The Indonesian seaweed industry

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Given the global context and trade patterns outlined in Chapter 1, this chapter telescopes down to developments in the Indonesian seaweed industry at the national level. It provides industry-wide context, examines the sectors of production, marketing, processing, and end-products, and describes the cross-cutting issues of zoning, investment, and food safety.

The chapter does not provide an exhaustive description of the Indonesian seaweed industry. Many aspects of the industry are already well-documented, including through value chain analyses at various levels, policy or institutional analysis (see Permani et al., 2023), and analysis of the individuals involved (see Neish and Suryanarayan, 2017). These dimensions of the industry are, however, collated in the chapter, with further detail provided in Appendices 2, 3, and 4.

The industry in context

After gathering momentum globally, the carrageenan seaweed sector found fertile ground for expansion in Indonesia in the late 1970s. The country’s aquatic resources, benign weather, and agrarian structures enabled the uptake of new rural activity in parts of the country. In a few short decades, seaweed production burgeoned to over 62,000 households across much of the archipelago (BPS, 2022). From this production base, other sectors of the domestic industry, including seaweed marketing, processing, incorporation into Indonesian foods and exports, evolved.

Governance structures

Principles of global value chain (GVC) analysis (e.g. Gereffi, 2018) have been applied to the seaweed industry with a focus on the transitions of governance systems (Neish and Suryanarayan, 2017). The principles provide a useful framework for the analysis of the contemporary structures in the Indonesian industry. In the 1980s, the Philippine industry was subject to captive or hierarchical governance systems. A small number of small-to-medium enterprises (SMEs) and later multinational corporations (MNCs) dealt directly with seaweed farmers. These actors aimed to capture returns from expanding cultivation and research and development...
activities. Neish and Suryanarayan (2017) argued that these companies explored and helped to establish the Indonesian seaweed production sector. In the 1990s, the development of simple processing technologies (for semi-refined carrageenan (SRC)) led to the proliferation of seaweed processing companies, some of which were founded by previous employees and traders associated with the SMEs and MNCs. Rather than dealing directly with farmers, the companies dealt indirectly through what they called integrated or allied suppliers in modular governance systems. Standards for seaweed farming were set by an international hydrocolloids organisation (MARINALG) and were enforced by the enterprises. By 2000, the Indonesian industry was dominated by market governance systems, where processors had become even more disconnected from farmers, linked by largely autonomous middlemen who conducted spot transactions. Seaweed and seaweed product standards proliferated but were applied unevenly or not at all, and farmers fended for themselves with little company or government support. As elaborated below, there were few cases of relational governance where contracts were used to link seaweed producers and downstream actors.

Neish and Suryanarayan (2017) suggested that industry development in Indonesia was led by economic agents, including farmers, companies, and scientists linked to companies and key individuals. Chapter 3 documents the involvement of Universitas Hasanuddin in South Sulawesi at this early stage. From this base, other actors have entered to formalise the industry development process including industry associations, development agencies, and, of most interest to this chapter, the government. Government interest can be explained by several key factors.

**Government interest in seaweed**

The seaweed industry has become increasingly economically significant. Like all countries, the share of agriculture, forestry, and fisheries in total GDP has declined and in 2021 stood at 13.28 per cent. Fisheries contributed 22 per cent or Rp. 505,061 billion to GDP at 2021 nominal prices (Bank Indonesia, 2023) and seaweed is a significant contributor to Indonesia’s total aquaculture production (BAPPENA, 2021, p. 65).

The industry also provides livelihood activity for a significant number of rural and coastal Indonesian households. Estimates vary largely (see Appendix 1), but suggest that around 62,000 households farm seaweed (BPS, 2022a), with more involved in the seaweed industry in other ways – for example, as casual wage labourers or service providers (see Chapter 8). To provide some context, this compares with 31 million households engaged in agriculture in Indonesia in 2013, 1.6 million of which were engaged in capture fishing, and 985,000 in fish farming (BPS, 2022).

The global carrageenan industry is large with high potential growth prospects (see Chapter 1). Already the dominant global carrageenan seaweed producer, Indonesia, is globally competitive in this sector (Yulisti et al., 2021). Ambitious plans for growth in downstream sectors are thought to provide an opportunity to generate much-needed off-farm employment, investment, and tax revenue. An Omnibus
The Indonesian seaweed industry, aims to develop a business-enabling environment and is supported by a large number of subordinate regulations, policies, and activities designed to generate investment.

While during the 1990–2000s the industry developed in a largely organic way, the government is aiming for a more orderly and formalised industry development process. This is thought to require increased policy attention in fields including industry planning, sea-use zoning, research and development, and the coordination of measures to attract investment. This has led to the proliferation of a large number of policies associated with seaweed production. A policy analysis by Permani et al. (2023) of the Indonesian seaweed industry revealed 67 policy documents with a peak of promulgations in 2021 (Figure 2.1).

A major landmark in the evolution of the Indonesian seaweed policy landscape was the issuance of the Presidential Decree 33–2019, Road Map of National Seaweed Industry Development 2018–2021. The Decree is wide in scope and encompasses a large number of other policies and is referred to throughout the chapter. However, there are many other high-level policies which are listed in Appendix 2.

Thus, an extensive institutional web has evolved to support industry development, governance, and service provision. Institutional actors include government administrative line bureaus to design and implement policy, government extension agencies to disseminate technologies, research and development organisations to

Figure 2.1 A count of government policies relevant to the Indonesian seaweed industry, 1999–2022
Source: Image reproduced from Permani et al. (2023).
increase technological levels, and associations to represent industry interests. Jurisdiction for the seaweed industry falls mainly under the Ministry of Marine Affairs and Fisheries (KKP) and its line bureaus but intersects with a large number of units in government, research, associations, and international organisations. These are detailed in Appendix 3.

The production sector

Early growth period

The carrageenan industry had globalised by the 1970s when MNCs from Western countries invested in seaweed production in the Philippines, to be used for both processing in the country and international export. Exploratory missions for wild seaweed and early efforts in cultivation were attempted in Indonesia in the 1970s, as described in the Preface. Particular staff of companies in the Philippines – Copenhagen and FMC (later to become MCI) sought to ascertain the technical feasibility of seaweed production around Bali and Nusa Dua in the 1980s (Mariño et al. 2019; Iain Neish, personal communication, 10 September 2022). When trials proved successful, seaweed breeding stock and technologies were disseminated to other areas, predominantly through contact with other local coastal communities and by movement between communities. Local businesspeople engaged in retail, trading, wholesale, and credit, in an integrated way which often acted as key extension conduits (Iain Neish, personal communication, 10 September 2022). The entrepreneurs were interested in adding a new activity to their portfolios alongside food and other aquatic products. As traders that were embedded in villages, they had close contact with farmers to disseminate knowledge and inputs (such as ropes, credit, and seedlings) into seaweed production.

Low-income coastal communities could be expected to be receptive to efforts to extend seaweed if the activity adds to or aligns with broader livelihood strategies. New activities may contribute to a livelihood diversification strategy (Ellis, 1998) especially if they are complementary to existing activities in relation to labour demand, seasonality, sustainability, barriers to entry, location, and potential income growth (Reardon, 1997). Seaweed is also a labour-intensive activity that can be expected to develop in areas with low wages and opportunity costs of labour.

Production structures

Unlike many other agricultural sectors where there are large estates (e.g. palm oil), contract systems (e.g. chickens), or economies of scale (some grains), the seaweed production sector is dominated by individual, autonomous households, with a dearth of examples of corporatised production.

Seaweed cultivation is sensitive to many environmental factors that are highly location-specific, variable, and uncontrollable, as Chapters 6 and 7 discuss (e.g. tides, seasons, rainfall events, disease, and other shocks). To be productive and resilient in these conditions, producers need to have both in-depth knowledge of local conditions and the flexibility and incentive to work around these conditions. For
all but the largest households, seaweed farming is not a full-time job so it requires flexibility to allocate labour across a range of other complementary activities.

The predominance of households in seaweed production conforms to theory related to the competitiveness of actors with different scale and governance structures. There can be an inverse relationship between productivity and farm size in agricultural activities where households allocate labour efficiently or endure shocks (Chayanov, 1991). Small farms can be more efficient than large farms when high levels of local knowledge are required (Hazell et al., 2010). When hired labourers are costly to monitor or motivate, the self-supervision function of family farms are more efficient than large farms (Keijiro et al., 2016). Smallholders are also highly responsive to increased access to new technologies and markets (Schultz, 1964).

Alternative structures to autonomous, individual households have been trialled but are yet to be successfully established. A processing company (Widjaya) sought to farm a large area of seaweed using hired labour but encountered problems with production. New technologies and products developed for seaweed farming in deeper waters, including the use of mechanised floating and harvesting methods (e.g. Sea6), are under development but not fully operational. Several processing companies (e.g. Mitsubishi) have, or are seeking to develop, contractual relations with households but these efforts remain at an exploratory stage. While these corporate structures are yet to gain a foothold, conditions that may see some incursion in the future include increases in labour costs (see Chapter 8) and demands for traceability (Kirsten and Sartorius, 2002).

This is not to say, however, that dominant smallholder systems are static. It can take time for news about seaweed to travel and be taken up, especially if the uptake requires substitution out of other activities. Risk-averse households may wait to see the activity ground-tested by other farmers. Households incrementally develop ways to deal with shocks (e.g. weather, disease) and to tinker with systems to increase production or productivity. Data from fieldwork sites in the household sector show the emergence of significant numbers of large-scale household farmers who employ casual wage labourers for some tasks (see Part II of this book and Langford, Waldron et al., 2024).

Household organisational modes also vary. Neish and Suryanarayan (2017) distinguished between two types of seaweed farmers. The first was the traditional nuclear family model, where spouses and their immediate relatives share the work and income from seaweed cultivation. The second is the lead farmer model where one person or a small team manage the farm enterprise and sell the crops, but where labour is bought in for a range of tasks, especially attaching cuttings and drying. Group structures (associations and cooperatives) are also promoted by government. There is wide diversity amongst households in their scale of production, sea space use, and labour use even within the same village (see Part II).

Policy settings for production

The Indonesian seaweed industry has grown somewhat organically through the activity of economic agents operating in a conducive biophysical and socio-economic environment. However, government is now playing an increasingly active role in
production aspects of the industry through technical extension, research and development, and in seed propagation. Permani et al. (2023) documented 24 policies that relate directly to the production-side aspects of the industry.

An important role of government is to invest in research and development. A wide scope of research has been conducted but production-side aspects feature in all of it. Most research is conducted on seed breeding and supply, but other areas include fish repellents and drying ovens.

Another fundamental role of government in the production sector is in technical extension. With equivalents in the agricultural sector and other aquaculture industries, the Department of Fisheries and Marine Affairs at provincial level (DKP) has a technical extension system charged with developing, testing, adapting, and disseminating new seaweed technologies or practices in coordination with farmers. Staff are located and managed by the DKP at the sub-district level. Similar to extension in other countries, the system is stretched for human resources. In South Sulawesi, the seaweed-intensive sub-districts have just two extension agents responsible for vast distances and large numbers of villages and households. Duties of the staff include a large range of additional administrative duties (e.g. statistics, administration, and certification). Farmers have questioned the effectiveness of the extension system at the local level and developed and disseminated many technologies themselves. However, several key production-side technologies have been derived from the extension system including the para-para drying method, the double-line cultivation method, and mixed-species cultivation. The DKP also disseminates inputs (e.g. ropes and boats), often through group structures that aim to improve production, marketing, and extension.

A final form of government involvement in the production sector is through technical implementation units (TIUs) that produce and disseminate seaweed tissue culture in fresh water, brackish water, and marine aquaculture. Known as seedling gardens (kebun bibit) the units come under the jurisdiction of the Ministry of Marine Affairs and Fisheries (Regulation 70–2020) and are located in 18 locations and 20 seaweed villages (Kampung Budidaya Rumput Laut). Examples of research laboratories include the Brackish Water Fisheries Aquaculture Centre in Takalar and the Mariculture and Fisheries Centre in Lombok.

The centres were established to increase the quantity and quality of supply of propagules, a key constraint in household production systems particularly at the start of the season (Grist, 2022; Langford, Waldron et al., 2023). The centres aim to propagate seaweed with quality characteristics that include vigour, colour, and branch structure, all of which are largely a function of age. The seedlings are bred in controlled environments using vegetative techniques. Sporulation that would allow increased production is being trialled but is yet to be scaled up for production. To increase production and dissemination, out-grower schemes with selected households are also used.

Despite these efforts, the volumes of propagule material disseminated from TIUs is just a fraction of that produced by households themselves or that traded between households. A relatively small proportion of households directly receive free tissue culture propagules from the programme (Grist, 2022) but
with frequent sales and exchanges between households, many may have received the material indirectly.

**Seaweed production**

The agro-climatic and socio-economic environment depicted in this discussion is conducive to growth in seaweed production. National production statistics have reported exponential growth in seaweed output since the 2000s with some decline in recent years. Export statistics from Indonesia trend similarly, with rapid growth to 2010 followed by fluctuations in recent years. If accurate, reported declines may have been due to labour transition from seaweed cultivation to other more lucrative or attractive activities such as tourism (Wiratmini, 2018; Keohane, 2016) but the COVID-19 pandemic induced the opposite effect (Langford et al., 2021; Nur-yartono et al., 2020). When the tourism sector was severely affected in areas like Bali, affected workers returned to on-farm activities including seaweed production (BBC, 2020; Pratiwi, 2020). Over-use of key production areas may have contributed to recent declines.

Much of the early expansion in seaweed production occurred in key areas including Bali, Nusa Dua, and South Sulawesi. By the 2000s, however, the industry had expanded across the archipelago with some of the expansion occurring informally. For example, members of households, mainly ethnic Buginese, from coastal communities in South Sulawesi, worked on palm plantations in Sabah in Malaysia (Iain Neish, personal communication, 10 September 2022). On route, these workers stopped over in North Kalimantan and observed conditions well suited to seaweed cultivation. The migration of workers and practices from South Sulawesi led to increased seaweed cultivation and has become a significant seaweed producing province.

While much information has been informally passed between those in the sector, more formal government programmes aim to expedite the process. These programmes aim to overcome issues related to dissemination in remote regions and this is reflected in national policies and plans (such as the Presidential Decree). However, provincial and sub-district government have also developed and implement policies. These efforts reflect Indonesia’s decentralisation programme implemented in 2000. Provinces hold jurisdiction over major issues such as marine zonation and regional development plans. The spatial distribution of seaweed production in Indonesia in 2020 is shown in Figure 2.2, which shows the importance of Sulawesi (especially South Sulawesi) in national seaweed production.

**The marketing sector**

The Indonesian seaweed marketing sector that links the production to processing sectors, comprises of a rich tapestry of actors, transport, and logistics systems, and institutional arrangements. Of particular interest is the role of traders, who play an important role in the organisation of the seaweed industry (Mulyati, 2015; Sutinah et al., 2018). In the earlier stages of industry development, MNCs were one
driver of the dissemination of production practices. These companies linked with local businesses with shops in villages or sub-district towns. Local traders were typically integrated with retail, wholesale, trading, and finance activities and were commonly ethnic Chinese Indonesians. With scientists and companies looking to expand seaweed production during the 1980s, these entrepreneurs were the key conduits in organising supply and linkages to farming communities.

These local-level relationships remain as the backbone of the seaweed marketing system, especially at the farmer-market interface. However, with increasing trade volume and demands from buyers, additional intermediaries have entered the industry to form a hierarchy of traders that lead to export markets or processing companies. Neish and Suryanarayan (2017) describe these as market-governed systems run by largely autonomous actors, although there are also remnants of the modular system, where companies and exporters have close relationships with certain buyers.

The market hierarchy

The structure of the Indonesian seaweed marketing system has evolved to form a hierarchy of actors, linked through the exchange of seaweed for money. Local traders weigh and visually assess local farmers seaweed and buy at an agreed price, usually for cash “on the spot”. The relationship is supported by embedded services and backward linkages. For example, traders provide inputs like rope, credit, or seedlings to the households which are paid off on the sale of the seaweed (Neish, 2013). Local traders can deal directly with farmers or, to reduce transaction costs, buy through local-level collectors. Unlike traders, collectors do not take ownership of seaweed but are provided with cash or credit from traders to buy seaweed from households based on their knowledge, contacts, trust, and negotiation, or logistical skills. The collectors might deal with 50–110 farmers and are sometimes heads of the local seaweed associations (Mulyati, 2015). Collectors tend to be more prevalent in the larger seaweed producing and marketing villages, like Laikang, rather than the smaller villages, like Pitu Sunggu (Waldron et al. 2022).
Local-level traders may also dry and clean the seaweed before aggregation with other lots, to then transport to downstream actors, which are larger traders or processors. There are a wide variety of traders in the hierarchy ranging from the village level to intra- and inter-island traders. In addition, there are estimated to be around 100 traders with export licences that supply foreign markets and domestic processors (Hogervorst and Kerver, 2019). This chain of traders can sometimes be shortened by processors that have more modular relations through more stable procurement arrangements with particular buyers. For example, the company Shanghai Brilliant Gum (BLG) sources seaweed through company procurement staff and traders in repetitive, ongoing relationships. These include seven former seaweed exporters based throughout Indonesia but especially in South Sulawesi, North Kalimantan, and the eastern provinces.

**Market characteristics**

The market-based governance system of the seaweed marketing system bears close resemblance to that of other commodities in Indonesia and other developing countries. This is especially the case for cash crops like fruit and vegetables, marine products, and some livestock and grain commodities. Indonesian seaweed markets have several characteristics.

The first is that transactions occur in informal spot markets between autonomous actors. Transactions are usually made in cash without compulsory sale, inputs, product specification, or other formal obligations. The relationships can be repetitive between households and the seaweed buyers. Trust and backward linkages of credit, seedlings, or rope are informal and socially bound relationships between the parties. This contrasts with transactions through farmer-buyer contractual systems, where parties are bound by formal legal arrangements. Smallholders are likely to move from spot to contract systems for food products that are differentiated, perishable, or where consumers have food safety concerns (Kirsten and Sartorius, 2002). While these demands are growing in a range of foods, seaweed can be regarded as a bulk commodity where spot markets are generally effective and minimise transaction costs (legal, measurement, and monitoring). Neish and Suryanarayan (2017) describes emerging seaweed technology and chains that may utilise a contractual system.

Second, a language to describe seaweed characteristics is widely accepted and used, but often in a broad, informal, or subjective way. For example, the buyer or seller may claim moisture content of 36–38 per cent and dirt and contamination of 3–5 per cent. Some processors have additional specifications for colour (light) and carrageenan yield (e.g. 25 per cent) linked to pricing schedules. In practice, however, these specifications are not always applied and are rarely measured in farmer-trader transactions. This may raise questions in relation to the accuracy of visual assessments (made by eye) and information asymmetries in the transaction. Notionally, buyers would have a better eye for seaweed characteristics as they buy and sell every day and would have an incentive to discount estimates of grade (moisture and contamination) in order to discount the price. On the other hand,
farmers who dry and pack the seaweed presented to the buyer also have an incentive to do so opportunistically (e.g. by putting wet or dirty seaweed at the bottom of sacks) to increase the weight, the measurement unit on which the transaction is made (Stone et al., 2023).

A third feature is that the seaweed chain is relatively long with a large number of actors and stages of transformation (Komarek et al., 2023). This means actors in the early stages of the chain (producers) have no direct contact with downstream actors (e.g. processors) and are unlikely to even recognise the final product. This makes it very difficult to effectively transmit price-grade differentials and buyer preferences down the chain. The indirect signalling of differentials is tested in price analysis discussed below.

Finally, there appears to be a large number of seaweed buyers in the industry which could be expected to create competitive markets. Indeed, in periods of high demand, buyers compete fiercely with each other for supply. Opposingly, however, the organisation of the hierarchy of traders leads to a limited number of end users who can be powerful. For example, the purchasing power of companies like BLG and Greenfresh are known to set prices for the week. The competitiveness of markets is also tested in the price analysis below.

Another feature of the Indonesian seaweed industry is that ethnic Chinese Indonesians dominate the post-production sectors. Chinese Indonesians have traditionally played a major role in seaweed trading and exports and own the majority of domestic Indonesian carrageenan processors, as is the case in the Philippines. This follows structures in agriculture-based trade established by early Chinese diasporas (Skinner, 1963) that have been observed in fisheries (Novaczek et al., 2001) and contemporary local-level business activities (Chiang and Cheng, 2017). The literature has documented ethnic Chinese business networks that form alliances with elites and may expedite business (McVey, 1992). These alliances can extend to mainland China through trade and investment flows (Ren and Liu, 2022). As established in Chapter 1, the vast majority of Indonesian seaweed is exported to China.

**Price analysis**

Prices provide valuable insights into the functioning of marketing systems. They signal the interplay between supply and demand, show patterns of change over time, and the degree of integration in time, space, and product attributes. Langford, Zhang et al. (2022) conducted a price analysis for Indonesian seaweed based on fortnightly price observations collected by Jaringan Sumber Daya (JaSuDa) in 13 locations across Indonesia. The data has been collected since 2005, but a sub-set from 2011 to 2021 were used. The prices have been updated to May 2023 and are presented in Figure 2.3.

The price data provides several insights. In January 2015 there was a large price decline that coincided with the announcement of a ban on raw seaweed exports as part of a broader industry policy to stimulate domestic processing. In September 2017, there were rapid price increases that coincided with the start of operations at Indonesia’s largest processor, BLG. From mid-2019 to mid-2021, prices declined...
The Indonesian seaweed industry and stagnated, aligning with the most severe disruptions from the COVID-19 pandemic. After the price analysis by Langford, Zhang et al. (2022), there were rapid and sustained price increases through the second half 2021 and first half of 2022 (Langford, Waldron et al. 2023). It is important to note that the prices are notional, but seaweed price increases outstripped inflation. The historically high prices were good for seaweed farmers but placed a strain on the capital stocks and margins of downstream actors. Price levels have since corrected but appear to remain above pre-COVID levels.

Another finding of the price analysis is that prices are (spatially) co-integrated between regions (Figure 2.3). This is an indicator of a competitive and generally well-functioning market, underpinned by competition and flow of information. However, prices however became less integrated after the rapid increases in 2017, possibly as a result of BLG purchasing, and into the 2020–21 COVID pandemic. Transport and supply chain disruptions meant that prices were relatively lower in more remote areas (Palopo in South Sulawesi, Tual in Maluku, and Bontong and Nunukan in Kalimantan) compared to areas closer to major trading hubs (Makassar). Model results also show that the area closest to Makassar (Takalar) leads prices in other regions (Langford, Zhang et al., 2022).

The data collected includes seaweed prices and the basic attributes of moisture content and contaminant levels (sand and salt). Regression analysis found a low correlation between these variables, suggesting low transmission of the value for quality characteristics of seaweed and narrow price-grade differentials. This may be a function of inaccurate (subjective) measurement or incentives by all parties to
not reveal characteristics (Stone et al., 2023). There would also appear to be limited incentives to produce quality seaweed defined by the content or quality of the carrageenan (the length of the gelling molecule). Measurement of these quality characteristics of seaweed are feasible in a laboratory environment but not at farm-trader level (Cozzolino et al., 2023). Furthermore, the downstream chemical processes are so harsh that they can negate carrageenan quality characteristics, especially for SRC, which is a more generic product (Neish, personal communication, 10 September 2022). In these conditions, subjective trading based on knowledge – where traders associate quality with particular production areas – appears appropriate. Measures to upgrade the marketing system should be examined critically.

**Marketing policy**

The trade of seaweed is conducted mainly on an informal and subjective basis but is nevertheless underpinned by broader, cross-sectoral market regulations. This includes business registration, access to finance, infrastructure for logistics and transport, and industry standards. In addition, government has issued a large number of regulations, standards, and certification schemes that are directly relevant to seaweed and its products (see Permani et al., 2023 and Appendix 2). Most of the standards relate to food safety, particularly given international contestation in the organic status and safety of carrageenan as a food additive. Several standards apply to the production sector (e.g. SNI 8228.2: 2–15 Good Fish Farming Practices: Seaweed) while others apply to downstream products (e.g. SNI 8391.1: 2017 (Refined Carrageenan) – Part 1: Kappa carrageenan – quality requirements and processing). These national standards are designed to harmonise with international standards (e.g. Halal, ISO 22000 Food Safety Management System Certification, Good Manufacturing Practice, FDA registration).

There are also a large number of standards that apply to dry seaweed for seaweed marketing from the farmer to processor level. For example, SNI 2690:2018 Dried Seaweed specifies that seaweed must meet requirements for its origins (unpolluted areas, a harvest time of at least 45 days), characteristics (clean and free from decomposition), appearance (clean, with large thallus, and, for Kappaphycus alvarezii, ivory yellow, green, light/dark brown), texture (not easily broken between the stem and the branch), and must fall below a threshold of metal contamination. The standard applies to a range of seaweeds.¹¹

While standards such as these provide minimum thresholds and a common language for industry actors, the standards are not widely or strictly used in farmer-gate transactions, partly because they are difficult to enforce. It is also important to note that processors have their own standards (for seaweed inputs) that deviate from national standards. Hogervorst and Kerver (2019) reported that Indonesian processors perform quality checks but lack written specifications (p. 24). They also claim that processors ignore their own standards when demand for seaweed is high, seldom invest in traceability or chain development, and do not provide incentives or feedback to traders and farmers to produce or maintain quality differentials. Issues in marketing practices at local level are discussed further in Chapter 9.
Another marketing initiative relevant to seaweed is the Warehouse Receipt System (*Sistem Resi Gudang*) under the jurisdiction of the Ministry of Trade and also endorsed in the Presidential Decree (33–2019). Under the system, receipts received by farmers or traders after storing their produce in a warehouse can be used as a collateral, including to buy more seaweed (BAPPEBTI, 2020). Organisations (such as the Indonesian Merdeka Workers’ Cooperative) and companies (such as PT Asia Sejahtera Mina) provide loans to seaweed chain actors on this basis. Regulations of the Ministry of Trade 33–2020 (amended by Regulation of the Ministry of Trade 14–2021) included seaweed in the list of 18 commodities that can use the warehouse receipt system. The Presidential Decree (33–2019) aimed to open warehouses in Nunukan, Wakatobi, and Makassar. Despite these efforts, transaction volumes in the Warehouse Receipt System remain low, reportedly because it is difficult to find professional warehouse management and farmers still have low awareness of the system and its benefits (Permani et al., 2023).

Another marketing initiative conducted by the Ministry of Trade was to develop three physical seaweed auction markets in South Sulawesi, Nusa Tenggara Barat, and East Java. There is also a plan to develop an online market platform to facilitate seaweed trade auctions (Permani et al., 2023). Initiative to develop apps that could be used by farmers to sell seaweed are still under development.

**The processing sector**

Scientists and industry explored Indonesia as a location for seaweed cultivation for export to processing facilities elsewhere, including the Philippines. While the majority of Indonesian seaweed is still exported, a combination of market forces and policy attention has seen the Indonesian carrageenan processing sector grow to become the third largest in the world.

Seaweed industrialisation started in Indonesia in 1976 when PT Bantimurung Indah was founded and began producing alkaline treated carrageenan (ATC) in Makassar. In 1988, PT Galic Artabahari was launched as an SRC company in Bekasi, West Java (Mulyati, 2015). From the 1990s conditions were conducive to growth. Seaweed cultivation was burgeoning and more accessible SRCs allowed for the proliferation of enterprises with lower barriers to entry. SRC was initially used for pet food, but food grade SRC was developed and became a substitute for refined carrageenan (RC) in the 1990s (Stanley, 1987). By this time there were a considerable number of companies producing semi-refined and refined carrageenan.12

Despite the development of the processing sector, the industry remained based on the export of raw dried seaweed (RDS). In 2015, the KKP reported that only one-third of Indonesia’s seaweed was partially or fully processed, while 70 per cent was traded in a raw dried form (Patutie, 2015; Porse and Ladenburg, 2015). To Indonesian policy makers, seaweed was an under-utilised resource that could otherwise be used to advance the national interest through further processing, thereby value-adding and generating investment, employment, and tax revenue. In 2014, Indonesia announced that it planned to process at least half of the seaweed
produced in the country by 2020 (Harrison-Dunn, 2014). A reconciliation of statistical sources indicates that in 2022, the proportion had reached 35 per cent (for *Kappaphycus alvarezii*, *Kappaphycus striatus* and *Eucheuma denticulatum*) (Zhang et al., 2023).

The plans for greater domestic processing were pursued through industry policy on two fronts. First, was the mooted introduction of export restrictions and tariffs. This instrument was first announced in 2011 by the KKP. The export restrictions were not implemented, due largely to concerns that they would reduce prices and hurt farmer interests (Harrison-Dunn, 2015) including those in remote locations (Neish, 2013). Nevertheless, a complete ban of seaweed exports by 2018 was announced by President Widodo as part of Indonesia’s Blue Economy programme. Again, the ban was not implemented (Wright, 2017).

A concomitant measure was to promote and encourage the development of domestic industrial capacity through investment policy. At a general level, national industrial policies (e.g. Presidential decrees 28–2008 and 2–2018) encourage districts to develop industry capacity. Indonesia’s Blue Economy programme launched in 2013 and called specifically for the development of seaweed processing capacity. To fast-track investment for seaweed in a more interventionist way, the KKP developed seaweed processing plants in the major production areas of Bulukumba and Takalar (established from 2003 to 2005), and Saumlaki (2010). The plants were operated by a regional state-owned enterprise (Badan Usaha Milik Daerah (BUMD)) but are now closed for reasons that include inadequate access to water, electricity, and human resources. In a renewed programme of the KKP in 2016 (called Downstreaming, or *hilirisasi*) saw further state investment in at least nine seaweed processing plants, mainly on Sulawesi Island. The plants were barely operating at the time of writing.

Even if the interventionist industry policies did successfully establish a group of operational processors, questions arise as to the effects. Export restrictions are likely to put downward pressure on prices, which effectively constitute a transfer from the revenues of seaweed farmers to processors (see Langford, Turupadang, and Waldron, 2023) for the case of provincial restrictions in Nusa Tenggara Timur (NTT)). Distortionary policies also cause price volatility that harms industry by making it risky to enter into longer-term purchase or supply contracts. The implication is that a more market-conforming approach where exporters compete with domestic processors (both Indonesian and foreign-invested) is more conducive to sustainable industry development and the interests of seaweed farmers. This is widely acknowledged within the industry (Seaweed Association of Indonesia (ARLI), personal communication, 10 September 2022).

**Foreign investment in processing**

While attempts at industry-building through domestic investment and ownership have faltered, one of the outcomes of Indonesia’s enthusiasm for processing within Indonesia was an injection of direct foreign investment, virtually all of which came from China. This includes investments from at least six Chinese companies,
including the three largest carrageenan processors in China. Greenfresh invested in Indonesia (Hongxin) in 2012 with plans to expand, followed by BLG in 2015, and Longrun Newstar in 2016 (Zhang et al., 2023). The processing capacity of these three investments is approximately 18,000 tonnes per year, with an average capacity utilisation of 60 per cent (higher than most domestic plants), and amounts to an estimated actual production of 10,000 tonnes for all carrageenan products (ATC, SRC, and RC). The Ministry of Industry estimates total domestic production of 25,057 tonnes of carrageenan ATC, SRC, and RC (Kemenperin, 2022), suggesting that the three Chinese-invested plants account for 40 per cent of total domestic production. This figure would increase well above 50 per cent if other Chinese plants were included in the estimates and the planned investment from Greenfresh is actualised.

The investments are driven by several forces. The companies already import the majority of their seaweed inputs from Indonesia but locating closer to production sites can reduce exposure to the risks of restrictive Indonesian export policies, increases security of supply, and generates competitive advantages over competitors in China and the Philippines. In addition, the investors were able to leverage Indonesia’s enthusiasm for investment to negotiate favourable terms. For example, BLG is located in a bonded zone (Pinrang) and Longrun Newstar in a special economic zone (Kendal) and are therefore eligible for preferential treatment for the import of inputs (machinery and chemicals) and exemptions from import duties, VAT, and excise tax.17 Indonesian companies and industry associations have complained that they do not receive the same treatment (ARLI, personal communication, 10 September 2022).

Current processing structures

Market and policy forces have caused an ebb and flow of companies in the Indonesian carrageenan processing sector, with companies opening, closing, merging, and changing names. The Ministry of Industry provided a snapshot of the sector in 2021 (Kemenperin, 2022) which listed 41 seaweed processing companies in Indonesia.18 The reported production of the companies in 2017, 2021, and planned production under the Presidential Roadmap (year not defined) are shown in Table 2.1. Of the total seaweed extract production in 2021, 86 per cent is carrageenan. Of total carrageenan production, 56 per cent is SRC, 34 per cent is ATC, and 10 per cent is RC. The Presidential Roadmap plans to increase the proportion of RC to 28 per cent.

Astruli also collected details from member companies, which was collected and supplemented with further information from other major non-members. Details on a total of 32 processors (name, locations, capacity, capacity utilisation, production, and country of investment) are provided in Appendix 4, locations are mapped in Figure 2.4.

Capacity utilisation in the processing sector

The Ministry of Industry also reported that the sector has a production capacity of 68,604 tonnes. With an actual production of 28,968 tonnes, this suggests a 42 per cent utilisation rate. The Presidential Roadmap aims for a 72 per cent utilisation rate for
the sector as a whole. In another data series, the Indonesia Seaweed Industry Association (ASTRULI) collected data on carrageenan production, capacity, and capacity utilisation from member companies (Table 2.2). Utilisation rates were high in 2018 (75 per cent) but reduced over the 2020–2021 period, possibly due to the COVID-19 pandemic. The rate was especially low in the first six months of 2022 (19 per cent) and recovered to 45 per cent in the second half of 2022 (August to December).

ASTRULI and its members report that the stark declines in capacity utilisation from January to July 2022 were caused by very high prices in the second half of 2021 and first half of 2022 (Figure 2.3). When processors (particularly smaller processors) had met their orders, many companies re-assessed input-output prices and reduced or closed operations. The companies resumed operations and utilised more capacity when prices began dropping in the second half of 2022.

Seaweed products

With a seaweed production and processing base established, in recent years the government of Indonesia has turned its attention to the final demand end of the industry with at least two objectives: to grow aggregate demand for seaweed; and to generate opportunities for value adding. While the downstream sectors may seem a world away from village life (Part II of this book), development in the downstream sectors impacts on the livelihoods of farmers through derived demand, prices, and potentially the form in which seaweed is cultivated and sold.

### Table 2.1 Seaweed production processing output in Indonesia, 2017, 2022, and forecast

<table>
<thead>
<tr>
<th>Product</th>
<th>2017 (tonnes)</th>
<th>2021 (tonnes)</th>
<th>Target for Roadmap (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrageenan</td>
<td>13,116</td>
<td>25,057</td>
<td>27,838</td>
</tr>
<tr>
<td>ATC</td>
<td>2,352</td>
<td>8,531</td>
<td>3,850</td>
</tr>
<tr>
<td>RC</td>
<td>2,618</td>
<td>2,423</td>
<td>7,814</td>
</tr>
<tr>
<td>SRC</td>
<td>8,146</td>
<td>14,102</td>
<td>16,174</td>
</tr>
<tr>
<td>Agar-agar</td>
<td>4,140</td>
<td>3,911</td>
<td>10,393</td>
</tr>
<tr>
<td>Total</td>
<td>17,256</td>
<td>28,968</td>
<td>38,231</td>
</tr>
</tbody>
</table>

Source: Data from Kemenperin (2022).

### Table 2.2 Carrageenan production, capacity, and capacity utilisation of ASTRULI member companies, 2018–22

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrageenan production (tonnes)</td>
<td>30,314</td>
<td>26,977</td>
<td>17,988</td>
<td>25,655</td>
<td>5,000</td>
</tr>
<tr>
<td>Production capacity (tonnes)</td>
<td>40,230</td>
<td>40,230</td>
<td>40,230</td>
<td>52,299</td>
<td>26,149</td>
</tr>
<tr>
<td>Capacity utilisation rate (%)</td>
<td>75%</td>
<td>67%</td>
<td>45%</td>
<td>49%</td>
<td>19%</td>
</tr>
</tbody>
</table>

Source: Data from ASTRULI (unpublished).
Figure 2.4 Location of major Indonesian carrageenan processors

Source: Location of major Indonesian carrageenan processors
Carrageenan products

Within the seaweed-to-carrageenan sector, Indonesian policy makers pursue multiple forms of upgrading or value-adding, which is a major focus of the Presidential Decree. As the majority (65 per cent) of Indonesian seaweed is exported in raw dry form, the government is seeking to increase the proportion processed domestically to 50 per cent. It also aims to make the country a global leader in the carrageenan sector, which appears sound given the high and sustained forecast growth (Chapter 1).

Another form of upgrade can be seen in the processing pathways of carrageenan. The majority (56 per cent) of Indonesian carrageenan is in the form of semi-refined product. The Presidential Roadmap aims to increase the proportion of seaweed processed into RC from 10 per cent to 18 per cent. Indonesia also aims to produce high-value niche carrageenan products for certain markets, including Europe (Hogervorst and Kerver, 2019). Within Indonesia, the vast majority of carrageenan produced is exported or used domestically as a food additive, especially for drink products. The Presidential Decree plans to increase the utilisation of carrageenan in other domestically produced foods including coffee, milk, meat, jellies, and toothpaste.

Non-carrageenan products

It is likely that the Indonesian seaweed will be oriented to the production of carrageenan for some time. However much of the attention of the Presidential Roadmap is concerned with the development of non-carrageenan products. This includes direct food products (Adharini et al., 2019), animal feed, fertilisers (biostimulants, liquid and solid fertilisers, and planting media), cosmetics (e.g. capsules, pills, toothpaste, hair cream, soap), and bioethanol (Sulfahri, Husain et al., 2020; Sulfahri, Langford et al., 2020). The use of seaweed in a wide range of applications has generated attention world-wide, partly due to perceived environmental benefits, especially for Asparagopsis (Kinley et al., 2020; Ball et al., 2022). However, many of the technologies and applications are in the early stages of development and face logistic or commercial challenges. Further development should not be based only on technological development but should be subject to a full cost-benefit analysis to ascertain economic viability.

In line with potential and ambition, Indonesia has invested significantly in organisations to conduct research and development into new seaweed projects. These include: the Centre of Excellence for Seaweed at Hasanuddin University; Badan Pengkajian dan Penerapan Teknologi (BPPT) (Agency for the Assessment and Application of Technology) with a seaweed-based capsules programme; Seaweed-based Capsule Shell Teaching Industry facility at Universitas Airlangga; and the Department of Aquatic Product Technology, Faculty of Fisheries and Marine Sciences, IPB University in Bogor.

Cross-cutting policies

The previous discussion overviewed the seaweed industry by reviewing on a sector-by-sector basis. However, several aspects of the industry cut across industry
sectors. This includes food safety and the regulation of the use of carrageenan in organic food, which is overviewed in Chapter 1. Other cross-cutting issues such as marine zoning and investment are reviewed below.

**Zoning**

The rules and norms that govern use of sea space have been developed by communities and households themselves through the development of informal institutions (see Chapter 5). However, the expansion and intensification of seaweed production may involve an increased role for government to mediate competing interests between seaweed farmers, other aquacultural activities, use of boat lanes, and marine protection zones. Zoning may have a role in reducing conflict, protecting public goods, allocating resources, and attracting investment (Permani et al., 2023). While land-based property rights are more established in Indonesia, the government in recent years has turned its attention to zonation in marine areas, which may impact on seaweed cultivation.

The national government has a stake in zoning, but jurisdiction lies at the provincial level. Law 7–2007 on the management of coastal areas and small islands provided a mandate for provincial governments to apply RZWP3K (*Rencana Zonasi Wilayah Pesisir dan Pulau-pulau Kecil* – ‘Coastal Area and Small Island Zone Planning’) to respective regulations. This mandate was amended by Law 23–2014 on regional governments, which requires each province to issue a provincial regulation to govern RZWP3K, and more recently Law 11–2020 which stipulates the integration of RZWP3K into RTRWP (*Rencana Tata Ruang Wilayah*, ‘Spatial Planning’). As a provincial issue, the issue of zoning is discussed further in Chapter 3.

**Investment**

The government is very interested in attracting and promoting inward investment. Investment is a driver of industry growth and development with associated public benefits including employment. The government can also generate revenue and taxes from the involvement in projects. In line with industry development objectives, investment in seaweed processing plants and farms is a priority for the government.

Investment is promoted through a large number of activities, forums, and trade shows at an international and local level. An underlying aspect of investment promotion is to provide an investor-friendly or a business-enabling environment including areas relevant to business processes (e.g. registration), preferential policies (e.g. tax treatment), and the clarification and harmonisation of laws.

To draw together these disparate and sometimes controversial objectives and mechanisms, China has used an Omnibus instrument to guide investment in Indonesia, known as the Job Creation Law 11–2020 (UU *Cipta Kerja*), enacted by the Indonesian president in November 2020. The Law aims to attract investment, generate employment, and stimulate the Indonesian economy by simplifying the licensing process and harmonising various laws and regulations. While the Omnibus

Conclusion

This chapter outlined the historical development of the seaweed industry that has led to current industry structures. While it is argued that most developments have occurred in a bottom-up way led by economic agents, it also outlines the plans and measures that industry and government actors are making to meet future challenges and objectives. While these measures seem significant at the (national) level of analysis, they may be unrecognisable at the local levels which are the subject of subsequent chapters.

Notes


2 Several individuals were instrumental in the development of the industry. These included foreign scientist-entrepreneurs (Hans Porse and Iain Neish) and a founder of the Indonesian industry known as the seaweed politician, Sulfahri Aziz (also known as Sulfahri Hussain).

3 Other strategic plan documents from ministries include: Ministry of Marine Affairs and Fisheries Strategic Plan 2020–2024, Ministry of Industry Strategic Plan 2020–2024, and the Coordinating Ministry for Maritime and Investments Affairs Strategic Plan 2020–2024. Prior to the 2018 Presidential Decree, notable documents include the Revitalization Program for Agriculture, Fisheries, and Forestry (Program Revitalisasi Pertanian, Perikanan, dan Kehutanan) initiated by the President of Indonesia in 2005, the Acceleration of Fisheries Industry Program (Inpres No. 7 Tahun 2016, Percepatan Industri Perikanan), and Presidential Regulation No. 3 of 2017, which focuses on the development of non-food industries using seaweed as a raw material.

4 Key research centres supported by the central government include the Research Institute for Seaweed Culture in the Gorontalo Province, the Agency for the Assessment and Application of Technology (BPTP), Institute for Marine Socio-Economic and Fisheries Research, the Indonesian Institute of Science and the Indonesian Institute of Science Centre for Oceanography Research. International centres include the Southeast Asian Regional Centre for Tropical Biology and the Tropical Seaweed Innovation Network. Other research centres are located in Lombok, Bali, and South Sulawesi. The latter includes the Centre of Excellence for Seaweed at Hasanuddin University and a Public Agricultural Polytechnic in Pangkep.

5 These are CV Jala Ganggang, PT Sindo Serene International, PT Mega Citra Karya, PT Rika Rayhan Mandiri, CV Mitra Sejahtera, PT Central Pulau Laut, and CV Guna Bahari.
These differ from estate crops (cocoa, rubber) or staple crops (wheat, rice) where there are centralised, corporatised, or state-led marketing systems. For detailed analysis of market structures for six different commodities see InterCAFE (2018).

The InterCAFE (2018) found all six commodities studied to be characterised by oligopsony or oligopoly structures.

For example, an industry association seeking market intelligence asked a trader on a Friday what their prices would be next week. The answer was “I don’t know, the Chinese haven’t bought yet.” The trader was waiting until then, because it would be too risky to set up a purchase order in case prices moved against them.

For example, Chinese Indonesians have established seaweed processing plants in West Java (Gumindo, Galic Artha Bahari, Hydrocolloid Indonesia), East Java (Algalindo Perdana, Seatech Carrageenan, Amarta Carrageenan) and South Sulawesi (Cahaya Cemerlang, Giwang Citra Laut, Wahyu Putra Bimasakti, Anugerah Mapan Jaya Hydrocolloid).

For an account of a well-known Chinese-Filipino entrepreneur see Gargan (1995).

For carrageenan seaweeds, moisture content must be a maximum of 38 per cent with a clean anhydrous weed (CAW) yield of 50 per cent minimum and a maximum of 3 per cent impurities. The standard goes on set requirements for proper handling techniques in harvesting, drying, packaging, labelling, and storage.

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The policy and outcomes for seaweed industry policy resemble those used in the Indonesian cocoa industry, where in 2010 exports taxes were imposed to encourage domestic processing and resulted in investment from MNCs (Harrison-Dunn, 2015). Another parallel is Russia’s industry policy settings which discourage the export of raw timber (export tariffs) in order to encourage domestic wood processing (Ekstrom, 2014). The provinces use similar industry policies, Nusa Tenggara Timur (NTT) province for beef cattle (Waldron et al., 2016) seaweed (Langford, Turupadang et al., 2022; Langford, Turupadang, and Waldron, 2023).

The Ministry of Industry (Kemenperin, 2022) list policies to encourage downstream processing: tax allowances, deductions for research and development, and vocational training costs, exemptions for machinery for industrial development and using commodity balance sheets to expedite export and import approvals.

These are in the South Sulawesi Province (Luwu Timur, Janeponto, Bone), South East Sulawesi (Bombana, Buton, Buton Tengah), Gorontalo, North Kalimantan (Tarakan), and Maluku Utara.

See, for example, information on the Kendal Industry Park/Special Economic Zone. https://www.kendalindustrialpark.co.id/page/index/17/special-economic-zone?p=1

A list of 52 seaweed processors and exporters in South Sulawesi were reported by the Makassar Agricultural Quarantine Agency (2023).

References


Porse, Hans and S. Ladenburg. 2015. Seaweed Value Chain Final Report. Report submitted to Smart-Fish Indonesia under the UNIDO Seaweed Value Chain Programme.


