

Research Article

Analysis of Seaweed Agroindustry Management in Indonesia: Potential, Challenges, and Prospects

Tabrani¹, Wisman Indra Angkasa^{2,*}, Ika Meidy Deviarni³

¹Department of Management, Faculty of Economics Pancasakti University Tegal, Tegal, Indonesia

²Research Centre for Agroindustry, National Research and Innovation Agency, Serpong, Indonesia

³Pontianak Polytechnic, Fishery Product Processing Technology Study Program, Pontianak, Indonesia

Abstract

This study analyzes seaweed agro-industry management in Indonesia with a focus on its potential, challenges, and prospects. The potential of seaweed agroindustry in Indonesia can be seen from the wealth of abundant seaweed natural resources and the diversity of species in various regions. The domestic and export markets are promising, with seaweed applications in the food, cosmetic, pharmaceutical and other industrial raw materials industries. However, challenges in seaweed agro-industry management are also significant, such as complex licensing, limited production technology, and challenges in marketing and distribution. Environmental sustainability is also an important issue that needs attention. To overcome these challenges, seaweed agro-industry management in Indonesia needs to be carried out comprehensively, involving the identification of relevant stakeholders, sustainable natural resource management, production technology innovation, and effective marketing strategies. The prospects for seaweed agro-industry development include market growth potential, export opportunities and strengthening competitiveness, agro-industry cluster development, as well as the government's role in encouraging the development of this sector. This study concludes that seaweed agro-industry management in Indonesia has great potential to be developed. Despite facing significant challenges, with the right strategic measures, the sector can develop sustainably. The implications and recommendations of this research are expected to help policy makers, industry players, and researchers in supporting the development of seaweed agroindustry in Indonesia.

Keywords

Agroindustry, Seaweed, Management, Potential, Challenges, Prospects

1. Introduction

1.1. Background

Seaweed has become an increasingly important natural resource in the agro-industrial sector in Indonesia. Indonesia is the world largest producer of the red seaweeds [15]. The

country has abundant natural wealth, consisting of thousands of islands with fertile waters and climatic conditions that favor the growth of diverse seaweed. This potential offers opportunities for the development of seaweed agro-industry that can provide economic, social, and environmental benefits.

*Corresponding author: wism001@brin.go.id (Wisman Indra Angkasa)

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The potential of seaweed agro-industry in Indonesia is driven by growing demand both in domestic and international markets. Seaweed has been widely used in various industries, such as food, pharmaceutical, cosmetic, and chemical industries. The demand for seaweed as an environmentally friendly alternative raw material is also increasing. In addition, Indonesia has a competitive advantage in terms of seaweed production with a diversity of types and high quality.

Despite its great potential, seaweed agro-industry management in Indonesia faces various challenges that need to be overcome. One of the main challenges is the complexity of licensing and regulation related to the production, handling, and marketing of seaweed. Complicated and slow licensing processes can hinder industry growth and encourage illegal practices. In addition, limited production technology and lack of innovation in the development of seaweed agroindustry are also important challenges that need to be overcome.

Another challenge is related to marketing and distribution. Limited access to markets, lack of understanding of consumer needs and preferences, and lack of adequate infrastructure in the seaweed supply chain are obstacles to the development of this agro-industry. In addition, sustainability aspects are also an important concern in seaweed agro-industry management. Unsustainable natural resource management can threaten environmental sustainability and reduce the long-term potential of the seaweed agroindustry.

To optimize the potential and overcome these challenges, a comprehensive analysis of seaweed agro-industry management in Indonesia needs to be carried out. In this context, this study aims to analyze the potential, challenges, and prospects of seaweed agroindustry development in Indonesia. By deeply understanding the challenges and opportunities that exist, strategic measures can be identified and implemented to strengthen the sector.

1.2. Method

In this study, using a qualitative approach by extracting information through literature review, related policy analysis, and interviews with relevant stakeholders. The data and information obtained will be analyzed systematically to identify policies, best practices, and strategic recommendations in seaweed agro-industry management in Indonesia.

Thus, this research is expected to provide a deeper understanding of seaweed agro-industry management in Indonesia, strengthen awareness of the potential and challenges faced, and provide relevant policy and strategy recommendations for the development of this sector.

1.3. Research Objectives

- a) Analyze the agro-industry potential of seaweed in Indonesia, including the identification of abundant seaweed natural resources and species diversity in various regions.

- b) Assess the economic and market value of seaweed in Indonesia, both on a domestic scale and export potential, and identify opportunities for seaweed agro-industry development.
- c) Analyze challenges in seaweed agroindustry management in Indonesia, including complex licensing and regulation, limitations of production technology, and constraints in marketing and distribution.
- d) Evaluate management approaches taken in the seaweed agroindustry, including sustainable natural resource management, production technology innovation, and effective marketing strategies.
- e) Identify the prospects for seaweed agro-industry development in Indonesia, including market growth potential, export opportunities, strengthening competitiveness, and developing agro-industry clusters.
- f) Provide relevant policy recommendations and strategies to support the development of seaweed agroindustry in Indonesia, based on an analysis of the potentials, challenges, and prospects that have been identified.

The purpose of this study is to provide a more comprehensive understanding of seaweed agro-industry management in Indonesia, as well as provide policy guidance and strategies that can strengthen the sector, address existing challenges, and harness the existing potential for sustainable economic development.

1.4. Research Scope

The scope of this study focuses on the analysis of seaweed agroindustry management in Indonesia by taking into account the potentials, challenges, and prospects that exist. Some aspects that will be discussed in the scope of this research include:

Seaweed Agroindustry Potential, including the wealth of seaweed natural resources in Indonesia, diversity of seaweed species available in various regions, economic value and market potential of seaweed in the country and export.

Challenges in Seaweed Agroindustry Management include, the complexity of licensing and regulations related to the production, handling, and marketing of seaweed, limitations of existing production technology, constraints in marketing and distribution of seaweed products.

Seaweed Agroindustry Management approach includes, sustainable management of seaweed natural resources, innovation in seaweed production technology, effective marketing strategies for seaweed products.

Seaweed Agroindustry Development Prospects include, market growth potential and seaweed export opportunities, strengthening seaweed agroindustry competitiveness, seaweed agroindustry cluster development, the role of the government in encouraging the development of this sector.

2. Results and Discussion

2.1. Seaweed Agroindustry Potential

Indonesia has a wealth of natural resources seaweed that is quite abundant. Indonesia has vast and diverse waters, which include the Indian Ocean to the west, the Pacific Ocean to the east, as well as the Java Sea, Bali Sea, Flores Sea, Banda Sea, Arafura Sea, and Timor Sea.

Some types of seaweed found in Indonesian waters include:

- a) *Eucheuma cottonii*: A type of red seaweed that has a soft texture and strong fibers. Usually used in food, cosmetics, and pharmaceutical industries.
- b) *Kappaphycus alvarezii*: A type of red seaweed that is widely cultivated in Indonesia. Used in food, cosmetics and pharmaceutical industries.
- c) *Gracilaria sp.*: A type of red seaweed that thrives in Indonesian waters. Usually used in food, cosmetics, and pharmaceutical industries.
- d) *Sargassum sp.*: A type of brown seaweed that can be found in Indonesian waters. Used in food, cosmetics and pharmaceutical industries.
- e) *Ulva sp.*: A type of green seaweed commonly known as "sea leaf". It can be found in various waters in Indonesia. Usually used in the food industry.

The potential of seaweed natural resources in Indonesia is very large, both in terms of species diversity and number [1]. This provides a great opportunity for the development of seaweed agro-industry in Indonesia. However, sustainable management and protection of these natural resources are also important in order to preserve the marine environment and the sustainability of the seaweed agro-industry sector in the future.

The distribution and diversity of seaweed species in Indonesia reflects the wealth of natural resources owned by this country [1]. Here are some regions in Indonesia that have the distribution and diversity of seaweed species, namely:

- a) Java Island: Java Island, especially around the north and south coasts, has a high diversity of seaweed species. Types such as *Gracilaria sp.*, *Eucheuma cottonii*, and *Kappaphycus alvarezii* can be found in these waters.
- b) Kalimantan: The island of Borneo has a large area of water, including large rivers and estuaries, which are habitats for various types of seaweed. Examples are types of seaweed such as *Gracilaria sp.*, *Ulva sp.*, and *Sargassum sp.*
- c) Sumatra: The waters around the island of Sumatra are also rich in seaweed species diversity. Some common species found in this region include *Gracilaria sp.*, *Kappaphycus alvarezii*, and *Sargassum sp* [4].
- d) Papua: The Papua region, including West Papua and Papua New Guinea, has very abundant seaweed natural resources. Types such as *Eucheuma cottonii*, *Kappaphycus alvarezii*, and *Sargassum sp.* can be found in these waters.

Seaweed has significant economic value in Indonesia, both on a domestic scale and export potential. Here is some information about the economic value and market potential of seaweed in Indonesia [5]:

The economic value of seaweed.

- a) Seaweed is one of the non-fish fishery commodities that has an important economic contribution in Indonesia, because seaweed has high economic value that can be utilized in various industries, such as food, cosmetics, pharmaceuticals, and other industries, and with the increase in domestic and international demand, the economic value of seaweed continues to increase.

Seaweed Market Potential:

- b) Domestic market: Seaweed is an important raw material in the food industry in Indonesia, such as agar-agar, seaweed noodles, and other food products. The domestic market for seaweed products continues to grow along with increasing public awareness of the health and nutritional benefits of seaweed.
- c) Export potential: Indonesia has a large seaweed export potential. Countries such as Japan, South Korea, China, and European countries are the main markets for Indonesian seaweed products. Global demand for seaweed continues to increase, especially in the food, beverage, cosmetics, and dietary supplement industries [1].

Seaweed agroindustry has an important role and contributes to Indonesia's national economic development [6]. Some of the roles and contributions of seaweed agroindustry in national economic development are:

- a) Role and contribution to the Economy:

Seaweed agroindustry contributes significantly to the national economy through job creation in both the production sector and its supporting sectors. This helps reduce unemployment and improve people's welfare.

- b) Role and contribution to Export and Foreign Exchange Income:

Seaweed agroindustry has great export potential. Exports of seaweed products can be an important source of foreign exchange income, improve the trade balance, and strengthen the national economy.

- c) Role and contribution to the development of the territory:

Seaweed agroindustry can be a driver of regional development, especially in coastal areas and islands. This agro-industrial development encourages local economic growth, creates new business opportunities, and helps improve the welfare of people in the area.

- d) Role and contribution to Economic diversification:

Seaweed agroindustry is an important form of economic diversification. This helps reduce dependence on certain sectors of the economy and creates new opportunities for the sustainable and competitive development of industries.

- e) Role and contribution to innovation and added value:

Seaweed agroindustry encourages innovation in seaweed

production and processing technology, thus creating added value to the products produced. The development of value-added products can increase competitiveness in domestic and international markets.

2.2. Challenges in Seaweed Agroindustry Management in Indonesia

Seaweed agro-industry management in Indonesia faces various challenges. Here are some of the challenges faced in seaweed agro-industry management in Indonesia:

a) Regulations and Policies:

Complex regulatory and policy challenges often hinder the development of seaweed agro-industry. Complicated licensing processes, inconsistent regulations, and misaligned policies can hinder the growth of this industry.

b) Quality and Production Standards:

Challenges related to the quality and standards of seaweed production are important issues. Strict supervision of seaweed quality and cleanliness is necessary to meet market requirements, both domestically and in export markets.

c) Technology and Innovation:

Technology development and innovation in seaweed cultivation, processing, and marketing are still a challenge, continuous research and development is needed to improve production efficiency, product quality, and added value in the seaweed agroindustry.

d) Market and Marketing:

Marketing challenges include meeting fluctuating market demand, the need for effective marketing strategies, and wider export market penetration. Product diversification and finding new market opportunities are also challenges in expanding market share.

e) Sustainability and Environment:

The sustainability of the seaweed agroindustry requires an environmentally friendly approach. Challenges in environmental management, such as waste management and monitoring of aquatic ecosystems, are important to maintain the sustainability of seaweed production.

f) Access to Capital and Funding:

Challenges in access to capital and funding can also affect the development of seaweed agro-industry. Limited access to financial resources and affordable financing can hinder growth and investment in the industry.

g) Licensing and Regulation

Licensing and regulation are important challenges in seaweed agro-industry management in Indonesia. Some aspects of licensing and regulation that are challenges include:

Cultivation and Processing Licensing:

Seaweed agroindustry requires cultivation and processing permits from relevant agencies, such as the Ministry of Marine Affairs and Fisheries or the Marine Resources and Fisheries Management Agency. This licensing process is often complex and takes a considerable amount of time [7].

Environmental Permits:

Seaweed agroindustry must meet environmental permit requirements which include environmental impacts and mitigation efforts that must be carried out. This licensing process involves agencies such as the Environment Agency and the local Marine and Fisheries Service.

Food Quality and Safety Standards:

Seaweed agroindustry needs to comply with food quality and safety standards set by regulatory bodies, such as the Food and Drug Supervisory Agency (BPOM). This involves testing, certifying, and monitoring product quality to meet market requirements.

Marketing and Export Regulations [9]:

Seaweed agro-industry that wants to export must comply with regulations and requirements set by the export destination country. This includes export licensing, product labeling, compliance with sanitary standards, and quarantine requirements.

Labor and Labor Regulations:

Seaweed agro-industry must also comply with regulations related to labor and labor, such as minimum wage, working hours, workers' rights, and labor protection. This is important to maintain the welfare of workers and comply with applicable labor regulations.

These challenges in licensing and regulation can affect the smooth operation and growth of seaweed agroindustry in Indonesia. It is important for industry players to understand and comply with applicable licensing and regulatory requirements to maintain business sustainability.

h) Seaweed Production Technology

Seaweed production technology continues to develop to improve efficiency, productivity, and yield quality. Here are some seaweed production technologies used in Indonesia [3]:

Floating cultivation methods:

This method involves the use of nets or floating skeletons to support seaweed seedlings above the surface of the water. Seaweed seedlings are placed on top of a net or skeleton, which allows optimal growth with good access to sunlight and good water circulation.

Longline Cultivation Methods:

This method uses a rope or long line floating on the surface of the water to support seaweed seedlings. Seaweed seedlings are tied on ropes at certain intervals. This method allows seaweed seedlings to grow well below the surface of the water.

Pond cultivation methods:

This method involves the construction of special ponds for seaweed cultivation [2]. The ponds used can have controlled inlet and outlet drains, thus allowing for appropriate regulation of water temperature and salinity. This method is generally used for the cultivation of *Gracilaria* seaweed.

Selection of high-yielding varieties:

The development of superior seaweed varieties through genetic selection and breeding is also an important part of seaweed production technology. High-yielding varieties have rapid growth, disease resistance and good quality, thus giving

more optimal yields.

Fertilization and Pest Handling:

Proper fertilization technology and effective pest control are also used in seaweed production. Proper fertilization provides enough nutrients for seaweed to grow properly, while pest control helps protect plants from pest and disease attacks.

Environmental Monitoring and Management:

The use of technology such as environmental monitoring and management systems helps monitor water conditions, including temperature, salinity, and water quality. It helps in making the right decisions regarding seaweed farming management.

The development of seaweed production technology continues with the aim of increasing productivity and sustainability of the industry. Continuous research and innovation are key in meeting challenges and improving seaweed farming practices.

i) Marketing and Distribution

In the seaweed agroindustry, marketing and distribution are crucial aspects to market products and reach a wider market. Here are some marketing and distribution strategies that can be applied in seaweed agroindustry management in Indonesia:

Target Market Designation:

Identification of specific and potential target markets is the first step in a marketing strategy. This includes determining market segments, such as the food, cosmetic, pharmaceutical, or other industrial raw materials.

Marketing Through Marketing Agencies or Companies:

Cooperation with agents or marketing companies that have an extensive network can help market seaweed products effectively. Marketing agencies or companies can help connect seaweed producers with potential buyers in domestic as well as export markets.

Value-added product development:

Diversifying seaweed products by developing value-added products can help enter a wider market. For example, processed products such as snacks, dietary supplements, cosmetics, or seaweed-based health products.

Online Marketing:

Utilizing e-commerce and online marketing platforms is an important strategy in dealing with current market trends. Building an online store or working with an e-commerce platform can increase the visibility of seaweed products and reach a wider range of consumers.

Promotion and Branding:

Conducting effective promotional activities and building a strong brand can increase consumer awareness about seaweed products. Promotional strategies that can be used include advertising, participation in exhibitions, use of social media, and collaboration with influencers.

Efficient Distribution:

Having an efficient distribution system is essential to ensure seaweed products can get to market well. Optimizing the supply chain, paying attention to logistics, and maintaining product quality during the distribution process are key factors

in distribution management.

In facing marketing and distribution challenges, it is important for seaweed agro-industry players to understand market needs, follow market trends, and continuously innovate in marketing and distribution strategies.

j) Environmental Sustainability

Environmental sustainability is an important aspect in seaweed agro-industry management in Indonesia. In order for this industry to be sustainable, it is necessary to pay attention to several factors related to the environment, including:

Natural Resources Conservation:

Seaweed agroindustry needs to pay attention to the conservation of natural resources used in cultivation, such as land, water, and energy use. Efficient use and sustainable management will help protect and sustain natural resources for the long term.

Pollution Handling:

Waste management from seaweed agroindustry must be done properly to prevent water pollution. Waste management includes organic waste management, the use of appropriate waste treatment technology, and water quality monitoring to ensure there is no negative impact on the environment.

Proper Use of Chemicals:

In the control of pests and diseases in seaweed, the use of chemicals should be carried out carefully and in accordance with applicable rules. Excessive use of chemicals can have a negative impact on the aquatic environment. Therefore, the adoption of organic practices and the use of natural alternatives for pest and disease control is highly recommended.

Ecosystem Restoration and Rehabilitation:

Seaweed agroindustry needs to involve efforts to restore and rehabilitate affected aquatic ecosystems. This includes seaweed replanting activities to restore biodiversity and the quality of aquatic ecosystems.

Climate Change Management:

Climate change is a significant challenge for the seaweed agroindustry. Climate change management through adaptation and mitigation, such as adjusting cultivation techniques, using renewable energy, and reducing greenhouse gas emissions, is essential to maintain the sustainability of this industry.

Through the implementation of sustainable practices and good management of the environment, seaweed agro-industry can continue in the long term, protect biodiversity, and maintain environmental sustainability.

2.3. Analysis of Seaweed Agroindustry Management in Indonesia

The analysis of Seaweed Agroindustry Management in Indonesia includes assessment and evaluation of various aspects related to seaweed agroindustry management in the country. This analysis aims to understand the potentials, challenges, and prospects associated with the development and management of the seaweed industry. Some aspects that

can be analyzed in seaweed agroindustry management in Indonesia include:

a) Natural Resource Potential

Analyze the potential of natural resources available in Indonesia, such as land/coastal locations, seawater availability, and environmental conditions that support seaweed cultivation. This evaluation helps in determining potential locations for seaweed cultivation and understanding the overall availability of raw materials.

b) Environmental Sustainability

Conduct an analysis of the impact caused by the seaweed agroindustry on the environment. This evaluation includes an assessment of natural resource use, waste management, chemical use, and climate change mitigation efforts. The aim is to ensure that the seaweed industry can run sustainably and not damage the environment.

c) Economic Aspect

Analyze economic aspects related to seaweed agroindustry, including economic value, market potential, investment required, as well as economic impacts for local communities and the national economy. This evaluation helps in the determination of marketing strategies, product development, and policies that support the growth of the seaweed industry.

d) Licensing and Regulation

Analyze licensing and regulations related to seaweed agroindustry in Indonesia. This evaluation includes a review of applicable regulations, licensing procedures, environmental requirements, and regulatory compliance. This is important to ensure the sustainability and compliance of the seaweed industry with applicable regulations.

e) Production Technology

Conduct an analysis of production technologies used in the seaweed agroindustry. This evaluation includes a review of cultivation methods, use of technology, selection of high-yielding varieties, fertilization, and pest control. The goal is to increase the efficiency, productivity, and quality of seaweed production.

Analysis of seaweed agro-industry management in Indonesia helps in a better understanding of the potential and challenges associated with this industry. By considering the results of this analysis, appropriate strategies and policies can be formulated for the development and sustainable management of seaweed agroindustry in Indonesia.

Identification of Stakeholders Related to Indonesian Seaweed Agroindustry

In the analysis of seaweed agro-industry management in Indonesia, it is important to identify relevant stakeholders who may influence or be affected by the activities of the industry. The following are some relevant stakeholders in this context:

Seaweed Producers:

Includes seaweed farmers, seaweed cultivation companies, and producers of processed seaweed products. This stakeholder is responsible for the production and management of seaweed and plays a role in providing raw material supplies

for the seaweed industry.

Government:

Includes relevant ministries, local governments, and regulatory agencies. The government has a role in regulating permits, policies, and regulations related to seaweed agroindustry. They can also provide support, incentives, or other resources for the development of this industry.

Associations and Non-Profit Organizations:

Includes seaweed farmers' associations, seaweed industry associations, and non-profit organizations related to the development and promotion of seaweed agroindustry. These stakeholders can play a role in advocacy, coaching, and improving the quality and standards of seaweed production.

Market and Consumers:

Covering food companies/industries, cosmetics, pharmaceuticals, and end consumers. These stakeholders are parties who buy and use seaweed products. Market demand and preferences as well as feedback from consumers are important to know in developing marketing strategies and improving product quality.

Research and Educational Institutions:

Includes universities, research institutes, and marine research centers. These stakeholders play a role in conducting research, technological innovation, and human resource development in the seaweed agroindustry. They can provide valuable knowledge and advice in optimizing seaweed management.

Local People:

Covering communities around seaweed and coastal cultivation sites. Local communities have a role as stakeholders in social and economic aspects. Their involvement in decision-making and participation in industrial activities can help ensure the sustainability and equitable benefits of the seaweed agroindustry.

This stakeholder identification is important to involve relevant parties in decision making, communication, and building mutually beneficial cooperation in seaweed agroindustry management in Indonesia.

Seaweed Natural Resources Management

Seaweed natural resource management is an important aspect in seaweed agro-industry management in Indonesia. Good management will ensure the sustainability of these natural resources and maintain healthy coastal ecosystems. The following are some factors that need to be considered in the management of seaweed natural resources:

Determination of Cultivated Area:

Establish seaweed cultivation areas in accordance with environmental characteristics and the availability of natural resources. Choosing the right site can minimize negative impacts on coastal ecosystems and maximize seaweed production potential.

Supervision and Control of Harvesting:

Conduct close supervision of seaweed harvesting activities to ensure that harvesting is carried out sustainably and does not damage seaweed populations. Controlling harvesting

through quotas, harvest sizes, and proper fishing periods is also important to maintain ecosystem balance.

Selection of Sustainable Cultivation Methods:

Using sustainable seaweed farming methods, such as floating rope systems, net baskets, or other environmentally friendly methods. This method can reduce negative impacts on ecosystems and maximize seaweed production efficiently.

Pest and Disease Control:

Control pests and diseases that attack seaweed effectively to prevent spread and production losses. The use of biological control methods or the use of safe and regulatory chemicals can be an option in this management.

Research and Development:

Conduct research and development related to seaweed natural resource management to improve understanding of seaweed ecology, improve cultivation techniques, and restore coastal habitats. The results of this research can be used to develop better management practices.

Seaweed natural resource management needs to involve cooperation between government, industry, local communities, and other relevant institutions. The active involvement of all parties will ensure the sustainability of seaweed natural resources and provide long-term benefits to the coastal industry and ecosystem.

Technological Innovation in Seaweed Production

Technological innovation in seaweed production has an important role in increasing efficiency, productivity, and quality of production. Some technological innovations that can be applied in seaweed agroindustry management in Indonesia include:

Controlled cultivation system:

The use of controlled aquaculture systems such as floating rope systems, net baskets, or floating racks allows for better control of environmental conditions such as temperature, light, and water nutrients. This can improve the growth and quality of seaweed and reduce the risk of loss due to natural disturbances.

Integrated cultivation system:

The use of integrated aquaculture systems that integrate seaweed farming with other species, such as fish or mollusks. This system can take advantage of synergies between species, optimize resource utilization, and increase the productivity of cultivated land.

Use of environmental monitoring and handling technology:

Utilization of environmental monitoring and control technology, such as temperature, salinity, and water quality monitoring systems. This technology helps in optimizing the environmental conditions of cultivation and reduces the risk of disturbances such as temperature changes or water pollution.

Application of Geographic Information Systems (GIS):

Utilization of geographic information systems for mapping seaweed cultivation sites, monitoring seaweed growth, and spatial analysis for more effective aquaculture planning. GIS can also assist in the management of coastal land use conflicts and ensure optimal cultivation sites.

Proper fertilization technology:

Development of appropriate fertilization technology, such as the use of organic fertilizers, controlled fertilization, and the application of doses according to the needs of seaweed. This technology helps to improve the productivity and quality of seaweed without having a negative impact on the environment.

Automation and mechanization:

The application of automation and digitalization technologies in seaweed production processes, such as automation of feeding, production data collection, and data analysis, can improve operational efficiency, minimize human error, and obtain more accurate information for decision making.

Technological innovations in seaweed production are enabling the industry to become more efficient, sustainable, and adaptive to change. In the Indonesian context, the development and application of this innovative technology can help increase the productivity, competitiveness, and contribution of seaweed agro-industry to national economic development.

Effective Marketing and Distribution Strategy

In seaweed agroindustry management in Indonesia, an effective marketing and distribution strategy is essential to market seaweed products well and reach a wide market. The following are some strategies that can be applied:

Market Understanding:

Conduct market analysis to understand consumer needs, preferences, and trends related to seaweed products. Knowing potential market segments and tailoring products to market needs can increase attractiveness and sales.

Product Diversification:

Developing various value-added seaweed products, such as processed foods, supplements, cosmetics, or industrial raw materials. Product diversification can expand market share and improve the competitiveness of the seaweed industry.

Branding and Digital Marketing:

Build a strong brand and promote seaweed products through digital marketing strategies, including social media, websites, and e-commerce platforms. Increasing visibility and online presence can reach a wider target market and increase brand awareness.

Partnerships and Distribution Networks:

Build partnerships with distributors, merchants, or retailers who have an extensive distribution network. Cooperation with the right partners can help optimize the distribution of seaweed products to local, regional, and international markets.

Certification and Labeling:

Obtain relevant certifications and labeling, such as organic certification, hygienic certification, or eco-labeling. This can increase consumer confidence, product value, and access to markets that prioritize sustainable products.

Finishing and Storage Innovation:

Developing attractive, functional, and environmentally friendly packaging for seaweed products. In addition, ensuring continuous storage and transportation so that products remain fresh and quality when they reach consumers.

Promotion and Education:

Conduct promotional and educational activities about the benefits of seaweed to consumers, including counseling, demonstrations, and participation in exhibitions or related events. Increasing consumer understanding and awareness can drive interest and demand for seaweed products.

An effective marketing and distribution strategy will help increase the competitiveness, market penetration, and growth of seaweed agroindustry in Indonesia. In implementing this strategy, it is important to consider market characteristics, changing consumer trends, and relevant marketing policies.

2.4. Sustainability Approach in Seaweed Agroindustry

The sustainability approach in seaweed agroindustry in Indonesia involves efforts to maintain a balance between production activities and environmental preservation and social welfare. The following are some approaches that can be applied [8]:

Sustainable Natural Resource Management:

Use sustainable management principles to ensure responsible use of seaweed natural resources. This includes prudent harvesting control, selection of suitable cultivation sites, and environmentally friendly cultivation practices.

Principles of Conservation and Protection of Coastal Ecosystems:

Integrate the principles of conservation and protection of coastal ecosystems in seaweed farming activities. Protecting mangroves, coral reefs, and other habitats that are important for the sustainability of seaweed is an important step in maintaining the balance of coastal ecosystems.

Local Community Empowerment:

Involving local communities in seaweed agro-industry activities, including decision-making, training, and economic benefit sharing. Empowering local communities will increase the participation, welfare, and sustainability of the industry. [7]

Continuous Technology Innovation:

Encourage the development and application of sustainable technological innovations in seaweed production. This includes the use of renewable energy, effective waste management, and the use of environmentally friendly technologies in production and processing processes.

Collaboration between Government, Industry, and Related Parties:

Build close cooperation between the government, industry, and other relevant parties in formulating policies, standards, and regulations that support the sustainability of the seaweed agroindustry. This collaboration will ensure mutual understanding and coordination in maintaining the sustainability of the industry.

Monitoring and Evaluation:

Continuously monitoring and evaluating the sustainability performance of the seaweed agroindustry, including in envi-

ronmental, social, and economic terms. This will help identify changes that need to be made as well as evaluate the impact of industrial activities on the environment and society.

By applying a sustainability approach in the seaweed agro-industry, it is hoped that this industry can continue in the long term while still preserving the environment and providing sustainable social and economic benefits to the community.

2.5. Prospects for Seaweed Agroindustry Development in Indonesia

The development of seaweed agroindustry in Indonesia has bright prospects with various opportunities for growth and sustainability. The following are some prospects for the development of seaweed agroindustry in Indonesia:

Broad Market Potential:

Indonesia has a wide market potential both domestically and in the international market. The demand for seaweed products continues to increase, both as food ingredients, industrial raw materials, as well as in the cosmetic and health supplement industries.

The Wealth of Overflowing Natural Resources:

Indonesia has a wealth of abundant natural resources, especially waters suitable for seaweed cultivation. This provides great potential for the development of seaweed agro-industry on a larger scale and wider product diversification.

Strong Government Support:

The Indonesian government has provided strong support for the development of seaweed agroindustry, both through policies, incentives, and development programs. This support includes infrastructure provision, training, financing, and marketing and export facilitation [12].

Evolving Technological Innovations:

Technological advances in the cultivation, processing, and marketing of seaweed continue to grow. Technological innovations such as the use of controlled cultivation systems, modern processing technology, and the application of artificial intelligence (AI) can improve efficiency, productivity, and product quality.

Positive Impact on Community Empowerment:

The development of seaweed agroindustry provides opportunities for the empowerment of local communities, especially in coastal areas that have seaweed cultivation potential [13]. These industries can create jobs, increase incomes, and strengthen local economies [13].

High Export Potential:

Indonesian seaweed products have great potential to be exported to the international market. Global demand for seaweed products continues to increase, especially in East Asian, European and North American countries. By meeting established quality and sustainability standards, the industry can expand its international market share.

The development of seaweed agroindustry in Indonesia has bright prospects, with broad market potential, strong gov-

ernment support, and abundant natural resource wealth. With the application of technological innovation, good collaboration between the government, industry, and related parties, and sustainability in environmental management, this industry can provide significant economic, social, and environmental benefits for Indonesia.

2.6. Market Growth Potential

The growth potential of the seaweed agro-industry market in Indonesia is very promising with several supporting factors. The following is the growth potential of the seaweed agroindustry market in Indonesia:

Constantly Increasing Demand:

The demand for seaweed products continues to increase both in domestic and international markets. Seaweed products are used in various industries such as food, cosmetics, pharmaceuticals, and other industries. This high demand provides a great opportunity for the growth of the seaweed market in Indonesia.

Increased Awareness of Health Benefits:

People are increasingly aware of the health benefits possessed by seaweed, such as high nutritional content, rich in fiber, low in fat, and rich in minerals and vitamins. This encourages increased consumption of seaweed products and supports market growth.

Product Diversification and Innovation:

There are efforts to develop processed seaweed products with added value and innovation in product processing. Diversification of products such as snacks, dietary supplements, beverages, cosmetics, and other innovative products can reach a wider market and increase consumer appeal.

High Export Potential:

Indonesian seaweed products have great potential to be exported to the international market. Global demand for seaweed products continues to increase, especially in East Asian, European and North American countries. This opens up opportunities for market expansion and export growth.

Government Support and Industrial Policy:

The Government of Indonesia provides strong support in the development of seaweed agro-industry through various development policies, incentives, and programs. This policy covers the provision of facilities, training, funding, and export promotion and facilitation. The government of Indonesia fosters and facilitates by providing strong support for the development of the national fishing industry. [12]

Local Market Utilization Potential:

In addition to exports, Indonesia's large and growing local market is also a significant growth potential. Increasing people's incomes and changing consumption patterns make seaweed products an attractive choice for local consumers.

With these factors, seaweed agroindustry in Indonesia has bright market growth potential. It is necessary to carry out effective marketing strategies, product innovation, collaboration between industry and government, as well as compliance

with quality and sustainability standards to take advantage of the market's growth potential.

2.7. Export Opportunities and Strengthening Competitiveness

Export opportunities and strengthening the competitiveness of seaweed agroindustry in Indonesia provide the potential to develop international markets and improve Indonesia's position in global competition. The following are some export opportunities and strategies to strengthen competitiveness [14]:

High Global Demand:

Global demand for seaweed products continues to increase, both for foodstuffs, industrial raw materials, as well as in the cosmetic and health supplement industries. Indonesia has the potential to meet this demand with its wealth of abundant seaweed natural resources.

Quality Improvement and Sustainability:

Strengthening the competitiveness of seaweed agroindustry can be done through improving product quality, both in terms of cleanliness, taste, aroma, and nutritional value. In addition, the implementation of sustainable and environmentally friendly production practices is also an important factor to increase the competitiveness of Indonesian products in the international market.

Product Diversification and Innovation:

Developing processed seaweed products with added value and innovation can increase competitiveness. Product diversification such as snacks, beverages, cosmetics, health products, and other innovative products can reach a wider market and meet the needs of diverse consumers.

International Standard Compliance:

Ensuring compliance with internationally recognized food quality and safety standards is critical to gaining consumer trust. Laboratory testing, product certification, and compliance with sanitary and health regulations are necessary steps to strengthen the competitiveness of Indonesian seaweed products in the international market.

Effective Marketing and Promotion:

Develop effective marketing and promotion strategies to market Indonesian seaweed products to international markets. Promoting product uniqueness, sustainability, quality, as well as health benefits can increase consumer attractiveness and confidence.

Collaboration between Government and Industry:

Close collaboration between the government and industry in the development of seaweed agro-industry is essential to optimize export opportunities and increase competitiveness. The government can provide policy support, infrastructure facilities, as well as access to international markets, while industry can play an active role in improving product quality and meeting international market requirements.

By taking advantage of export opportunities and making efforts to strengthen competitiveness, seaweed agroindustry

in Indonesia can become a major player in the international market. Through quality improvement, product diversification, compliance with international standards, and effective promotion, the industry can expand market share and make a significant contribution to the national economy.

2.8. Seaweed Agroindustry Cluster Development

The development of seaweed agro-industry clusters is an effective strategy to increase competitiveness, productivity, and added value in this industry. The following are some aspects that need to be considered in the development of seaweed agro-industry clusters in Indonesia [11]:

Collaboration between Stakeholders:

Build close cooperation between relevant stakeholders, such as seaweed farmers, producers, marketers, government, research institutions, and educational institutions [11]. This cooperation is important to support each other, share knowledge and technology, and strengthen the seaweed agro-industry supply chain.

Infrastructure and Supporting Facilities:

Provide adequate infrastructure and supporting facilities, such as modern and efficient production, processing, and storage facilities. Good infrastructure will improve the efficiency of production, distribution, and marketing of seaweed products.

Provision of Access to Financing:

Ensure access to adequate financing for seaweed agro-industry players, including farmers, producers, and other businesses. This will help in business development, investment in production technology, as well as increasing industrial capacity and competitiveness [12].

Capacity and Skill Building:

Providing continuous training and education to seaweed agro-industry players. Increased capacity and skills in production management, technology, marketing, and other aspects will help increase the productivity and competitiveness of the industry [11].

Research and Innovation:

Encourage research and innovation in the development of new seaweed-based production, processing, and product technologies. Collaboration between research institutions, universities, and industry players will accelerate the development of innovation and the discovery of solutions to the challenges faced [11].

Promotion and Co-Marketing:

Conduct joint promotion and marketing to increase the visibility of Indonesian seaweed products in domestic and international markets [12]. Coordinated promotion and strong branding will help expand market share and strengthen the image of Indonesian seaweed products.

With the development of a strong seaweed agro-industry cluster, it is expected to create synergies between industry players, improve product quality, production efficiency, and

increase competitiveness. This will have a positive impact on the growth of the seaweed industry in Indonesia as well as a significant contribution to national economic development.

2.9. The Government's Role in Encouraging the Development of Seaweed Agroindustry

The role of the government is very important in encouraging the development of seaweed agro-industry in Indonesia. The following are some of the roles government can perform:

Policy and Regulation Development:

The government can develop policies and regulations that support the development of seaweed agro-industry, including in terms of licensing, natural resource management, environmental protection, and tax incentives. Clear and supportive policies will create an environment conducive to industry growth.

Facilitation and Coordination:

The government can facilitate and coordinate cooperation between various stakeholders, such as seaweed farmers, producers, research institutions, and educational institutions. With good coordination, synergy between industry players can be formed and the development of seaweed agro-industry can run more effectively.

Financing and Investment Support:

The government can provide financial support and investment incentives for seaweed agro-industry players, including in terms of capital assistance, business credit, and subsidy programs. This will help businesses access the financial resources needed for business development and modernization.

Infrastructure Development and Market Access:

The government needs to develop supporting infrastructure, such as ports, transportation networks, and efficient distribution facilities. In addition, the government can also help expand market access both at national and international levels through export promotion and facilitation.

Research and Innovation:

The government can allocate funds for research and development in the seaweed agroindustry. It will promote technological innovation, product quality improvement, and value-added product development that can enhance the competitiveness of the industry.

Education and Training:

The government can provide quality education and training for seaweed farmers and agro-industry players. This will help improve their capacity and skills in production management, processing, and marketing, so as to produce quality and competitive products.

With the active role of the government, the development of seaweed agroindustry in Indonesia can be accelerated and achieve more optimal results. Collaboration between the government, industry players, and other stakeholders will have a positive impact in encouraging the growth and sustainability of seaweed agroindustry in Indonesia.

3. Conclusion

Potential:

Indonesia has great potential in the development of seaweed agroindustry because it has a long coastline, suitable environment, and abundant variety of seaweed species.

Seaweed has many benefits, including as a raw material for food, cosmetics, medicines, fertilizers, and renewable energy.

Global demand for seaweed products continues to increase, especially in the markets of seafood, dietary supplements, and natural beauty products.

Challenge:

Key challenges in seaweed agro-industry management include environmental issues, such as pollution, climate change, and illegal fishing that damages seaweed habitats. [10]

Lack of infrastructure, technology, and skilled human resources are also obstacles in the development of this industry.

Inconsistent regulations and policies as well as licensing issues can hinder the growth of the seaweed agro-industry.

Prospects:

Despite the challenges, the long-term prospects for the seaweed agroindustry in Indonesia remain bright. [10]

The government and relevant institutions have realized the potential of this industry and are committed to increasing the development of the seaweed sector.

There are efforts to improve infrastructure, technology, and human resource training in the field of seaweed agroindustry.

Government support and greater investment can help accelerate the growth of this industry and increase the competitiveness of Indonesian products in the global market.

Implications and Recommendations

The following implications and recommendations can be drawn from conclusions regarding seaweed agro-industry management in Indonesia:

Implication:

The importance of awareness of environmental protection and conservation of natural resources in the development of seaweed agroindustry. Protecting seaweed habitat must be a priority to ensure the long-term viability of the industry.

There needs to be close cooperation between the government, the private sector, and communities in addressing environmental and licensing challenges. Effective collaboration will accelerate industry growth and ensure the sustainability of the seaweed industry.

Investment in infrastructure, technology, and human resource training is critical to improving the competitiveness and efficiency of the seaweed industry. Efforts are needed to build capacity in seaweed processing and packaging and improve product quality in order to compete in the global market.

4. Recommendation

The government needs to improve clear and consistent policies and regulations to support the growth of the seaweed agro-industry. The licensing process and business require-

ments need to be more transparent and efficient.

Continuous research and innovation in seaweed cultivation, processing, and utilization technology is needed. The use of green and environmentally friendly technology also needs attention.

Training and education tailored to the needs of the seaweed industry should be provided to seaweed farmers and industry workers, so that they have the necessary skills and are able to face the challenges at hand.

Encourage partnerships between seaweed farmers, agro-industry companies, and domestic and international markets to increase added value and expand access to markets.

This recommendation aims to encourage the growth and sustainability of seaweed agroindustry in Indonesia, while paying attention to environmental and social aspects. However, implementation of these recommendations will require strong coordination and collaboration between all relevant stakeholders.

Abbreviations

GIS: Application of Geographic Information Systems

BPOM: Food and Drug Supervisory Agency

AI: artificial intelligence

Author Contributions

Tabrani: Resources, Data curation, Formal Analysis, Supervision, Visualization

Wisman Indra Angkasa: Conceptualization, Funding acquisition, Writing - original draft, Methodology, Writing - review & editing

Ika Meidy Deviarni: Formal Analysis, Validation, Investigation, Visualization, Project administration

Conflicts of Interest

The authors declare no conflicts of interest.

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