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Economic Returns from Farming Different types of Seaweed (Eucheuma) and for Farms of Different Sizes in Nusa Penida, Bali, Indonesia

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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

Investment in seaweed (*Eucheuma*) culture by small farmers in Indonesian coastal areas is now considerable, but there appears to be no estimates of the economic returns from this activity. After providing background information on seaweed farms, cost of establishing a seaweed farm and farm revenue from seaweed farming, we estimate the economic returns from seaweed farming using data obtained from Bali. It is estimated that the economic rate of returns in investment in seaweed farming in Bali is very high and the pay-back period for this activity on most farm surveyed was less than a year. Currently small farmers can depend on this culture as their main source of household income in areas ecologically suitable for this culture provided market-access is not too difficult. This culture would also seem to be environmentally less damaging than many existing mariculture activities, e.g. shrimp farming. In addition, it is relatively labour-intensive and does not require significant quantities of processed or imported inputs such as fertilisers, chemicals, fuel and food. Indications are that seaweed farming is likely to be economically more attractive than giant clam mariculture in Bali.

Keywords: Eucheuma, Seaweed farming, Bali, mariculture.

JEL Classification: Q57, Q21, Q22

Economic Returns from Farming Different Types of Seaweed (Eucheuma) and for Farms of Different Sizes in Nusa Penida, Bali, Indonesia

1. Introduction

The farming of seaweed is becoming more common in Indonesia. Several studies on economic returns from seaweed farming have shown that yields from investment in this activity can be high (Padilla and Lampe, 1989; Shang, 1976; Firdausy and Tisdell, 1991).In the Indonesian context, for instance, Firdausy and Tisdell (1991) estimated that the pay-back period for seaweed (*Eucheuma cottonii*) farming in Jungut Batu, Bali on a one ha model farm to be 7.8 months and seaweed cultivation gave an accounting rate of return of 123 per cent and an investment rate of return (IRR) of 153 per cent.

However, the study mentioned above was based only on a particular one hectare model farm. One may wonder if seaweed farming is likely to be profitable for small farmers and for a range of seaweed farm operations. Therefore, it is necessary to consider a wider range of production possibilities and conditions, as is done in this paper. Although the data and the results are specific to Bali, the techniques used to evaluate and analyse the data are of general applicability to seaweed farming.

2. Methods of Analysis

Many methods can be used to evaluate the economic desirability of business projects. Project evaluation methods include the pay-back period method, the average rate of return approach and discounting methods. The last set of methods include the net present value (NPV) or discounted cash flows (DCF), the internal rate of return (IRR), and benefit-cost ratio methods (Shang, 1981; Tisdell, 1972; Gittinger, 1982; Allen et al., 1984; Little and Mirrlees, 1976; Schmid, 1989; Mishan, 1982).

The pay-back period and the average rate of return methods, however, fail to make any allowance for the timing of benefits and costs. For instance, the pay-back period method simply estimates the speed with which the project repays the original investment. Projects which repay the original investment or outlay in the shortest period of time are preferred. The limitations of this method are that it ignores the flow of returns beyond the pay-back period and does not take into account the receipt pattern within the pay-back period. No account is taken of the possibility that some projects involve capital outlays in other than the initial period. Thus this measure ignores much of the time pattern and, indeed, some of the net benefits from projects (Tisdell 1972, p. 388, Gittinger 1982, p. 302; Little and Mirrlees 1976, pp. 325-326).

While there is widespread acceptance by economists of the use of the net present value (NPV) criterion for evaluating projects, there are differing views on what rate or rates of discount should be used for calculating net present values (Pearce and Nash, 1981; Mishan, 1982; Bradford, 1975; Mendelsohn 1981; Gittinger, 1982; Tisdell, 1972). One view is that because capital should be invested where returns are highest, the appropriate rate of .discount is the opportunity cost of capital. Although this is appealing theoretically, it is difficult to apply in practice since the opportunity cost of capital is imperfectly known. Therefore, the present study only employs three economic indicators, namely, the pay-back period, accounting average rate of return on investment and Internal Rate of Return (IRR) as used by Shang (1976, 1981) and Firdausy and Tisdell (1991).

3. Background Information on Seaweed Farms in the Villages Surveyed

Data from two seaweed villages in Bali were selected for investigation, namely Jungut Batu and Ped. These villages were chosen for the survey because seaweed farming is well established in this area relative to other areas of Indonesia. A total of 195 seaweed households, 20 per cent of the total number of households in each village, were randomly selected for investigation. Data collected from the sampled seaweed farmers included their production practices in seaweed culture, size of their operation, the volume of their production, operating expenses, labour input by activity, capital investment, financial sources, prices received for their seaweed, marketing outlets and problems encountered in the production. These data were obtained by interviewing heads of seaweed households using a questionnaire. Interviews were conducted from April to July of 1990.

All the heads of seaweed households interviewed in the villages surveyed were owner-farmers. They decided to practice seaweed culture partly because they thought that it was profitable as a business venture. Furthermore, their alternative possibilities gave lower income, for example, their earning from traditional fishing, dry-land agriculture, collecting of corals and salt. Also, the low initial capital investment required for seaweed culture compared with other aquaculture activities favours it.

Eucheuma spinossum is the most widely cultured species in both villages surveyed. Also, mixed culture of *Eucheuma spinossum* and *Eucheuma cottonii* occurs on farms in Jungut Batu. But· a few farmers in Jungut Batu still culture only *Eucheuma cottonii*. In Ped village, the species cultured is mostly *Eucheuma spinossum*. The off-bottom cultural technique is used for seaweed production in the two villages surveyed.

Eucheuma spinossum is now widely cultured in Bali because this species has a higher market price than *Eucheuma cottoni*i. In July 1990, the average farm gate price of a dried *Eucheuma spinossum* was Rp. 1200 per kg, while that for dried *Eucheuma cottonii* was Rp. 800 per kg. Consequently, many farmers especially in Jungut Batu who only used to culture *Eucheuma cottonii* in 1988 have changed to a mixed cultured of the two species.

Seaweed holdings in the villages surveyed can be divided into approximately 15 sizes. Seaweed farms in Jungut Batu range between 1 'are' (0.01 ha) and 20 'are' (0.2 ha) in size, whereas in Ped the range is from 1 'are' (0.01 ha) to 8 'are' (0.08 ha). The higher upper size of seaweed holdings in Jungut Batu may be because the coastal area suitable for seaweed farming in this village is much larger than in Ped. In Jungut Batu, of the 120 ha of coastal area suitable for seaweed farming, about 80 per cent has been used for this purpose. However, no farm size exceeded 0.2 ha in size. Because of risks and uncertainties farmers are reluctant to farm large seaweed areas.

The risks involved in seaweed farming are of two kinds, namely natural risks and risks from non-natural causes. Natural risks arise from variations in biological and environmental conditions. The biological risks may arise due to limited knowledge about the control of disease organisms, parasites and water pollution. Storms, strong waves and floods involve primary physical risks in seaweed culture. On the economic side, risks may arise from variations in the price of seaweed or costs.

In 1989, for example, it was reported that the presence of water pollution and diseases were major reason why many farmers with a large sized holdings (e.g. of 1 ha) in the villages surveyed have .disposed of them and split them into smaller sized holdings. In 1990 there were no farmers with holdings in excess of 1 ha in the villages surveyed.

Table 1 shows the proportion of households sampled according to farm size and the composition of species cultured in the villages surveyed.

Table 1. The proportion of households sampled by farm size and species cultured in Jungut Batu and Ped villages, Bali

Size of holding (ha)	Percentage of households					
	Jungut Batu (N = 101)			Ped (N = 94)		
	a	b	c	a	b	c
0.010	1.0	-	1.0	3.2	-	-
0.015	1.98	-	-	2.1	-	-
0.020	1.98	2.97	1.98	19.2	-	-
0.025	2.97	-	-	5.3	-	-
0.030	9.90	-	4.95	19.2	-	-
0.035	1.98	-	-	2.1	-	-
0.040	7.92	7.92	4.95	21.4	-	-
0.050	5.94	4.95	4.95	15.9	-	-
0.060	4.95	7.92	2.97	7.4	-	-
0.070	5.94	-	-	2.1	-	-
0.080	-	1.98	-	2.1	-	-
0.10	1.98	2.97	-	-	-	-
0.12	-	1.98	-	-	-	-
0.15	-	1.0	-	-	-	-
0.20	-	1.0	-	-	-	-
Total	46.54	32.69	20.8	100.0		

Note : N is total household sampled;
– no households with farms of this size;
a culture of *E. spinossum*;
b mixed culture of *E. spinossum* and *E. cottonii*;
c culture of *E. cottonii*.

Source Calculated from household survey data, April-July 1990.

4. Cost of Establishing a Seaweed Farm and Farm Revenue from Seaweed Farming

The process of establishing a seaweed farm and producing seaweed is much simpler than for most other forms of aquaculture. Little operating expenditure is required relative to that for other types of aquaculture (e.g. prawn and milkfish cultures). No fertiliser, pesticide and feeding outlays are involved. In addition, neither a long gestation period is involved nor is a large capital outlay needed, e.g. ponds do not have to be dug or dykes constructed. Seaweed can be harvested in four weeks, whereas milkfish requires six to nine months to achieve marketable size (Santelices and Doty, 1989; Collier, 1981; Shang, 1976).

The major items required to establish a seaweed farm are seeds, nylon ropes (including plastic raffia), bamboo posts and netting. These items account for about 50-60 per cent of the total initial capital costs of any farm. The overall expenses incurred in establishing a seaweed farm vary depending on the size of farm. For example, the average outlay needed to establish a 0.01 ha farm is about Rp. 275,900 (US$ 151), whereas it is about Rp. 3 million (US$ 1644) to establish a 0.2 ha. Thus, the larger the size of farm, the larger will be the cost of its initial establishment although costs do not rise proportionately with increased size.

Apart from variation with the size of farm, the initial cost of establishment is also affected by location. The further the location of a seaweed farm is from a farmer's dwelling, the higher will be the initial cost since the farmer will need to have a wooden boat to collect and/or to bring seaweed from the dwelling to the farm, and vice versa. Usually, farmers with holdings of more than 0.05 ha (5 are) in size have a wooden boat for seaweed transportation. This is more common now since coastal sites near farmers' dwelling have become infertile and polluted due to for example oil spills from boats. So farmers have to farm their seaweed further away from their dwellings.

Another large initial capital cost is the cost of building a hut. This will cost a farmer an average of Rp. 100,000 (US$ 55). A hut is built for the purpose of storing seaweed, and provides a place for farmers to work (e.g. tying up plants) and to store equipment. For some farmers, the cost of building a hut may be low since they collect all the materials (wood, bamboo and coconut leaves) from the nearby jungle. Table 2 shows an example of the initial establishment costs, operating costs and expenditure items for a 100 square metre (0.01 ha) seaweed (*Eucheuma spinossum*) farm using the off-bottom culture technique.

Table 2. The initial capital costs, operating costs and items in establishing 0.01 ha of *Eucheuma spinossum* farm

Items	Cost (Rupiah)	Life (years)
- 200 kg seed stock at Rp. 350/kg	70,000	
- 10 kg nylon plastic (4 mm) at Rp. 4200/kg	42,000	1
- 2 kg nylon plastic (8 mm) at Rp. 4200/kg	8,400	1
- 110 pcs bamboo at Rp. 200 each	22,000	0.5
- 3 kgs rolls plastic rafia at Rp. 2500/kg	7,500	0.5
- 2 large bamboo basket Rp. 1500 each	3,000	0.5
- 2 tyre tubes Rp. 5000 each	10,000	1
- 2 knives at Rp. 1000 each	2,000	5
- 100 square metre net	15,000	2
- 1 bull hammmer	5,000	5
- 1 iron bar	6,000	5
- initial set up labour cost e.g. setting up the bamboo posts	10,000	
- hut	75,000	4
A. Total initial capital costs	275,900	
B. Operating Costs		
- 2 family labourers at Rp. 25,000/person/month thus per year	600,000	

Note : - Cost data are based on existing price at the time of survey;
- seed can be used for subsequent planting, thus it is included in initial capital cost.

Source Calculated from household survey data, April-July 1990.

Labour is the major operating cost involved in the production in seaweed farming. Depending on the size of farm, it accounts for more than 50 per cent of total annual expenses. This cost covers labour for seeding, weeding, harvesting, drying and maintenance. However, in practice, labour expenses (actual outlays) are low since farmers employ their own family members including children. The opportunity cost of their employment may also be low.

The average level of production of seaweed varies with farm size. For 100m square farm size (0.01 ha), the average level of total production is about 80 kg per month of dried seaweed and it is about 1500 kg per month for a farm of 2000 m square (0.2 ha). The revenue obtained from farms of this size is about Rp. 96,000 (US$ 53) per month and Rp. 1,800,000 (US$ 986) respectively, using the market price of *Eucheuma spinossum* of Rp. 1200/kg. There are 10 harvests in a year. There are no taxes and administration fees. Transportation costs to market are absent for growers because buyers collect the seaweed on the site. Table 3 shows estimates of initial capital cost, annual operating costs and annual farm revenue by size of holding for seaweed culture in the villages surveyed.

Table 3. Estimates of initial capital costs, operating costs and annual farm revenue by size of holding and species cultured

Farm size	Initial capital costs[e] (x Rp. 1000)			Operating costs per year (x Rp. 1000)			Farm revenue per year (x Rp. 1000)		
(ha)	a	b	c	a	b	c	a	b	c
0.010	275.9	-	259.9	600	-	600	960	-	850
0.015	409.1	-	-	600	-	-	1200	-	-
0.020	477.8	467.8	437.8	600	600	600	1560	1720	1040
0.025	572.5	-	-	600	-	-	2040	-	-
0.030	666.2	-	606.2	600	-	600	2400	-	1600
0.035	782.4	-	-	1200	-	-	3000	-	-
0.040	840.6	810.6	760.6	1200	1200	1200	3240	3800	2400
0.050[d]	1826	1786	1726.0	1200	1200	1200	4200	4400	3200
0.060	2024.4	2004.4	1904.4	1200	1200	1200	4800	5000	4000
0.070	2549.8	-	-	1500	-	-	5400	-	-
0.080	2709.2	2669.2	-	1500	1500	-	7200	7600	-
0.10	3324.3	3193.0	-	1800	1800	-	9600	8800	-
0.12	-	3549.8	-	-	1800	-	-	10400	-
0.15	-	4019.5	-	-	2400	-	-	12800	-
0.20	-	4879.0	-	-	3000	-	-	18400	-

Note: a is an estimate of costs and revenue for Eucheuma spinossum culture;
b is an estimate of costs and revenue for mixed E. spinossum and E. cottonii;
c is an estimate of costs and revenue for Eucheuma cottonii culture;
d A jump in initial capital costs for a farm size between 0.050 to 0.2 ha is due to expenditure for buying a wooden boat;
e Differences in initial cost of establishment and of production within the same farm size are due to different prices of species cultured, while others items are quantitatively the same;

- no households in this farm-size group.

Source: Calculated from household survey data, April-July 1990.

As shown in Table 3, there is· as expected a direct relationship between farm size, initial capital costs and farm revenue from seaweed culture.

Note that in estimating total initial capital costs and operating costs, it is assumed that all resources for seaweed culture such as seed, wood, bamboo and family labour used are paid for. In other words, the calculation takes into account cash and non-cash costs (including the imputed value of unpaid family labour, seed, wood, bamboo, etc.). Any family member working on seaweed farm will be paid a basic wage of Rp. 25,000 per person per month as a standard wage in the villages surveyed. The market price of seed is Rp. 250 per kg and Rp. 350 per kg for *Eucheuma cottonii* and for *Eucheuma spinossum* respectively. This is used for the purpose of the above calculation.

5. Economic Returns: Empirical Results

Recall that it is intended to estimate the pay-back period, the accounting-type rate of return, and the internal rate of return for seaweed farming. The assessment of returns takes into account all private costs of production, including cash and non-cash costs. Cash costs include direct expenses needed in the production of seaweed, such as seed, wood, bamboo and netting. Non-cash items include depreciation of materials and equipment, and unpaid family labour employed in operating a seaweed farm. The straight line method of depreciation is used and assets are assumed to have no residual value at the end of their useful life. Also, current market prices and costs are assumed not to alter throughout this period.

Further, since seaweed culture involves risks and uncertainties, such as changes in the price of both inputs and output, there is a need to take account of these risks in estimating economic returns of seaweed farming. In the literature there has been many methods suggested to allow for risks and uncertainty in estimating future benefits of projects (Tisdell 1972, Chapter 21; Schmid 1989, Chapter 10; Lilieholm and Reeves, 1991; Allen et al. 1984, Chapter 2; Little and Mirrlees 1976, Chapter 15). These methods include

1. Certainty equivalence (CE) method;
2. Shortening the planning horizon of the projects;
3. Increasing the discount rate (e.g. the use of a risk premium); and
4. Portfolio theory through quadratic progamming.

However, none of these methods is entirely satisfactory [See, for example, Tisdell (1972, pp. 392-397), Schmid (1989); Lilieholm and Reeves (1991); Little and Mirrlees (1976); Pouliquen (1970); Mishan (1982)].

In this study, the planning period is shortened to five years to allow for uncertainty in seaweed farming project. All benefits and costs within the planning period are assumed to be riskless. A five year planning period was chosen for the seaweed case because seaweed farmers have a short planning horizon. This period also coincides with the equipment replacement cycle.

The internal rates of return calculated in this analysis indicate what can be achieved under risk-free conditions in a five-year planning interval. Cost and revenue conditions for each farm for the five-year period are assumed to be constant in real terms. This implies constant real prices and technology.

Bearing in mind the assumptions made above, the results of the pay-back period and the average rate of returns for seaweed holdings of different size are presented in Table 4.

Table 4. The pay-back period and the rate of return of different size of seaweed holdings

Size of holding (ha)	Pay-back period (months)			Rate of Return (%)		
	a	b	c	a	b	c
0.010	10.1	–	13.5	81.56	–	45.52
0.015	8.9	–	–	94.57	–	–
0.020	6.5	5.4	9.5	147.49	186.23	71.54
0.025	5.1	–	–	188.73	–	–
0.030	4.8	–	9.4	205.69	–	74.20
0.035	5.6	–	–	154.06	–	–
0.040	5.4	4.2	8.2	172.43	258.86	91.82
0.050	7.6	7.3	11.3	124.75	139.30	74.62
0.060	7.3	6.9	8.8	128.50	155.21	110.88
0.070	8.5	–	–	106.65	–	–
0.080	6.2	5.7	–	162.22	194.22	–
0.10	5.5	5.9	–	187.57	183.10	–
0.12	–	5.4	–	–	204.38	–
0.15	–	5.0	–	–	207.10	–
0.20	–	4.1	–	–	269.15	–

Note: a culture of *E. spinossum*;
b mixed culture of *E. spinossum* and *E. cottonii*;
c culture of *E. cottonii*;
An example of the computation in the pay-back period and accounting rate of return is provided at the Appendix (Table A.1).

Source: Calculated from household survey data, April-July, 1990.

Table 4 indicates that seaweed farming has the potential to give a high annual rate of return and the pay-back period for each size of holding is less than a year. As between· the species cultured, it appears that *Eucheuma cottonii* farming has a relatively longer pay-back period and it has a low annual rate of return on initial investment. For *Eucheuma cottonii* farming, the pay-back period declines and the annual rate of return rises with increased farm size. For example, the pay-back period for a 0.01 ha farm size is 13.5 months, but it is 8.8 months for farm of 0.06 ha.

In mixed *Eucheuma* farming, the highest rate of return and the shortest pay-back period occurs for a holding of 0.2 hectare. In this case, the initial investment can be paid back within 4.1 months period and the rate of return on initial investment is about 269.15%. The second shortest pay-back period occurs for farms of 0.040 ha in size, and then for holdings of 0.15, 0.12, 0.020 and 0.080 respectively. This sequence, however, does not necessary the case in relation to the ranking by the rate of return on initial investment. In order words, the pay-back period and the rate of return on the initial investment does not necessary increase (decrease) with farm size (fall).

In the case of *Eucheuma spinossum* farming, farms of 0.030 ha have the shortest pay-back period (4.8 months) and the highest rate of return, 205.69 per cent. The longest pay-back period is for farms of 0.010 ha in size. This averages of 10.1 months and the rate of return on the initial investment in such farms is 81.6 per cent.

However, the accounting method used in Table 4 to calculate returns is deficient from an economic viewpoint since no allowance is made for differences in the flow of returns and costs over the life of the project. Therefore, to allow for this, the internal rate of returns for each farm size, as set out in Table 5, were computed.

Table 5. The internal rate of return on seaweed farming for seaweed holdings of various sizes

Size of holding (ha)	Internal rate of return (%)		
	a	b	c
0.010	77.19	-	35.97
0.015	89.65	-	-
0.020	146.14	184.36	49.04
0.025	193.77	-	-
0.030	134.78	-	63.78
0.035	146.16	-	-
0.040	179.75	256.65	83.98
0.050	119.90	134.62	63.38
0.060	135.05	149.89	102.66
0.070	114.09	-	-
0.080	172.21	190.22	-
0.10	200.22	177.79	-
0.12	-	199.13	-
0.15	-	205.48	-
0.20	-	264.98	-

Note: a is IRR for Eucheuma spinossum farming;
b is IRR for a mix of E. spinossum and E. cottonii;
c is IRR for Eucheuma cottonii;
An example of IRR calculation see Appendix (Table A.3).

Source: Calculated from household survey data,-April-July, 1990.

Assuming an economic life for a seaweed farming project of 5 years, it is found that the internal rate of return (IRRs) varies greatly by size of holding and by species cultured. A mixed farming on an 0.2 hectare holding has the highest IRR, 264.98 per cent, followed by that for a farm of 0.040 ha (256.65%), while the lowest IRR is for a farm of 0.050 ha (134.62%).

In the case of *Eucheuma spinossum* farming, the highest IRR is for a farm of 0.10 ha and then for a farm of 0.025 ha in size. The IRRs for farms of this size are 200.2% and 193.8% respectively. Further; for farming of *Eucheuma cottonii*, the highest IRR occurs for farms of 0.060 ha (102.7%). All these IRRs indicate the maximum rate of interest which could be paid for funds to invest in this activity and still break even.

It can be seen that seaweed farming in Bali is a high yielding investment. There appears to be no systematic tendency for economic returns from seaweed farming to increase (decrease) with farm size. Returns are relatively constant in relation to farm size. In general, the figures suggest that seaweed farming is a potentially attractive economic investment for coastal rural dwellers in Bali. It is also economically attractive to most households because family labour can be used as an input instead of hired labour. Also, this culture does not require the import of inputs such as fertiliser, chemicals, fuel and food.

6. Other Contributions of Seaweed Farming to Coastal Rural Dwellers

6.1 Rural employment contribution

As noted earlier, labour is the major operating cost of seaweed farming. Depending on the size of farm, it accounts for more than 50% of total annual expenses. This cost includes labour for seeding, weeding, harvesting and drying. However, skilled labour is not required. Children, adult, male or female can all work in seaweed farming. Their level of education, training and expertise are not important for work in seaweed culture. This suggests that seaweed culture has the potential to contribute to employment opportunities in countries such as Indonesia where unskilled labour is relatively abundant.

6.2 Household savings contribution

The revenue generated from seaweed farming in coastal areas is not only used to satisfy household consumption, many farmers can also save and 'invest' in durables from their income. This saving and 'investment' by households usually takes at least four forms: (1) the placing of savings in rural banks or in rural cooperative units; (2) the buying of valuable durable goods (such as gold, electrical appliances); (3) the sending of children for higher education outside the village; and (4) up-grading of their houses. The proportion of household respondents in survey villages who can save or 'invest' is shown in Table 6.

Table 6 Percentage of household respondents in villages surveyed who could save or 'invest' and/or who are in debt

Descriptions	Jungut Batu (N=101)	Ped (N=94)
Save		
- in rural cooperative units or rural banks	43.6	21.3
- buying electrical appliances/valuable goods	28.7	63.8
- sending children to higher education outside the village	10.0	11.7
- up-grading houses	12.9	15.9
No savings*	30.7	37.2
Indebt**	10.0	11.7

Note: Percentages at Jungut Batu and Ped villages do not add up to 100 per cent since they can save their money in more than one form;

* Seaweed farmers who cannot save from their income received from seaweed cultivation are usually those with the size of farm less than 200 m^2 (0.02 ha);

** In debt seaweed farmers are those who just recently involved in seaweed farming in which financial sources are borrowed from money lenders or seaweed collectors in the villages surveyed.

Source: Calculated from household survey data, April-July, 1990.

Note that seaweed farming has contributed to Government revenue mainly through export receipts (export taxes). In Indonesia, seaweed farmers do not pay income tax. Since it is unlikely that this tax will be imposed on the seaweed farmers in the foreseeable future, no Government revenue can be expected from this source. Some tax revenue may be expected from business supplying farm inputs. But this is likely to be relatively small. The extra export tax received from seaweed exports can be saved and invested elsewhere in the economy by the Government.

6.3 Environmental effects

The possible adverse consequences of seaweed farming for the environment may occur partly because of the type of culture system used and the techniques used to grow it. For example, farming techniques using sticks, rafts and cages may present a navigational hazard· and have an adverse visual impact.

In the villages surveyed, there were no reports of adverse effects of seaweed farming on water quality and on coastal environment. This is because this culture does not require the use of chemical or fertiliser and fuel. However, at least three problems can be identified. First, the use of floats and stakes in this culture restricts tourists who want to go surfing and diving. Second, it affects corals due to shading and possibly nutrient competition. Third, the use of woods or bamboos for floats and stakes may lead to adverse effects on forests and cause erosion. More appropriate technologies for seaweed culture (e.g. seeking alternative materials to replace wood and bamboo used in seaweed culture) and improved selection of coastal sites are worth considering.

7. Concluding Notes

Seaweed farming is a potentially attractive economic investment for coastal rural dwellers in Bali and is profitable for small farmers in Bali. This may be so in other coastal areas in Indonesia where similar conditions apply. The 'accounting' rate of return on investment from each seaweed farm size exhibits a very high rate of return. However, the returns estimated in this study must be regarded as above-normal because returns have been calculated assuming that no risks and no uncertainties both economic and non-economic. At this stage, we do not have estimates available for risks, but these would no doubt reduced expected returns. A severe cyclone or typhoon in the 5-year period could mean that all capital is lost and would greatly reduce returns from seaweed farming. Nevertheless, these findings are consistent with those suggested by previous studies that returns to seaweed farming may be high in Southeast Asia (Padilla and Lampe, 1989).

Besides promising potential economic returns, seaweed farming provides employment opportunities, foreign exchange earnings, and may be environmentally less damaging than many existing mariculture activities, e.g. shrimp farming. It does not require significant quantities of processed or imported inputs such as fertilisers, chemicals, fuel and food. The relative non-perishability of seaweed is a particular advantage of seaweed growing compared to many other types of aquaculture. It is, therefore, suggested that the Indonesian Government should encourage seaweed farming in other coastal areas of Indonesia which are economically and ecologically suitable for seaweed farming.

It may be interesting to compare the economics of seaweed farming with the economic potential of giant clam mariculture. Present indications are that ocean grow-out of giant clams can be expected to give much lower internal rates of return than seaweed farming, where there are alternative possibilities. Furthermore, ocean grow-out of giant clams involves a much longer pay-back period than that for seaweed cultivation (Cf. Tisdell et al., 1991; Tisdell et al., 1991; Firdausy and Tisdell, 1990). In addition, it is more difficult to preserve giant clam meat than seaweed. In Bali, these factors are likely to make giant clam farming an unattractive economic alternative to seaweed farming. It may, however, be that there would be scope for mixed cultivation of seaweed and clams. This possibility has not been sufficiently researched to be able to come to a definite conclusion. In any case, once the market for giant clam products becomes re-established, giant clam farming in any area will need to compete in profitability terms with alternative forms of mariculture if it is to prove economically worthwhile from a commercial point of view.

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APPENDIX

Table A1: An example of the computation in cost and returns analysis for 0.06 ha seaweed farming (*Eucheuma spinossum*) in Bali

	Cost (Rupiah)	Life (years)
A. Initial investment (Cash Outflows)		
- 1200 kg seeds stock at Rp. 350/kg	420,000	
- 60 kg nylon plastic (4 mm) at Rp. 4200/kg	252,000	1
- 12 kg nylon plastic (8 mm) at Rp. 4200/kg	50,400	1
- 650 pcs bamboo at Rp. 200 each	130,000	0.5
- 18 rolls plastic rafia at Rp. 3000/kg	54,000	0.5
- 6 large bamboo baskets at Rp. 1500	9,000	0.5
- 50 m plastic rugs at Rp. 1000/m	50,000	1
- 1 wooden boat	750,000	5
- 1 bull hammers at Rp. 5000 each	5,000	5
- 1 iron bar at Rp. 6,000	6,000	5
- 3 knives at Rp. 1000	3,000	5
- 60 m square net	100,000	2
- 1 kerosene lamp	35,000	2
- 1 mask	30,000	2
- initial set up labour cost e.g. setting up the bamboo posts	30,000	
- hut	100,000	4
Total initial cash outflows	2,024,400	
B. Operating costs		
- 4 labourers at Rp. 25,000 for a year	1,200,000	
- Depreciation (derived from initial invesment)	998,700	
Total production costs	2,198,700	
C. Cash inflows (there are 10 harvest in a year 4000 kgs/ year at Rp. 1200/kg)	4,800,000	
D. Profit (C - B)	2,601,300	
E. Profit (C - B) without Depreciation	3,600,000	
F. Pay back period (A/E x 13 months)	7.31 months	
G. Rate of return on initial investment (D/A)	128.50 %	

Note: - Cost data are based on existing April- July 1990 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 Calculated from household survey data, April-July, 1990.

Table A.2 Estimates of annual capital and operating costs for 0.06 ha seaweed farm in Bali, 1990

unit : x Rp. 1,000

Cash outflows	Year					
	0	1	2	3	4	5
Capital Costs						
Seed	420	-	-	-	-	-
Nylon plastic (4 mm)	252	252	252	252	252	252
Nylon plastic (8mm)	50.4	50.4	50.4	50.4	50.4	50.4
Plastic rafia	54	108	108	108	108	108
Bamboo posts	130	260	260	260	260	260
Baskets	9	18	18	18	18	18
Wooden boat	750	-	-	-	-	750
knives	3	-	-	-	-	3
Plastic rugs	50	-	50	-	50	-
Net	100	-	100	-	100	-
Mask	30	-	30	-	30	-
Bull hammers	6	-	-	-	-	-
Iron bar	5	-	-	-	-	-
kerosene lamp	35	-	35	-	35	-
Hut	100	-	-	-	100	-
costs of tying up seeds and setting up bamboo	30	-	-	-	-	-
Total	2024.4	688.4	903.4	688.4	1003.4	1441.4
Operating Cost						
labourer wage	-	1200	1200	1200	1200	1200
Total	-	1200	1200	1200	1200	1200
Cash inflows	0	4800	4800	4800	4800	4800
Net cashflows ((Rp. 1000)	-2024.4	2911.6	2696.6	2596.6	2158.6	1932.6

Note: Assumed economic horizon of seaweed farming is 5 years or cycle of 5 years;
Assumed no change in real annual operating cost;
Assumed no change in real price.

Source: Calculated from household survey data, April-July, 1990.

Table A.3 Internal rate of return calculation for 0.06 ha seaweed farm

unit : x Rp. 1000

Year	NI	Discount Rate (140 %)	PV	Discount Rate (135 %)	PV
0	-2024.4	1.000	-2024.4	1.000	-2024.4
1	2911.6	0.4167	1213.2	0.4255	1238.9
2	2696.6	0.1736	468.2	0.1811	488.3
3	2596.6	0.0723	187.8	0.0770	200.1
4	2158.6	0.0301	65.1	0.0328	70.8
5	1932.6	0.0126	24.3	0.0139	26.9
Total			- 65.8		0.60

IRR = 135 + 5 (0.60/66.40)= 135.05 %

Note: NI = net income; PV = present value of net income stream;
The initial discount rate is found by trial and error which will make the net present worth of the incremental net benefit stream equal to zero (Shang, 1981; Gittinger, 1982).

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