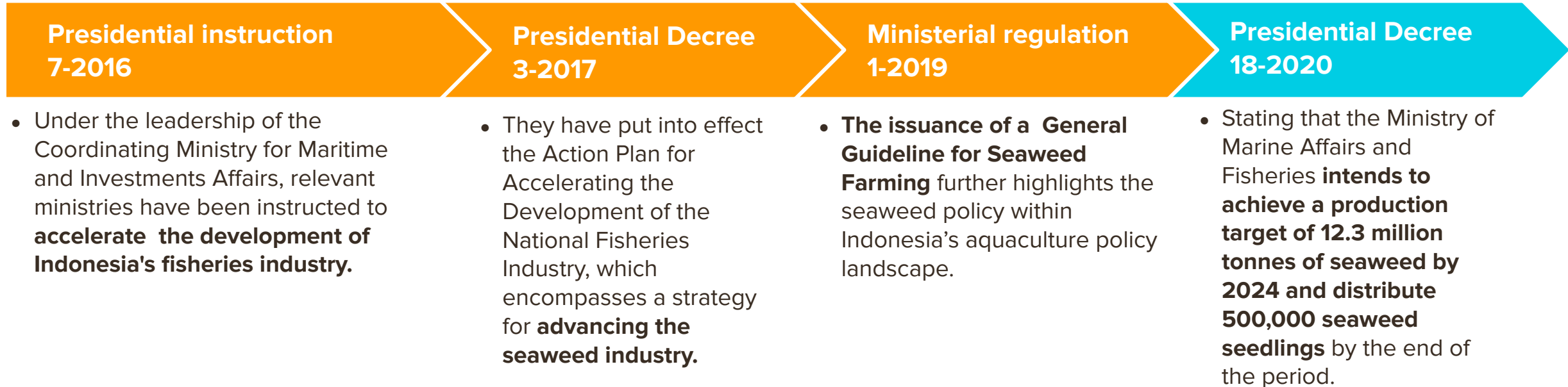
## Growth in production volumes

by species, 2010-2020, in million tonnes, growth %



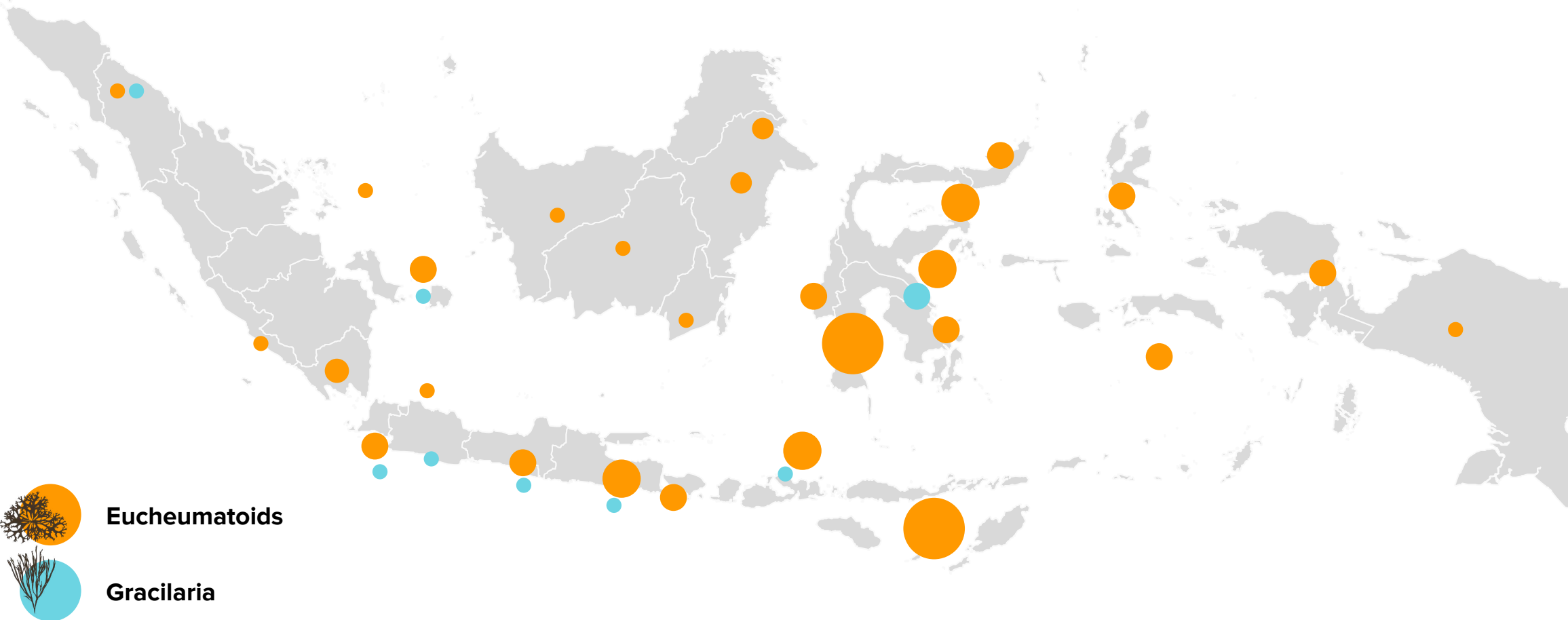
\*Eucheumatoids and Gracilaria are two species that are highly cultivated in Indonesia

# The Indonesian government has committed to fostering the growth of the seaweed industry by issuing several regulations since 2016.



Source: Partnership for Australia-Indonesia Research, 2023

# The seaweed cultivation landscape in Indonesia centers on two major seaweed types: **eucheumatoids** and **gracilaria**.

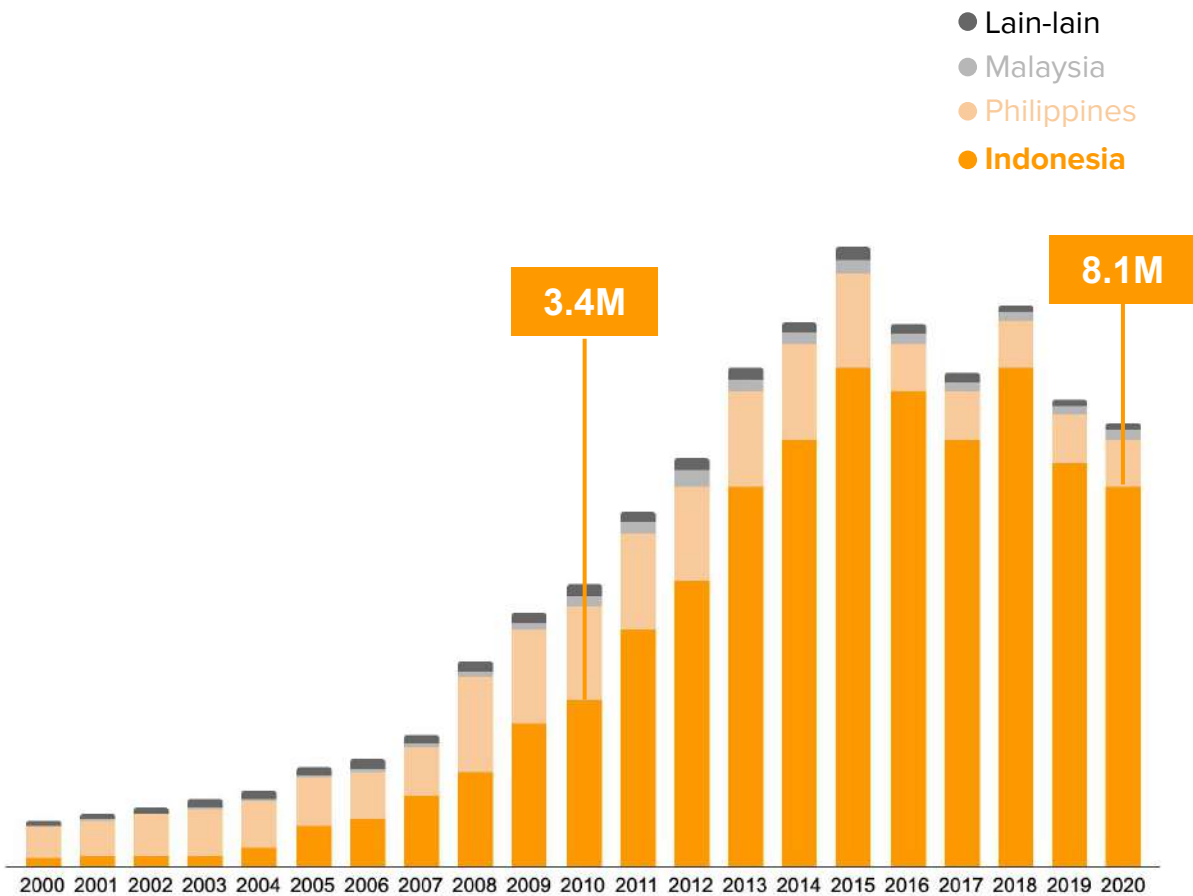


Source: Swiss Import Promotion Programme & KKP, 2019

With Indonesia being one of the world's major producers of eucheumatoids and gracilaria types of seaweed.

### Global production volume for Eucheumatoids

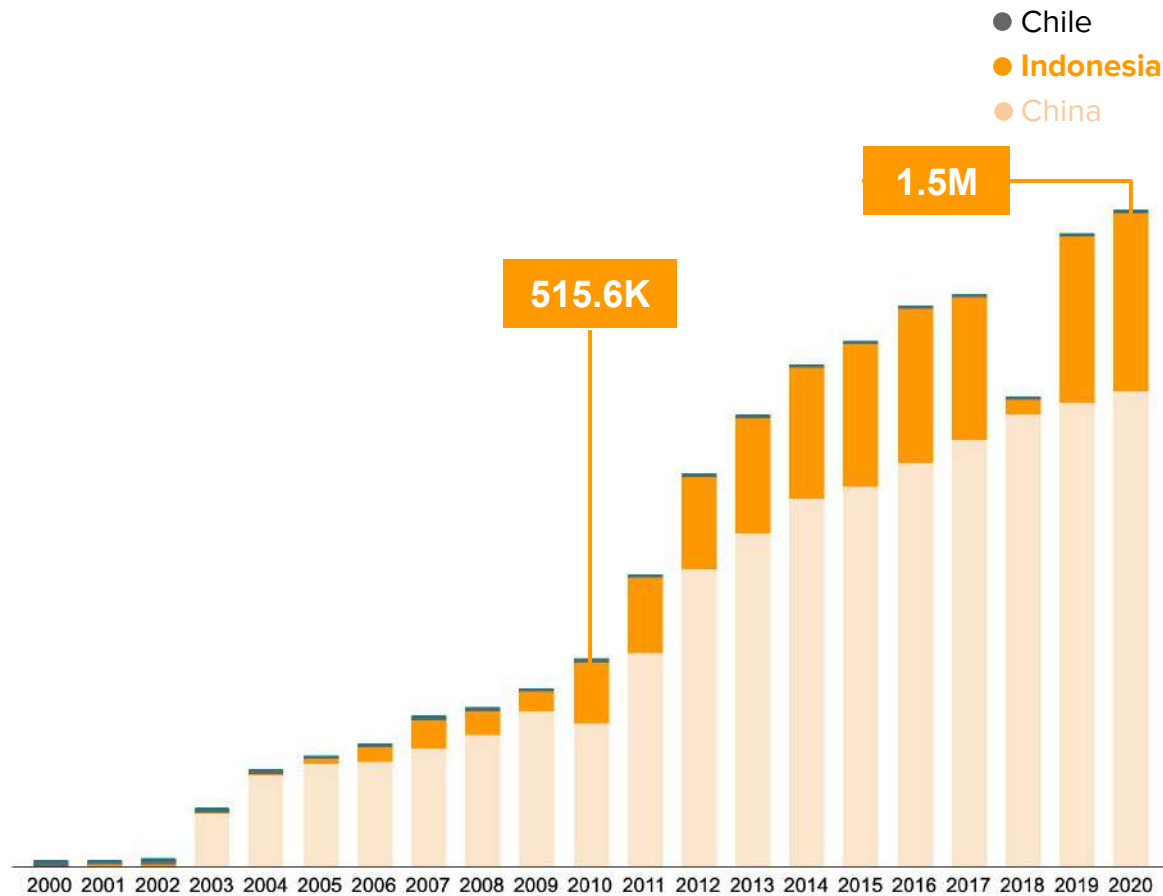
in million tonnes



Source: Seaweed Insights

### Global production volume for Gracilaria

in million tonnes

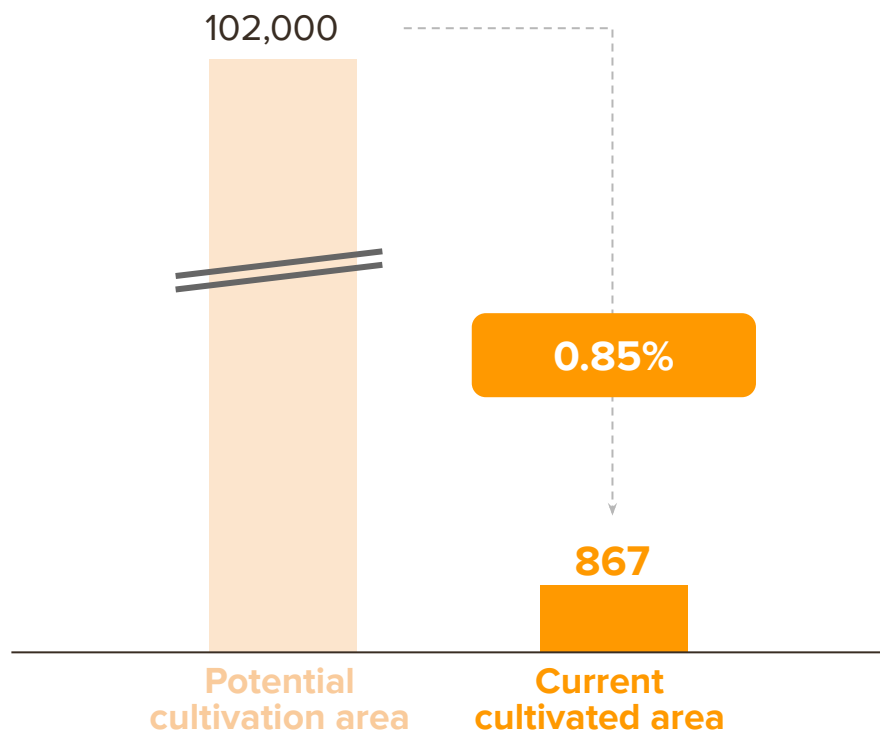


However, Indonesia has yet to capture the huge potential of the seaweed industry, as the country is only cultivating a fraction of the potential cultivation area, and the majority of exports are in the form of raw or dried seaweed.

### Seaweed potential vs current conditions

#### Cultivation area

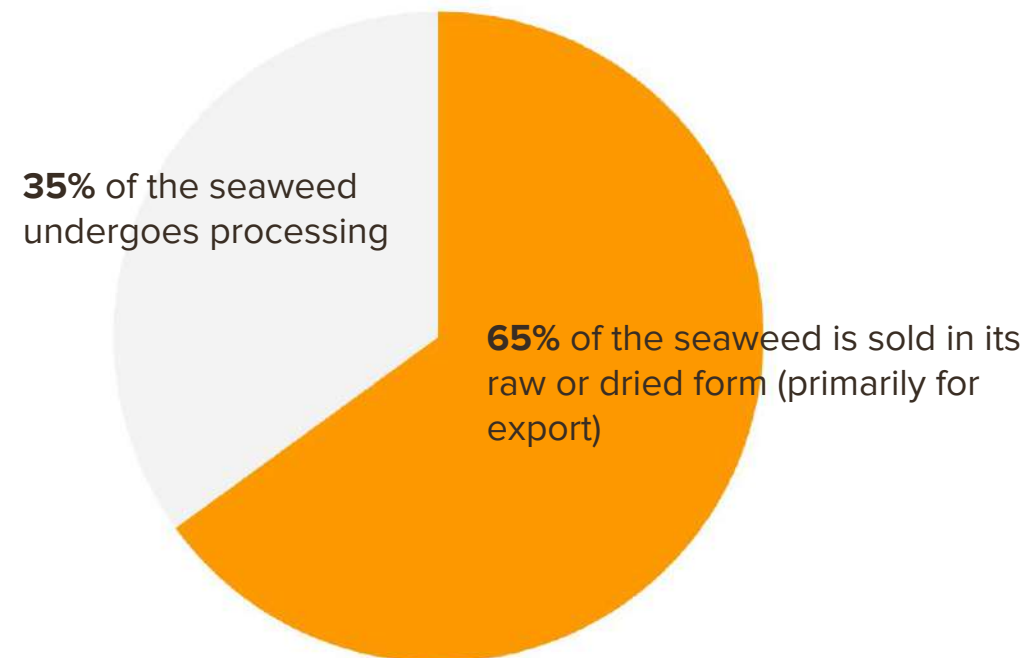
in Ha



Source: *United Nation, Antara News*

#### Level of processing

in %



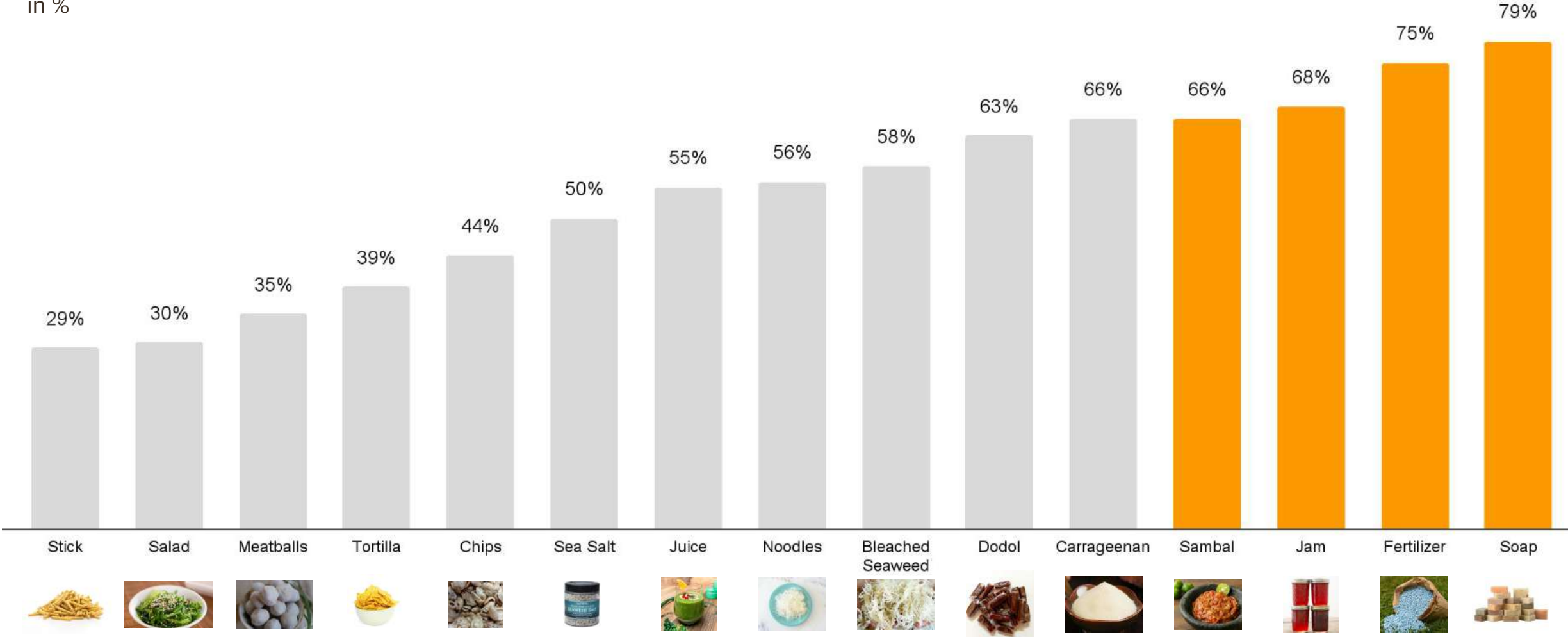
Source: *Ministry of Cooperative and MSMEs, in Expat Life Indonesia*



# Processing seaweed, while adding complexity, can lead to the creation and capture of more economic value within Indonesia.

## Estimated profit margin

in %



Source: Kopernik analysis

There are **26 targeted provinces** in Indonesia for national priority projects related to seaweed production. In Papua, due to the nascent stage of the seaweed sector, the government's focus is on seaweed seedling distribution.

Priority locations



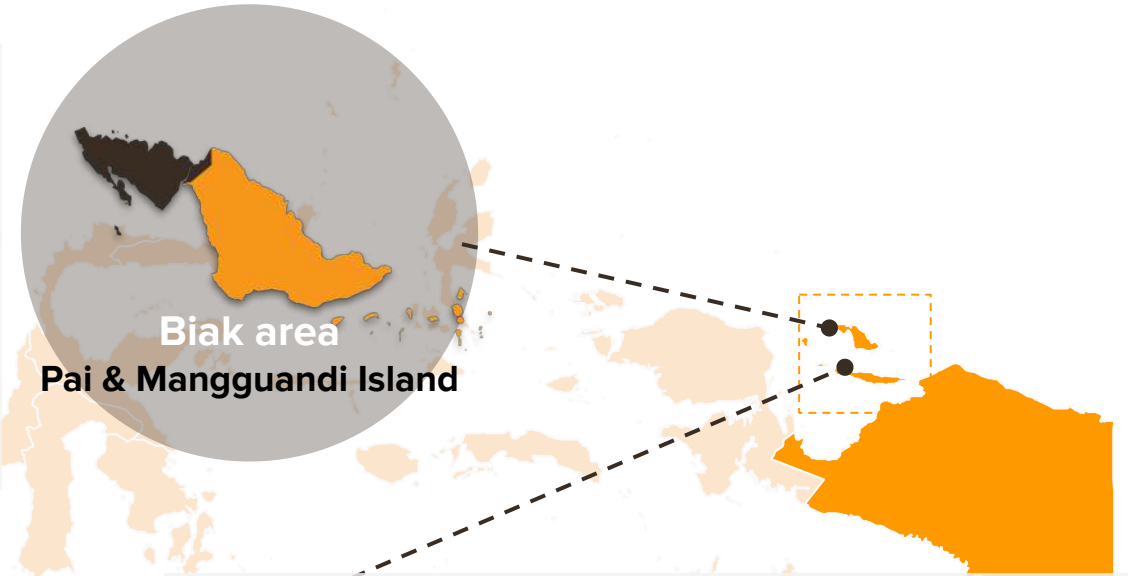
# Kopernik started an initiative to support coastal communities in Papua on revitalizing seaweed cultivation to create and capture more value in the seaweed market.

## Initiative to restore seaweed farming in Biak



### Economic Hardship Due to Limited Market Access

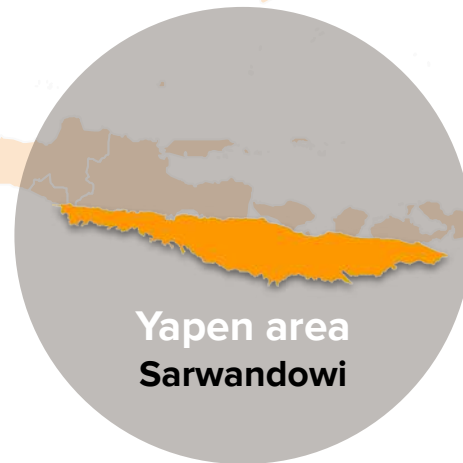
Seaweed farmers on Pai and Manggwandi Islands sold their harvest for only **Rp 5,000 per kilogram** because the local government was their only buyer. High logistics costs limited their access to broader markets, stunting economic growth.



Biak area  
Pai & Manggwandi Island

### Impact of COVID-19 on Seaweed Farming

The pandemic in 2019 had a devastating effect on the seaweed farming community, **eliminating buyers** and forcing farmers to **abandon** their seaweed plots, which led to economic and emotional distress.



Yapen area  
Sarwadowi

### Revival Through Community Efforts

Kopernik, supported by Japan's Ministry of Foreign Affairs, initiated a program to **restore seaweed farming** in these communities. The program currently includes **16 farmers** managing a total of **10 developed plots (0.65ha)**. Their efforts, which included training and group discussions, eventually led to a successful harvest after four years, bringing renewed hope and economic opportunity.

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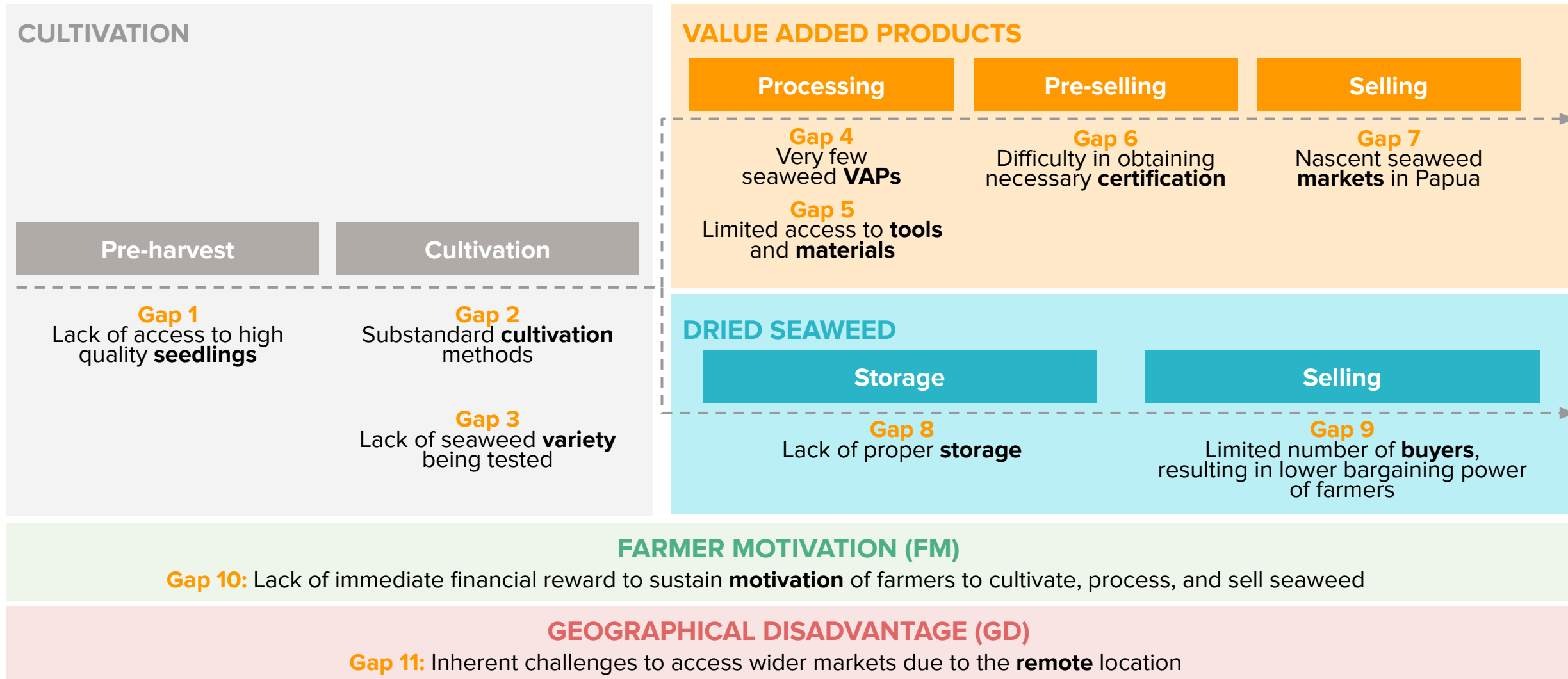
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# Project implementation and additional research identified **11 key gaps and opportunities** in the seaweed value chain in Papua

## Value chain of seaweed and **identified gaps**



# Gap 1: Despite the importance of using **high-quality seedlings**, farmers **do not know the relative quality of their seedlings** due to a **lack of vegetative cycle recording**.

## Importance of Ensuring Seedling Quality

*“When you have an old seaweed seedling, it will produce fewer young thalluses and thus, less carrageenan”*

- Erina Sulistiani, ERSAM Agro-Biotech

*“You can only propagate seedlings using **vegetative methods** up to **20 times** before the seaweed quality begins to decline”*

- Prof. Laode M. Aslan, Universitas Haluoleo

**BUT**

## Farmers

*“Occasionally, we receive **seedlings** from the **government**, which are said to be of good quality.*

*At **other times**, I buy **seaweed from other farmers** and cultivate my own seedlings. However, I **often don’t know the vegetative cycle of the seedlings I purchase**”*

- Yoseph, farmer in Yapen.

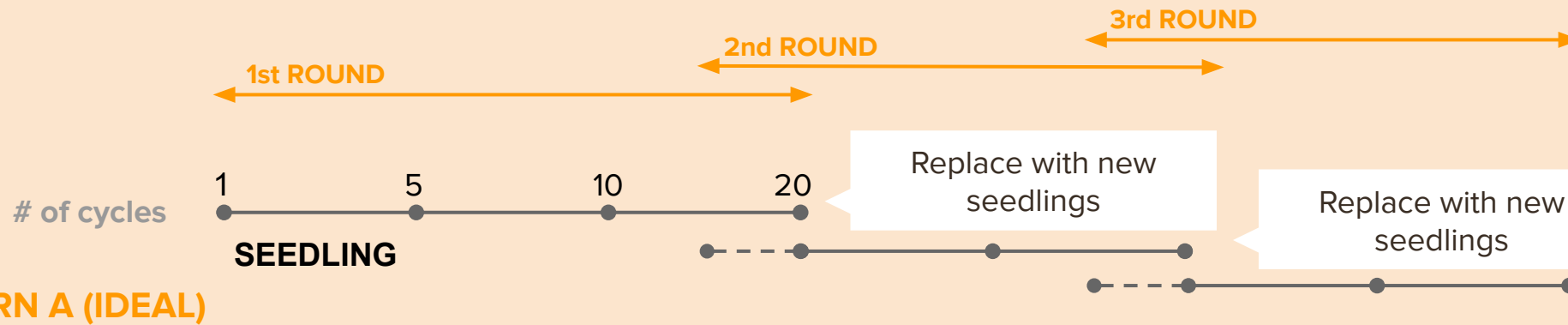
## Seedling Companies

*“It is **the responsibility of the nursery and farmers to track the number of times they propagate our plantlets** through the vegetative process, ensuring they do not **exceed 20 cycles.**”*

- Erina Sulistiani, ERSAM Agro-Biotech  
- Petrus Rani, BRIN & Ex-KKP  
- Wayan Sukadana, farmer in Nusa Penida

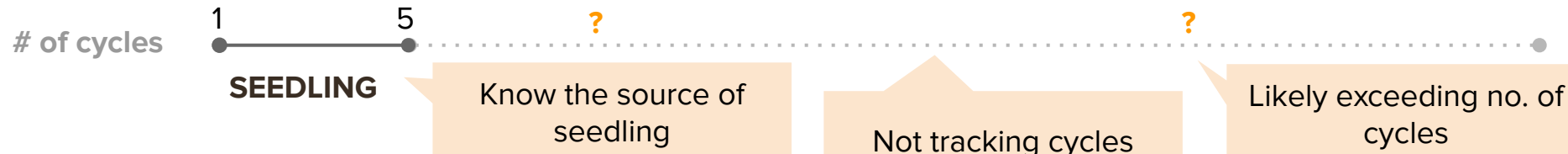
Once cultivation begins, farmers often lose track of the number of vegetative cycles, likely exceeding the maximum of 20 and resulting in lower-quality seaweed.

End Result

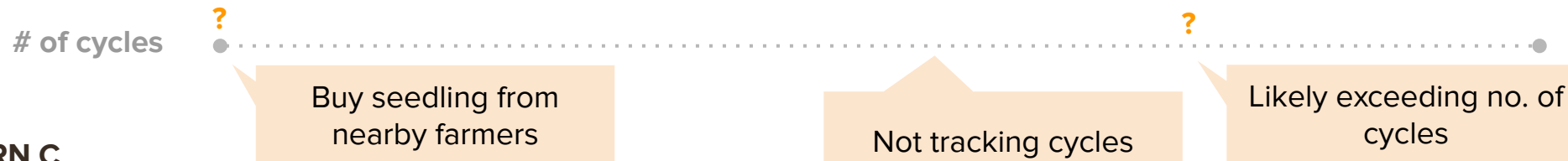


- High carrageenan content
- High Price

COMMON PRACTICE IN PAPUA

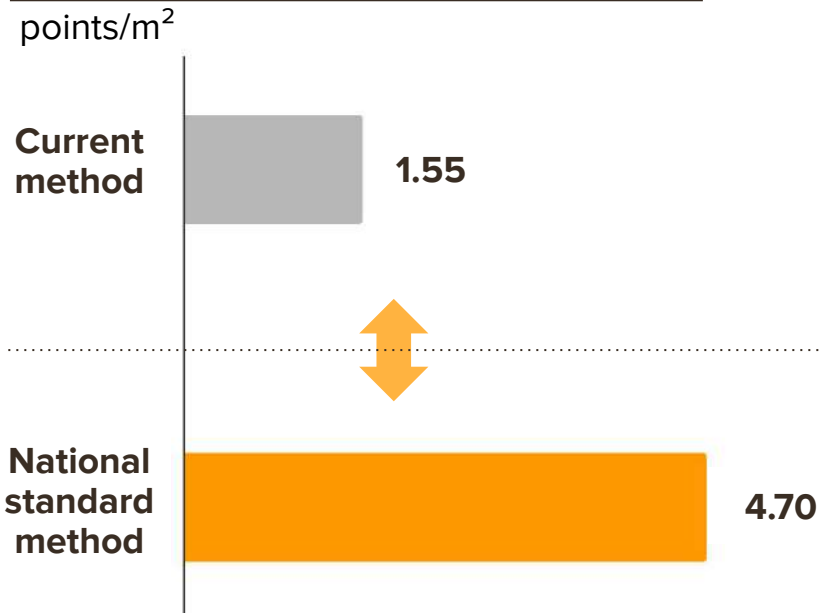


- Low carrageenan content
- Low Price



## Gap 2: Seaweed cultivation plots in Papua do not adhere to national standards, resulting in reduced yields, lower quality and increased susceptibility to disease.

### Density of seaweed cultivation



The density of seaweed in cultivation plots in Papua is much lower than the national standard.

### Tying Methods for Seaweed Seedlings

Overhand knot

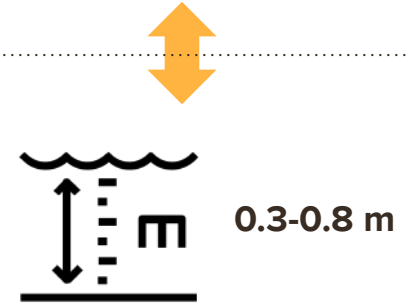
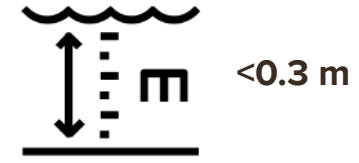


Ribbon knot  
(*simpul pita*)



When harvested using an overhand knot, the rope is cut and dried together with the seaweed, often leaving behind small plastic pieces that cause impurities. Switching to the national standard ribbon knot (*simpul pita*) could make it easier to remove the rope, reducing these impurities.

### Depth of Cultivation



Seaweed grown closer to sea level is more exposed to rainwater during the rainy season, increasing the risk of ice ice disease and potentially leading to failed harvests

Source: Indonesia National Standard (SNI) 7579.2:2010 \* for *Kappaphycus Alvarezii (cottonii)* cultivation using longline method

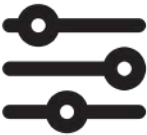


**Gap 3: In Papua, seaweed farming focuses exclusively on eucheumatoids (cottonii). This single-species approach increases **vulnerability to disease** and limits opportunities to diversify into other value added products (VAPs).**

**Disease mitigation, optimizing cultivation, and increase VAPs**



Cultivating a variety of **seaweed species can help manage and mitigate diseases**. Different seaweed species exhibit unique **resistance to various pathogens** and **environmental stresses**, enhancing the overall resilience of seaweed farms\*.






Diversifying seaweed cultivation by introducing new, disease-resistant varieties and optimizing cultivation techniques can **improve the sustainability and health of seaweed farming operations\*\***.



Expanding the cultivation beyond cottonii to include other species could **increase the potential for various Value-Added Products (VAPs)**. This diversification can open up new market opportunities and create a broader range of seaweed-based products

**Potential value-added products (VAPs)**

Type of Seaweed	Type of VAPs
<b>Spinosum</b> 	Agar
	Gelling agent
	Salad
<b>Gracilaria</b> 	Biofertilizer
	Agar
	Salad
<b>Cottonii</b> 	Carrageenan
	Food ingredients
	Cosmetics



\*Swiss Import Promotion Programme & KKP, 2019  
 \*\*Asha, A., Rathi, M., Patric Raja, J., & Sahayaraj, K. (2012).

# Gap 4: The **limited market for value-added seaweed products** in Papua and Indonesia, coupled with the **absence of cottonii processing facilities** in Papua, presents both challenges and opportunities.

## Rare examples of seaweed-based products



Smallholder farmers in Yapen have begun producing seaweed sticks on a small scale

## Cottonii processing plants in Indonesia



# Gap 5: Although some **general tools for creating value-added products** are available in Biak City, farming families face **challenges accessing them**. Additionally, **specialized equipment** often needs to be **shipped in from outside Biak**, further complicating access.

## General tools and materials can be found in the city

(not exhaustive)

Mixing bowls and spoons	
Blender & food processor	
Cooking & hygiene products	
General ingredients	

## Special tools that need to be shipped from outside of Biak

(not exhaustive)

Dehydrator or drying racks	
Specific machinery	
Packaging tools & materials	
Specific ingredients	

## Gap 6: Farmers, micro and small businesses in Papua **struggle to obtain necessary certification** due to a lack of understanding about the requirements or processes to apply.

		Type of VAP		
		Simple	Semi-Complex	Complex
PIR-T	<b>1. Application Letter:</b> An application letter submitted to the local Health Department or County/City Health Department.	✓	✓	✓
	<b>2. Applicant Identity:</b> Photocopy of the business owner's ID card (KTP).	✓	✓	✓
	<b>3. Business Domicile Certificate:</b> A certificate of business domicile from the local village office.	✓	✓	✓
	<b>4. Business Location Map:</b> A map or layout of the business location.	✓	✓	✓
	<b>5. Product List:</b> A list of products produced along with their types.	✓	✓	✓
	<b>6. Food Safety Training Certificate:</b> A certificate indicating that the applicant has completed food safety training conducted by the Health Department.	✓	✓	✓
	<b>7. Laboratory Test Results:</b> Laboratory test results for the produced products, such as microbiological tests.	✓	✓	✓
BPOM	<b>8. Registration Application Letter:</b> An application letter addressed to BPOM.		✓	✓
	<b>9. Product Data:</b> Complete information about the product, including its name, composition, and packaging.		✓	✓
	<b>10. Laboratory Test Results:</b> Laboratory test results proving the safety and quality of the product.		✓	✓
	<b>11. Product Label:</b> A sample label that complies with BPOM regulations.		✓	✓
	<b>12. Production Certificate:</b> A certificate indicating that the production site meets BPOM standards.		✓	✓
NIB	<b>13. Applicant Identity:</b> Photocopies of the business owner's or responsible person's ID card (KTP) and taxpayer identification number (NPWP).		✓	✓
	<b>14. Business Data:</b> Complete information about the business, including its name, address, type of business, and capital.		✓	✓
	<b>15. Deed of Establishment:</b> For legally registered businesses, include the deed of establishment and any amendments		✓	✓
	<b>16. Environmental Permit:</b> If required, include an environmental permit or environmental impact analysis.		✓	✓

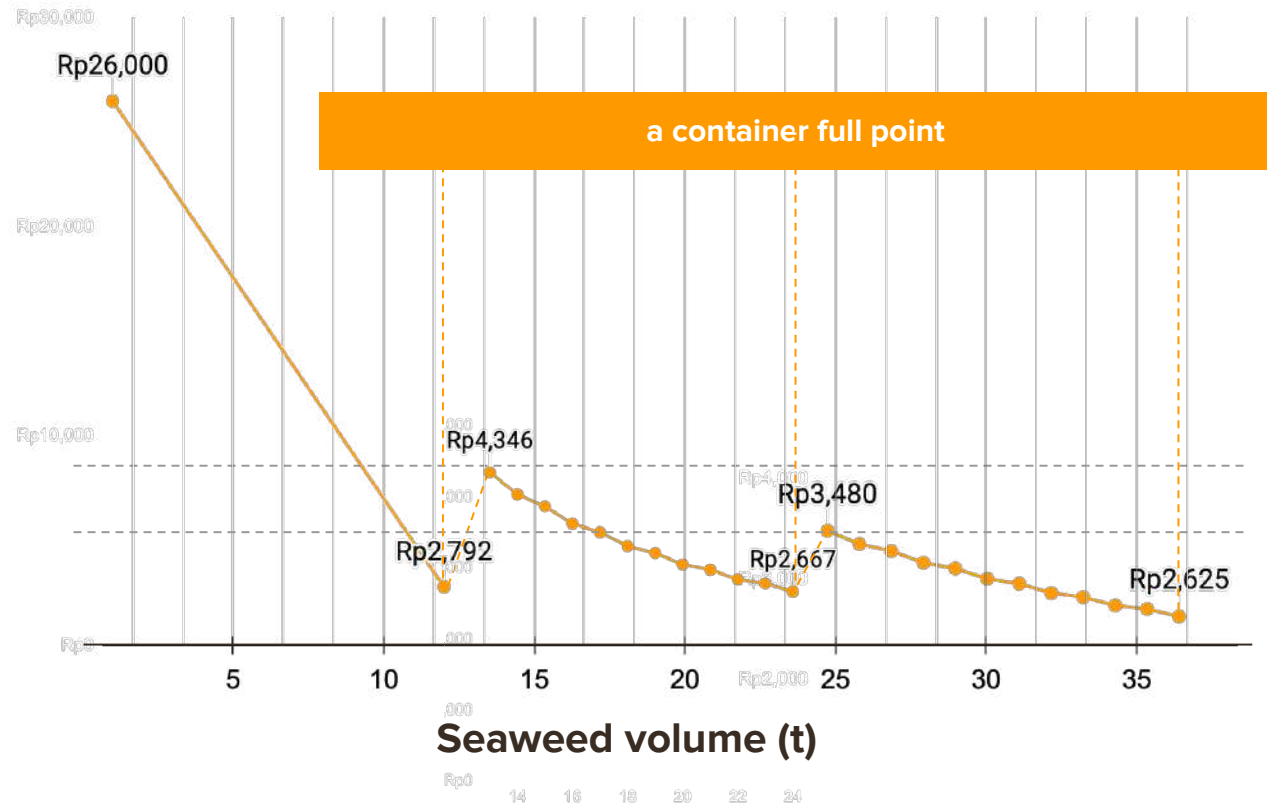
**Gap 7: Value Added Products are currently sold **only within the local area through word of mouth**, missing out on broader market opportunities.**



**Gap 8: Current production levels are too low for farmers to fill a full shipping container, making it challenging to sell to buyers in major cities due to high shipping costs. As a result, seaweed must often be stored for up to 30 months while farmers cultivate sufficient seaweed.**

### Cost of shipping seaweed per kg

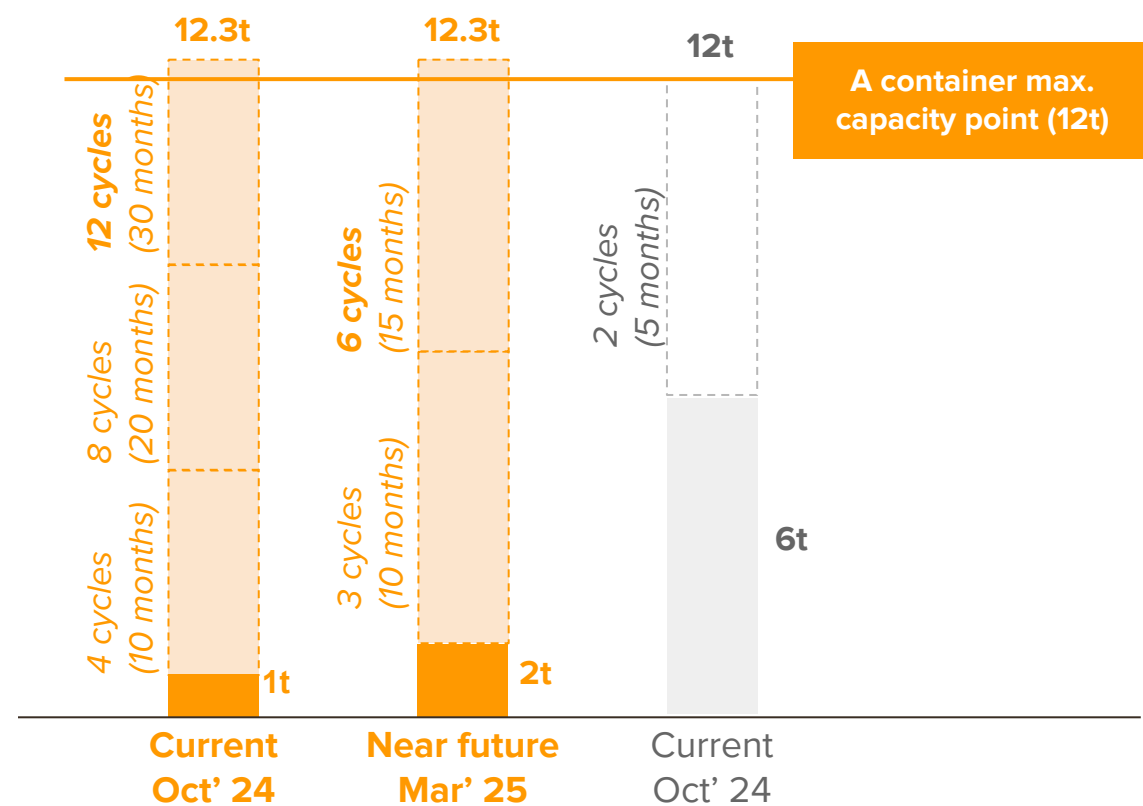
Cost in IDR per kg



### Current and future production volume

in tonnes

■ Biak ■ Yapen



However, Papua **lacks proper storage facilities** for dried seaweed, which in turn compromises the quality and marketability of the product.

### Existing storage facility available in Biak



An example of a seaweed storage facility in Biak, owned by a local middleman, has a size comparable to a standard shipping container (4mx4mx2m), allowing for easy estimation of the quantity of the stored commodities. However, this facility has several shortcomings:

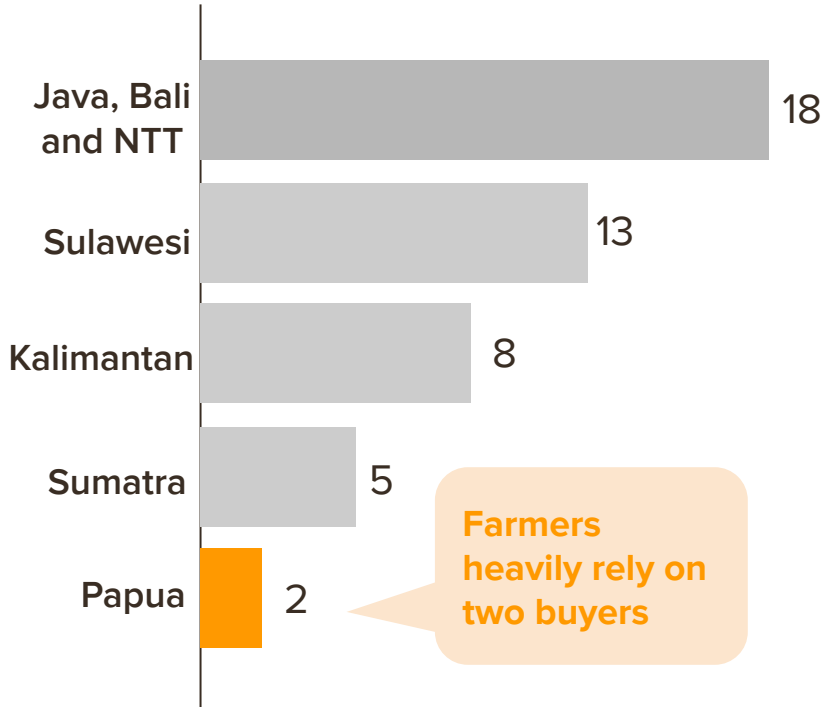
1. **No ceiling**, making the seaweed susceptible to falling dust and debris.
2. **No temperature or moisture control** makes it hard to manage humidity and temperature, putting the seaweed at higher risk of mold and mildew, especially in humid conditions
3. **No labelling system** to track the origin and age of the seaweed.
4. **No proper ventilation**, which affects air circulation.
5. **No floor elevation**, leading to potential moisture condensation and increased risk of pest or dust contamination.

These limitations make it difficult to maintain the seaweed quality during storage.

# Gap 9: Farmers in Papua heavily rely on only a few buyers, which restricts their bargaining power and leads to lower-than-fair market prices.

## Seaweed buyers in the region

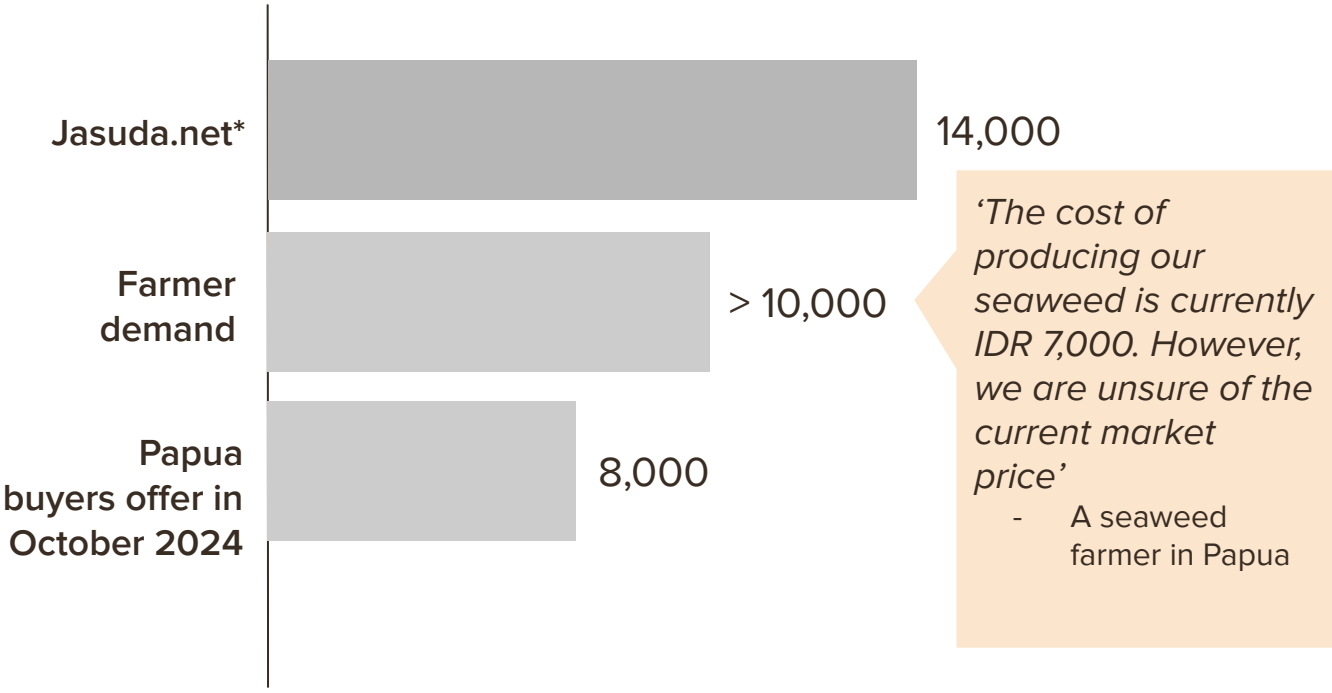
# of seaweed buyers, indicative



**Farmers heavily rely on two buyers**

## Price perceived by different stakeholders

IDR per kg, October 2024



*'The cost of producing our seaweed is currently IDR 7,000. However, we are unsure of the current market price'*  
 - A seaweed farmer in Papua

Source: Findings from Kopernik's field visit to Papua & Kopernik internal analysis

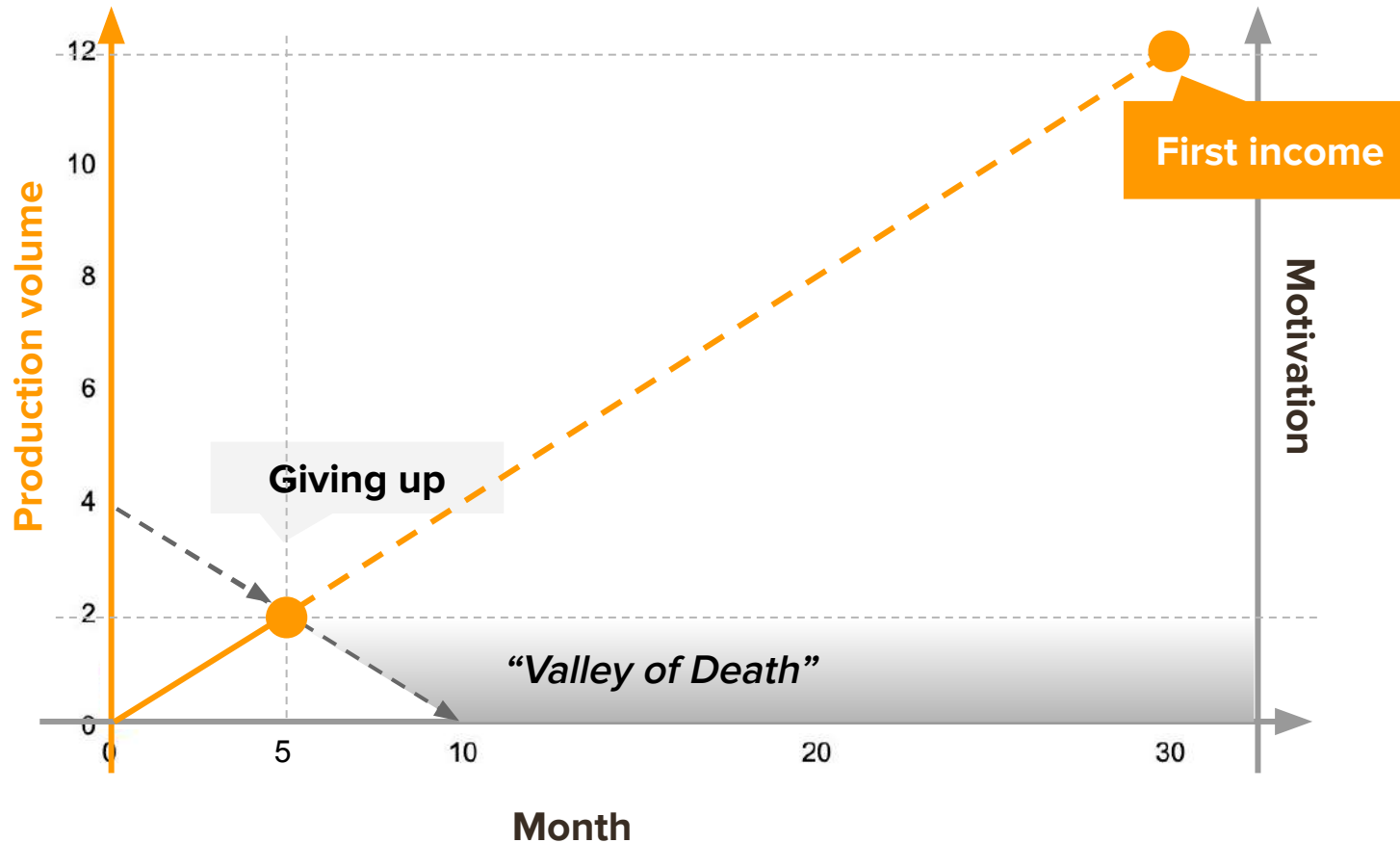
\*Jasuda.net: JaSuDaNeT is an information network platform for seaweed in Indonesia, affiliated with Seaplanet Foundation



**Gap 10: If farmers must wait until they reach full shipping container volume to receive their first income, they may abandon seaweed production altogether, as has happened in the past.**

### “Valley of Death” for seaweed farmers

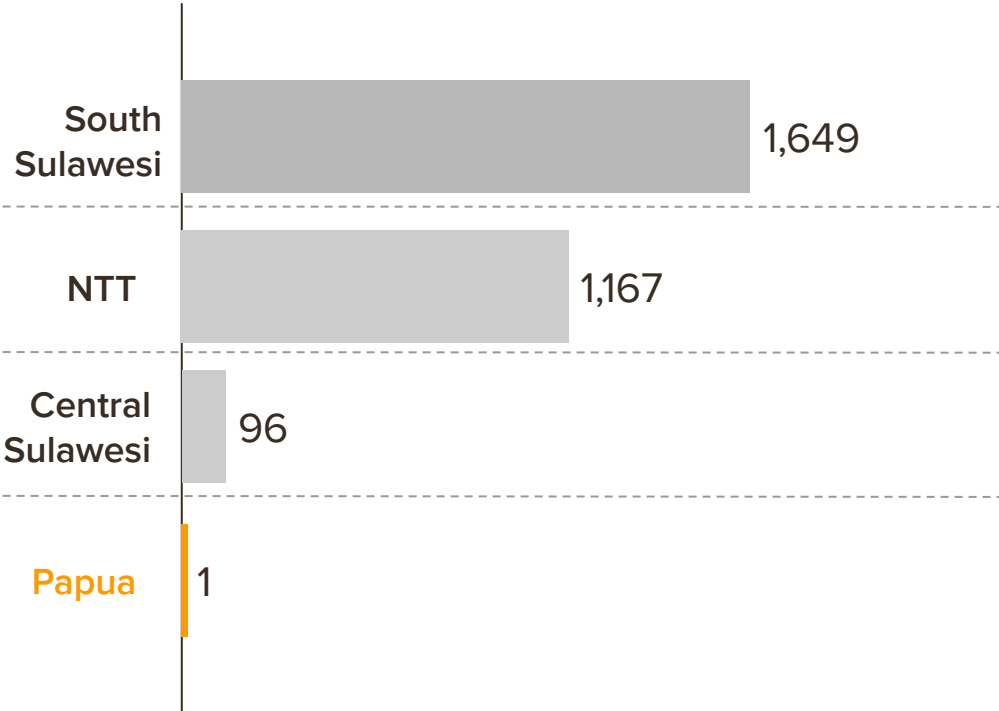
motivation vs. production volume



**Gap 11: The seaweed industry in Papua faces inherent challenge in accessing wider Indonesian and international markets, largely due to its remote location.**

**Top 3 provinces of eucheuma cottonii production**

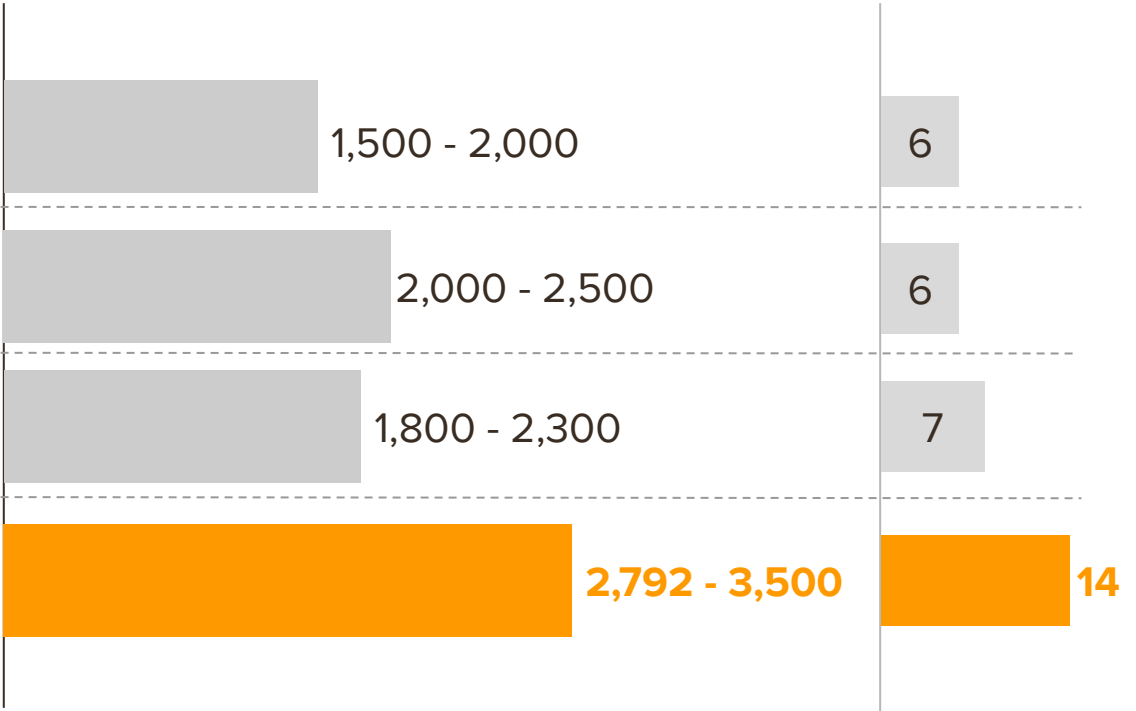
in tonnes



Source: Ministry of Marine Affairs and Fisheries

**Cost of shipping a container full of seaweed to Surabaya**

(left - IDR per kg; right - # of days for shipment to arrive)



Source: PT.PELNI and Linustrans Indonesia

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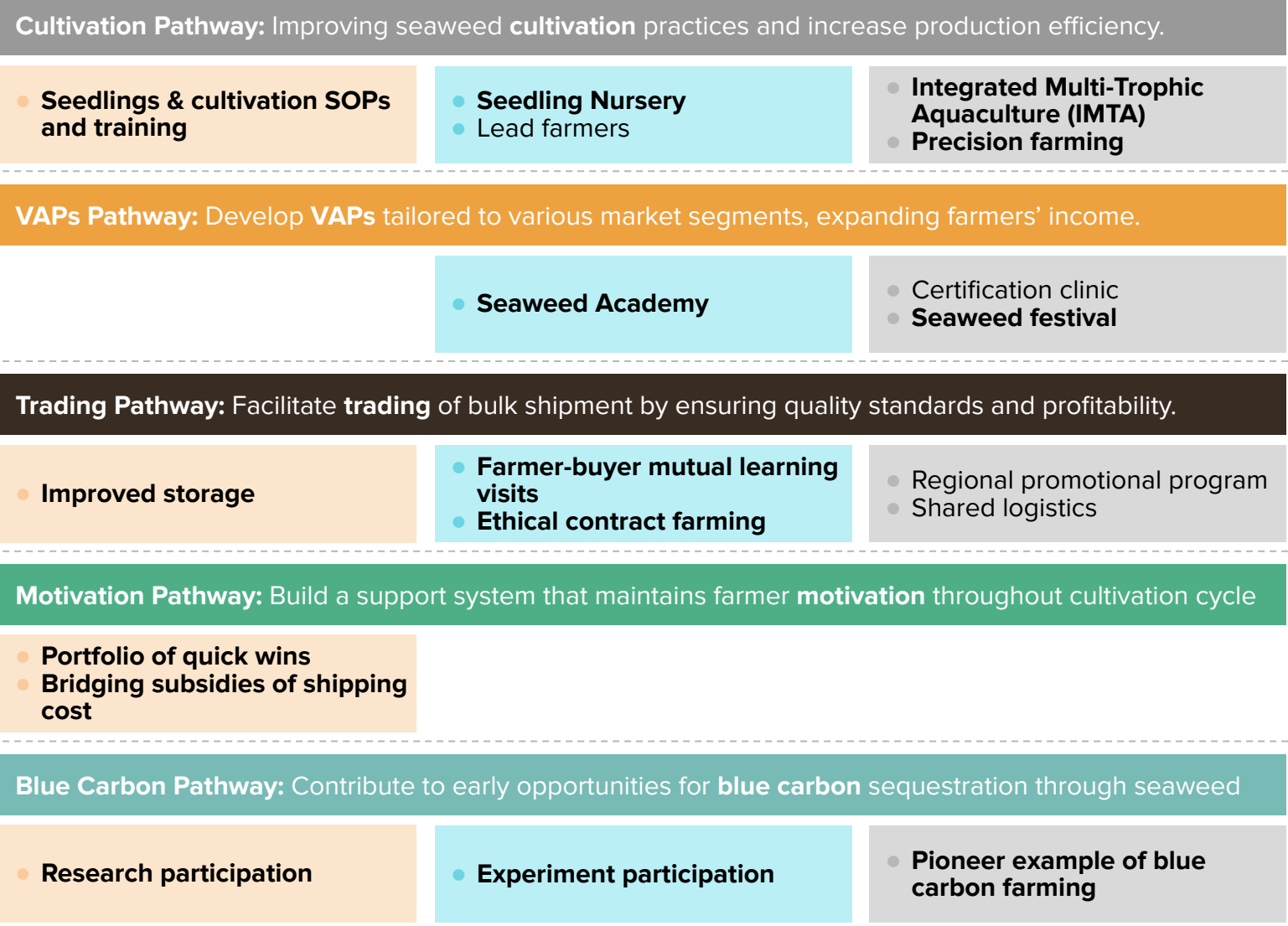
# Several prioritized potential solutions have been identified to address 11 unmet needs.

## Gaps identified

- |             |     |   |
|-------------|-----|---|
| CULTIVATION | 1.  | Lack of access to high quality seedlings  |
|             | 2.  | Substandard cultivation methods   |
|             | 3.  | Lack of seaweed variety being tested  |
|             | 4.  | Lack of knowledge on seaweed VAPs   |
| VAPs        | 5.  | Limited access to tools and materials   |
|             | 6.  | Difficulty in obtaining necessary certification   |
|             | 7.  | Nascent seaweed markets in Papua  |
| DRIED       | 8.  | Lack of proper storage  |
|             | 9.  | Limited number of buyers, resulting in lower bargaining power of farmers                                    |
| FM          | 10. | Lack of immediate financial reward to sustain motivation of farmers to cultivate, process, and sell seaweed |
|             | 11. | Inherent challenges to access wider markets, due to the remote project location                             |
| GD          |     |   |

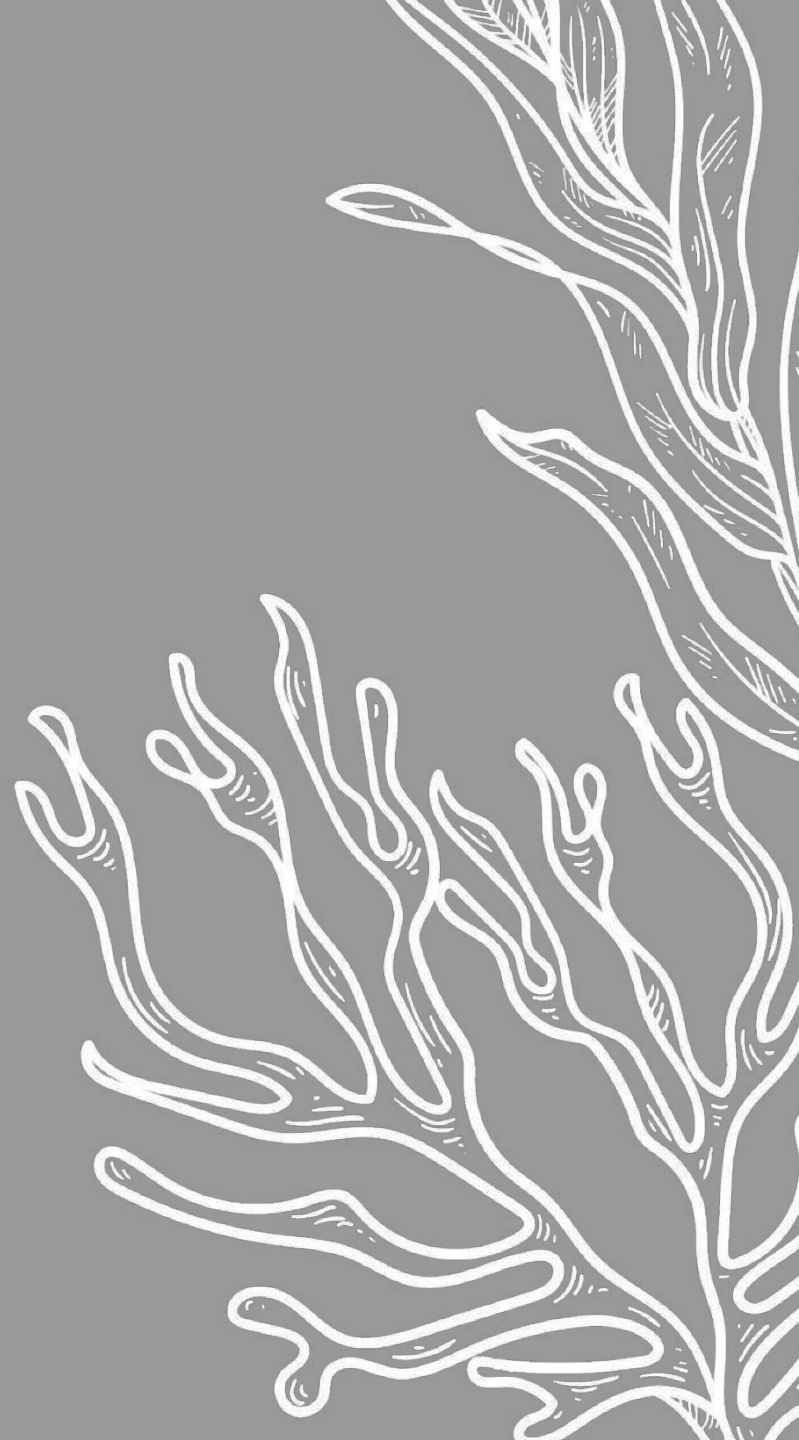
## Stage of potential solutions

Early stage
Establishing stage
Developing stage



# CULTIVATION PATHWAY

How might we equip farmers to meet market demand by **improving seaweed cultivation practices, increasing production efficiency, and enhancing overall quality** to ensure competitiveness in the market.



**The cultivation pathway** aims to improve seaweed farming techniques, increase production efficiency, and ensure better product quality.

### Early stage

#### Seedling & cultivation SOPs and training

Creating Standard Operating Procedures (SOP) to ensure all farmers follow best practices, improving consistency in crop quality and harvest outcomes.

Gap 1

### Establishing stage

#### Seedling Nursery

Establishing nurseries on each island dedicated to growing seaweed seedlings to ensure that farmers have a reliable supply of high-quality, disease-resistant varieties, which will lead to improved yields and more sustainable cultivation practices.

Gap 1

Gap 3

#### Lead Farmers

Identifying lead farmers to take on specific roles (e.g., management, logistics, seedling distribution), whereby tasks can be streamlined, ensuring better coordination and execution of farming activities. These lead farmers will be independent of farmers who are doing cultivation.

Gap 1

Gap 2

### Developing stage

#### Integrated Multi-Trophic Aquaculture (IMTA)

Cultivating seaweed with other species such as clams, fish and shellfish in one farming area to maintain a balanced ecosystem.

Gap 2

Gap 3

Gap 10

#### Precision Farming

Developing data-driven farming by measuring temperature, salinity, pH, growth rate etc. to optimize planting location, schedules, disease management, and harvest timing.

Gap 1

Gap 2

Gap 11

# Seedling & cultivation Standard Operating Procedures (SOPs) and training seeks to standardize practices for consistent crop quality and improved harvest outcomes.

## Gaps & challenges:

1. Lack of access to high quality seedlings

2. Substandard cultivation methods

## Program/experiment design

### Key activities



- Develop **cultivation Standard Operating Procedures (SOPs)** for farmers to follow good practices in seedling sourcing and cultivation processes, such as **seedling cycle, cultivation density, tying methods, depth of cultivation** etc.
- **Provide regular training to farmers using the developed SOPs** to enhance and retain their knowledge and skills for better productivity.
- **Monitor implementation regularly** to ensure farmers adhere to SOPs, promoting accountability and continuous improvement.

## Outputs



- Increase in knowledge of farmers regarding seedling sourcing and cultivation processes.

## Outcomes



- Improved crop quality that increases market value and competitiveness.

# A Seedling Nursery works towards establishing reliable sources of high-quality, disease-resistant seaweed seedlings on each island.

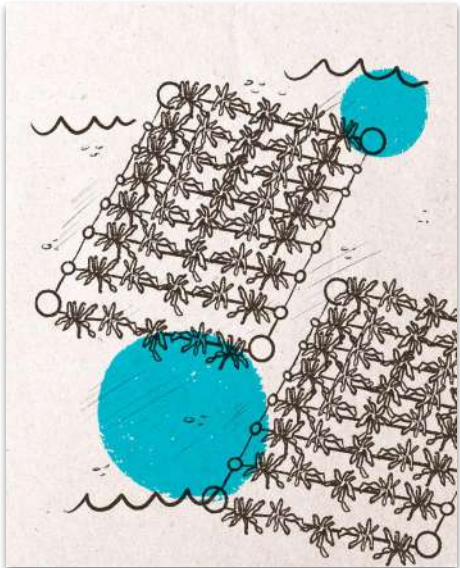
## Gaps & challenges:

1. Lack of access to high quality seedlings

3. Lack of seaweed variety being tested

## Program/experiment design

### Key activities



- Establish **nurseries on each island** dedicated to growing seaweed seedlings, providing farmers with a reliable, localized supply.
- **Select and cultivate high-quality, disease-resistant varieties** to ensure improved yields and more resilient crops.
- **Train nursery staff and farmers on seedling handling, maintenance, and distribution** to ensure proper techniques are followed throughout the process.

## Outputs



- Consistent supply of high-quality seedlings to farmers.

## Outcomes



- Increased yields due to better seedling quality.
- Reduced crop failure.
- Higher price due to the resulting higher quality seaweed.



# Integrated Multi-Trophic Aquaculture (IMTA) aims to increase seaweed farming resilience against environmental stresses while offering farmers additional income.

## Gaps & challenges:

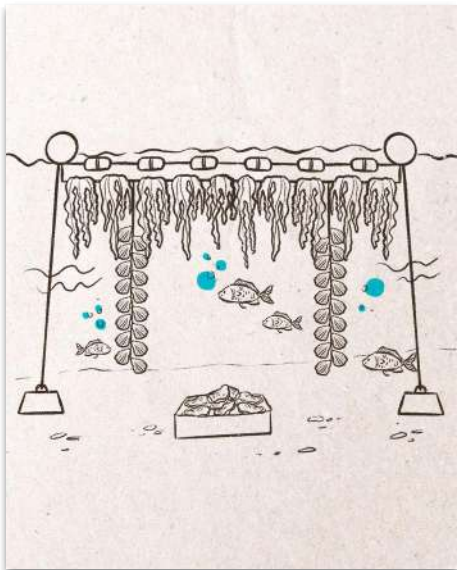
2. Substandard cultivation methods

3. Lack of seaweed variety being tested

10. Lack of immediate financial reward to sustain motivation of farmers to cultivate, process, and sell seaweed

## Program/experiment design

### Key activities



- Conduct training sessions for farmers on **multi-species cultivation techniques**, highlighting the **economic** and **ecological advantages** and best management practices for cultivating seaweed alongside **clams, fish, and shellfish**.
- Conduct site visits and workshops where **farmers can observe successful multi-species farms and learn about best practices** for maintaining a balanced ecosystem.
- Assist farmers in **implementing IMTA** by providing technical guidance and support.
- **Monitor farming practices and provide feedback** to ensure the health of each species and that the balance of the ecosystem is maintained.

## Outputs



- Improved farmer knowledge and capacity for cultivating seaweed alongside other marine species.

## Outcomes



- More resilient farming that reduces the risk of disease and crop failure.
- Increased income and income stability for farmers due to diversified products.

# Precision Farming aims to improve decision-making through data collection and monitoring for optimized overall farming practices.

## Gaps & challenges:

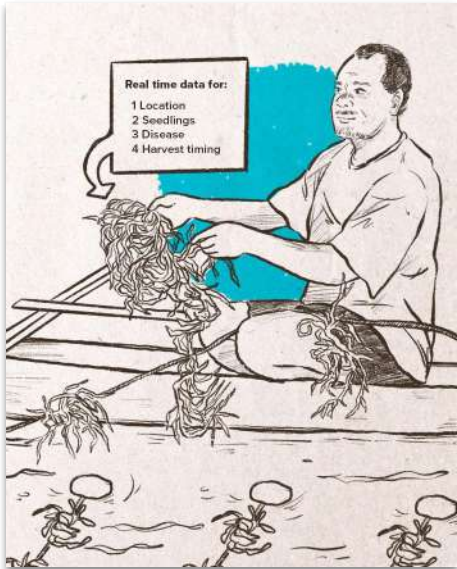
1. Lack of access to high quality seedlings

2. Substandard cultivation methods

11. Papua's remote location poses inherent challenges to access wider markets

## Program/experiment design

### Key activities



- Identify areas where real time data is most needed, such as:
  - Determining farming locations
  - Timing of introducing new seedlings
  - Detection and mitigation of diseases
  - Growth monitoring
  - Harvest timing
- Support farmers with **data** and **technological tools** such as **satellite data**, **remote sensing devices**, and **weather forecasting software** to optimize farming practices.
- Provide **ongoing guidance on using technology** to interpret data and adjust practices through **frequent extension agent visits**.

## Outputs



- Better-informed farming practices.
- Development of optimized cultivation calendar based on seedling cycles and environmental data.

## Outcomes



- Higher yields.
- (Easier and lower cost of data collection for carbon sequestration calculations).

# VAPs PATHWAY

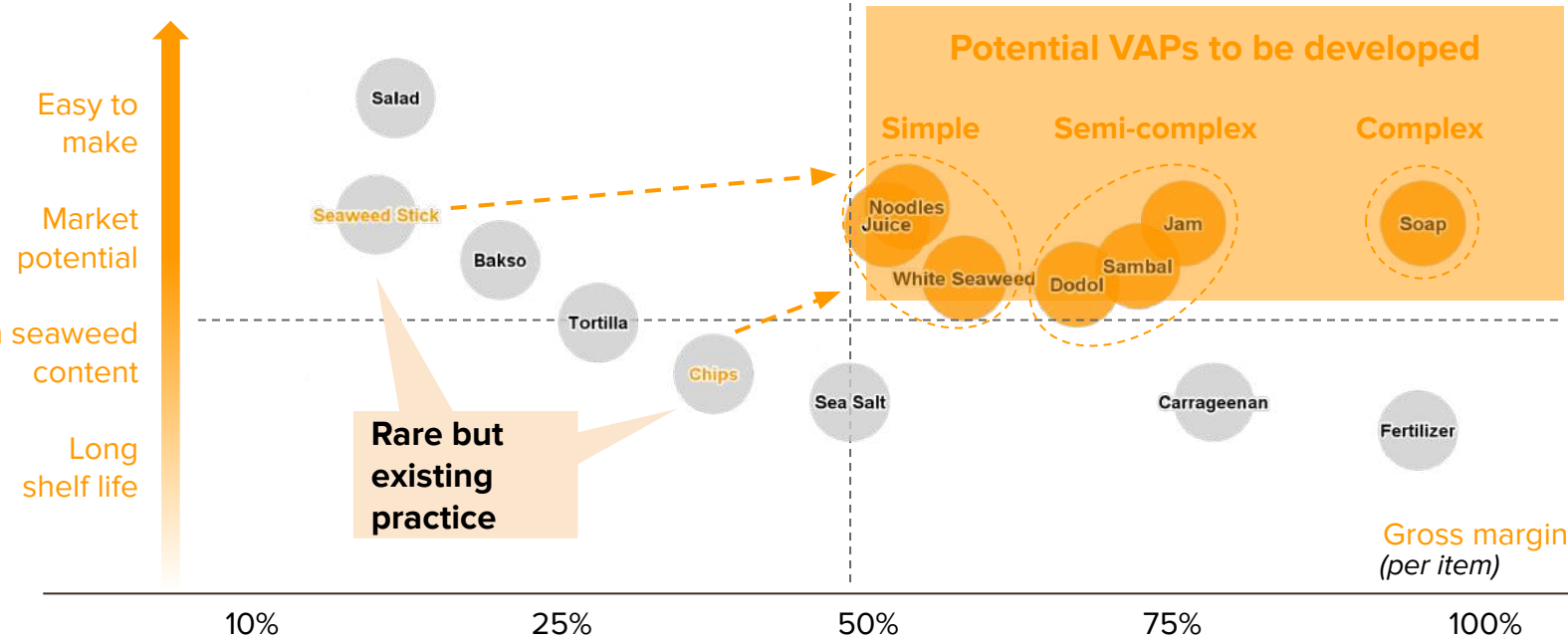
How might we create a diverse portfolio of seaweed-based products **tailored to various market segments, increasing farmers' income opportunities** and strengthening the seaweed value chain.



# There are many potential Value Added Products (VAPs) to explore and experiment with.

## Seaweed value added products aggregated data on various indicators\*

% of gross margin, aggregated data (average of complexity, market potential, seaweed content, shelf life)



Chips



Noodle



Dodol



Soap



Sambal



ATC\*\*

\*Kopernik internal analysis

\*\*ATC=Alkali Treatment Cottonii: This process involves treating Cottonii with an alkaline substance, typically potassium hydroxide (KOH) or sodium hydroxide (NaOH).

# The VAP pathway aims to develop a diverse range of seaweed products and target various market segments.

## Establishing stage

### Seaweed Academy

Establishing a Digital Seaweed Academy platform to provide comprehensive resources for farmers to innovate and develop their VAPs.

Gap 4

Gap 5

Gap 6

## Developing stage

### Seaweed Festival

Hosting a seaweed festival to promote products, increases consumer interest, and strengthen community support for seaweed farming.

Gap 7

Gap 10

Gap 11

### Certification clinics

Develop a certification clinic to guide farmers and producers through the certification process, helping them meet industry standards.

Gap 6

**The Seaweed Academy** can provide MSMEs and farmers families with comprehensive training to develop seaweed-based VAPs, offer a hub equipped with production tools to support the creation of VAPs, as well as a digital knowledge portal.

Gaps & challenges:

4. Lack of knowledge on seaweed VAPs

6. Difficulty in obtaining necessary certification

2. Substandard cultivation methods

## Program/experiment design

## Outputs

## Outcomes

### Key activities



- **Tools and equipment provision:** The VAPs development will be supported by providing the MSMEs and women in islands with **tools** and **equipment** needed to produce VAPs.
- **Training program:** The training program aims to equip MSMEs in Biak and women in islands entrepreneurial skills through VAPs development. The training modules cover topics such as **production management**, **financial management**, and **product marketing & branding**.
- **Digital knowledge portal:** Digital knowledge portal to empower farmers, families, and MSMEs with: Market-ready value-added **product ideas**, Easy-to-follow VAP **recipes** Basics of seaweed **cultivation**, **types**, **certifications**, and **blue carbon opportunities**.



- MSMEs and women have access to essential production tools and equipment.
- MSMEs and women trained in VAP production and marketing, as well as have access to digital knowledge portal.



- Increased number of VAPs available and sold in the market.

# The Seaweed Festival aims to raise awareness of the role of seaweed in Papua's economic development and strengthen engagement between local communities and stakeholders.

## Gaps & challenges:

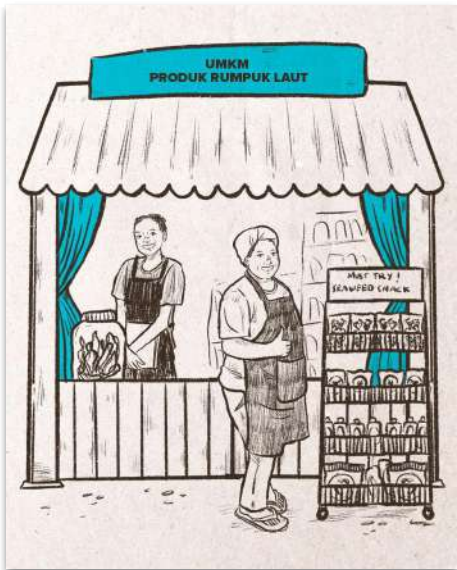
7. Nascent seaweed markets in Papua

10. Lack of immediate financial reward to sustain motivation of farmers to cultivate, process, and sell seaweed

11. Papua's remote location poses inherent challenges to access wider markets

## Program/experiment design

### Key activities



- **Organize a large scale seaweed festival** in Papua to **raise awareness** on the opportunities in seaweed farming and seaweed derived products, which can include:
  - **Product fair and competition** to display and sell seaweed derived products and engage visitors to test and vote for the best seaweed products
  - **Cooking demonstrations**, featuring local chefs and showcasing dishes that incorporate seaweed.
  - **Seaweed discussion** where relevant stakeholders discuss the challenges and opportunities of seaweed in Papua
  - **Match-making** to facilitate networking between farmers, MSMEs, bulk buyers, and investors

## Outputs



- Increased awareness on Papuan seaweed and its potential by the participants of the festival.
- Farmers and VAP producers earning income from product sales.

## Outcomes



- Additional partnerships created to further encourage seaweed industry in Papua.
- Seaweed becomes one of the important industries in Papua.

# TRADING PATHWAY

How might we **facilitate efficient market access** by **streamlining the bulk trading process**, **enhancing transaction transparency**, **ensuring quality standards**, and **increasing profitability** for seaweed farmers.





**The seaweed trading pathway** aims to help farmers improve each stage of the process from farm to factory, emphasizing the benefits of selling dried seaweed in larger quantities.

### Early stage

#### Improved storage

Aggregating and storing seaweed in a controlled environment could ensure quality and allow farmers to use more efficient shipping methods.

Gap 8

### Establishing stage

#### Farmer-buyer mutual learning visits

Inviting industry stakeholders to participate in cultivation initiatives as part of a seaweed quality awareness campaign can foster dialogue and ensure alignment on quality standards, benefiting both producers and the market. Additionally, facilitated seaweed sample testing and feedback collection can further improve farmers' understanding of industry expectations, leading to better practices and outcomes.

Gap 9

Gap 2

#### Ethical contract farming

Centrally managing cultivation and market access can ensure stable pricing and consistent purchase orders, securing financial sustainability for community businesses. Providing fair and regular income and technical support for farmers can sustain farmer motivation and economic empowerment.

Gap 9

Gap 2

Gap 10

### Developing stage

#### Regional promotional program

Launching regional promotional campaigns, including tourism events and advertisements, can raise awareness of seaweed products and attract more customers.

Gap 9

#### Shared logistics

Developing a shared logistics network can allow farmers to pool resources and reduce transportation costs by consolidating shipments.

Gap 9

Gap 11

# Improved seaweed storage can allow farmers to aggregate their harvest and store high quality dried seaweed for bulk shipping.

Gaps & challenges:

8. Lack of proper storage

## Program/experiment design

### Key activities



- Design and build a **low cost storage facility** with the capacity to safely store up to 12 tonnes of dried seaweed.
- Test a variety of **moisture-absorbing** materials and tools to maintain an optimal humidity level in the storage environment, preventing mold and degradation of seaweed quality.
- Create an simple storage system that includes:
  - **Ventilation**
  - **Storage management** and **labelling** system
  - **Elevated flooring**
- Create detailed Standard Operating Procedures (SOPs) for storage.

## Outputs



- Seaweed is kept in good condition, in terms of moisture level and purity.

## Outcomes



- Container full (12 tonnes) of well-preserved seaweed is regularly and consistently purchased by buyers at a satisfactory price.

# Farmer-buyer mutual learning visits will improve mutual understanding between both parties and attract more buyers of Papuan seaweed.

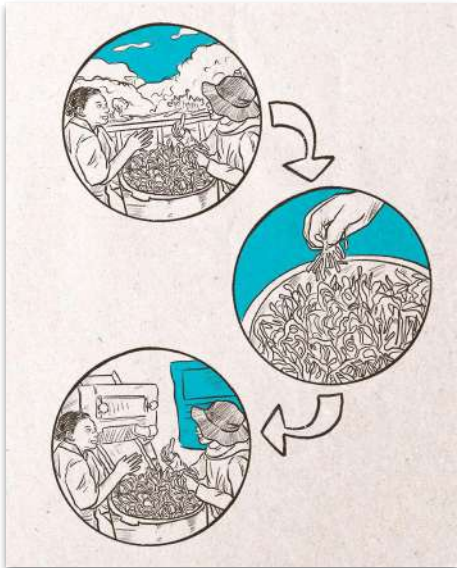
## Gaps & challenges:

9. Limited number of buyers, resulting in lower bargaining power of farmers

2. Lack of cultivation methods

## Program/experiment design

### Key activities



- Invite **potential buyers** to seaweed farms and jointly conduct **workshops with farmers on seaweed quality standards, including moisture levels, color, and cleanliness, using easy to use visual guides and quality checklist.**
- Company participants take back **seaweed samples** for quality testing and provision of direct feedback.
- Arrange **visits for farmers to processing facilities** to enhance their understanding of quality standards and factory operations.

## Outputs



- Meaningful interaction between farmers and buyers, leading to a better understanding of market expectations and farmer reality.

## Outcomes



- Increased number of buyers of seaweed
- Higher-quality seaweed produced

# Ethical contract farming provides farmers with direct market access and a reliable offtaker partnership, ensuring stable income and market security.

**Gaps & challenges:**

- 9. Limited number of buyers, resulting in lower bargaining power of farmers
- 2. Substandard cultivation methods
- 10. Lack of immediate financial reward to sustain motivation of farmers to cultivate, process, and sell seaweed

## Program/experiment design

## Outputs

## Outcomes

### Key activities



- **Secure agreements with multiple buyers on price, frequency, quality standards and quantity of purchase of dried seaweed.**
- **Employ local farmers** to create stable and fair job opportunities, support skill development, and generate predictable income.
- **Centralize management across seedling, cultivation, harvesting, processing and distribution** processes in order to maintain consistent quality standards and timely delivery
- **Invest in infrastructure and technology** to improve productivity and product quality that can meet global market standards.



- Farmers earning regular, fair and stable income
- Seaweed regularly sold to buyers in line with agreement



- Seaweed becomes one of the important industries in Papua

# MOTIVATIONAL PATHWAY

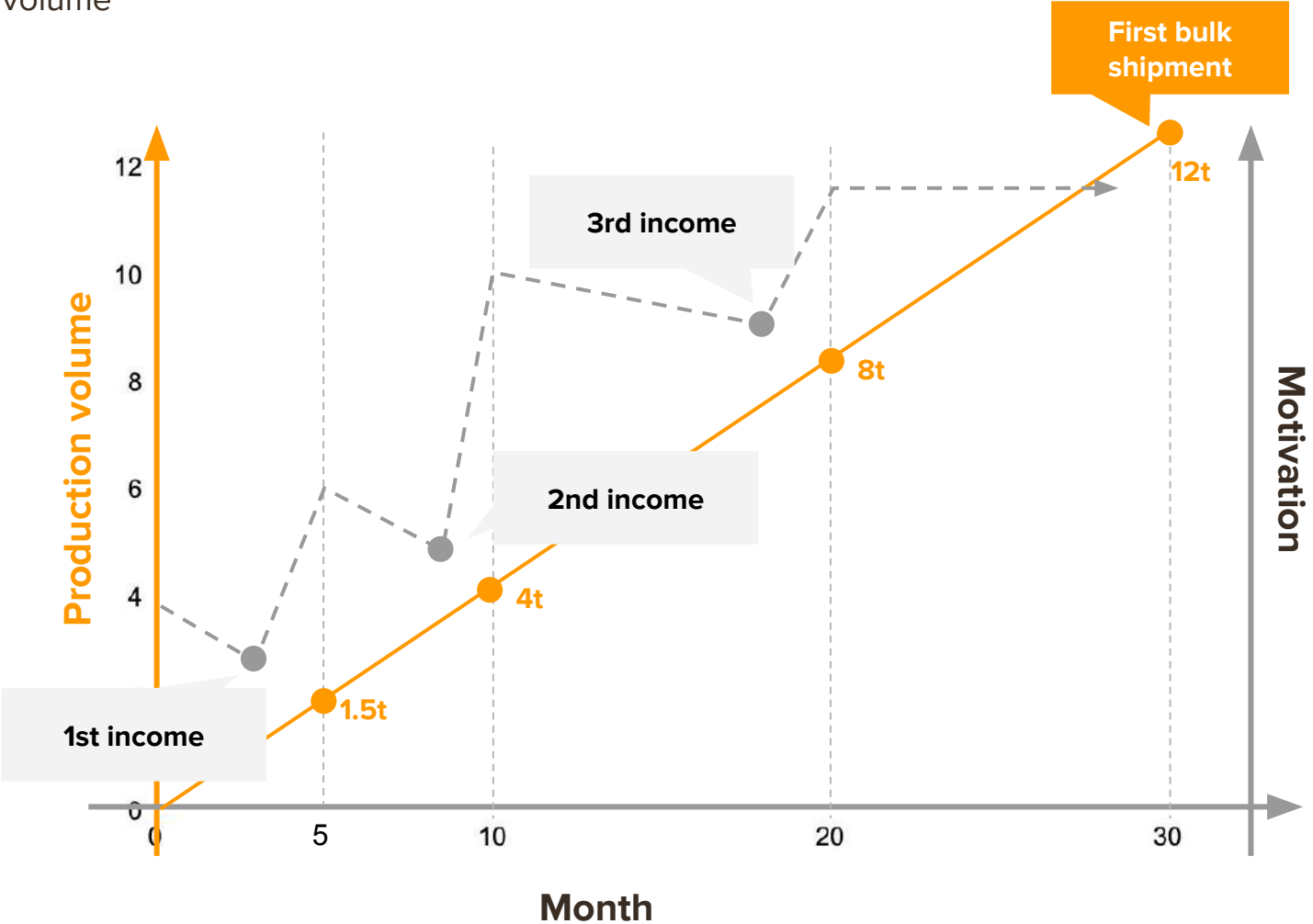
How might we **build a resilient support system that maintains farmer motivation throughout the cultivation cycle**, ensuring long-term sustainability and continued engagement.



The **motivational pathway** ensures farmers remain motivated throughout the entire farming process, by providing early, diverse, and regular income.

**Ideal conditions to maintain motivation of smallholder farmers**

motivation vs. production volume



**The motivational pathway** ensures farmers remain motivated throughout the entire farming process, serving as a sustainable support mechanism.

### Early stage

#### A portfolio of quick wins

Experiment with a wide range of simple VAPs and explore potential buyers to test the market, and make small but consistent sales

Gap 10

#### Bridging subsidy of logistics costs

Provide subsidy to cover the extra cost of shipping until the farmer reaches the container full production capacity

Gap 10

# A portfolio of quick wins provides farmers with immediate income opportunities, improving motivation and sustained engagement.

## Gaps & challenges:

10. Lack of immediate financial reward to sustain motivation of farmers to cultivate, process, and sell seaweed

## Program/experiment design

### Key activities



- Test market interest by **engaging diverse buyers**, including high-end restaurants, specialty shops, and simple VAP buyers.
- Create and sell **small, quick-turnaround products** to generate immediate income and feedback on market demand.
- Collect buyer **feedback** to refine product offerings and understand market preferences.

## Outputs



- A variety of products produced and sold to different buyer segments.
- Early cash flow for farmers and those who produce derivative products.

## Outcomes



- Enhanced farmer motivation and sustained engagement in seaweed cultivation.
- Additional farmers participate in seaweed farming.



# A bridging subsidy of logistics costs to enable farmers to ship less than a container full volume of seaweed until they reach a sustainable scale, maintaining their motivation throughout the cultivation process.

Gaps & challenges:

10. Lack of immediate financial reward to sustain motivation of farmers to cultivate, process, and sell seaweed

## Program/experiment design

### Key activities



- Implement a **temporary subsidy** for shipping dried seaweed to enable farmers to reach paying markets and earn immediate income.
- Set **production targets** for farmers to **progressively increase output**, with the **subsidy decreasing** as they approach full container capacity.
- Demonstrate that **paying customers exist** for the seaweed, helping farmers see the financial reward of their efforts.

## Outputs



- Farmers earning early income without the burden of high logistics costs.
- Increased farmer motivation.

## Outcomes



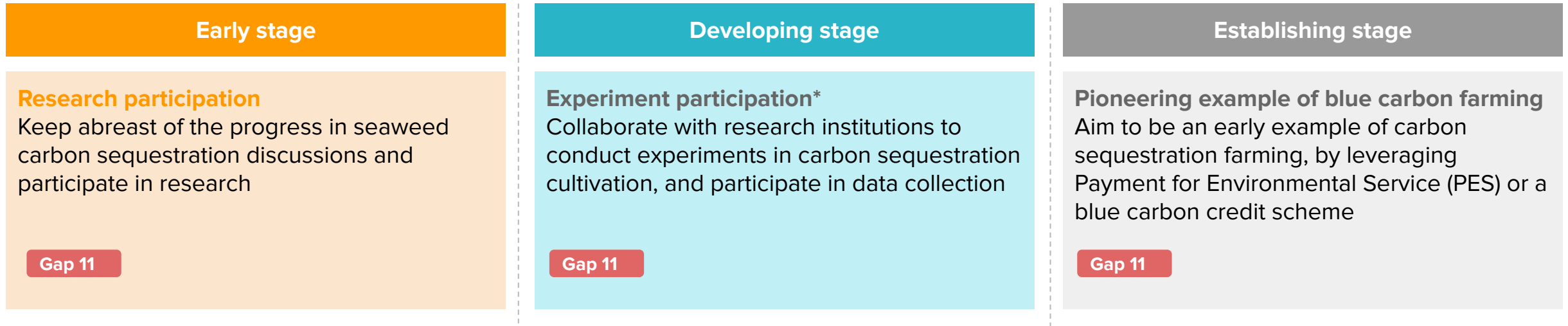
- Enhanced farmer motivation and sustained engagement in seaweed cultivation.
- Additional farmers participate in seaweed farming.

# BLUE CARBON PATHWAY

How might we **create systematic opportunities for carbon sequestration through seaweed cultivation**, and develop rewards for farmers?



**The Blue Carbon pathway aims to engage early in research and experimentation, positioning itself as a pioneering example\* of carbon-sequestering seaweed farming with financial incentives.**

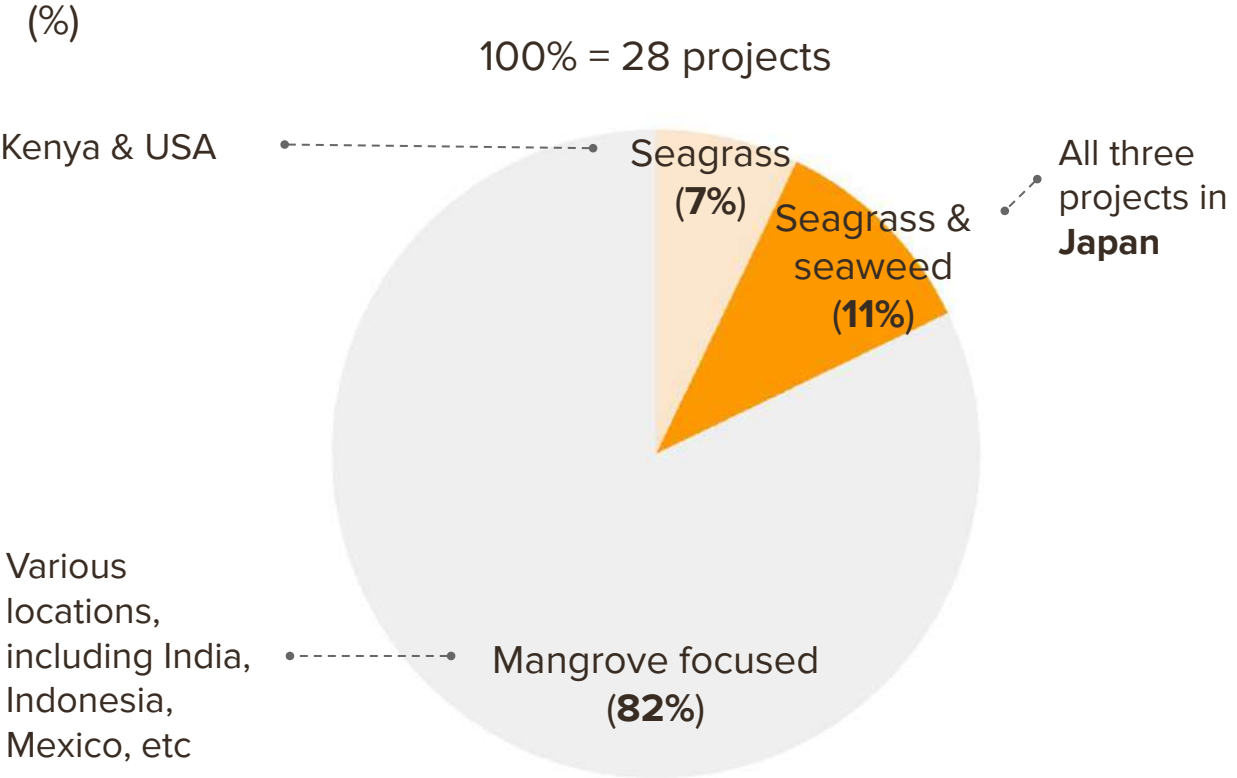


*\*Through Japan's Blue Economy Association's work, in early 2024, Japan has become first country to include carbon sequestered by seaweed in its national emissions inventory submitted to the U.N.*

Source: [Japan Times 23 June 2024](#)

In 2022, there were only a handful of seaweed blue carbon projects globally. The number of seaweed blue carbon projects in Japan increased significantly since, paving the way for the future expansion of seaweed blue carbon projects elsewhere.

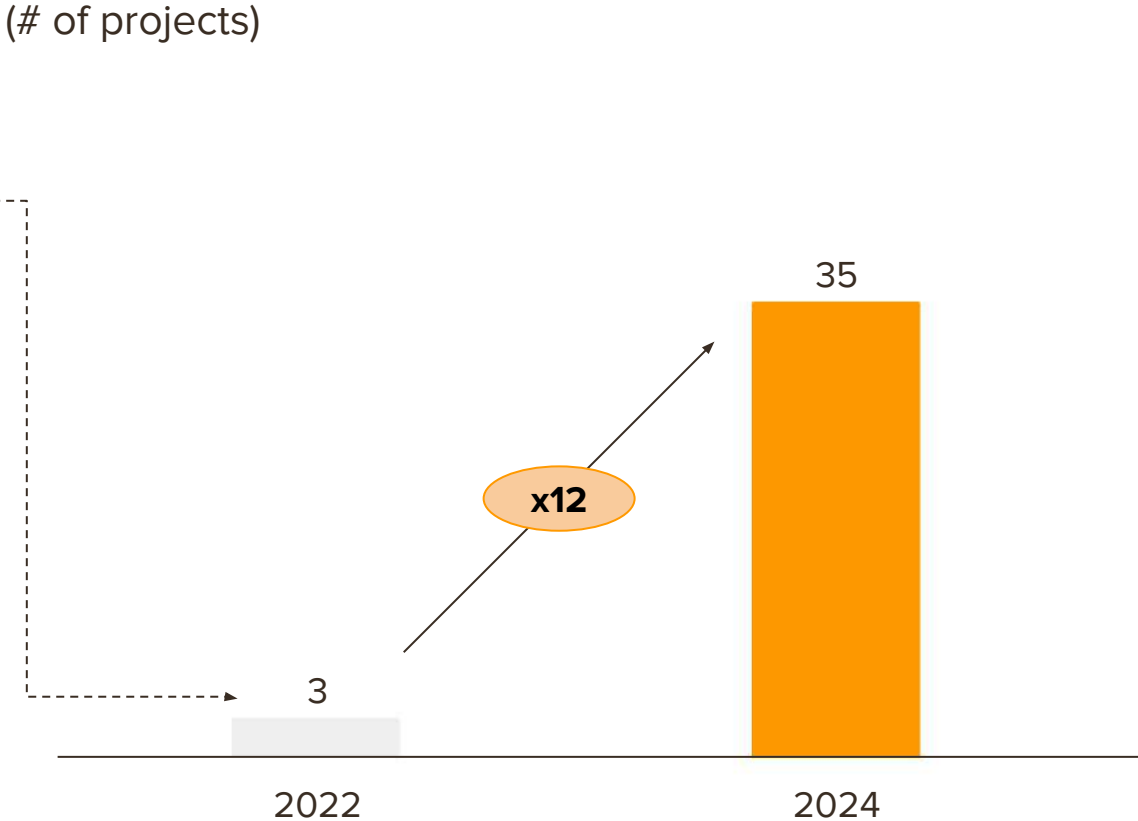
**Type of Blue Carbon projects\* globally in 2022**



\*includes both ongoing and pipeline projects

Source: [Capitalizing on the global financial interest in blue carbon | PLOS Climate](#)

**Growth of seaweed related blue carbon credit projects in Japan**



Source: Discussion with [Japan Blue Economy Association](#) on 15 November 2024

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# LIST OF INTERVIEWEES

Type of Respondent	Interviewee	Type of Respondent	Interviewee
<b>Company</b>	PT Urban Farms Nusantara	<b>Distribution Channels and Communities</b>	Pawai Souvenir Gallery
	CV Lars Makassar		Papua Youth Creative Hub (PYCH)
	PT Kappa Carrageenan Nusantara		Bina Tani Sejahtera Foundation
	PT Karagen Indonesia		Rumah Komunitas Biak
	Ocean Fresh	<b>Seaweed Farmers</b>	Ishak Karubaba
	Aquabloom		Yoseph Takanyuai
	PT. Ekosistim Bumi Lestari (KOBUMI) - part of EcoNusa		Daniel
Sea Vegetable Company	Adrianus Sabarofek	<b>Logistic Companies</b>	PT Fatir Samudra Timur
<b>Government</b>	Fisheries Department of Papua Province, Biak, and Yapen		PT SBN/ PT Pelni
	Cooperative Department of Papua Province, Biak, and Yapen		PT Tanto
	Forestry Department of Biak		PT Pelindo
	Ambon Marine Fisheries Research and Development Center (BPBL Ambon)		PT Salam Pacific Indonesia Lines (SPIL)
<b>Seaweed Expert</b>	Lideman Zawawi, BRIN Resarcher		PT Pelabuhan Wapnor
	Erina Sulistiani, ERSAM Agro Biotech		Transportation Department (Dinas Perhubungan)
	Petrus Rani Pong Masak, BRIN Researcher	PT Pelabuhan Wapnor	
<b>MSME</b>	Rikolto	<b>Potential Aggregator</b>	UD. Sumber Hasil Laut
	Good Karma		Koperasi Narwastu
	Togean Naturale		Pak Uding
	MOOI Papua		
	Women community		
	Sambal Julung Mama Ivana		
Bin Myos Food Stall			



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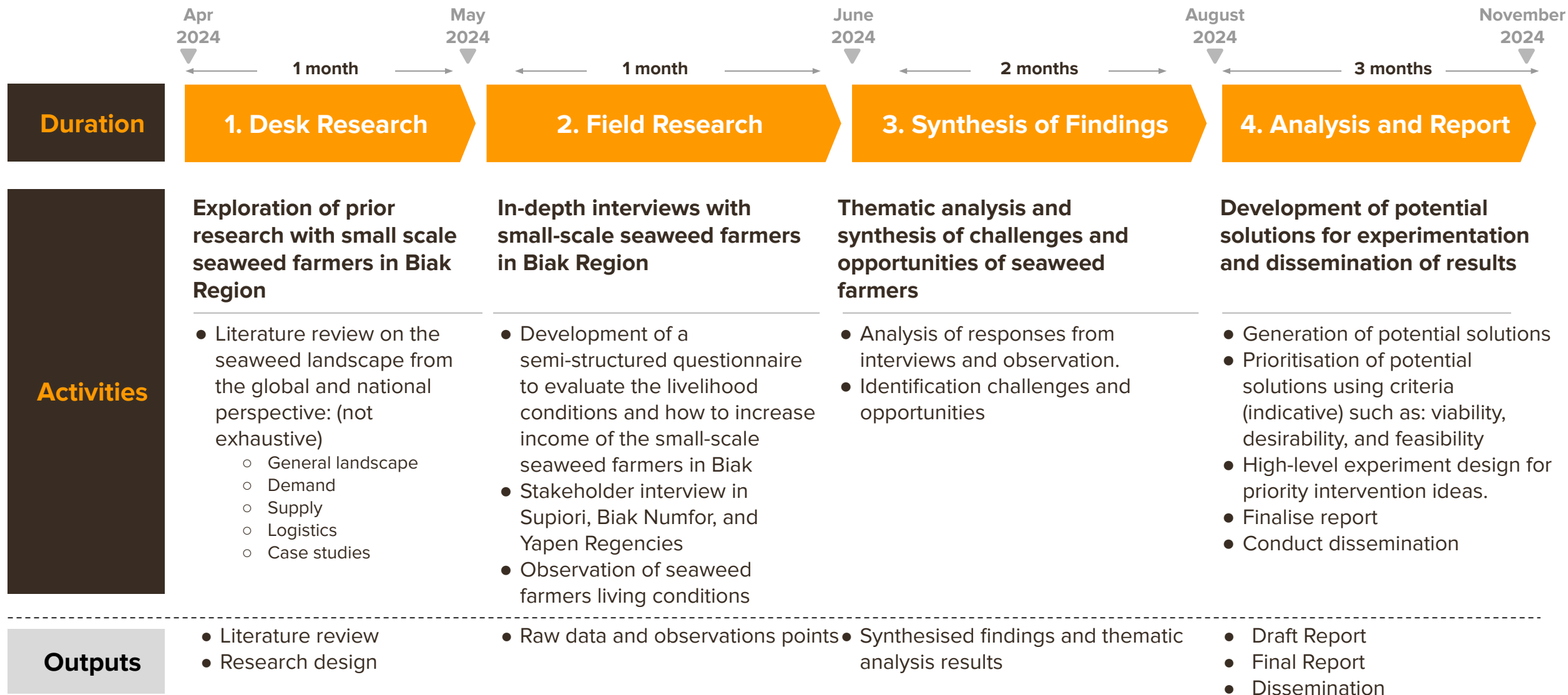
▶ 06 | **Appendices**



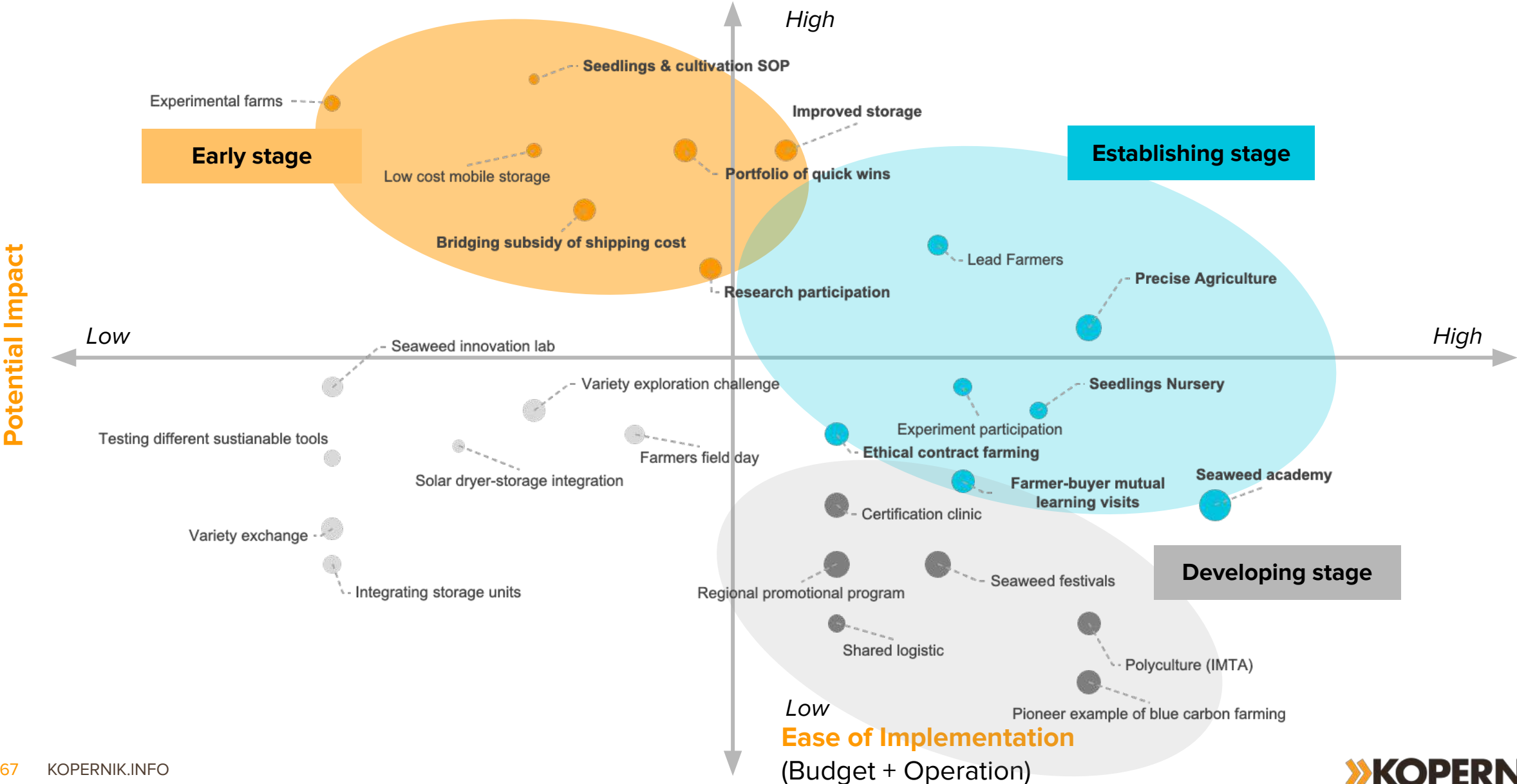
We conducted research to map the seaweed industry landscape, encompassing an analysis of market trends, demand and supply dynamics, logistics challenges, and case studies.

General Landscape	Demand	Supply	Logistics	Case Studies
Benefits	Overall <i>Global &amp; Indonesia</i>	Production <i>Current &amp; potential</i>	Papua and Overseas	VAPs Examples from Smallholder Farmers <i>Global &amp; Indonesia</i>
Risk	Derivatives <i>Global, Indonesia, Papua</i>	Processing <i>Current and potential</i>	Papua and Indonesia	Intervention Examples for Smallholder Farmers <i>Global &amp; Indonesia</i>
Government of Indonesia Policy		Comparative Advantage	Within Indonesia	
Types of Seaweed				

# The activities were organised across four main steps to conduct the unmet needs research with small-scale seaweed farmers in Biak Region, Indonesia.



We developed **28 potential ideas**, categorized and prioritized them into three stages: early, developing, and establishing stages.



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**Kadek Adnya**

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This research is dedicated to the smallholder farmers in Papua who demonstrate incredible resilience, and inspire us to continue to find what works in solving some of the most pressing issues facing the world today.



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