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Working Paper No. 2

Seafarming as a Part of Indonesia's Economic Development Strategy – Seaweed and Giant Clam Mariculture as Cases

by

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Carunia Firdausy[2] and Clem Tisdell[3]

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The technical feasibility of culturing giant clams for food and for restocking tropical reefs was established in an earlier ACIAR project. This project is studying the economics of giant clam mariculture, to determine the potential for an industry. Researchers will evaluate international trade statistics on giant clams, establish whether there is a substantial market for them and where the major overseas markets would be. They will determine the industry prospects for Australia, New Zealand and South Pacific countries, and which countries have property right factors that are most favourable for commercial-scale giant clam mariculture. Estimates will be made of production/cost functions intrinsic in both the nursery and growth phases of clam mariculture, with special attention to such factors as economies of scale and sensitivity of production levels to market prices.

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ABSTRACT

Seafarming is a growing economic activity in Indonesian coastal areas. The level of investment required for this activity is lower than in the capture fisheries and in the agricultural industry. However, in considering the development of seafarming activities one not only needs to take into account direct economic benefits, but also social and environmental spillovers with a view to approaching a more sustainable degree of economic development.

After outlining the economic significance, development and adverse environmental effects of seafarming activities in Indonesia, this paper examines the economics and socio-economic benefits of seafarming taking seaweed culture as a case. It is estimated that the potential economic return from seaweed farming appears to be high in Indonesia as can be best judged from the internal rate of return figure which is estimated to be 47 per cent.

The paper also considers the socio-economic prospects for giant clam farming in Indonesia. It reviews the current status and utilisation of giant clams, examines the environmental advantageous of clam farming and considers the market and possible socio-economic benefits of clam culture.

Keywords: Giant clams, mariculture, seafarming, Indonesia,

JEL Classification: Q57, Q31

Seafarming as a Part of Indonesia's Economic Development Strategy - Seaweed and Giant Clam Mariculture as Cases

1. Introduction

Indonesia faces several structural problems in its economic development. These include a high incidence of rural poverty especially in coastal areas, and a very high degree of dependence on exports of minerals (especially oil and natural gas) for foreign exchange earnings. In 1981, minerals accounted for 83.6 per cent of the value of Indonesia's exports, the highest degree of export dependence on minerals of any ASEAN country (Mckern and Koomsup, 1988).

In its development policies, the Indonesian government is aiming to diversify its exports and reduce its export dependence on oil and natural gas, and reduce rural poverty. The development of seafarming or mariculture in rural coastal areas may contribute to the achievement of these goals. It is well recognised that - mariculture can increase income, employment and foreign exchange earnings and add to protein supply (Chua, 1986; Collier, 1981; Directorate of General Fisheries, 1988). Furthermore, being an archipelago, Indonesia has a long shoreline (relative to its land mass) suitable for seafarming.

The World Commission on Environment and Development (1987: 138) recommended that the expansion of aquaculture should be given high priority in developing and developed countries because of the anticipated growing gap between demand for fishery products and available supplies from the capture fishery. More generally some researchers have argued that growth in supplies from agriculture, domestic livestock and capture fisheries will be unable to meet the growing protein demand of expanding - population (Korringa 1983: 17-29; Allen et al. 1984: 1).

However, expansion of aquaculture is no panacea for increasing food supplies. Aquaculture can have, depending upon the species cultured and the methods used, adverse environmental impacts and unsatisfactory consequences for inco1ne distribution (Pullin, 1989; Tisdell, 1989). For instance, the intensification of aquaculture activities through the conversion of mangrove areas to brackish water fish and shrimp ponds has not only depleted the valuable mangrove resources but has also impaired the ecological balance in the estuarine ecosystem where mangroves are generally located. In addition, it is argued that the current implementation of brackish water pond intensification programs (INTAM) in Java has solely benefited owners of middle sized and large ponds thereby increasing inequality of income (Hannig, 1988: 5-6). Hence, it is necessary to be selective in supporting aquaculture/seafarming activities if the Indonesian goal of economic development with equity and sustainability, as stressed in the Indonesian Five-Year Plan, is to be achieved.

In the light of the above, this paper, first outlines the economic significance and development of seafarming activities in Indonesia using official statistics. Secondly, some environmental and sustainability effects of seafarming are highlighted. Thirdly, the possible socio-economic contribution of seafarming activities to coastal rural people are discussed taking seaweed culture as a case. Finally, clam farming is considered as a new possibility for Indonesian coastal areas.

2. Seafarming or Mariculture in Indonesia : Present Status And Its Economic Contribution

2.1 Present Status

Seafarming or mariculture is defined as the culture and husbandry of marine organisms (animal and plants) in marine and/or brackishwater, whereas aquaculture is the more general term and includes organism farmed in freshwater.

Unlike, other activities (capture fisheries, agriculture and domestic livestock), seafarming activity is less dependent on the availability of land since it is farmed in the coastal areas. The level of investment - required for this activity is lower than in the capture fisheries and in the agriculture industry (Chua, 1986: 4). This suggests that seafarming activities may be economically advantageous for countries facing land availability problems but having significant marine resource areas.

The potential area for aquaculture and mariculture in Indonesia is very large. According DGF (Directorate General of Fisheries 1988: 2) about 70 per cent of the Indonesian territory consists of water (marine, brackish and freshwater) and it has more than 81,000 km of coastline. The potential area for seafarming, however, is estimated to be about 71,050 ha. This consists of 29,000 ha for finfish culture, 17,000 ha for cockle culture, 19,700 ha for mussel culture, 7,500 ha for oyster culture, 2,850 ha for pearl oyster culture, and 21,100 ha for seaweed culture.

To say that there is much potential for seafarming activities does not mean that it will be easy to realise it. The Indonesian Government has given attention to the development of seafarming nationally since 1980. The Government through Presidential Decree No. 23 of 25 May 1982 took steps to regulate mariculture development. Also, the Government issued implementation and technical guidances through Ministerial Decree No. 473 of July 8, 1982 and Directorate General of Fisheries letter No. IK-210/D4. 5055 of September 4, 1982 (Abdulmalik and Rahardjo, 1988: 2).

Mariculture development is occurring in many coastal - rural areas with sites suitable for seafarming. It is hoped that through seafarming activities poverty in coastal rural areas, as widely highlighted in literature, can be reduced (Mubyarto, 1988; Tjondronegoro, 1988; Bailey et al, 1986).

Several seafarming activities already engaged in and/or being developed in Indonesian waters include shrimp culture in brackish water ponds; fish culture (groupers, rabbit fish and snapper) in nets and cages in the coastal areas; and seaweed culture in floating cages and/or by bottom methods in coastal areas. Species cultured and the number of seafarming units in Indonesia is presented in Table 1.

Table 1: Species Farmed and the Number of Seafarming Units in Indonesia, August 1988.

Province	Seaweed	Groupers	Rabbit Fish	Snapper	Sea Cucumber	Shrimp	Pearl
DKI Jakarta	361	95	10	1	-	204	-
Lampung	10	-	-	-	-	-	-
North Sumatra	185	-	-	-	-	-	-
South Sumatra	-	40	-	-	-	-	-
East Java	44	-	-	-	-	-	-
Bali	111,104	-	-	-	-	-	-
East Nusatenggara	22	-	-	-	10	-	9
West Nusatenggara	1,860	-	-	-	-	-	-
South Sulawesi	2,171	-	-	-	21	-	-
TOTAL	115,757	135	10	1	31	204	9

Source: The Directorate General of Fisheries, Jakarta, 1988, Appendix 3.3.

From Table 1, it can be seen that seaweed culture is the most frequent form of seafarming in coastal rural areas when this is accounted for by the number of productive units engaged in the activity. This is followed by shrimp culture in brackish water ponds. Shrimp culture, however, is mostly adopted by wealthier groups in coastal areas and city based-entrepreneurs because it has high capital requirements. Farming of groupers and rabbit fish has not yet developed to any great extent in rural coastal areas since it largely depends on natural seed availability.

Shellfish (cockle, mussel and oyster) are least frequently maricultured in coastal rural areas. Coastal rural people or fishermen have not cultured these species to any great extent since the bulk of supplies can still be collected from the nature. In addition, not so many Indonesians like to eat shellfish and rumours of high contamination reduce the rate of development of shellfish farming (Eidman and Suprapto, 1988: 5). Culture of giant clams has not yet developed in Indonesia but research is being carried out in the Seribu Islands and in Karimun Java (Pasaribu, 1988: 44; Romimohtarto and Sutomo, 1988: 258). As will be discussed below, culture of this species may provide economic benefits to coastal rural areas and have little adverse environmental impact.

2.2 Contribution of Seafarming to Indonesian Economic Development

Seafarming activity in Indonesia has increased, but mariculture is not yet well developed. Reliable production statistics for mariculture are not easily available and are included in aquaculture production statistics. Despite this, some useful information is available on the development of seafarming in Indonesia.

According to the Directorate of General Fisheries (1988: 7), between 1983 and 1987 production from seafarming rose from 134.1 thousand tonnes to 186.2 tonnes, that is by 38.9 per cent, or at the rate of 8.6 per cent per year. In the same period the number of fish farmers rose from 121,023 to 209,000, that is, by 72.7 percent, or at the rate of 14.6 per cent per year. In addition, the area used for seafarming rose from 220,563 ha to 249,000 ha, that is by 12.9 per cent, or at annual rate of 3.1 per cent. The average production per hectare from seafarming rose from 608 kg/ha to 749 kg/ha.

Compared with other fisheries subsectors, the average growth rate of production from seafarming (brackishwater) activity was almost twice the average growth rate of that from capture fisheries in the period between 1983 and 1987. In terms of the average growth rate in production and its absorption of labour, seafarming (brackish water and cage activity) had a higher average growth rate than capture fisheries (Table 2 and Table 3).

Table 2: Indonesian Fishery Production by Sub Sectors 1983-1987 (unit: 000 tonnes)

Description	1983	1984	1985	1986	1987	Average Growth/yea (%)
Marine Fishery	1,682	1,713	1,822	1,923	2,029	4.8
Inland Fishery	532.5	548.1	573.8	607.0	640.8	4.7
Open Water	265.5	269.3	269.3	273.0	278.0	1.2
Brackish Waterpond	134.1	142.4	156.4	170.3	186.2	8.6
Freshwater pond	80.7	76.5	84.2	88.7	96.5	4.8
Cage	1.0	1.0	0.7	0.5	0.9	5.4
Paddy Field	51.2	59.8	63.2	74.5	79.2	11.1
Total	2,214.5	2,260.9	2,395.5	2,529.8	2,669.8	4.8

Source : Directorate General of Fisheries, Jakarta, 1988 : 7.

Table 3. Size of Labour Force Employed in Fisheries Sector, 1983-1987

Activity	1983	1984	1985	1986	1987	Average growth/ year (%)
A: Capture Fisheries						
Marine Fishermen	1,266,643	1,294,472	1,286,448	1,357,279	1,456,600	4.4
Open waters fishermen	424,726	438,953	434,290	450,382	472,700	2.7
B: Culture Fisheries						
Freshwater fish farmers	986,337	1,018,909	1,147,195	1,327,742	1,421,800	10.1
Brackishwater fish farmers	121,023	131,385	134,900	162,266	209,000	14.6
TOTAL	2,740,729	2,883,719	3,002,833	3,297,669	3,560,100	6.8

Source :The Directorate General of Fisheries, Jakarta, 1988: 19

In terms of exports, between 1983 and 1987 fisheries' commodities exported from Indonesia increased by 58.9 per cent in volume. In 1983 the export of fisheries' product was 88,365 tonnes in volume or US $ 257.084 million in value and it increased to 140,378 tonnes or US

$475.524 million in value in 1987. Seaweed is the major non-food fishery item exported from Indonesia. However, it ranks fourth in terms of volume among fishery exports following shrimp, tuna, and other fish (Table 4). Total production of seaweed in 1985 was estimated to be 5,446 tonnes and it increased to 9,882 tonnes in 1987. The main markets for seaweed products are in Hong Kong, Singapore, Denmark and Japan.

It should be noted that the available statistics are in terms of volume rather than value. While one can learn something from such statistics, it would be useful from an economic point of view to have the data expressed in value terms.

Table 4. Indonesia's Export of Fisheries' Product by Type of Commodities, 1983-1987.

unit: tonnes

Commodities	1983	1984	1985	1986	1987	Average Growth/ year (%)
Food Items	78,268	66,392	72,629	92,579	122,270	13.4
- prawn	26,166	28,025	30,980	36,101	44,267	14.0
- Tuna/ Skipjack	20,311	14,702	17,889	24,236	33,995	17.5
- Other fishes	13,661	8,623	9,158	10,611	18,902	15.8
- Frog thigh	3,296	2,200	2,802	3,752	3,078	-2.5
- Sea cucumber	1,274	1,318	3,123	2,362	2,517	30.6
- Jelly fish	4,108	2,556	1,875	4,762	3,372	-15.1
- Crabs	2,419	2,143	1,749	1,944	2,049	1.3
- Others	7,033	6,823	5,053	8,811	13,730	25.4
Non-Food Items	10,097	9,303	11,868	14,866	18,108	16.7
- Ornamental fish	197	204	235	859	530	61.5
- Seaweeds	3,402	3,061	5,446	7,111	9,882	34.4
- Sea shell	2,302	2,603	2,832	2,389	2,740	5.2
- Others	4,196	3,435	3,355	4,507	4,956	6.0
Total	88,365	75,695	84,497	107,443	140,378	13.8
Total Value (FOB US$ 000)	257,048	248,063	259,444	374,117	475,524	18.1

Source: The Central Bureau of Statistics, Jakarta, 1987

Although Indonesia exported a large range of fishery commodities, it still imported fishery products. However as can be seen by comparing the last lines of Table 4 and of 5, Indonesia has an extremely large net surplus of export income from fisheries' products. In 1987, the value of its exports were more than 17 times its imports, and its imports have tended to fall relative to its exports. The main item imported is fish meal or fish flour which is used as a raw material for livestock feeds. In 1987, the imported fishery products to Indonesia amounted 65,371 tonnes worth US$ 27.8 million. Preserved fish, fish oil and fish feed imports have shown large growth rates in the period 1983-1987 (Table 5).

Table 5. Indonesia's Import of Fisheries Product, 1983-1987

unit: tonnes

Commodities	1983	1984	1985	1986	1987	Average Growth/year (%)
Preserved fish	23	22	208	259	52	196.4
Canning fish	1,177	788	730	2,015	508	15.2
Fish Oil	300	286	454	4,166	9,152	247.8
Molluscs	36	52	79	42	42	12.4
Agar-agar	350	163	170	165	140	- 13.4
Fish flour	51,593	41,853	47,792	44,107	52,476	1.6
Fish feed	11	37	816	823	213	567.1
Others	4,399	7,505	4,854	6,672	2,788	3.6
Total	57,878	50,669	54,287	57,426	65,371	3.6
Total Value (CIF US$ 000)	34,347	28,789	23,891	28,177	27,832	- 4.1

Source: The Central Bureau of Statistics, Jakarta, 1987.

From the foregoing figures, it seems clear that in the 1980s seafarming activities in Indonesia have added to income, to foreign exchange earnings, to employment opportunities for coastal rural people and to the supply animal protein. From the statistics, one cannot judge the extent to which seafarming has resulted in import substitution in Indonesia but reduction in imports of agar-agar (which is produced from seaweed) (Table 5) suggests that some import substitution has occurred.

3. Environmental Effects And Sustainability Impacts Of Seafarming

Although seafarming activities can contribute to economic development, they may also have an adverse impact on the coastal ecosystems, the environment and income distribution.

The possible adverse consequences of seafarming for the environment, however, depend upon the type of culture system used, the type of product grown, the techniques used to grow it, the location in which it is grown. For example, farming techniques using cages, sticks, rafts, pens, etc., may present (a) a navigational hazard; (b) be incompatible with use of the area for recreational purposes and for fishing; (c) have an adverse visual impact; (d) lead to destruction of wild species because of habitat change; and (e) hardening of bottom sediment due to the build-up of waste and possibly the formation of insoluble phosphate compounds (Tisdell, 1989: 10; Pullin, 1989: 11; Folke and Kautsky, 1989: 237-238). The use of pesticides (chemical substances) against parasites in intensive and/or semi-intensive culture systems may cause lethal and sublethal effects and accumulate in the marine food web, and degrade the quality of reared fish (Folke and Kautsky, 1989: 239).

Furthermore, intensification of seafarming activities, particularly, the conversion of mangrove areas or wetlands to brackish water fish and shrimp ponds can have the following adverse environmental impacts' (a) destruction of natural ecosystems, especially mangroves; (b) salinization/acidification of soils/aquifers; and (c) the release of effluents/drainage high in biological oxygen demand (BOD) and suspended solids. Such projects tend to increase income inequality since brackish water shrimp and fish ponds involve low labour-intensities and high capital plus land ratios (Tisdell, 1989: 9; Pullin, 1989: 12).

In Indonesia the impact of seafarming activities on the coastal environment has been recognised. For instance, large scale conversion of mangrove areas to shrimp ponds in Marunda area and Tanjung Karawang, East of Jakarta has rapidly depleted valuable mangrove resources. Environmental impacts on mangrove swamps include coastal erosion, changes in shoreline configuration and destruction of habitats for fish, shrimp and other marine organisms. As a consequence, the Indonesian Government through the Directorate of Forest Protection and Nature Conservation has limited the expansion of pond culture in these areas and other areas along the north coast of Java, and has established coastal nature reserve areas (Atmawidjaja, 1987: 3-4).

Apart from its negative impact on the environment, intensification of culture of shrimps in brackish water ponds in Java may increase the concentration of wealth. This culture appears to benefit only owners of middle-sized and large ponds. The small owner-cultivators are therefore, induced to sell their ponds to this group (Hannig, 1988: 6).

As mentioned before seaweed is the most frequent item maricultured in Indonesia. Seaweed is mostly cultured on reef flats and it is dependent on natural productivity. It is an extensive rather than an intensive form of mariculture. So far there are no reports of adverse chemical effects on water quality and on the environment. However, one problem arising from this farming in Nusa Penida (Bali) is that it restricts tourists who want to go surfing and diving, because of the stakes or floats used in the culture.

The above evidence indicates that in considering the development of seafarming activities one not only needs to consider direct economic benefits, but also social and environmental spillovers with a view to approaching a more sustainable degree of economic development (Barbier, 1987). In Indonesian context, this possibility means that seafarming systems should benefit the bulk of coastal rural poor and to the extent possible minimise resource depletion, environmental degradation, cultural disruption, and social instability. In this respect seaweed farming is a very suitable coastal farming system for Indonesia.

4. Seaweed Farming :Economic and Socio-Economic Benefits

4.1 Culture System and Current Status

Seaweed farming is the most common marine culture adopted by coastal people in Indonesia. Increasing demand for and rising price of seaweed have resulted in a rapid expansion of seaweed farming in recent years. In addition, this farming system does not require much capital compared to other aquaculture activities. It requires few commercial inputs, and does not need pharmaceuticals, chemicals, or supplementary feed to sustain production. It also has few adverse environmental effects. Consequently, most coastal rural poor can afford to adopt this culture as their main source of income.

Six species of seaweed are of economic importance in Indonesia, namely, *Gracilaria* sp., *Gelidium* sp., *Laminaria* sp., *Sargassum* sp., *Eucheuma* sp., and *Hypnea* sp. The product of these species are agar, algin and carrageenan. Agar is produced from *Gracilaria* sp. and *Gelidium* sp. Algin is produced from *Laminaria* sp. and *Sargassum* sp. Carrageenan is the product of *Eucheuma* sp. and *Hypnea* sp.

These products have applications as stabilizing agents in milk and ice cream products, suspending agents in paint, thickening and gelling agent in canned products, ingredients in ointments, jellies, dental impressions, shampoos, as an ingredient of waterproof paper, cloth and glue, as a clarifying agent in the manufacture of wines, beers and coffee and as a covering for pharmaceutical capsules (Shang, 1976:1; Veloso, 1988:2).

However, of these six species, *Eucheuma* sp. is the most extensively cultured because the market price of this species is higher than for other seaweed species. For example, in December 1988, at the farm gate in Bali the market price of dried *Eucheuma cottonii* and dried *Eucheuma spinosum* was Rp. 400 per kg (Indonesian currency unit), but the price of dried *Gracilaria* sp. and *Gelidium* sp. was only Rp. 250 per kg as one author found from interviews in Bali.

Culture techniques used are mostly raft and off-bottom methods depending on the nature of the coastal site. The cost of using the raft method is higher than for the use of the off-bottom method. However, seaweed - grown by the raft method has a higher average growth rate and the raft can hinder fish predators of seaweed (Indonesian Marine Fisheries Research Institute, 1979: 60).

The main area in Indonesia where seaweed is cultured is in Jungut Batu village, Nusa Penida (Bali). In this village seaweed farming is the main economic activity and has replaced fishing and the collecting of corals as the main activity. Based on village data collected in 1988, the number of household heads engaged in seaweed farming is about 513 or about 71.8 per cent of total household heads. The distribution of household heads according to their occupation is presented.in Table 6.

Table 6. Distribution of household heads according to occupation, December 1988.

Occupation	Number of Household Heads	Percentage
Cassava/Corn Farmers	69	9.7
Seaweed farmers	513	71.8
Small traders	12	1.7
Handicrafts	43	6.0
Transportation	25	3.5
Rural Banking	1	0.1
Government officer	51	7.2
Total	714	100

Source : Village Head Office, Jungut Batu, Nusa Penida (Bali), December 1988.

Due to the success of seaweed farming in Bali and increasing demand for *Eucheuma*, many other coastal rural dwellers in Pulau Seribu (DKI Jakarta), Sibolga (North Sumatra), and South Sulawesi have been attracted to seaweed farming. However, results in these areas are not yet satisfactory and low quality seaweed is supplied. As a result, the price of seaweed from these areas is very low compared to the price obtained in Bali.

4.2 Economics and Socio-Economic Benefits of Seaweed Farming

The cost of farming seaweed varies depending on the size of the planting area available and the type of culture used. However, compared with the cost of brackish water pond for shrimp and milkfish, seaweed farming is less costly per unit area. Shang (1976: 6) argued from his study in Taiwan that seaweed (*Gracilaria*) farming requires lower initial operating expenditure than many types of aquaculture. Annual profit can reach $1,399 - $2,413/ha. By comparison, profits from milkfish culture are about $ 250 - $ 500/ha. In addition, seaweed farming involves labour-intensive production. Seaweed is ready to be harvested in 6 weeks, whereas milkfish need six to nine months to achieve market size.

Based on the available data collected from a seaweed farmers[1] in Nusa Penida (Bali) in December 1988 by C. Firdausy, the initial capital cost of culturing seaweed on one ha area

[1] This farmer has a one ha farm. It is larger than the average farm. His returns are indicative of the potential return from seaweed farming in Indonesia.

using the off-bottom method is about Rp. 8,2 million or about US$ 4753 (1 US$= Rp. 1725). Cost and return analyses for this one ha seaweed farm are presented in Tables 7, 8, 9, and 10.

Table 7. Cost and return analysis for a selected one ha seaweed farm (*Eucheuma cottonii*) in Bali, 1988.

	Cost (Rupiah)	Life (years)
A. INITIAL INVESTMENT		
- 20,000 kg seed stock at Rp. 50/kg	1,000,000	
- 1000 kg nylon plastic (4 mm)	4,000,000	2
- 100 kg nylon plastic (8 mm)	400,000	2
- 8000 pcs bamboo at Rp. 200 each	1,600,000	2
- 300 kgs rolls plastic at Rp. 1000/kg	300,000	1
- 2 bull hammmers at Rp. 5000 each	10,000	10
- 1 iron bar at Rp. 3,000	3,000	10
- 1 knife at Rp. 500	500	5
- 15 pairs of gum boots at Rp. 5000 a pair	75,000	1
- 2 pcs mask at Rp. 25,000	50,000	1
- 15 basket at Rp. 1,000	15,000	6 mths
- 2 scoop net at Rp. 3000	6,000	1
- 100 gunny sacks at Rp. 400	40,000	6 mths
- 1 axe at Rp. 4000	4,000	5
- 1 wood saw at Rp. 5,000	5,000	5
- 50 m net at Rp. 2,000/m	10,000	2
- initial set up labour cost e.g. setting up the bamboo posts	750,000	
TOTAL INITIAL CAPITAL COST	8,268,500	
B. OPERATING COSTS		
- 15 labourers at Rp. 30,000 for a year	5,400,000	
- license	50,000	
- Depreciation (derived from initial invesment)	3,549,200	
TOTAL PRODUCTION COST	8,999,200	
C. REVENUE (there are 6 harvest in a year 48,000 kgs/ year at Rp. 400/kg)	19,200,000	
D. PROFIT (C - B)	10,200,800	
E. PROFIT (C - B) without Depreciation	13,750,800	
F. **PAYBACK PERIOD (A/E)**	**0.60**	
G. **RATE OF RETURN (D/A)**	**123 %**	

Note : - Cost data are based on existing 1988 price;
- Seedlings for subsequent planting are obtained from initial first planting. Thus, it is included in initial capital cost.
- Payback period (see Tisdell, 1972) and rate of return method after Shang (1976).

Source : Personal communication with seaweed farmer in Nusa Penida, Bali, December 1988.

Table 8 Estimates of annual capital and operating costs for ha selected seaweed farm in Bali, 1988.

unit: x Rp. 10,000

Costs	Year										
	0	1	2	3	4	5	6	7	8	9	10
Capital Costs											
[redacted]	[redacted]	-	-	-	-	-	-	-	-	-	-
Nylon plastic (4 mm)	400	-	-	400	-	400	-	400	-	400	-
Nylon plastic (8mm)	40	-	-	40	-	40	-	40	-	40	-
Bamboo	160	-	-	160	-	160	-	160	-	160	-
Net	1	-	-	1	-	1	-	1	-	1	-
Plastic rolls	30	-	30	30	30	30	30	30	30	30	30
Gum boots	7.5	-	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Mask	5	-	5	5	5	5	5	5	5	5	5
Basket	1.5	1.5	3	3	3	3	3	3	3	3	3
Scoop net	0.6	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Gunny sacks	4	4	8	8	8	8	8	8	8	8	8
Bull hammers	1	-	-	-	-	-	-	-	-	-	-
Iron bar	0.3	-	-	-	-	-	-	-	-	-	-
Knife	0.05	-	-	-	-	-	0.05	-	-	-	-
Axe	0.4	-	-	-	-	-	0.4	-	-	-	-
Wood saw	0.5	-	-	-	-	-	0.5	-	-	-	-
costs of tying up seeds and setting up bamboo	75	-	-	-	-	-	-	-	-	-	-
Total	826.85	5.5	54.1	655.1	54.1	655.1	55.05	655.1	54.1	655.1	54.1
Operating Cost											
labourer wage	-	540	540	540	540	540	540	540	540	540	540
License		5	5	5	5	5	5	5	5	5	5
Total	-	545	545	545	545	545	545	545	545	545	545
REVENUE	0	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920
NET INCOME ((Rp. 1000)	-8268.5	13695	13209	7199	13209	7199	13199.5	7199	13209	7199	13209

Note : Assumed enonomic horison of seaweed farming is 10 years or cycle of 10 years;
Assumed no change in real annual operating cost;
Assumed no change in real price.

Table 9 Net present value and benefit cost ratio assuming economic horison of farming of 10 years of selected seaweed farm

Unit : x Rp. 1000

Year	TC	TR	NI	DF 12 %	DNI
0	8268.5	0	-8268.5	1.000	-8268.5
1	5505	19200	13695	0.893	12229.6
2	5991	19200	13209	0.797	10527.6
3	12001	19200	7199	0.712	5125.7
4	5991	19200	13209	0.636	8400.9
5	12001	19200	7199	0.567	4081.8
6	6000.5	19200	13199.5	0.507	6692.1
7	12001	19200	7199	0.452	3253.9
8	5991	19200	13209	0.404	5336.4
9	12001	19200	7199	0.361	2598.8
10	5991	19200	13209	0.322	4253.3
Total					62500.1

Net Present Value at 12 % * = Rp. 62,500,100
(excluding initial capital outlay)

Net Benefit-Cost Ratio at 12 %** = 7.59

Note : TC = Total Cost; TR = Total Revenue;
NI = Net Income; DF = Discount factor;
DNI = Discounted net income.
No residual value since capital assets assumed to be used up in 10 years;
* Net present value (NPV) = discounted revenue - discounted cost
NPV assumed a constant cash flow over a 10 year period with a 12 % discount rate;
** Net B/C ratio = discounted net income / initial capital cost

Table 10 Internal rate of return calculation for selected seaweed farm

unit : x Rp. 1000

Year	NI	Discount Rate (45 %)	PV	Discount Rate (50 %)	PV
0	-8268.5	1.000	-8268.5	1.000	-8268.5
1	13695	0.690	9449.6	0.664	9134.6
2	13209	0.476	6287.5	0.444	5864.8
3	7199	0.328	2361.3	0.296	2130.9
4	13209	0.226	2985.2	0.198	2615.4
5	7199	0.156	1123.0	0.132	950.3
6	13199.5	0.108	1425.5	0.088	1161.6
7	7199	0.074	532.7	0.059	424.7
8	13209	0.051	673.7	0.039	515.2
9	7199	0.035	251.9	0.026	187.2
10	13209	0.024	317.0	0.017	224.6
Total			17138.9		14940.8

IRR = 45 + 5 (17138.9/32079.7)= 47.67 %

Note : NI = net income; PV = present value of net income stream;
To find the first approximate discount rate, the initial capital cost is divided by the average annual profit. The result of this division lies at discount rate of 45 % in discount rate Table. The true internal rate of return can then be interpolated using Gittinger's method (1982: 333-336).

From Tables 7, 8, 9 and 10, it can be seen that seaweed farming has the potential to give high return to the seaweed growers. The rate of return of 123 per cent per annum using the type of method employed by Shang (1976) is way above the opportunity cost of capital in Indonesia (Table 7). The yield provides an income of Rp. 19,200,000 in the first year is more than twice that of annual operating costs and the initial investment can be paid back in less than a year. But the method used in Table 7 to calculate returns is deficient from an economic viewpoint since returns and costs are not considered as a stream over the life of the project.

This compares with Padilla and Lampe (1989) who estimated return of 78 per cent for the Philippines. However, it is not clear whether this is calculated on the above basis or on one of the basis considered below.

By assuming an economic life for a seaweed farming project of 10 years, it is found that the internal rate of return (IRR) of this activity is 47 per cent-that is, the maximum interest that this activity could pay for the resources used if the activity is to recover its investment and operating costs and still break even (Table 10). The net benefit-cost ratio for seaweed farming is estimated at 7.59 (Table 9) using a discount rate of 12 per cent. Thus the potential economic return from seaweed farming appears to be high in Indonesia as can be best judged from the above IRR figure.

It is worth noting that labour is the most important operating cost. It accounts for 60 per cent of total annual expenses. This cost includes seeding, weeding, harvesting and drying. For some farmers, labour expenses (actual outlays) are low since they employ their own family members including children and the opportunity cost of their employment may be low.

The size of the holding of small seaweed farms in Jungut Batu varies between 0.05 - 0.25 ha and the average product harvested per month varies between 200-1500 kg/area holding. Small farmers usually do not hire labour in managing their farms. They rely mainly on family labour to reduce labour outlays. Also, seedlings are sometimes obtained free from neighbours or relatives or natural stocks. The initial investment for a farmer planting 0.25 ha, for example, is about Rp. 1000,000 (US$580). Funds to meet the initial capital cost are usually obtained from credit institutions or informal financial sources available in rural areas. The average gross revenue of small farmers with farm sizes less than 0.25 ha is Rp. 200.000 per month, whereas for farmers with farms of 0.25 ha is about Rp. 500,000 per month. Small farmers feel that seaweed culture give good returns and the initial investment can be paid back in less than one year (pers. comm.).

To sum up: seaweed farming in Indonesia appears to be economic under reasonable management conditions and ecologically and socially suited to many coastal areas. Seaweed farmers in Jungut Batu, Bali stated in December 1988 that seaweed farming has led to an improvement in the standard of living in their coastal areas. As a result of seaweed farming, they claim to have increased their material possessions and to have improved their housing. In addition, there is reduced unemployment of household heads and more hopeful attitudes towards the future. It is, therefore, suggested that the Government should encourage seaweed farming in other coastal areas of Indonesia which are economically and ecologically suitable for seaweed farming.

5. Socio-Economic Prospects For Clam Farming in Indonesia

Giant clams (*Tridacnidae*), locally known in Indonesia as 'Kima' have been one of the main sources of income of many coastal rural people in Indonesia. However, because of the serious depletion of natural stocks of clams, these species have been listed as a protected species since 1987 under a decree of the Minister of Forestry of The Republic Indonesia issued January 12, 1987 (Atmawidjaja, 1987: 2).

Although such regulation is important for conservation purposes, no less important is ensuring that coastal rural-dwellers have alternatives to maintain their income apart from collecting giant clams. Since few alternatives exist, coastal rural users still collect clams illegally and are prepared go to jail if necessary (pers. comm.).

Development of clam farming may be one way to overcome this problem. Such farming may assist in maintaining natural stocks and provide an additional source of income. As Tisdell (1986: 87) based on his study on economic and socio-economic potential of giant clam in Western Pacific suggests:

> "Clam farming as a possible economic activity is of considerable interest as a potential contribution to the economic development of atoll economies and coastal communities in areas ecologically suited to giant clams. The cultivation of giant clams appear to be relatively simple, does not seem to be capital intensive and unlike many other forms of aquaculture, does not require artificial feeding of the stock, except possibly for a very short time in the veliger stage."

Although it may be economically beneficial in the Western Pacific and in other countries, this does not automatically imply that it will be so in Indonesian coastal areas.

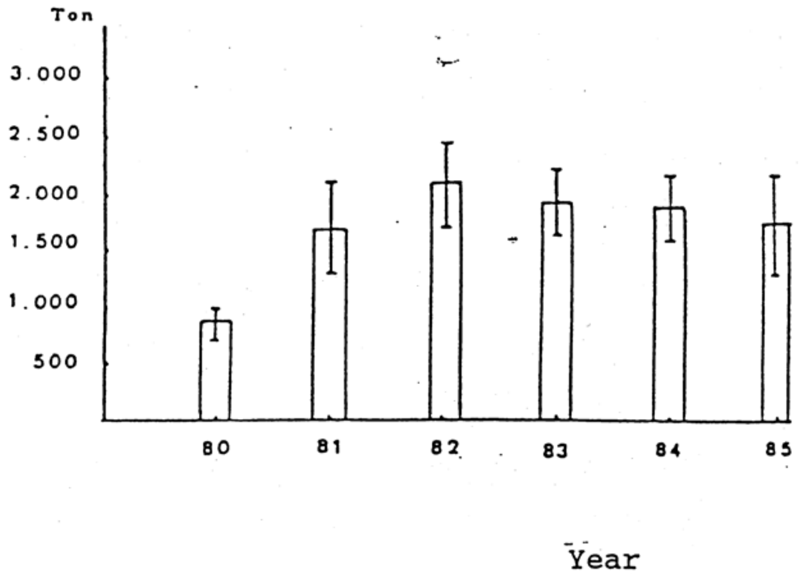
5.1 Current Status and Utilisation

Giant clams are marine bivalve molluscs. There are seven species consisting of five species of *Tridacna* and two species of *Hippopus*. Giant clams occur in almost all Indonesian coastal areas (Romimohtarto et al, 1987 cited in Pasaribu, 1988: 44).

The size of the natural stocks of these species in Indonesia is not known in detail. However, investigations show that population of *T. gigas*, *T. derasa* are low and *H. porcellanus* is extremely rare if not actually extinct. While *T. crocea*, *T. squamosa* and *H. hippopus* are still found, their populations are rapidly declining (Brown and Muskanofola, 1985: 25; Romimohtarto and Sutomo, 1988: 258). A similar situation has occurred in other countries like the Philippines, Japan, and Micronesia (Lee, 1988: 27). Australian waters, particularly on the Great Barrier Reef, now hold the largest stocks of giant clams in the world, but these are not available for commercial harvesting (Tisdell, 1986: 76).

The reasons why the natural stocks of these species in Indonesia have been seriously depleted is mainly due to high demand as a result of human population increase and transportation advances associated with the expansion of local market availability. Coastal rural people utilise clams for many purposes: the meat is used as a food resource, and their shells are utilized traditionally for a variety of purposes such as ornaments, ashtrays, washbasins, jewellery and for the tile industry.

Increasing demand from the tile industry has been a major contributor to the depletion of natural stocks (Sya'rani, 1987; Romimohtarto, 1987). In Karimun Jawa, for example, almost all coastal rural dwellers collect giant clams for income. They sell these products to the middlemen in Jepara who sell these shells in turn to floor tile manufacturers in Jakarta, Central Java, East Java and Bali. The supply of giant clams shells at Jepara market is shown in Figure 1.



Source: After Sya'rani (1987)

Figure 1: The supply of giant clams at Jepara, 1980-1985.

From this Figure, it can be seen that since 1982 the supply of clam shells to Jepara has declined. The decline in supply seems to be accompanied by an increase in prices. The price of the dead shells clams was Rp. 25 per kilogram in 1980, but in January 1989 it increased to Rp. 125 per kilogram.

5.2 Clam Farming and Its Environmental Advantages

Clam farming technology has advanced rapidly in recent years. Major scientific research centres are located at the Micronesian Mariculture and Demonstration centre (MMDC) in Palau, and at James Cook University in Northern Australia. Research is also being conducted at other locations. For example, in the Philippines both at Silliman University and at the University of the Philippines, in Fiji by the Department of Primary Industry, in Papua New Guinea at the University of Papua New Guinea and in the Solomon Islands by International Center for Living Aquatic Resources Management (ICLARM).

In Indonesia clam farming has not yet been developed, but research efforts to culture these species have been underway since 1984. This research is carried out in the Seribu Islands and Karimun Jawa, Nothern Java (Pasaribu, 1988: 45; Romimohtarto and Sutomo, 1988: 258). This research program, however, has not progressed well due to limited funding and water toxicity which has killed mature clams (Pasaribu, pers comm).

Basically three phases are involved in the farming clams: (1) the hatchery phase, (2) ocean nursery phase and (3) grow out phase. In the hatchery, which is typically located on the ocean foreshore, clams are bred and their progeny reared in saltwater tanks. At about 9 months of age, the seed clams are then transferred to a position in the ocean where they are protected by some type of covering (e.g. plastic mesh) from predators. This is the ocean nursery phase. At about 3 years of age the clams can be moved to unprotected ocean situation to commence their grow out phase. The farming methods can be done intensively or extensively (Tisdell, 1986 and 1989:16-17).

Unlike prawns, oysters, abalone or other bivalves, clams do not need fertiliser and feeding (except during the first week in the larvae stage). Clam farming does not require continuing capture of broodstock from the wild or the taking of seed from the wild. The ocean grow- out phase appears technically simple and requires little capital investment beyond the purchase of juvenile clams and as far as is known clams of grow-out size have few predators. In addition, the clam farming appears in many respect to be less environmentally damaging than many other forms of seafarming and it has appealing self-sustainability properties (Tisdell, 1986 and 1989).

However, there are many other issues that have to be considered for farming clams. For instance, which groups are likely to operate clam farms? What is the appropriate culture method to use and what is the cost and returns of the operation? What sized farms should be operated and where should nurseries be located? Should low production cost technology (extensive farming methods) be adopted in preference to high technology production cost methods (intensive methods)?

A decision to implement various operational alternatives requires an understanding of the possible effects through time of biological and financial alternatives. This will allow maximisation of the economic benefits to the farming operation. Furthermore, by knowledgeable application of management tools in decision making, the risk in operating clams farming can be reduced.

5.3 Market and Socio-Economic Potential Benefits of clam farming

Having assumed that it is technically, and ecologically possible to culture clams in Indonesia, consideration on market potential and socio-economic profitability are at least as important as the other criteria.

Markets which have existed are mainly limited to local areas but some shells have been exported to the Philippines. The Indonesian local market for clams is mainly dominated by the tile manufacturing industry. Tiles from this industry are extensively demanded in modern construction in Indonesia. Little information exists on the market clams for food consumption. Information on local demand for clams by seafood retailers, tourists, hotels and restaurants is not available. What is known is that clam meat is eaten by some coastal people. Thus, a survey to determine supply and demand for clams in Indonesian markets is needed.

Similarly, as far as the potential for export is concerned, Taiwan, Hong Kong, Singapore, Japan and USA are potential countries for exports. The price of clam meat in these countries appears to be very high. Top-grade, dried giant clam adductor muscle (which closes the shells) can retail for up to US $100 per kilogram in Taiwan and Japan (Lee, 1988: 27). It is about US $120 per kg in Hong Kong (Munro, 1983 cited in Brown and Muskanofola, 1985: 37). In the Philippines a pair of large shells about a metre in length will fetch more than US

$100 (Lee, 1988: 27).

However, for international markets, the clams have to be collected, prepared and packed. The muscle must be separated from the mantle, the kidney discarded. These products have to be frozen and packed for shipment, and stored under controlled cold room conditions until shipment or sales. The exporter needs skills in arranging international exchange. This suggests that the successful operation of an export orientated market requires an adequate infrastructure to support it. The economic benefit of export market clams needs more investigation.

Thus, it is clear that the economic success of clam farming in Indonesia will depend on many factors. Further study of the economic and socio-economic potential as well as environmental impacts of clam farming in the Indonesian coastal area is needed before deciding whether to recommend the likely possibility of this species on economic grounds for culture in Indonesia.

6. Conclusions

Seafarming is a growing economic activity in Indonesian coastal areas. There is considerable potential for it to contribute to economic development, improve coastal rural incomes and provide foreign exchange earnings. However, in assessing the socio-economic benefits provided by seafarming activities one should also take into account its possible negative impact on the environment. Seafarming should be assessed not only in terms of economic gains, but also in terms of environmental and social effects.

Seaweed farming seems especially suited to Indonesia and has the potential to give high economic returns with few adverse social and environmental consequences. However, the effects of seaweed farming on coastal rural poverty and income inequality in Indonesia need further study. In the case of clam farming, there is no firm basis at this time to decide whether it is likely to be a profitable economic activity for the Indonesian economy. However, it would also seem to have economic potential and to be environmentally less damaging than many existing mariculture activities, e.g. shrimp farming. It is even possible to grow clams in conjunction with seaweed thereby providing a source of animal protein but the economics of mixed farming has not been assessed yet.

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