



Quality management and industrialization of seaweed products as an effort to improve the welfare of coastal communities in the province of East Nusa Tenggara, Indonesia - A review

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Abstract. World seaweed production reached 30 million tonnes in 2019, Indonesia contributing to more than 40% of the world's total seaweed production. One of the provinces that contributes with the largest seaweed production in Indonesia is East Nusa Tenggara (NTT). The seaweed industry in the province of NTT is capable of producing 25.9% of the Indonesian seaweed. The increase in seaweed production in NTT is the result of cooperation between the Ministry of Maritime Affairs and Fisheries for the Provinces of West Nusa Tenggara (NTB) and NTT. In 2020, there was a decrease in production from the available potential, which only reached 10.1%. This decline in production was attributed to the Covid-19 pandemic. The NTT province experienced an increase in production from 1.6 million tonnes in 2020 to 2.2 million tonnes in 2021, while the overall seaweed producing industry in Indonesia continues to decline. The low quality of the products and the fluctuation in the selling price of seaweed on the market affect the income of farmers. The strategy that can be taken in this case is the empowerment of seaweed cultivators and product industrialization. The low education of seaweed cultivators in NTT requires a special approach in transferring knowledge and technology. Assistance in efforts to diversify processed seaweed products (DIPORLA) in North Kalimantan province Indonesia in 2019 was able to increase turnover by 249.2%.

Key Words: development, East Nusa Tenggara, *Euचेuma cottonii*, potential, production of seaweed.

Introduction. Indonesia, as a tropical region, has great water resources, including diverse seaweed germplasm. With a coastline length of approximately 99093 km and a water area of 3.2 million km², Indonesia has great biological and non-biological resources, including seaweed (Widiarti 2022). The area of water as a habitat for seaweed is estimated to reach 1.2 million ha (Widiarti 2022), being the largest in the world. The abundance of seaweed biological resources is an advantage, which can be used as a driver of the national economy, a provider of employment, a foreign exchange earner and a source of national food and nutrition (Artati 2021).

Indonesia has relatively rich various marine resources available in large quantities. The government has taken steps in developing national seaweed production and industry through Presidential Regulation Number 33 of 2019 concerning the Road Map for the Development of the National Seaweed Industry (Widiarti 2022). In addition, the Ministry of Industry is trying to increase the added value of seaweed products, so that they can become derivative products with a large market share, both for domestic and export needs. This review paper aimed to analyze various information related to the development of the seaweed industry in the Province of East Nusa Tenggara (NTT), Indonesia.

Seaweed Potential. Indonesia has 6400000 km² of ocean area and 110000 km of coastline, being supported by a tropical climate, and being a suitable area for the growth of various seaweeds. 550 types of seaweed with high economic value are present in Indonesia, one of which is *Euचेuma cottonii*. According to the Ministry of Foreign Affairs,

the potential for *Eucheuma cottonii* in Indonesia is estimated to reach 10 billion USD per year (Ministry of Foreign Affairs 2021).

One of the steps to increase the selling value of seaweed is to optimize the role of the processing industry, so that it can have a broad impact on the national economy and the welfare of the community, especially the farmers (Ardika 2021). Seaweed is one of the most abundant biological resources in Indonesian waters. In fact, the number reaches 8.6% of the total marine biota. The area of seaweed habitat in Indonesia reaches 1.2 million ha, being the largest in the world (Widiarti 2022).

Development Potential. Currently, seaweed in Indonesia is widely developed on the coasts of Bali and Nusa Tenggara. Given the length of Indonesia's coastline, the opportunity for seaweed cultivation is very promising. The market demand from Indonesia annually reaches an average of 21.8% of the world demand, and fulfillment to supply this demand is lacking, around 13.1%. Indonesia's seaweed production continues to increase every year, from 7.5 million tons in 2014 to 9.9 million tons in 2015, 11 million tons in 2016, 13.4 million tons in 2017, 16.23 million tons in 2018, and 19.5 million tons in 2019, with an average increase of 38% (<https://kkp.go.id/djpb>). However, only 81394 tons were processed to seaweed products (<https://kkp.go.id/djpb>). This means that the seaweed processing industry in Indonesia can be developed further. Currently, Indonesia has become one of the world's major seaweed producers with wet seaweed production reaching 11.6 million tons in 2021 (<https://kkp.go.id/djpb>). Seaweed production in seven provinces of Indonesia according to data from the Indonesian Central Statistics Agency is presented Figure 1 (BPS 2023).

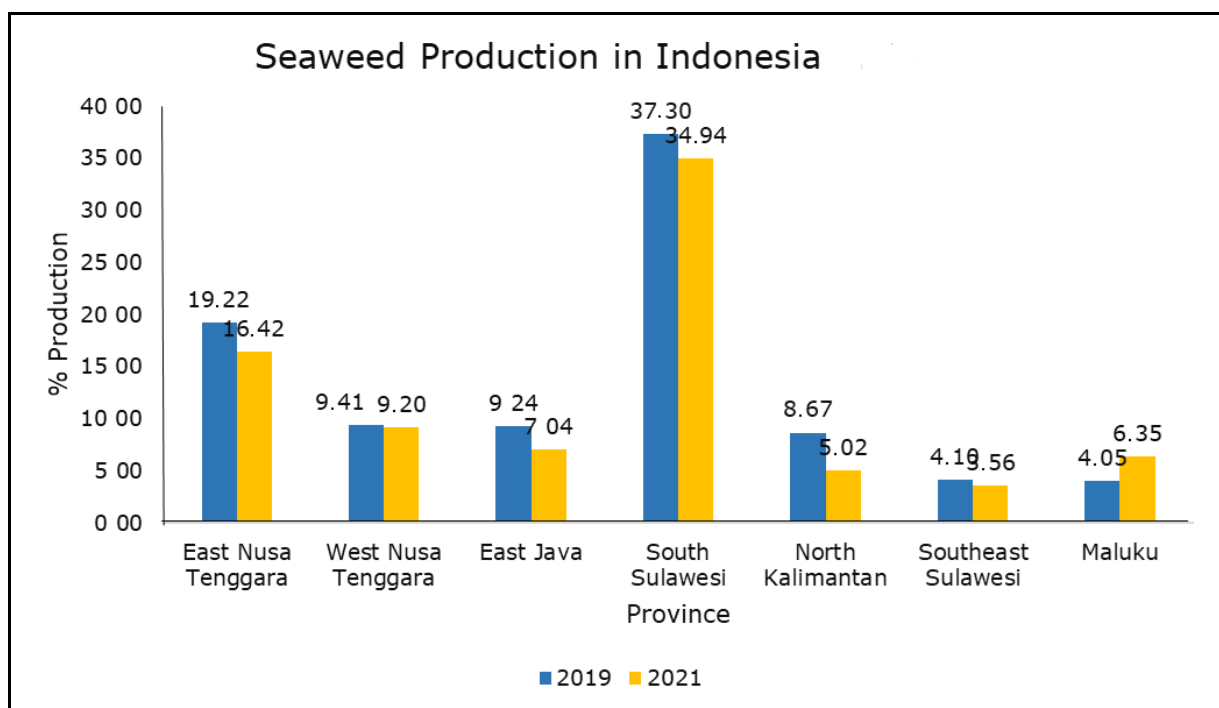


Figure 1. Seaweed production in seven provinces of Indonesia (BPS 2023).

Most of the production is composed of *Eucheuma* spp. and *Gracilaria* spp. (FAO 2021). For comparison, in 2019, world seaweed production was approximately 30 million tons, and Indonesia contributed with almost 40% (FAO 2021). In international trade, trademap data shows that Indonesia is one of the main players with an export volume in 2018 of 213000 tons (rank 1, with a contribution of 30% of total world exports) (FAO 2021). However, in terms of value, Indonesia is ranked 3rd with a value of 294 million USD, 12% of the total world export value. This indicates that Indonesia's exports are mostly in the form of raw materials or products with low added value. As comparative data, China is

the highest exporting country with a value of 594 million USD, only exporting 76000 tons of seaweed in 2019 (FAO 2021).

Most of Indonesia's seaweed production comes from South Sulawesi, followed by NTT, Central Sulawesi, West Nusa Tenggara, East Java, Southeast Sulawesi and North Sulawesi. In 2019, South Sulawesi produced 37.3% of the national production of 9.7 million tons (BPS 2023). The second position, NTT, is only able to produce a maximum of 19.2% of the national production. In 2021, almost all seaweed-producing areas in Indonesia experienced a decrease and stagnation of seaweed production, except for NTT. South Sulawesi, the highest seaweed producer in Indonesia, experienced a production decline of 34.94%. In contrast, NTT's seaweed production increased by 16.42% (BPS 2023). According to KKP (2022), the decline in production in several regions in Indonesia was caused by the impact of the Covid-19 pandemic.

Seaweed Potential and Production in East Nusa Tenggara Province. The increase in seaweed production in NTT is the result of cooperation of the Ministry of Maritime Affairs and Fisheries (KKP), West Nusa Tenggara (NTB) and NTT. The Head of the Lombok Mariculture Fisheries Center (BPBL) stated that for the past few years, the Lombok BPBL has carried out several interventions in East Nusa Tenggara, both through the province and the districts in NTT, one of which is the development effort of seaweed cultivation (KKP 2022). It was also said that seaweed nursery development had been carried out in East Sumba and Kupang Regencies.

East Nusa Tenggara has 54000 ha of seaweed cultivation land with a production potential of 15.8 million tons per year (Wurgiyanto 2020). Utilization of available potential in 2019 reached 12.5%. In 2020, there was a decrease in production from the available potential, which only reached 10.1% (NTT in Numbers 2023). This decline in production could have been because of the impact of the Covid-19 pandemic that occurred in 2019. However, in 2021 the impact of covid-19 appears to have diminished with the increase in seaweed production from NTT reaching 13.7% of the available potential (NTT in Numbers 2023). Nationally, NTT's seaweed production ranks second after South Sulawesi. South Sulawesi seaweed production in 2019 reached 3.4 million tons or 28.5% of national production, while NTT produced 1.6 million tons or 18.7% of national production (BPS 2023). In 2021, South Sulawesi experienced a decline in production reaching 20.63%, from the production of 3.4 million tons in 2019 to 2.7 million tons in 2021 (BPS 2023). In 2021, South Sulawesi experienced a decline in production reaching 26.6%, from the production of 3.4 million tons in 2019 to 2.7 million tons in 2021. On the other hand, NTT experienced a production increase of 25.9%, from 1.6 million tons in 2019 to 2.158 million tons in 2020, but further decreasing to 1.392 million tons (NTT in Numbers 2023).

The increase in production in NTT is encouraging because it shows that the use of aquatic resources for seaweed production is increasing. However, if one looks at the available potential of 15.8 million tons per year, the utilization rate of the resource has only reached 13.7%. Even though production only reached 13.7%, this achievement can be said to be quite good, considering the conditions in the Covid-19 pandemic. In 2021, the province of NTT was able to increase production from 10.1% to 13.7%.

The increase in seaweed production is inseparable from the government's role, in this case the DKP of the Province of NTT, which has formed seaweed cultivation clusters (Figure 2) in four seaweed production centers. The clusters are Cluster I for the Sumba region, Cluster II for Timor and Rote regions, Cluster III for Sabu region, Cluster IV for Alor, Lembata and East Flores regions, Cluster V for Sikka – West Manggarai region. In addition, processing plants for seaweed production centers have been established in four of the five clusters.

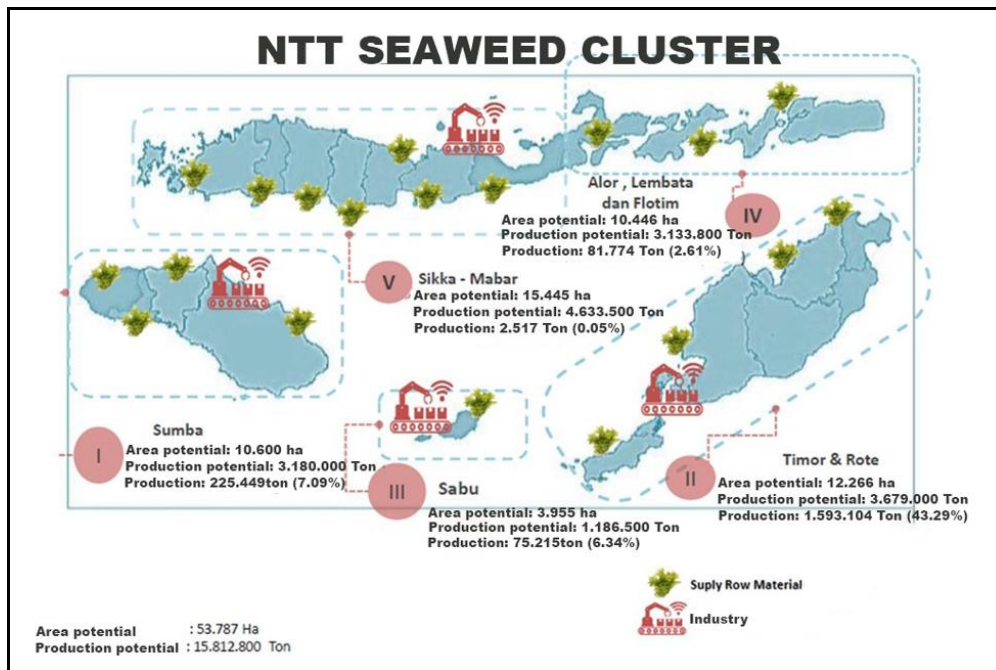


Figure 2. East Nusa Tenggara (NTT) seaweed cluster.

Problems in the Indonesian Seaweed Industry and Efforts to Improve It. The increase in seaweed production in Indonesia is currently faced with low quality, where dry production from farmers does not fully meet the quality standards desired by the processing industry. The impact that often occurs is that the processing industry incurs additional production costs to re-sort dry products from cultivators, which ultimately results in the bargaining position of dried seaweed products from cultivators not being able to compete (<https://kkp.go.id/djpb>).

Currently the Government of Indonesia has issued regulations specifically for the management of seaweed. The government regulations are contained in the Presidential Regulation no. 33 of 2019 concerning the Guide Map (Road Map) for the Development of the Seaweed Industry. The presidential decree describes the problems of seaweed development in Indonesia. The application of the Indonesian National Standard (SNI) for seaweed cultivation and postharvest implies the following:

1. Availability and supply of quality raw materials for the seaweed processing industry in a sustainable manner.
2. The price of seaweed raw materials fluctuates.
3. Developing cultivation and postharvest in the provision and supply of quality seaweed raw materials to meet industrial and export needs.
4. Availability of Human Resources (HR) for cultivators, both in number and competence for cultivation and processing, especially small and medium scale enterprises (SMEs) and the involvement of extension workers.

Until now, there have been issued several SNIs for seaweed products, including SNI No. 7672 of 2011 concerning seaweed seeds, no. 7673 of 2011 concerning cultivation and postharvest, no. 2690:2 of 2015 concerning dry seaweed quality standards, no. 2690:3 of 2009 handling and processing. In addition, DKP, through the Directorate General of Aquaculture Fisheries, issued the Technical Guidelines for seaweed cultivation, harvesting and post-harvesting to maintain the quality of upstream seaweed products, which determine the quality of their derivative products. In addition, a problem often faced by farmers is the fluctuating selling price of wet or dry seaweed. Many factors affect the price fluctuations of seaweed products in the market. One of the factors is product quality and the dynamics of world seaweed price fluctuations. Seeing the fact that the quality of seaweed production is low on one hand, and the many quality assurance instruments on the other hand, it can be concluded that the main problem for seaweed development in Indonesia is the availability of competent human resources for

cultivators, which are a key factor in the seaweed production industry. The low quality of products and the fluctuation in the selling price of seaweed on the market affect the income of farmers. The strategy that can be taken in this case is the empowerment of seaweed cultivators and product industrialization.

Empowerment. The issuance of various seaweed quality assurance instruments does not have a positive correlation with quality improvement. The approach that can be taken is through the empowerment of cultivator human resources. Several research results show that the education level of seaweed cultivators is very low. For example, the education level of seaweed cultivators in Kaliuda Village, East Sumba is dominated by those who did not finish elementary school, namely 53%, while 40% finished elementary school, and 7% finished junior high school (Marak et al 2018). The results of Turupadang et al (2021) show that the education level of seaweed cultivators in Sulamu District reaches elementary school education and below (88.75%), while in Semau Selatan District, the highest education level is elementary school. The low education level of seaweed cultivators in NTT requires a special approach in transferring knowledge and technology. Cultivator empowerment can be pursued by 2 approaches, as stated by Soleh (2014), namely human development and establishing businesses. Soleh (2014) stated that human development is the main component in empowering people with low levels of education and welfare. There are two reasons: empowerment aims to improve the quality or standard of human life, and the subject of empowerment is the community or the cultivators themselves, while other parties are only facilitators. An important effort in community or cultivator empowerment is business development. Empowerment in any form that is unable to increase welfare will be difficult to respond to and difficult to get support in an active participative form.

Product industrialization. The industrialization of seaweed products provides a very important added value compared to the raw material products. In Presidential Decree No. 33 of 2019 concerning the National Seaweed Industry Road Map, it is explained that the processing of seaweed provides a much higher added value than its raw materials. Alkali Treated Carrageenan (ATC) products with a yield of 30% are able to produce an added value of 1.7%. Semi Refined Carrageenan (SRC) with a yield of 25% produces an added value of 2.0%. Refined Carrageenan (RC) with a yield of 20% produces an added value of 2.8%. According to Ngamel (2012), the profit rate for processing seaweed into carrageenan is 51.99% and the labor reward per kilogram is 0.08 USD.

In addition to semi-finished materials, seaweed can be processed into processed products with high added value and stable prices. Picauli & Ngamel (2015) noted that several types of processed seaweed products yielded varying profit rates, but the value was greater than 25%. The highest value was obtained from the meatball industry, which reached 58%, followed by seaweed crackers with 50% and seaweed dodol with 48%.

Assistance in efforts to diversify processed seaweed products (DIPORLA) was able to increase turnover by 249.2%. In addition, this program was able to improve product quality, marketing and management of seaweed business management (Suciyati et al 2019). Industrialization through micro, small and medium enterprises at the level of seaweed cultivators in West Nusa Tenggara is of value in the strengthening and resilience of the local and community economies (Hidayat & Safitri 2019). On two processed seaweed products, namely nuggets and banana seaweed ice cream, showed that each product generated an added value of 13.61 USD and 11.2 USD per kilogram of dried seaweed (Tang et al 2015). The seaweed tortilla product generates an added value of 3.17 USD per kilogram of dried seaweed (Tang et al 2015) and most seaweed products in NTT reached 2.96 USD per kg (Oedjoe et al 2019).

Conclusions. The utilization of seaweed resources in NTT only reached 13.7% in 2021. Even though the value is low, NTT's seaweed production is close to that of South Sulawesi. In 2021, South Sulawesi produced 33% and NTT produced 29.3% of the national production. NTT produced 2.2 million tonnes in 2021, an increase of 26.6% from the previous year, when 1.6 million tonnes were produced. The low quality of cultivated

seaweed plays a role in price fluctuations. The large number of seaweed quality assurance instruments issued by the government have not been able to overcome the problems that occur, so a sustainable strategic step is needed. Community empowerment is an important step to improve the quality of cultivator human resources. In addition, to increase the welfare of farmers and coastal communities, micro-scale industrialization is needed for product diversification. The results of the research have shown that micro-industrialization, which produces processed products can increase added value, which may increase people's income and welfare.

Conflict of Interest. The authors declare that there is no conflict of interest.

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