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Mariculture Potential In Indonesia: A Review

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ABSTRACT

Marine aquaculture*(mariculture)*is the cultivation of marine organisms in their natural habitat, usually for commercial purposes, and is the cultivation of plants and animal organisms both at sea and in the brackish waters. Marine cultivation is not widely practiced in Indonesia, while natural resources are very adequate and the availability of marine fish for various needs is still insufficient. The purpose of writing this review paper is to determine what potential commodities from the mariculture sector can be developed in Indonesia and the challenges that must be faced by cultivators in the mariculture sector. Several commodities in Indonesia have supported marine cultivation, including seaweed, where Indonesia is one of the producers of the species of seaweed *Kappaphycus* and *Eucheuma* which are used as the main material for making carrageenan. Also, in mollusk cultivation, Indonesia is more focused on pearl oyster cultivation, while others focus on abalone cultivation. In crustacean cultivation, in Indonesia, there is lobster cultivation which is known for its high value with a lot of market demand. In finfish cultivation, there are several consumption fish cultivated in Indonesia such as grouper (*Epinephelus sp.*) seabass (*Lates calcarifer*), red snapper (*Lutjanus campechanus*), cobia fish (*Rachycentron canadum*), star pomfret fish (*Pampus argenteus),* and others which of course have a high enough selling value. However, marine cultivation also has challenges, including the limited supply of seeds, a production system that requires a high capital requirement, feed that still relies on 'Rucah' fish because it is relatively cheaper than artificial feed (pellets), and environmental impacts that result of the poor system management and the competition in the market.

***Keywords*:**
Mariculture, Indonesia, Commodities, Challenges

1. INTRODUCTION

Indonesia is the largest island country in the world, with a coastline of more than 81,000 km, and more than 17,508 islands. Marine aquaculture*(mariculture)*is the cultivation of marine organisms in their natural habitat, usually for commercial purposes, and is the cultivation of plants and animal organisms both at sea and in the brackish waters. Aquaculture worldwide is developing and according to FAO statistics, shows an increase from 9 million tonnes in 1990 to more than 24.7 million tonnes in 2012. Marine aquaculture has not been widely practiced in Indonesia, while natural resources are very adequate and fish

availability sea for various needs is still not sufficient. Aquaculture has increased dramatically around the world with various species ranging from giant clams, mussels, oysters, carp, salmon, grouper, milkfish, catfish, pomfret, and tuna being cultivated in diverse environments. Aquaculture production can reduce pressure on catch production and can reduce investment in fishing fleets and effort. Aquaculture offers good quality food and is relatively more efficient than some other food production systems. It is recognized that all forms of marine culture disturb biodiversity at the species, genetic, and ecosystem levels and will have adverse impacts. The main effects include habitat degradation, a decline in wild populations, the introduction of non-native species, biological pollution, genetic impacts of target species, and social effects such as human health problems, loss of income from traditional fishing jobs. There are several open approaches to avoiding the adverse impacts of marine culture on biodiversity. These include effective site selection, appropriate environmental assessment, appropriate feeding protocols, better waste and waste control measures, better management of genetic resources, an arrangement of hatcheries for seed collection, reduced collection of wild seeds, and increased positive effects. from marine cultivation to reduce pressure on capture fisheries.

The purpose of writing this review paper is to determine what potential commodities from the mariculture sector can be developed in Indonesia and the challenges that must be faced by cultivators in the mariculture sector.

2. SOME OF INDONESIAN MARICULTURE COMMODITIES

2.1 Seaweed

Seaweed cultivation has emerged as alternative activity in the Indonesian fisheries sector. Indonesia is one of the producers of seaweed species *Kappaphycus* and *Eucheuma* which are used as the main ingredient for carrageenan. Apart from that, other seaweed cultivation objectives are to be consumed directly as food or medicine, as fertilizer, and as feed for several cultivation commodities such as abalone. The method applied for this seaweed cultivation process uses the floating long line method which is also used by other seaweed producing countries such as the Philippines and Africa. However, there are also obstacles to the seaweed cultivation process, such as the current seaweed drying technology that is unable to support increased seaweed production, especially during the rainy season. Besides, the varied rainy season and long marketing channels are still major obstacles to industrial development. Finally, capture fisheries, the main economic livelihood for older generation fishermen, are slowly being replaced by seaweed cultivation.

2.2 Molluscs

Mollusc cultivation in Indonesia is more focused on the cultivation of pearl oysters. Meanwhile, others cultivate abalone. Pearl clam is a fishery product with promising prospects. Until now, the pearl industry still relies on natural fishing activities. Pearl oyster cultivation activities have a positive impact, including reducing the capture of oysters from the wild to maintain stocks in the wild (Haws et al 2010). Cultivation of pearl oysters can also reduce waste/pollutants in coastal water (Gifford et al 2005). Most of the cultivation activities in Indonesia focus on pearl production as opposed to oysters for consumption (Rimmer et al 2013). Indonesia has the potential as a pearl oyster industrial area, not only because it has stable natural conditions throughout the year, but also because the types of pearl oysters produced in Indonesia are superior to those produced in other countries (Suryanto et al. 2005). Several factors that influence the success or failure of pearl farming include physical factors, water quality, biology, as expressed by Rimmer (2010) that the environment (presence of food and temperature) and conditions of agricultural land (density, depth, and competitors) are the dominant factors.

Meanwhile, abalone cultivation has also developed in several provinces in Indonesia, such as Bali, West Nusa Tenggara, South Sulawesi, and Southeast Sulawesi, which costs up to US $ 33 / kg (Fermin et al., 2009). The development of abalone cultivation has not been done much because of the lack of information about the cultivation technology system and the benefits of abalone cultivation.

2.3 Crustaceans

Cultivation of crustaceans in Indonesia is mostly engaged in legal ponds, which are relatively easy to find on several coasts. However, the notion of mariculture itself does not include shrimp farming activities in its definition. Therefore, here will be discussed about lobster cultivation in the crustacean section.

Lobster is a high-value crustacean with strong and growing demand, especially in Asia. Most lobster production comes from capture fisheries, where catch rates are at or above maximum sustainable yields. Lobster cultivation is successful in Vietnam due to a large number of puerulus settlements along its extensive coastline. Recently, puerulus settlements were discovered in bays in Lombok, Indonesia, and lobster cultivation has started in the adjacent bays.

The dominant obstacles in the development of the lobster enlargement industry in Indonesia are the price and availability of seeds. Seed prices have been observed to fall rapidly due to the discovery of new puerulus settlements and an increase in the number of puerulus collectors. Mortality and crop prices are key parameters affecting economic viability. As the demand for lobster increases, it is likely that the price of the harvest will increase in the medium term. The potential increase in fuel prices is not expected to have a significant impact on industry profitability. However, a disease epidemic will destroy this industry.

Postponing the harvest until the lobsters were much larger was seen as very beneficial to farmers. Today, farmers harvest lobsters as soon as they can be marketed in size to reduce the risk of death and to generate income as soon as possible. However, as the industry develops, farmers will likely have the capacity to cultivate their lobsters in larger sizes to benefit from the higher yields. This aspect needs further research.

Farmers feed the lobsters mostly using trash fish they catch themselves at low cost. Although the artificial feed is not yet available to farmers in Indonesia, farmers generally show a willingness to try it. Scenario analysis on the various potential for improved feed shows that the feed produced tends to significantly increase the return on investment for farmers, perhaps increasing the FCR to 2: 1 or even higher if the feed is also functional (Petersen 2013). It is thought that introducing pellets to farmers early in industrial development will reduce the environmental impact of lobster rearing.

2.4 Finfish

Grouper (*Epinephelus sp.*) is a commodity that has a high economic value in both tropical and subtropical areas (Pierre et al., 2007). Grouper is widespread in Indo-Pacific waters, especially Southeast Asia, and has been widely consumed globally. The grouper of the Ephinephelinae subfamily consists of 159 species and is distributed in tropical and subtropical waters (Pierre et al., 2007).

The Director-General of Aquaculture (DJPB) said that grouper cultivation technology has shown rapid development. The major marine aquaculture fisheries centers have been able to produce seeds of several grouper species, such as mouse grouper, tiger grouper, sunu grouper, kertang grouper, and batik grouper. These centers have also succeeded in creating

hybrid groupers, such as cantang grouper (tiger and kertang grouper hybrid), beautiful grouper (tiger-beautiful grouper), tiktang grouper (batik-kertang grouper hybrid).

Cantang grouper is a hybrid fish from tiger grouper and kertang grouper which is done to accelerate the growth of grouper to make it more resistant to disease but with a delicious fish taste. According to Halver *et al.* (1989) grouper fish are carnivorous, naturally preferring animal-based food so that in artificial feed the protein content is higher than herbivorous fish (around 45 - 60%). The maintenance period for Cantang grouper is quite long, ranging from 5 - 7 months to reach a weight of 500 grams.

Apart from groupers, there are other consumption fish that are cultivated in Indonesia such as seabass (*Lates calcarifer*), red snapper (*Lutjanus campechanus*), cobia fish (*Rachycentron canadum*), pomfret fish (*Pampus argenteus*), and others.

3. SUSTAINABLE SEA CULTIVATION

For an effective marine aquaculture industry, the main recommended objectives are the expansion of lower trophic level fish farming, reduction of fish feed and fish oil input in feed, development of integrated farming systems, promotion of environmentally friendly marine cultivation practices for management. resources and sustainability success in biodiversity conservation. It is known that many capture fisheries resources are declining and marine culture appears to be the only substitute for increasing fish production from the sea. Aquaculture with the best scientific and technological reserves with a public and private sector business approach, based on the principles of ecosystem-based management is a necessity today.

Since most marine aquaculture production is focused on production for the export market, aquaculture production is an important source of foreign income for the Indonesian economy. Currently, the main commodity of marine cultivation in Indonesia is seaweed for carrageenan production. Other major commodity groups are marine finfish and pearl oysters. Commodities developed for marine cultivation in Indonesia include abalone and lobster. The prospects for the continued development of marine aquaculture in Indonesia look positive. Indonesia has several advantages for the development of marine culture, including many potential marine cultivation locations, a stable tropical climate, and no cyclone storms. The Indonesian government plans to increase aquaculture production substantially over the next four years, including aquaculture production. Globally, the demand for seafood products is increasing due to an increase in population and an increase in per capita consumption of fish products. The obstacles to continuing the development of marine culture in Indonesia include a limited supply of seeds, especially species that cannot be produced economically in hatcheries, such as spiny lobster; it is necessary to develop more efficient production systems for some marine finfish; the need to improve environmental sustainability by increasing feed and reducing environmental impacts; and market issues related to environmental sustainability.

3.1 Challenges for the Development of Mariculture in Indonesia

Recently, the issue of the sustainability of aquaculture production has become a significant issue in terms of market access for marine products. The following sections list some of the main constraints to marine aquaculture development in Indonesia, in the context of environmental, economic, and social sustainability.

Seed Supply

Seed supply for marine culture comes from two sources: wild populations, where larvae or juveniles are harvested to provide seeds for rearing (catch-based cultivation), and seed production in hatcheries. Catch-based aquaculture is widely practiced in the Asia-Pacific region. However, in general, the availability of seeds from wild sources has decreased due to overfishing and habitat destruction. Therefore, it is necessary to develop sustainable technology for seed production, particularly seed production.

Production System

Except for pearl farming, marine culture in Indonesia is mostly still in the hands of small or medium-scale farms. An emerging trend, especially for marine aquaculture, is the development of large-scale livestock that combines various technologies to increase the efficiency of production costs. These large-scale systems tend to be more cost-effective for some species (such as cobia) than for others (grouper).

Feed

Fish called 'Rucah' fish (small fish species, or low-value bycatch) is the main source of feed inputs in cultivation in the Asia-Pacific region. The term trash fish is inaccurate because this species of fish is not necessarily wasted, and alternative uses include reducing fish sauce for human consumption, a source of protein for other agricultural commodities (such as pork and poultry), or even direct human consumption. (FAO, 2005).

The issues related to trash fish use are well documented, most recently in the report 'APFIC Regional Workshop on Low Value and' Junk Fish 'in the Asia-Pacific Region' (FAO, 2005). Although pellet feed is available for a variety of marine finfish as well as some crustaceans, important constraints remain to the widespread use of compound feed for aquaculture:

♦ Farmers acceptance of pelletized feed is often low due to perceptions that this diet is much more expensive than trash fish. Farmers often do not understand that the feed conversion ratio from pelletized feed (for finfish, usually 1.2–1.8: 1) is dramatically better than the trash fish feed conversion ratio (usually 5–10: 1, but sometimes higher) and relative feed costs pellets are often comparable to, or lower than, the cost of trash fish required to produce the same fish biomass.

♦ Variable feed quality, and deterioration due to transport and storage at high temperatures, can also have a major impact on the growth and viability of cultured fish.

♦ Farmers' inexperience in feeding pellets can result in considerable waste.

♦ Fish that are fed 'Rucah' fish may not immediately turn to dry pellet feed, resulting in poor reception and perceived lack of appetite.

♦ Pellet feed distribution channels are not widely available in rural areas. Apart from limiting accessibility to feed, this factor increases feed costs.

♦ Small-scale fishers or farmers operating fish cages may not have access to the financial resources necessary to invest in feed pellet purchases or infrastructure such as refrigerators, find it easier to collect trash fish on their own, or in small quantities when and when financial or 'Rucah' fish resources are available. For many cultivators, collecting trash fish is an opportunity cost that is easily absorbed in a family farm, whereas purchasing pellets is a cash cost.

Environmental Impacts

Although Indonesian aquaculture production is dominated by seaweed, which can be considered to provide environmental benefits, there is significant production of commodities requiring feed inputs, such as marine. finfish and crustaceans (lobsters), and the production of these high trophic level species that thrive. The environmental impacts associated with the aquaculture of marine finfish and lobster cages come primarily from the input of nutrients from uneaten fish feed and fish waste. In severe cases, this 'self-contamination' can cause cage farms to exceed the capacity of the local environment to provide inputs (such as dissolved oxygen) and assimilate waste, contributing to fish disease outbreaks and resulting in mass mortality.

An area of mariculture that is generating some interest is the concept of Integrated Multi-Trophic Aquaculture (IMTA) (Troell et al., 2009). In IMTA systems, nitrogenous wastes produced by fed organisms (eg finfish) are removed by cultured macroalgae, reducing the environmental impacts of the overall aquaculture system (Troell et al., 2009). To date, most research on IMTA systems has been undertaken in temperate environments. The limited amount of research undertaken on tropical systems suggests that bacterial utilization of dissolved nutrients is much higher and much more rapid, than is seen in temperate systems and that dissolved nutrients may be largely utilized by bacterial or phytoplankton populations close to the effluent source, and thus availability may be limited for macroalgae production. Overall, the application of IMTA in tropical mariculture systems needs substantially more research to evaluate its potential to improve the environmental sustainability of mariculture.

Markets

As noted above, many mariculture commodities target international markets. Today, food safety and production sustainability issues are driving developments in these markets, and regulators and industry are developing increasingly stringent requirements in terms of food safety and, increasingly, environmental sustainability issues. While the earlier focus of seafood advisory and certification schemes has been on capture fisheries, more recently they have begun to include aquaculture products (Belton et al., 2009).

Many such schemes are contentious with aquaculture producers. Some of the issues identified in these schemes include lack of transparency regarding performance claims and assessment criteria, simplistic and biased assessment criteria, inconsistent application of technical criteria between species and production systems, and discriminatory access to the assessment process. On current indications, such schemes are likely to act as non-tariff trade barriers, and particularly restrict market access by smallholder aquaculture farmers (Belton et al., 2009). With mariculture production in Indonesia so highly dependent on small-scale producers, the proliferation of these schemes and their potential impacts on market access may in the future be a significant limiting factor to the expansion of mariculture in Indonesia as well as in other Asia-Pacific countries.

4. CONCLUSIONS

Indonesia have much potential on mariculture. Several commodities in Indonesia have supported marine cultivation, including seaweed, where Indonesia is one of the producers of the species of seaweed *Kappaphycus* and *Eucheuma* which are used as the main material for making carrageenan. Also, in mollusk cultivation, Indonesia is more focused on pearl oyster cultivation, while others focus on abalone cultivation. In crustacean cultivation, in Indonesia, there is lobster cultivation which is known for its high value with a lot of market demand. In finfish cultivation, there are several consumption fish cultivated in Indonesia such as grouper (*Epinephelus sp.*) seabass (*Lates calcarifer*), red snapper (*Lutjanus campechanus*), cobia fish

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