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Review

Seaweed Cultivation in Indonesia: Recent Status

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Abstract Indonesia is well-known as biggest producer of seaweed especially for *Eucheuma* and *Gracilaria* and also has huge potential resources and capability to develop seaweed cultivation and product. There are several provinces which have potential resources and have been contributing on seaweed production. The next challenge about seaweed production is using integrated system on brackishwater and marine aquaculture. Furthermore, about 2,000,000 ton of potential seaweed production is not explored yet. This article also tries to figure out some related aspects which are technical, economical and forecasting aspect. There is a disease which named "ice-ice" is one of the main problem and giving a new challenge in developing of problem solving for seaweed cultivation method. Economical parameters are also main important key to find out the feasibility of seaweed cultivation industry. In addition, the seaweed cultivation and production in Indonesia also have potential performance on biofuel resources as a part for solving the world problem on energy demand.

Key words : seaweed, cultivation, *Eucheuma, Gracilaria*

Introduction

Indonesia has about 81,000 km of coastal line and 17,504 islands, and also has huge potential capability for developing of seaweed cultivation. There are about 555 of seaweed species had been found in Indonesia and about 55 species have high economical value such as *Eucheuma*, *Gracilaria* and *Gelidium*. Furthermore, according to revitalization program by Indonesian Ministry of Marine and Fisheries (2005), the total potential area of seaweed cultivation is 1,491,255 ha which is divided by 1,110,900 ha (marine aquaculture) and 380,355 ha (brackishwater aquaculture pond) as shown in Table 1 and Table 2. Furthermore, location of potential area of seaweed cultivation in Indonesia can be shown on Figure 1.

Potential Production

According to data by Ministry of Marine and Fisheries (2007), the production of seaweed was increasing gradually during 2000-2006 and the rapid occurred on 2004-2006 (Table 3). However, in accordance with the existence of two types, namely *Eucheuma* and *Gracilaria* as the main product, it required the development of the cultivation activities of both types of seaweed in the various areas of Indonesia due to some important biological factors and its conditions. Estimate of production of *Gracilaria* until 2009 is about 400,000 ton (wet wt.) per year which is spreading on 7 provinces; Aceh, Lampung, West Java, Central Java, East Java, South East Sulawesi, and South Sulawesi. *Eucheuma* has been estimated more than *Gracilaria* which is about 1,500,000 ton (wet wt.) per year (Table 4).

Based on data above, we can state that Indonesia has huge potential of seaweed production which can be more explored by seaweed cultivation activities. The total targeted seaweed production during 2000-2003 was 7,983,000 ton, but on the other hand the seaweed production on the same period was only 670,422 ton. It means about 7,000,000 ton of seaweed production

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Table 1. Potential area of seaweed cultivation in Indonesia

Province	Prefecture	Potential Area (ha)
Aceh	Aceh Besar, Aceh Barat, Pidie, Aceh Utara, Aceh Timur, Aceh Selatan, Simeulu, Singkil, Sabang	104,100
North Sumatra	North Sumatra	2,000
Jakarta	Seribu islet	1,800
West Java	Sumur, Panjang islet	2,400
Central Java	Jepara, Kebumen, Rembang	5,200
East Java	Sumenep, Situbondo, Pacitan	29,500
Bali	Buleleng, Karangasem, Klungkung, Badung, Jembrana	18,100
West Nusa Tenggara	Lombok Barat, Lombok Timur, Lombok Tengah, Sumbawa, Dompu, Bima	12,000
East Nusa Tenggara	Kupang	1,000
North Sulawesi	Manado, Minahasa, Bitung, Sangihe Talaud, Bolaang Mongondow, Gorontalo	10,500
Central Sulawesi	Donggala, Banggai, Banggai islet	106,300
South Sulawesi	Sinjai, Selayar, Bulukumba, Jeneponto, Takalar, Maros, Pangkep, Bantaeng, Mamuju	26,500
South East Sulawesi	Kendari, Kolaka, Buton, Muna	83,000
Moluccas	Maluku Utara, Maluku Tengah, Maluku Tenggara, Halmahera, Ternate	206,600
Papua	Biak Numfor, Yapen Waropen, Manokwari, Sorong	501,900
Total		**1,110,900**

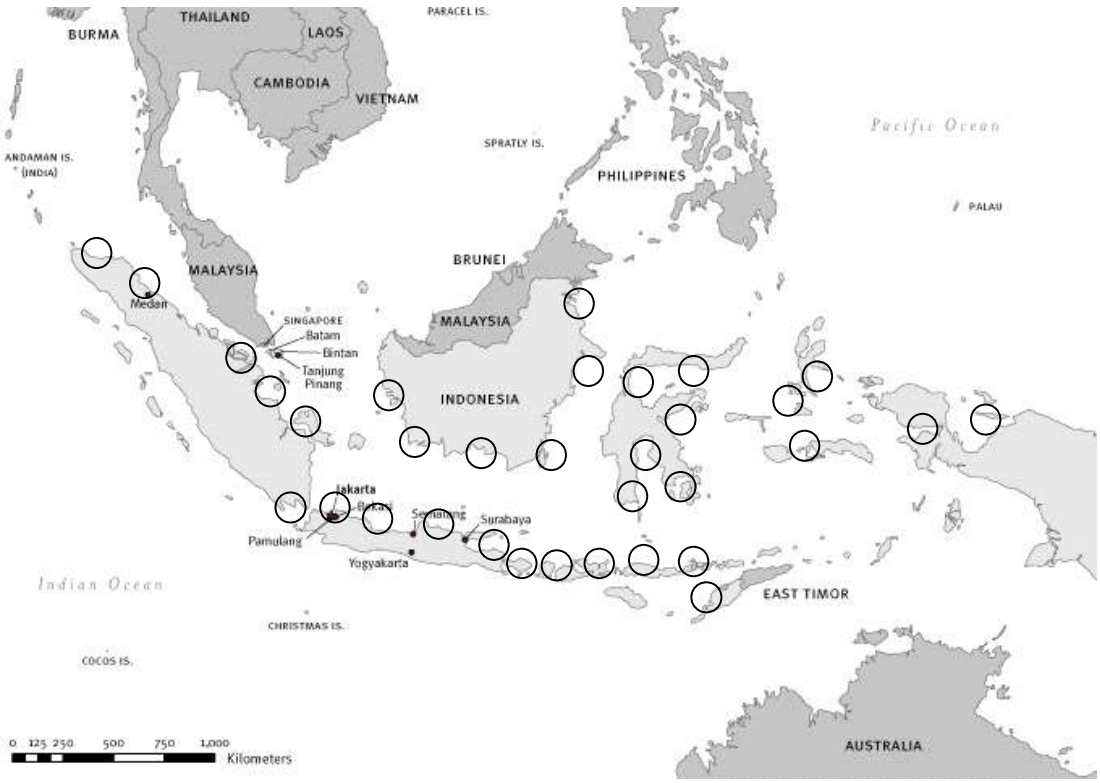

Fig. 1. Location of potential area of seaweed cultivation in Indonesia.

was not explored yet during this period. Furthermore, only 1,341,141 ton of seaweed had been produced on 2006 and this amount was still less than total targeted seaweed production on 2003 which was about 2,934,000 ton.

Technical Aspect

Long-line method is still the most used technology

Tabel 2. Potential development area of brackishwater aquaculture

Province	Intensification (ha)			Extensification (ha)		Sub-total
	Low	Medium	High	Medium	High	
Aceh	8,300	19,600	2,300	8,000	-	38,200
North Sumatra	2,000	1,000	200	3,500	800	7,500
Riau	-	-	-	1,500	500	2,000
Jambi	-	-	-	1,000	-	1,000
South Sumatra	1,900	300	150	6,550	5,500	14,400
West Sumatra	-	-	-	750	750	1,500
Lampung	12,800	1,300	6,230	1,100	3,500	24,850
West Java	22,750	7,980	950	100	250	32,030
Central Java	16,300	6,000	1,350	100	-	23,750
Yogyakarta	-	-	-	-	100	100
East Java	31,670	7,000	1,200	-	100	39,970
Bali	500	150	-	-	-	650
West Nusa Tenggara	4,430	800	300	1,000	1,300	8,330
East Nusa Tenggara	-	-	-	2,000	500	2,500
West Kalimantan	500	100	50	1,900	450	3,000
Central Kalimantan	375	100	-	3,300	500	4,275
South Kalimantan	1,500	200	100	2,400	2,500	6,700
East Kalimantan	7,400	2,800	200	10,200	1,700	22,300
South Sulawesi	53,500	20,000	800	8,000	1,500	83,800
South East Sulawesi	2,300	5,000	200	5,400	1,350	14,250
Central Sulawesi	2,000	1,600	150	2,400	750	6,900
North Sulawesi	-	300	-	1,000	150	1,450
Molluca	-	-	-	9,500	10,100	19,600
Papua	-	-	-	7,300	12,500	19,800
Total	**168,225**	**74,230**	**14,100**	**78,500**	**45,300**	**380,355**

Table 3. Indonesian seaweed production, 2000 – 2006

Year	Existing production (ton)*	Estimated production (ton)**
2000	2,937	1,134,600
2001	212,478	1,605,600
2002	223,080	2,308,800
2003	231,927	2,934,000
2004	397,964	-
2005	866,383	-
2006	1,341,141	-

Sources: * Statistic of Fisheries (MOMAF, 2007)
** Directorate General of Aquaculture (1999)

for cultivating seaweed due to easiest way to get all the tools and also more durable. *Gracilaria* is well-known cultivated on brackishwater pond on aquaculture integrated system. Seaweed farmer also already made track-line method and this is a combination between floating-raft method and long-line method. Another method such as off-bottom, floating-raft and floating-basket method also still exists. Appearance of disease on seaweed cultivation which has high water visibility is well-known as "ice-ice" disease (Javanese local name: *lumut gotho*). The symptoms of "ice-ice" disease are appearance some bright color spot in the thalli and will reduce seaweed color until being white and broken-off easily. "Ice-ice" disease affects to *Eucheuma* and occurred due to some factors; environmental alteration (water current, temperature, water visibility, etc) in seaweed cultivation area on long period of time. Method to prevent occurrence of "ice-ice" disease is monitoring environmental alteration and also keep the thalli sinking down under water surface to reduce sun light radiance.

Important factors that should be considered for harvesting seaweed are the age of seaweed and climate. Quality of harvested seaweed relates with the age of seaweed and if it will become seeds, harvesting should be operated while on 25-35 culturing days. However, harvesting time on 45th day cultivation can produce more carrageenan compound inside of seaweed. Otherwise, harvesting time on 25th day is only for produce seed of seaweed (Anonymous, 2005).

Economical Aspect

The main importers of Indonesian seaweed are China,

Table 4. Potential production of *Eucheuma* by province

Province	Potential Production (ton)				
	2005	2006	2007	2008	2009
Aceh	0	29,474	35,361	42,421	50,000
Riau	9,821	11,789	14,144	16,968	20,000
West Sumatra	9,821	11,789	14,144	16,968	20,000
Lampung	24,553	29,474	35,361	42,421	50,000
Jakarta	1,964	2,358	2,829	3,394	4,000
Banten	1,473	1,768	2,122	2,545	3,000
Central Java	9,821	11,789	14,144	16,968	20,000
East Java	26,605	36,447	48,221	62,342	77,500
Bali	39,284	47,158	56,577	67,874	80,000
West Nusa Tenggara	83,743	91,368	109,618	131,505	155,000
East Nusa Tenggara	81,287	88,421	106,082	127,263	150,000
South Kalimantan	3,928	4,716	5,658	6,787	8,000
East Kalimantan	9,821	11,789	14,144	16,968	20,000
North Sulawesi	22,185	23,579	28,288	33,937	40,000
Gorontalo	39,691	47,158	56,577	67,874	80,000
Central Sulawesi	39,691	47,158	56,577	67,874	80,000
West Sulawesi	27,675	31,640	33,466	35,655	38,006
South Sulawesi	78,979	96,965	116,331	139,560	164,494
South East Sulawesi	61,469	70,737	84,865	101,811	120,000
Molluca	39,284	47,158	56,577	67,874	80,000
North Moluccas	58,926	70,737	84,865	101,811	120,000
West Papua	22,185	23,579	28,288	33,937	40,000
Papua	44,371	47,158	56,577	67,874	80,000
Total	**736,579**	**884,210**	**1,060,816**	**1,272,631**	**1,500,000**

Spain, Denmark, Hongkong, Japan, United State of America and Philippines. During 1977-2002 period, export of seaweed have been increasing for about 51,76% annually, started from 12,698 ton in 1977 and become 28,874 ton in 2002. Furthermore, the export value also had been increasing about 25,71% per year that is US$ 10,52 million in 1977 into US$ 15,79 million in 2002. Demand of seaweed for *Eucheuma* sp is about 555,888,073 ton (dried) and for domestic demand is 20,000 ton (dried). It shows that there is a potential market niche for exporting seaweed and saturated demand is not occurs yet (Anonymous, 2006). Furthermore, due to that economical point of view, it can be stated that seaweed cultivation has potential benefit and good prospect.

Invest Efficiency Rate of business activity is important value to the investor. By knowing this value, investor can allocate limited capital in certain business which has most benefits. This efficiency is calculated by Incremental Capital Output Ratio (ICOR) Index where is lower index indicates more efficient (Sundararajan, V and Subhash Thakur, 1980). These author mentioned that ICOR index which is lower than 4 indicates the business sector is efficient enough, and 2 indicates more efficient. Otherwise, if the index is more than 4, it means the certain business sector needs more effort to be more efficient.

According to result by Fisheries Investment Analysis Team in Directorate General of Aquaculture (1999), generally ICOR index for fisheries business is 3.55, the lowest index than another business sector on agricultural (Table 5.). This index showed that investment in fisheries business is more efficient than another agricultural business sector. Furthermore, if that index is compared to World Bank assessment which showed ICOR index of Indonesia are 3.7 for fisheries business sector, and indicates the efficiency mentioned before.

Fisheries Investment Analysis Team (1999) reported

Table 5. ICOR Index of Fisheries business sector and other sector

Sector	ICOR Index
Fisheries	3.55
Horticulture	3.60
Crop	3.90
Plantation	3.95

Table 6. ICOR Index for each sub-sector in fisheries business

Sub-sector	ICOR Index
Marine fisheries	
Tuna catchments	2.80
Other fin fish catchments	3.50
Fingerling fin fish catchments	3.65
Marine aquaculture	3.95
Seaweed cultivation	3.85
Marine fish hatchery	3.05
Shrimp and lobster catchments	3.25
Freshwater fisheries	
Freshwater aquaculture	3.55
Brackishwater aquaculture	3.15
Crustacean aquaculture	2.75
Brackishwater fish hatchery	2.95
Crustacean hatchery	3.70

that there are business activities in fisheries sector which has lower ICOR index than its general index as mentioned in Table 6.

Forecasting

The two most well-known of Indonesian seaweed (*Eucheuma* and *Gracilaria*) can be prime product (wet and dry wt.) to provide food, bioactive, chemical compound, etc. In accordance with the potential area, the most suitable area for development of seaweed cultivation is South Sulawesi, and following by Nusa Tenggara area and another part of Sulawesi Island. Furthermore, about 2,000,000 ton of potential seaweed production is not explored yet and needs more effort from stakeholders to still bring Indonesia as biggest seaweed producer in the world and can provide more to fulfill seaweed demand. ICOR Index of seaweed cultivation also shows that this business activity is effective and reliable.

According to business analysis by Indonesian Directorate General of Aquaculture (2006), long-line method has 1.3 of Return of Capital and this number is the smallest among of seaweed cultivation method. It means long-line method is still can be main method in Indonesian seaweed cultivation.

Recently, issue of energy demand in the world become important topic because has direct effect to the life of people. Many researchers already tried to get substitution product for oil (biofuel) from plants such as corn, palm oil, *Jatropha curcas Linn*. (Jarak oil) and also cassava. These plants has disadvantage to be biofuel resources because will compete to food demand of human being. According to this fact, seaweed can be next option to be biofuel resources with lower risk if we compare to other plant sources about food demand competition in the world.

Considering the important potential area and production of seaweed cultivation, Indonesia has a chance to be prime candidate for providing seaweed to produce biofuel instead of another product.

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