Mini-review Mariculture Status in Indonesia

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ABSTRACT

Mariculture is all kinds of activities related to the cultivation, management, and harvesting of marine organisms in the natural habitats where these organisms live. Marine aquaculture is an important contributor to foreign income, as most of Indonesia's marine aquaculture is exported. The obstacles faced by Indonesian marine aquaculture are divided into two, internal and external. External problems related to restrictive regulations, weakening markets, environmental degradation, and conflicts over the use of marine space. Meanwhile, internal problems are the capacity of seeds, human resources and institutions in the application of technology and management, as well as the competitiveness of the marine aquaculture business. The performance of Indonesian marine aquaculture continues to develop starting from upstream efforts to prepare production facilities and infrastructure ranging from superior seeds, medicinal feed, energy and labor, production processes, to downstream in the form of post-harvest processing and marketing. Indonesia is the world's leading producer and exporter of seaweed and grouper commodities. This is because of the advantages it has when compared to competing countries such as Vietnam, Thailand, Taiwan, Malaysia, and the Philippines. Efforts to increase the value and optimize the utilization of marine catch production are by developing value-added products, both traditional and modern processed. Thus, the sustainable development of aquaculture should be based on species selection technology which should be more relevant for developing countries to increase the accessibility of seafood for people who are under economic pressure.

Keyword: *Aquaculture, Fish, Mariculture, Marine, Production, Seaweed*

1. Understanding

Marine aquaculture (mariculture) is all kinds of activities related to the cultivation, management, and harvesting of marine organisms in the natural habitats where these organisms live [1]. Marine aquaculture (mariculture) is carried out in marine waters that are protected from the threat of natural disasters, such as bays, straits, and shallow waters that are protected from the threat of natural disasters, such as high waves and storms. However, with the advancement of technology in the field of seawater treatment, mariculture in the form of captive breeding and collection can actually be carried out on land far from the sea. One of these technologies is a form of recycling (recycling) seawater through a process of recirculation and filtration, known as the Recirculation Aquaculture System (RAS).

1.1 Mariculture Influence

Mariculture is one of the country's economic potentials in the midst of declining conventional sectors on land. As the largest maritime and archipelagic country in the world, Indonesia has a suitable area for marine cultivation. Mariculture directly creates jobs for the community, thereby helping to reduce unemployment. In addition, mariculture has a major influence on the growth of Indonesian aquaculture, the national seaweed production in 2019 reached 9.9 million tons and managed to dominate 60% of the total national aquaculture production.

Mariculture is an important contributor to Indonesian fishery products. According to FAO data [2] marine aquaculture products in Indonesia were more than 320 million dollars in 2008. Marine aquaculture is also an important contributor to foreign income, because most of Indonesia's marine aquaculture products are exported. The

dominant marine aquaculture commodity in Indonesia is seaweed (mostly Kappaphycus species) which accounts for 98% of production and 84% of Indonesia's marine aquaculture production value. Some of the other main commodities are marine fish (grouper and baramundi) and Pearl oysters. The pair of sea cucumbers and sea lobsters is a relatively small contributor to the total production.

In addition to capture fisheries, aquaculture is an economic driver for the country of Indonesia, which is one of the world's fish source countries, fisheries and marine development aim to meet the needs of the international market [3] Youth participation is very much needed in developing the maritime fisheries sector. The development of aquaculture with potential resources and sustainable management can contribute to economic independence and increase income and welfare, especially for cultivators (RPJMN IV, 2015 – 2019).

1.2 Indonesian Mariculture Contraints

The performance of Indonesian mariculture continues to develop from the upstream effort to prepare production infrastructure and facilities ranging from superior seeds, medicinal feed, energy and labor, production processes, to downstream in the form of post-harvest processing and marketing. Indonesia is the world's leading producer and exporter of seaweed and grouper commodities. This is because of the advantages it has when compared to competing countries such as Vietnam, Thailand, Taiwan, Malaysia, and the Philippines. The obstacles faced by Indonesian mariculture are divided into two, internally and externally. External problems related to restrictive regulations, market weakening, environmental degradation, and conflicts over the useof marine space. Meanwhile, internal problems are seed capacity, human and institutional resources in the application of technology and management, and the competitiveness of the mariculture business

2. Mariculture Processing

Efforts to increase value and optimize the utilization of marine catch production are by developing value-added products, both traditional and modern processed. Oneof the fish processing that is done by many community groups, both home industries and SMEs is tuna shredded products [4].

Seaweed is one of the mariculture commodities and is also one of the mainstay commodities for cultivation nationally. Seaweed is not only processed intofood, pharmaceuticals, cosmetics, but seaweed processing can be used as raw material for *pulp* for paper making. The type of seaweed that can be used as *raw material for* pulp is a type of red algae *(read algae)* which has a high fiber content [5][6].

A part from seaweed, there are various mariculture processing commodities.
As one example is sea fish. Fish contains protein with high quality so that it is not inferior to livestock meat, even the protein covers 95% of the total weight consumedby humans. In addition to protein, fish contains many beneficial compounds such asunsaturated fats, Vitamin A, Vitamin D, and lime [7].

Fish is a food that is very perishable because of the levels of fatty acids that can be easily oxidized and go rancid. To prevent fish damage, the fish meat is processed into a variety of food innovations. There are several fish processing techniques with the aim of increasing the shelf life of fish, including: smoking (smokedusing firewood with the aim of preserving fish and adding to the smell and taste) [8], *Pemindangan* (by salting and boiling or steaming fish) [9], and there are many other methods of processing marine fish, oneexample of processing it into frozen food ready for sale such as fish nuggets [10]. In addition to seaweed and fish, there are also crustaceans. Crustaceans areanimals whose habitat is mostly in marine waters, crustaceans themselves breathe using gills. [11].

Crustaceans have a very high economic value and are in great demand among the lower to the upper class so that many places are made for breeding crustaceans that aim to meet demand in the market and also support the economy ofthe surrounding community [12].

3. Benefits of Mariculture Consumption

Marine fish is food obtained from the sea. Indonesia is an archipelagic country with most of the population living along the coast and consuming mostly seafood, including fish. regulations It is also necessary for the government to use local food and seafood Improvements have been made to obtain sufficient food sources. In

addition, marine fish have also been shown to contain nutrients that can improve health, it is necessary to study this issue. Big improvement in fisheries production Related to fish availability, which will ultimately support a robust systemwhere this component consists of availability, distribution, and consumption subsystems [13].

Fish is the second source of animal protein after meat, milk, and eggs. Fish is a seafood product that contains a long-chain fatty acid: omega-3 (DHA). Less or even no soil products (animals and vegetables) and omega 6, which play a very important role in growth and health [13]. Fish is one of the foods with a high level of protein absorption compared to other animal products such as beef and chicken. fish meat Protein fiber is shorter than beef or beef protein fiber Chick.

Fish is also rich in calcium, phosphorus and other minerals Formation of bone, and iron which is needed for the formation of hemoglobin. Blood. The essential fatty acids found in fish are also required for the normal growth and function of all tissues, including the optimal development of brain cells [14].

The results of interviews with coastal communities, according to [15]. The types of marine fish that are often eaten are those caught by fishermen. fish Snapper or evil calcarifer (Centropomidae) that live in coastal waters, estuaries, salt water. The length of the snapper can reach 200 cm, generally 25-100 centimeters. Its distribution area is mainly the north coast of Java and the coast of East Sumatra, Kalimantan, South Sulawesi, Alafru. The northern part includes the Bay of Bengal, the coast of India, Siam, the coast of the South China Sea of the Philippines, the south coast to the north of Australia, to the west to East Africa. The types of fish are sardines or Sardine Ha sirm (Clupeidae), tuna or *Auxis thazard* (Scombridae), skipjack tuna or *Katsuwonus pelamis* (Scombridae), tuna or Thunnus obesus (Scombridae), grouper or *Cephalopholis bunack* (Serranidae).

According to [16], the benefits of consuming marine fish, including:

1. Prevent heart disease Sea fish is high in protein and low in cholesterol compared to red meat. This makes fish meat healthy protein for heart health. This fact is also supported by research that shows that regular consumption of fish rich in omega-3 fatty acids can reduce the amount of fat in the blood, thereby reducing the risk of heart disease.
   Maintain brain function and health Marine fish, such as salmon, sardines, and anchovies, are rich in omega-3 fatty acids that children need for brain development and formation. Omega-3 Helps Relieve Symptoms of Depression and Dementia in Elderly Children, and its benefits to maintain brain health Concepts supporting the effectiveness of omega-3 fatty acids in symptom relief To date, depression, dementia and impaired brain functionhave not been consistent.
2. Supports Bone Health Vitamin D is not only formed by the body with the help of sunlight, but also through you can get it by eating marine fish. Marine fish is a great source of Vitamin D and calcium to support bone health and prevent certain diseases. Eating 8 grams of salmon a day can satisfy 75 Percent Daily Value of Vitamin D.
3. Prevents thyroid damage 95 Marine fish contains minerals that are good for thyroid disease, namely iodine and selenium. One of the risk factors that are known to increase so far a person's chances of developing thyroid disease is iodine deficiency, so sea fish can prevent thyroid disease very well. Further research shows that the selenium content of marine fish can help maintain thyroid function and prevent further thyroid damage.
4. Keep your eyes healthy Diet rich in omega-3 fatty acids obtained frommarine fish or supplements Proven to help maintain eye health.Research shows that people who regularly consume marine fish or omega-3 supplements at a minimum dose of 500 mg daily, reduce the risk of diabetes-related macular degeneration and retinal damage.
5. Mariculture as a Source of Nutrients and Sustainable Production. The demand for seafood from the sea around the world continues to increase while most of the world's regions have reached their maximum capture potential for fisheries production [17]. By 2050 aquaculture production needs to be increased by 50 million Mt in order to meet future demand for fish supply for food [18]
   Nutrition from seafood is very important, fish currently provides 17% of the world's animal protein. The benefits of consuming seafood nutrients are found in complex fatty acids in fish that contribute to brain development, body metabolism and prevention of cardiovascular disease [19]. In addition, seafood also provides micronutrients that are essential in promoting healthy growth and development in children and pregnant women.

Technological advances and the significant importance of fish nutrition to produce seafood, the level of consumption is increasing. In 2025, it is estimated that the global consumption of fish will increase by more than 20% because the human population and economic development will increase in the next few years.Driven by these improvements, aquaculture has been the fastest growing food production sector over the past few decades and now exceeds that of wild fisheries. Some argue that further improvements in aquaculture production will come from further investment in biotechnology [20] [21] [22].

The increase in knowledge and the development of new methods in aquaculture biotechnology have resulted in various breakthroughs and advances for the industry in this sector. However, if there is no clear acknowledgment of the large industry's dependence and impact on natural ecosystems and society Traditionally, the aquaculture industry will never fully develop or only complement marine fisheries [23] [24].

Various fish commodities in the sea are increasing, especially Atlantic fish species such as salmon (Salmo salar), grouper (*Epinephelus* spp), seabream (*Pagrus major)* and white snapper (*Lates calcarifer*), so this has made the potential of the mariculture industry quite large in the last two decades. [25] [26] In general, the production process will inevitably produce feed waste with a very high protein content, especially if one of the constituent parts is oil and fish meal, this can lead to degradation of environmental quality (Burford and Williams, 2001). [27]

Thus, sustaining aquaculture development should be based on species selection technology which should be more relevant for developing countries to increase the accessibility of marine food for people who are under pressurein the economy [28] [29] [30].

Table 1. Several Studies about mariculture Development in Indonesia

No	**Papers**	**Focuses**	**Results**
1	Marikultur Development In Indonesia: Prospects and Constraints, Michael A. Rimmer *faculty of veterinary science, University of Sydney, Australia* (*Received 2 November 2010; Accepted 3 December 2010*)	This journal reviews the prospects and constraints for the continued development and expansion of marine aquaculture in Indonesia.	The results obtained from this journal are to find out what prospects are right in building a mariculture economy and find out what obstacles are in the development and expansion of cultivation in Indonesia, as well as how to overcome these problems.
2.	La Ode M.Aslan,Wa Iba,La Ode Ridwan Bolu,Brett A. Ingram , Geoff. J. Gooley , Sena S. de Silva. Mariculture in Sulawesi,Indonesia: Culture Practices and the socio economic aspects of the major commodities,Ocean & Management 116 (2015) 44-57	This journal reviews the development of marine aquaculture in the Southeast Sulawesi region.	The results obtained in this journal are related to cultivation trends and their development in the Southeast Sulawesi region.

3	Muhammed A. Oyinlola, Gabriel Reygondeau, Colette C. C. Wabnitz, William W. L. Cheung (2019). Projecting global mariculture diversity under climate change. *Global Change Biology*, 26:2134–2148.	This journal reviews the changing impacts on aquaculture diversity for 85 days from currently most commodity fish and invertebrate species that are commonly cultured on the coast or the open sea.	The results obtained in this journal are to find out what changes, and the impact of these changes on marine aquaculture diversity and find out what commodities are most suitable for cultivation in the region.
4.	Owen R. Liu, Renato Molina, Margaret Wilson and Benjamin S. Halpern. (2018). Global opportunities for mariculture development promote human nutrition. *PeerJ*.	This journal reviews the identification of the potential of marine aquaculture or capture of marine products to increase sources of nutrients, protein and macronutrients consumed by humans so that malnutrition and calorie deficiencies do not occur.	The results obtained in this journal are to know the mapping of countries with the potential for cultivation and capture of marine products that are large enough so that they are very dependent on the wealth of marine products to improve the nutritional value of their people and the economy of their country. As well as promoting the importance of seafood for the nutritional and economic needs of the country in the future
5.	M. Troell, C. Halling, A. Neori, T. Chopin, A. H. Buschmann, N. Kautsky, C. Yarish (2003). Integrated mariculture : asking the right questions. *Aquaculture journal*, 69-90.	This journal reviews the main findings and methodological aspects of 28 peer-reviewed studies of integrated marine aquaculture systems fed and extractive organisms.	The results obtained in this journal are that the nutrients from land-based and open-water mariculture operations are suitable for seaweed growth. However, authoritative synthetics are lacking on many of the factors that can determine seaweed culture design and function in commercial integrated mariculture.
6.	Muhammed A. Oyinlola, Gabriel Reygondeau, Colette C. C. Wabnitz, William W. L. Cheung. 2019. Projecting Global Mariculture Diversity Under Climate Change.	This journal reviews the impact of climate change on the diversity of marine aquaculture in the scope of mariculture.	The results obtained from this journal are exposure that climate change can cause a substantial redistribution of the potential richness of marine aquaculture species, with an average of 10%- A 40% decrease in the number of species potentially suitable for culture in the tropics to subtropics, and conversely, the potential species richness of aquaculture is projected to increase by about 40% at latitudes.
7.	Site selection for grouper mariculture in indonesia. W. Brian Szuster and Hatim Albasri, Departemen of Geography, University of Hawai'i at Manoa Sauders 445, 2424 Maile Way Honolulu Hawai'i, USA 96821, Research Center for Indonesian Aquaculture, Indonesian Ministry of Marine Affairs and Fisheries, Jakarta< Indonesia. Accepted 8 January, 2010	This journal assesses the site selection approach for net cage grouper cultivation from the island of Kaledupa in Indonesia.	The results of this study indicate that the study area generally has a gravel-sand substrate which is very suitable for grouper farming with a bathymetric profile dominated by a large number of lagoons with water depths ranging from 5 m to 53.9 m.

8.	Carolus P. Paruntu, Suria Darwisito, Antonius P. Rumengan, Hengky J. Sinjai, Billy Wagey dan Johan Tumiwa. 2019. *Science and Technology of Marine Aquaculture for Group of Fisheries South Motandoi Village, East Pinolosian District, South Bolaang Mongondow Regency.* Jurnal Pesisir dan Laut Tropis, Vol.7, No.3, 2019.	This journal examines the capacity building of independent and sustainable marine fish farming groups through the community partnership program (PKM).	The results of the research through this PKM activity, two groups of fish cultivators gained knowledge and technology about the biology of economical marine cultured fish. Grouper and baronang fish are types of fish that have the opportunity to be kept together in floating net cages as superior marine aquaculture technology that can increase the income of fishermen or fish cultivators.

4. REFERENCES

[1]. Rijal, S. S. 2021. Penentuan Kesesuaian Lokasi Marikultur Ikan Kerapu Di Sumatera Utara, Indonesia Menggunakan Google Earth Engine. Jfmr (Journal of Fisheries and Marine Research). 5(2), 357-367.

[2]. FAO. 2010. FISHSTAT Plus - Universal software for fishery statistical time series. Aquaculture production 1950-2008. FAO Fisheries and Aquaculture Information and Statistics Service. Food and Agriculture Organization of the United Nations, Romania.

[3]. Nikijuluw V. P. H., 2005. Politik Ekonomi Perikanan, Bagaimana Dan Kemana Bisnis Perikanan. Jakarta: Ferry Agung Corporation.

[4]. Arman dan Ruslang T. 2017. Analisis Finansial Usaha Abon Ikan Tuna (Thunnus Sp) Produksi UMKM Kota Parepare. Jurnal Pendidikan Teknologi Pertanian, Vol. 3 (2017) : 174-179.

[5]. Aries, G. Jubaedah, L. 2010. Uji Coba Pengembangan Budidaya Rumput Laut Gelidium amansii dengan Metode Vertikal Longline. Laporan Hasil Penelitian. Jurusan Penyuluhan. Sekolah Tinggi Perikanan. Jakarta.

[6]. Irfan, M., Ali, S. M., Muchdar, F., Studi, P., Perairan, B., Perikanan, F., & Khairun, U. (2021). Jurnal Marikultur , p-ISSN : Pengaruh Jenis Substrat Terhadap Pertumbuhan Rumput Laut Gelidium sp . dalam Wadah Terkontrol [Effect of Substrate Type on The Growth of Seaweeds Gelidium sp . In Controlled Container].

[7]. Indrawati, Veni, Purwati TJ, Sri Sudaryati. 1997. Pengolahan Ikan untuk Makanan Restoran. Yogyakarta: Lembaga Pengabdian kepada Masyarakat IKIP Yogyakarta.

[8]. Winarno, F.G., dkk, 1980. Pengantar Teknologi Pangan. Jakarta : PT. Gramedia Pustaka Utama

[9]. Hadiwiyoto, Soewedo. 1983. Hasil Hasil Olahan Susu, Ikan, Daging dan Telur. Yogyakarta Liberty.

[10]. Faisal, N, H. 2021. Analis Peningkatan Nilai Ekonomi Ikan Laut Menjadi Olahan Nugget. Jurnal Agribisnis Vol. 7, No.2, Oktober. Universitas Tulungagung.

[11]. Romimohtarto K dan juwana S. 2007. Biologi Laut. Djambatan. Jakarta. Hal 1-4, 195-205.

[12]. Septiyadi, Aji. 2011. Pengaruh Material Lamun Buatan Terhadap Keanekaragaman dan Kelimpahan Crustacea di Perairan Pulau Pari Kepulauan Seribu. Skripsi. Program Studi Biologi Fakultas Sains dan Teknologi. Universitas Islam Negeri Syarif Hidayatullah. Jakarta.

[13]. Dewi PFA, Widarti IGAA, DP Sukraniti. 2018. Jurnal Ilmu Gizi: Journal of Nutrition Science. Vol. 7, No. 1.

[14]. Almatsier, S. (2003). Prinsip Dasar Ilmu Gizi. Jakarta: Penerbit Gramedia Pustaka Utama.

[15]. Lararenjana, E. 2020. 10 Jenis Ikan Laut Konsumsi Masyarakat, Kaya Gizi dan Manfaat Kesehatan. Merdeka.com.https://www.merdeka.com/jatim/10-jenis-ikan-laut-konsumsi-masyarakat-kaya-gizi-dan-manfaat-kesehatan-kln.html?page=8

[16]. Adrian K. 2018. Lima Manfaat Ikan Laut yang Sayang Dilewatkan. Alodokter.

[17]. FAO (Food and Agriculture Organization of the United Nations). 2001. The State of World Fisheries and Aquaculture 2000. Food and Agriculture Organisation of the United Nations, Rome.

[18]. Tacon, A.G.J., Forster, I.P. 2001. Global Trends and Challenges to Aquaculture and Aquafeed Development in the New Millennium. International Aqua Feed Directory and Buyer's Guide. Turret RAI PLC, Uxbridge, pp. 4 – 24.

[19]. Larsen R, Eilertsen KE, Elvevoll EO. 2011. Health benefits of marine foods and ingredi-ents. Biotechnology Advances 29:508–518 DOI 10.1016/j.biotechadv.2011.05.017.

[20]. Hardy, R.W. 1999. Collaborative opportunities between fish nutrition and other disciplines in aquaculture: anoverview. Aquaculture 177, 217 – 230.

[21]. Hew, C.L., Fletcher, G.L. 2001. The role of aquatic biotechnology in aquaculture. Aquaculture 197,191– 204.

[22]. Melamed, P., Gong, Z., Fletcher, G., Hew, C.L. 2002. The potential impact of modern biotechnology on fish aquaculture. Aquaculture 204, 255 – 269.
[23]. Naylor, R.L., Goldburg, R.J., Primavera, J.H., Kautsky, N., Beveridge, M.C.M., Clay, J., Folke, C., Lub-chenco, J., Mooney, H., Troell, M. 2000. Effect of aquaculture on world fish supplies. Nature 405, 1017–1024.
[24]. Chopin, T., et al. 2004. The AquaNet Intgrated multi-trophic aquaculture project. Bulletin of Aquaculture Association Canada 104: 11-18.
[25]. Sadovy. 2000. Regional survey for fry/fingerling supplies and current practices for grouper mariculture : evaluating current status and long term prospects for grouper mariculture in South East Asia. Final report to the Collaborative APEC grouper research and development network (FWG 01/99).
[26]. Toranzo, A.E., B. Magarinos, and J.L. Romalde. 2005. A review of the main bacterial fish diseases in mariculture systems. Aquaculture, 246:37-61.
[27]. Burford, M.A. dan Williams, K.C. 2001.The fate of nitrogenous waste from shrimp feeding. Aquaculture 198: 79-93.
[28]. Naylor, R.L., Goldburg, R.J., Primavera, J.H., Kautsky, N., Beveridge, M.C.M., Clay, J., Folke, C., Lub-chenco, J., Mooney, H., Troell, M., 2000. Effect of aquaculture on world fish supplies. Nature 405, 1017 – 1024.
[29]. Williams, J.R., N.D. Martinez, E.L. Berlow, J.A. Dunne & A-L. Barabasi. 2000. Two degrees of separation in complex food webs. Santa Fe Institute Working Paper 01-07- 036.
[30]. Hambrey, J., L. Tuan and T. Thuong. 2001. Aquaculture and poverty alleviation II. Cage culture in coastal waters of Vietnam. World Aquaculture, vol. 32, p. 34-38.