SEAWEED FARMING IN THE PHILIPPINES:
ITS PROSPECTS IN NORTHEAST SORSOGON

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Preliminary Draft

Abstract

Study Background

This paper represents work undertaken by the lead author as part of a study of the capabilities of rural coastal communities capabilities for resource management which focuses on seaweeds. That study was funded by a one-year fellowship to Dr. Tagarino and Mr. Kick from the Research and Training Program for Agricultural Policy (RTPAP). RTPAP, a component of the Philippines' Department of Agriculture's Accelerated Agricultural Productivity Program (AAPP), is a joint effort of UPLB's Center for Policy and Development Studies (CPDS) and College of Economics and Management (CEM).

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I. Introduction

A. Background Information

Seaweeds have been a noteworthy foreign exchange earning product in the fishery sector coming after tuna and prawns In 1989, ___ mt of seaweed exports valued at P______ accounted for ___% of the total fishery export value. Although there are ___ species identified in Philippine waters, only two species, Eucheuma and Caulerpa lentillifera, are farmed commercially for local and export markets. Seaweed production is primarily done in Tawi-tawi, Cebu and a few other provinces in the south.

Commercial farming of Eucheuma in the Philippines started in the early 1970s and has undergone changes in two major areas. First, production has shifted from simple bottom culture to more sophisticated and well-managed support systems such as the floating raft method, the fixed off-bottom method, and the monoline method. Second, changes in organization and management included a shift from highly organized "hacienda-type", or company, farms to individual family farms (RAPA, 1986). Hence, recent production generally comes from family farms living in small islands.

Culturing seaweeds in inter-tidal and sub-tidal zones is attractive to coastal households. These households engage in this form of coastal aquaculture because of the relatively higher cash income that can be derived from this activity compared with small-scale fishing. For instance, fishing incomes in Hingonatan, Bohol, averaged P21.60 ($2.70)per day while seaweed farming incomes ranged from P43 00 - P140.00 ($5.40 - $17.50) per day (Smith, 1980). Hollenbeck (1983) estimated that there were about 20,000 people directly and indirectly involved in the P300 million seaweed industry. Recent data (source, date), however, indicated that there are some 350,800 farmers and their families engaged in seaweed farming and primary processing. Seaweed farming provides alternative and/or additional income to fishermen, hence, coastal aquaculture generates income for coastal populations without adding to the alleged over-exploitation of fishery resources in the country.

From the economic aspects, commercial seaweed production in the country has proved to have a comparative advantage over developed, temperate countries and even other tropical countries. This advantage is due to low local production costs and the availability of planting materials either from the wild or from improved strains. There is an abundance of labour in the country that suits the labour-intensive operations of seaweed farming. Furthermore, sophisticated energy consuming technologies for drying harvested seaweeds are not required in the country. Current (date) market situation reveals that Philippine carrageenan costs P_____ ($7-8) per kg; this is about 50% cheaper than the American processed carrageenan (which is produced at $15 per kg) (Manila Bulletin, December 6, 1990).

With adequate information and technology dissemination, seaweed farming can ultimately be a successful coastal aquaculture activity. This additional activity would help ease the economic hardships experienced by rural coastal households without destroying valuable marine and coastal habitats. However, there are signs that some overall direction and encouragement are needed.

Research into all aspects of seaweed culture, from production through post-harvest processing, marketing, financing and even information and technology dissemination should be centrally recorded in order to provide a venue for identifying gaps and provide basis for policy formulation.

B. Importance and Utilization of Seaweeds

Aside from being the very most important component in the marine ecosystem's food chain, seaweeds are directly consumed as human food and as components of animal feeds and organic fertilizers. Natural products derived from seaweeds, such as carrageenans, agars, alginates and fucellaran, are important components of food, chemical, pharmaceutical and other industrial products.

Commercial production of seaweeds was a response to the increasing importance and variety of uses of seaweeds in food and industrial products. Before seaweeds were cultured, production came from the wild.

As noted, commercial seaweed cultivation in the Philippines, (particularly Eucheuma), started in the early 1970's. Commercial production is now concentrated in two species of Eucheuma and Caulerpa letillifera (RAPA, 1986). It is noteworthy, however, that about 95% of East Asia's (except the Philippines) seaweed production is commonly used as human food. The Philippines exports semi-processed or dried Eucheuma to world markets (Europe, US, Japan) and a significant amount of Laminaria to China.

II. State of Culture/Farming Technology

A. Existing Indigenous Practices

Seaweed production in northeast Sorsogon comes mainly from the wild. The gathering of species with commercial value, (Galidiela acerosa), supplements coastal families' incomes in the area. Other species such as Eucheuma, Gracilaria and Sargassum are also found and collected in the reef area, but in much smaller quantities that G. acerosa, hence, income from those species are not as substantial than G. acerosa.

Since seaweed gathering is done in open-access coastal areas, gatherers are concerned with maximizing output at the present time, without considering the implications of their rate of harvest on future harvests. Indiscriminate uprooting of seaweeds with commercial value, and, to some extent, scrubbing the stone surface with sharp-edged objects (e.g. knife and leveled spoons) were reported during the RTPAP survey of seaweed gatherers and buyers in northeast Sorsogon. These methods of gathering are widespread in the area, and could be attributed to the people's lack of knowledge (and, hence, concern) for conservation of the resource. Individual gatherers are more concerned with maximizing harvest in order to obtain substantial amount of cash from selling the dried seaweeds.

Drying of seaweeds, particularly G. acerosa, is also best described by crude traditional household technologies. G. acerosa comprises the bulk of the harvests in the areas of Barcelona and Bulusan. The plants are washed either with sea water or water from one of the numerous springs in Bulusan. Stones, coral and other debris are removed from the fresh weeds [How?]. The cleaned seaweeds are then placed either in metal casseroles or huge cans, and are boiled in [fresh] water for a few minutes. Then the seaweeds are strained using a fine-meshed metal screen and evenly spread on pandan mats (or plastic sheets). In cases where there is an abundance of seaweeds collected, they are spread on cleaned concrete roads or on other, multi-purpose pavements in the barangay.

The seaweeds usually remain greenish even after a few hours of sun drying. Hence, they are either sprinkled (or completely washed) with water (salt of fresh) for them to attain a bone-white colour. White and debris free dried seaweeds command a higher price from, and are desired by, buyers. Sundrying usually takes 2 to 3 days in order to obtain a moisture content < 35%, another specification desired by buyers. Dried seaweeds are collected in huge cans or similar containers. Weights are usually placed on top of the dried weeds in order to compress them into a bale. A bale is usually ___ to ___ (cu. meters) (kg.) [or other size descriptor].

Small biscuit containers (c. 6) are commonly used. When filled with dried seaweeds, the bale is tied with abaca or plastic rope, wrapped in plastic sheets, and sold to local buyers either in their barangay or in the market at the poblacion. Since most G. acerosa gatherers are low income earners in need of cash for their daily subsistence, small quantities (2 to 3 bales of weeds) are immediately disposed. A similar household processing technology is applied to Eucheuma and Gracilaria by the smaller number of gatherers collecting these species.

Sargassum, on the other hand, is sun dried for 2 to 3 days after removing the entangled debris. Due to the limited market for Sargassum at present, there are few gatherers of or buyers for this species in northeast Sorsogon. Dried and chopped Sargassum is used as an organic fertilizer by some farmers while fresh Sargassum are used as a cushion for the crates or baskets filled with fresh Caulerpa which are transported to markets in population centers. Nevertheless, Sargassum is also a source of alginates.

B. Recommended Farming Methods

A number of methods of farming seaweeds have been tested in order to increase the production of commercially important seaweed species. These tests of methods could also be done for the culturing of ecologically and biologically important seaweed species which are approaching depletion. Most of the tested procedures produced successful results. These culture systems are broadly categorized into: (a) the submerged; and (b) the floating system (Table 1). There are numerous culture systems developed, and tested and suggested, due perhaps to the wide variability of coastal environments. In comparison with land-based farming, seaweed cultivation practices have to be modified more often in order to suit the "difficult-to-manipulate" coastal reef environment. Too, sea-farming is subject to more frequent weather and tide changes. Hence, risk-bearing is generally much higher with sea-farming than land-farming.

Barraca (1988) reported that the submerged culture system is recommended for reef areas with less changeable water levels. The water may either be high or low. If water is normally high (deep), then the seaweeds in the submerged support system should be set at a level where the plant can get a substantial amount of sunlight without being exposed above the water level. On the other hand, if the water is normally low (shallow), the submerged support system is fixed at a level where the plants will not be exposed to the air during low tides, while at the same time the plants could get some sunlight. The submerged system also avoids having the plant touch the sea bottom, thereby minimizing dirt, the weeds. The choice of a specific type of submerged support system, however, depends on the sea bottom, its type, substrate, the availability of material inputs in the area, and the cost of the support system.

Conversely, floating support systems are recommended in areas with fluctuating water levels, so that the plant could still get substantial sunlight during high tides, while not being exposed above the water during low tides. This system is also suited for areas with stronger water movement because its flexibility means less pressure on the plants and, thereby, fewer broken plants. Similarly, the grazing of fishes, sea urchins and other aquatic animals could be minimized through frequent movement of the support system holding the plants. The choice of a specific type of floating support system would also depend on the type of sea bottom, substrate, the availability and cost of materials, etc.

TABLE 1. DESCRIPTORS OF VARIOUS SEAWEED CULTURING SYSTEMS

	TECHNOLOGY	SITE REQUIREMENT	FARMING PRACTICES
A.	**Submerged Systems**		
1.	Rock or Stone Method	Ideal for rocky or hard bottom sites and strong natural current	Propagules are tied to stones big enough not to be carried away by current. ADVANTAGES: Low material input cost DISADVANTAGES: Labor intensive.
2.	Wood/Bamboo Stakes Method	Good for soft, not sandy bottom & available wood or bamboo.	Propagules are tied to stakes driven into sea bottom. ADVANTAGE: Uses inexpensive materials. DISADVANTAGE: Most labor intensive.
3.	Net Method	Can be used only in areas with moderate current.	Propagules are tied to each intersection of the 20cm mesh net. Nets 2.5cm x 2.5cm made of nylon/ropes anchored to sea bottom by tying corners to stakes. DISADVANTAGES: High cost material inputs; vulnerable to strong waves, especially when net is loaded with mature seaweeds.
4.	Cage Method	Recommended only in areas with strong natural current	Propagules are placed in cages (1m wide x 0.5m deep x 3m long) covered with 3cm mesh nylon nets on all sides. Each cage is divided into 6 compartments of 2.5 to 5kg propagules each (not tied).
5.	Monoline method &/or Off-bottom Monoline System	Suitable for areas with shallow water (0.5m); soft or sand bottom; and moderate to strong current as lines could be oriented perpendicular to shore to reduce damage (e.g. uprooting stakes, propagule breakage) from strong currents and floating debris.	Propagules are tied to monofilament nylon line or braided rope/nylon (2.5 to 10m long) at distances ranging from 5 to 25cm. The stakes are parallel to each other at 15 to 50cm spacing. Harvesting is done either by untying the lines with the plants intact or by removing the entire plant individually. The former is recommended because lines can be hung and drying is easier and cleaner.
6.	Raft/Planting Frame Method	Suitable for areas with low water levels and moderate current.	Propagules tied to nylon lines which are tied to 2.5m x 2.5m frames. Frames are anchored. ADVANTAGE: The frames are reuseable. DISADVANTAGES: High initial investment although cheaper in the long run.
B.	**Floating Systems**	(Constant Level Systems)	
1.	Modified Floating Raft System	Suggested for areas with fluctuating water levels (1-2m deep) to maintain constant sunlight without drying during low tides.	Propagules are tied to nylon lines (1.6cm spacing attached to parallel poles. Poles tied to stakes tied to stakes anchored to reef bottom. ADVANTAGES: Higher yield due to better gas exchange and photosynthetic rates; & less plant sedimentation, sea urchin grazing damage, breakage and/or losses.

2. <u>Long Line Floating System</u>	Recommended for areas with usually high water level. The same environmental requirements as modified floating raft.	Propagules tied to 20m nylon lines whose ends are attached to 5m poles supported by 1m anchor stakes. Five floats on line at 4m intervals. Lines 2m apart. ADVANTAGES: Less labor and fewer poles breakage especially when the long lines sag due to heavy load of mature plants.

Along with the wide variability of reef environments and the multiple economic factors such as cost and availability of material inputs, social factors must receive equal consideration in the adoption of these generated technologies. Farmers (and potential farmers) have to be informed of the ecological and biological considerations of growing seaweeds as well as the financial benefits that might be derived from this activity. Good information dissemination systems could equip potential seaweed growers with the appropriate criteria for the selection of the most viable culture system in his area.

C. Species Cultured:

The FAO-UNDP Regional Office for Asia and the Pacific (1986) reported that there are three major (commercial?) species under cultivation in the Philippines. They are as follows:

(1) Caulerpa lentillifera, J. Agardh, which is cultivated in ponds (?) using vegetative propagation or cuttings. These seaweeds are used fresh, as food (raw) or vegetable (cooked). Culture ponds can be found in Cebu Province (municipalities?).

(2) Eucheuma alvarezii., Doty, which is also propagated from vegetative cuttings using artificial support systems on open reefs. The seaweeds are dried and processed for carrageenan production. Extensive farm areas are found in the southern Philippines.

(3) E. denticulatum, (Burman) Collins et Harvey, which is cultivated much the same as E. alvarezii, but which grows slower. This is also a source of carrageenan, although more carrageenan are produced from this variety than from the same amount of E. alvarezii. (Where?)

III. Financial Analysis of Seaweed Farming:

A. Detailed Activities and Expenses;

The previous section discussed technological and agronomic aspects of seaweed farming. These aspects do not, however, guarantee a successful seaweed farming enterprise. The potential of these technologies rely on their technical and economic viability on actual farms. Undeniably, the technologies can give desirable yields in terms of quantity and quality in farm trials.

Among those culture systems, monoline methods are being adopted by most seaweed farmers in Tawi-tawi (Posadas, 1988) reported that monoline systems, low production costs and simple yet systematic practices as the main attractions for farms who have adopted this system. Table 2 indicates that monoline systems require comparatively lower initial investment and have lower production costs over raft and net methods.

Table 2. Investment Items and Costs for the First Crop of Selected Seaweed Species by culture method, 1 ha farm.

Item		Specification	Unit	Unit Price	Monoline Method Qty	Monoline Method Cost	Raft Method Qty	Raft Method Cost	Net Method Qty	Net Method Cost
Material Costs/Cash				PHP		PHP		PHP		PHP
Farmhouse & drying platform		bamboo & nipa	no	9000	1	9,000	1	9,000	1	9,000
Motorized banca		6-7 hp	no	6000	1	6,000	1	6,000	1	6,000
Banca		dugout	no	500	1	500	1	500	1	500
Crowbars		medium size	pc	160	2	320	5	800	5	800
Sledgehammers		medium size	pc	140	2	280	5	700	5	700
Rattan baskets		medium size	pc	40	10	400	20	800	15	600
Round wood/bamboo		5-7cm dia. x 1.5m	pc	2	1500	3,000	4000	8,000	0	0
Short stakes		anchor, 1m long	pc	1	100	100	400	400	3200	3,200
Nylon rope		No. 6 (3mm)	roll	80	50	4,000	260	20,800	20	1,600
Plastic straw		(Softie brand)	roll	40	30	1,200	80	3,200	72	2,880
Round wood for fence		5-7cm dia. x 5m	pc	3.5	150	525	150	525	150	525
Fish net		20 lb test, 2" mesh	meter	9	100	900	100	900	100	900
Fish net		100 lb test, 12" mesh	meter	30	0	0	0	0	5000	150,000
Floats		styrofoam, 2x3x4"	pc	0.3	5880	1,764	3200	960	3200	960
Materials for boundaries		bouys, chains, etc.	lot	3000	1	3,000	1	3,000	1	3,000
Seeds (purchased)	a)	60-120 grams FW/pc	kg FW	2	3175	6,350	6000	12,000	6000	12,000
Seeds (purchased)	b)	60-120 grams FW/pc	kg FW	1.5	3175	4,763	6000	9,000	6000	9,000
Seeds (purchased)	c)	60-120 grams FW/pc	kg FW	0.5	3175	1,588	6000	3,000	6000	3,000
Fuel & oil for boat	a)	3 l/day	l/days	30	71	2,130	121	3,630	71	2,130
Fuel & oil for boat	b)	3 l/day	l/days	30	61	1,830	111	3,330	61	1,830
Fuel & oil for boat	c)	3 l/day	l/days	30	56	1,680	106	3,180	56.33	1,690
Material Costs/Non-Cash										
Seeds for succeeding crops	a)	60-120 grams FW/pc	kg DW	15	397	5,955	2000	30,000	1296	19,440
Seeds for succeeding crops	b)	60-120 grams FW/pc	kg DW	10	397	3,970	2000	20,000	1296	12,960
Seeds for succeeding crops	c)	60-120 grams FW/pc	kg DW	4.5	397	1,787	2000	9,000	1296	5,832
Sub-Total/Materials	a)					45,424		101,215		214,235
Sub-Total/Materials	b)					41,552		87,915		204,455
Sub-Total/Materials	c)					36,043		70,765		191,187
Labor costs/cash										
Wages	a)	4 fulltime workers	manday	90	368	33,120	1040	93,600	368	33,120
Wages	b)	4 fulltime workers	manday	90	328	29,520	960	86,400	328	29,520
Wages	c)	4 fulltime workers	manday	90	308	27,720	840	75,600	308	27,720
Labor Costs/Non-Cash										
Entrepreneurship	a)	1 owner-operator	manday	240	281	67,440	331	79,440	281	67,440
Entrepreneurship	b)	1 owner-operator	manday	240	271	65,040	321	77,040	271	65,040
Entrepreneurship	c)	1 owner-operator	manday	240	266	63,840	306	73,440	266	63,840
Sub-Total/Labour	a)					100,560		173,040		100,560
Sub-Total/Labour	b)					94,560		163,440		94,560
Sub-Total/Labour	c)					91,560		149,040		91,560

Other Costs/Cash									
Concessionaire's annual fee	appl'n & licence	fee	70	1	70	1	70	1	70
Repair & replacement	40% of material cost		4428		1,771		3,176		10,324
Surveyors' professional fee	2 surveyors	manday	500	24	12,000	24	12,000	24	12,000
Insurance	5 to 9 persons	units	500	5	2,500	9	4,500	9	4,500
Miscellaneous expenses	fares, fees, etc.	lot	12500	1	12,500	1	12,500	1	12,500
Sub-total/Other Costs					28,841		32,246		39,394
Total Cash Costs	(a)				101,430		197,061		267,309
Total Cash Costs	(b)				95,943		186,561		260,409
Total Cash Costs	(c)				90,818		169,611		252,469
Total Non-Cash Costs	(a)				73,395		109,440		86,880
Total Non-Cash Costs	(b)				69,010		97,040		78,000
Total Non-Cash Costs	(c)				65,627		82,440		69,672
TOTAL COSTS	(a)				174,825		306,501		354,189
TOTAL COSTS	(b)				164,953		283,601		338,409
TOTAL COSTS	(c)				156,444		252,051		322,141

a = refers to Eucheuma spinosum which grows slower than E. cottonii but cost higher.

b = refers to E. cottonii which is more popularly cultured and cheaper than spinosum.

c = refers to Sargassum sp. which is made into organic fertilizer.

Although the stone and stake methods of cultivation listed in Table 1 obviously costs less, these methods lack systematic operations and can be done only in limited areas with rocky bottoms and moderate currents. Hence, the monoline, raft and net methods of cultivation are considered for financial evaluation. The specific activities involved in these culture system are presented in Table 3.

B. Investment Items and Cost

All methods using support systems require the same basic types of materials and other investment items. They differ in the quantities of these materials used due to the varying planting densities across different culture systems. Regarding labour requirements, the raft method is most labour intensive, generally because it has the highest density of 180,000 plants (or 800 planting frames) per hectare.

This financial analysis considers all the cash and non-cash costs that can be incurred from the pre-investment until the first crop. As seaweed farming is a labour intensive activity, careful planning has to be done prior to the first planting. Table 3 enumerates these activities and details their estimated duration of and the costs associated with each. Some literature on the financial analysis of seaweed farms consider cash costs only and disregards management and other"overhead" costs incurred per cropping season (Barraca, undated; and Basa, 1987). The more comprehensive study by Smith (1987) considered management, tax, maintenance, depreciation and lease in addition to cash expenses on materials and hired labour. However, the imputed costs of pre-investment activities were not considered. Disregarding non-cash expenses in financial evaluations will give results biased towards a more highly viable and profitable enterprise than really might eventuate.

C. Financial Analysis of Selected Culture Systems and Species

Results of the financial analysis considering all cost from the pre-investment activities until the harvesting activities are shown in Table 4. Considering the first crop only, all the three methods incurred losses because of pre-investment, investment and imputed labour costs. However, the raft method showed positive returns (in the amount of P12,146) over total cost in the first year of operation with Eucheuma spinosum. Rafts planted with Eucheuma cottonii and Sargassum were viable but did not give positive returns over total cost due to the relatively low gross value of production, P300,000 from Eucheuma cottonii and P135,000 from Sargassum. Eucheuma spinosum is priced higher (estimated at P15/kg) than E. cottonii

(P10/kg) due to the higher carrageenan yield from the former. Sargassum is an inferior species and is mainly used for fertilizer, and, although it is a source of algenin, it is not yet commercially tapped.

Table 3. Schedule of Activities for Eucheuma culture (1 ha farm) Using Raft or 1" in the Support Systems in Sorsogon.

ACTIVITY/EXPENSE/INCOME	Qty.	Unit	Pesos per Unit	COST PER ACTIVITY	INCOME FROM ACTIVITY	NET RETURN/ ACTIVITY	DURATION Work-days	Actual days	Total Actual
INVESTMENT ACTIVITIES (IA)									
1. Inquiries regarding concession, licence to culture & loans. Prepare documents, i.e. application forms, area-specific feasibility studies, market studies, etc.									
(a) fares, others	1	lot	2000	2,000					
(b) entrepreneurship	77	m/day	240	18,480					
				20,480	0	(20,480)	77	90	90
2. Survey reef, establish boundaries									
(a) materials (buoys, chains, etc.)		lot	3000	3,000					
(b) fuel/oil for boat	36	liters	10	360					
(c) wages	48	m/day	90	4,320					
(d) entrepreneurship	12	m/day	240	2,880					
(e) surveyors' professional fee	24	m/day	500	12,000					
				22,560	0	(22,560)	12	14	104
3. File loan applications, pay fees and permits									
(a) application to culture		fee	20	20					
(b) fares, others		lot	5000	5,000					
(c) entrepreneurship	12	m/day	240	2,880					
				7,900	0	(7,900)	12	14	118
4. Scout for laborers and train them on seaweed culture & farm op'ns									
(a) fares, others		lot	500	500					
(b) entrepreneurship	10	m/day	240	2,400					
				2,900	0	(2,900)	10	12	130
5. Canvass source and prices of material inputs									
(a) fares, others		lot	1000	1,000					
(b) entrepreneurship	10	m/day	240	2,400					
				3,400	0	(3,400)	10	12	142
6. Follow-up licence/permit/loans and prepare other requirements as needs arise. Pay fees if OK.									
(a) concessionaire's fee		fee	50	50					
(b) fares, others		lot	2000	2,000					
(c) entrepreneurship	26	m/day	240	6,240					
(d) interest on loan			24763	24,763					
				33,053	0	(33,053)	26	30	172
7. Slack (contingency for delays)									
(a) fares, others		lot	1000	1,000					
(b) entrepreneurship	51	m/day	240	12,240					
				13,240	0	(13,240)	51	60	232
8. Purchase of:									
(a) materials for farmhouse and drying platforms		lot	9000	9,000					
(b) motor boat (16hp)		no	6000	6,000					

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ACTIVITY/EXPENSE/INCOME	Qty.	Unit	Pesos per Unit	COST PER ACTIVITY	INCOME FROM ACTIVITY	NET RETURN/ ACTIVITY	DURATION Work-days	Actual days	Total Actual
(c) tools (saw, hammer, bolo, crowbar)		lot	2000	2,000					
(d) entrepreneurship	6	m/day	240	1,440					
				18,440	0	(18,440)	6	7	239
9. Construction of farmhouse and drying platforms (4 workers)									
(a) wages	48	m/day	90	4,320					
(b) entrepreneurship	12	m/day	240	2,880					
				7,200	0	(7,200)	12	14	253
10. Employ 8 laborers to clear debris from reef, etc.									
(a) wages	72	m/day	90	6,480					
(b) fuel/oil for boat	27	liters	10	270					
(c) entrepreneurship	9	m/day	240	2,160					
				8,910	0	(8,910)	9	11	264
11. Purchase material inputs									
(a) planting frames	800	no.	50.00	40,000					
(b) long stakes (3m)	240	no.	1.50	360					
(c) short stakes (1m)	160	no.	1.00	160					
(d) floats	3200	no.	0.30	960					
(e) baskets, netbags,bamboo rafts		lot	700.00	700					
12. Apply and secure insurance				0					
(a) annual premium	9	pers	500.00	4,500					
(b) entrepreneurship	6	m/day	240.00	1,440					
				48,120	0	(48,120)	6	7	271
13. Constructiing 300 frames for planting 6,000 kg initial seedlings 500 more frames to be made daily after planting & harvesting									
(a) wages	72	m/day	90	6,480					
(b) entrepreneurship	9	m/day	240	2,160					
				8,640	0	(8,640)	9	11	282
INVESTMENT COST				194,843			240		
TOTAL INCOME DURING THE PERIOD					0			282	
NET RETURN DURING THE PERIOD						(194,843)			282

Table 3. Schedule of Activities for Eucheuma culture (1 ha farm) Using Raft or 1" in the Support Systems in Sorsogon.

ACTIVITY/EXPENSE/INCOME	Qty.	Unit	Pesos per Unit	COST PER ACTIVITY	INCOME FROM ACTIVITY	NET RETURN/ ACTIVITY	DURATION		
							Work-days	Actual days	Total Actual
FIRST CROPPING ACTIVITIES (1CA)									
14. Planting first crop									
(a) seaweed cuttings/seeds	6000	kg FW	2	12,000					
(b) fuel/oil for boat	150	liters	10	1,500					
(c) wages	400	m/day	90	36,000					
(d) entrepreneurship	50	m/day	240	12,000					
				61,500	0	(61,500)	50	50	332
15. Harvesting first crop and replanting for the second crop									
Outflow:									
(a) fuel	120	liters	10	1,200					
(b) seeds for next crop*	2000	kg DW	15	30,000					
(c) wages	320	m/day	90	28,800					
(d) entrepreneurship	40	m/day	240	9,600					
(e) repairs & replacemnt		lot	3553	3,553					
(f) miscellaneous expenses		lot	1000	1,000					
Inflow:									
(g) sale of dried seaweeds	8000	kg DW	15		120,000				
(h) value of seeds used***	2000	kg DW	15		30,000				
				74,153	150,000	75,847	40	40	372
TOTAL COST OF FIRST CROPPING ACTIVITIES (1CA)				135,653			90		
TOTAL INCOME FROM FIRST CROP					150,000			90	
TOTAL NET RETURN FROM FIRST CROP						14,347			372
ACTIVITIES FOR SUCCEEDING CROPS									
16. Harvest existing crop and replant for following crop									
Outflow:									
(a) fuel	120	liters	10	1,200					
(b) seeds for next crop*	2000	kg DW	15	30,000					
(c) wages	320	m/day	90	28,800					
(d) entrepreneurship	40	m/day	240	9,600					
(e) repairs & replacement		lot	3553	3,553					
(f) miscellaneous expenses		lot	1000	1,000					
Inflow:									
(a) sale of dried seaweeds	8000	kg DW	15		120,000				
(b) value of seeds used***	2000	kg DW	15		30,000				
TOTAL COST OF ONE CROP				74,153					
TOTAL INCOME FROM ONE CROP					150,000				
TOTAL NET RETURN FROM ONE CROP						75,847			
DURATION OF ONE CROPPING (CALENDAR DAYS)								40	

* NON-CASH EXPENSE

DW ≈1 kg dry weight = 8 kg fresh weight

Table 4. Financial Analysis of Eucheuma spinosum, E. cottonii and Sargassum Using Monoline Culture System, 1 ha. Farm.

METHOD:	Monoline Method			Raft/Frame Method			Net Method		
ITEM	1st Crop	Year 1	2 - 5	1st Crop	Year 1	2 - 5	1st Crop	Year 1	2 - 5
BASIC DATA									
Area planted/crop (sq m)	7299	7299	7299	5000	5000	5000	5000	5000	5000
No. of crops/year	1	3	7	1	3	7	1	3	7
Planting units/ha/crop	980	980	980	800	800	800	800	800	800
Yield/planting unit (Kg FW)	22.195	22.195	22.195	200	200	200	130	130	130
Prod'n Volume (kg DW) H	1985	5954	13892	10000	30000	70000	6500	19500	45500
Disposable harvest .8H	1588	4763	11113	8000	24000	56000	5200	15600	36400
Harvest of seeds .2H	397	1191	2778	2000	6000	14000	1300	3900	9100
SPECIES CULTURED									
a) *Eucheuma spinosum*									
Price/kg DW	P15.00	P15.00	P15.00	P15.00	P15.00	P15.00	P15.00	P15.00	P15.00
Gross Value of Prod'n-GVP	29,768	89,303	208,374	150,000	450,000	1,050,000	97,500	292,500	682,500
Value of crops sold	23,814	71,443	166,699	120,000	360,000	840,000	78,000	234,000	546,000
Value of harvest for seeds	5,954	17,861	41,675	30,000	90,000	210,000	19,500	58,500	136,500
b) *Eucheuma cottonii*									
Price/kg DW	P10.00	P10.00	P10.00	P10.00	P10.00	P10.00	P10.00	P10.00	P10.00
Gross Value of Prod'n-GVP	19,845	59,535	138,916	100,000	300,000	700,000	65,000	195,000	455,000
Value of crops sold	15,876	47,628	111,133	80,000	240,000	560,000	52,000	156,000	364,000
Value of harvest for seeds	3,969	11,907	27,783	20,000	60,000	140,000	13,000	39,000	91,000
c) *Sargassum*									
Price/kg DW	P4.50	P4.50	P4.50	P4.50	P4.50	P4.50	P4.50	P4.50	P4.50
Gross Value of Prod'n-GVP	8,930	26,791	62,512	45,000	135,000	315,000	29,250	87,750	204,750
Value of crops sold	7,144	21,433	50,010	36,000	108,000	252,000	23,400	70,200	163,800
Value of harvest for seeds	1,786	5,358	12,502	9,000	27,000	63,000	5,850	17,550	40,950
COSTS OF PRODUCTION									
Cash Costs a)	101,430	145,972	170,355	197,061	244,414	205,889	267,309	328,956	520,921
(mat'ls, paid labor and b)	95,943	132,684	143,055	186,561	223,285	178,589	260,409	314,256	223,621
misc. expenses)-CC c)	90,817	123,659	129,405	169,611	205,264	164,939	252,469	302,416	209,971

Non-cash Costs	a)	73,394	109,301	125,675	109,440	193,440	294,000	86,880	149,760	220,080
(seeds and	b)	69,009	96,147	94,983	67,040	156,240	207,200	78,000	123,120	157,920
entrepreneurship)	c)	65,626	85,998	71,302	82,440	117,240	121,800	69,672	98,136	99,624
Total Costs (TC)	a)	174,824	255,273	296,030	306,501	437,854	499,889	354,189	478,716	741,001
	b)	164,952	228,831	238,038	253,601	379,525	385,789	338,409	437,376	381,541
	c)	156,443	209,657	200,707	252,051	322,504	286,739	322,141	400,552	309,595
RETURN OVER CASH COSTS										
(RCC=GVP-CC)	a)	(71,662)	(56,669)	38,019	(47,061)	205,586	844,111	(169,809)	(36,456)	161,579
	b)	(76,098)	(73,149)	(4,139)	(86,561)	76,715	521,411	(195,409)	(119,256)	231,379
	c)	(81,887)	(96,868)	(66,893)	(124,611)	(70,264)	150,061	(223,219)	(214,666)	(5,221)
RETURN OVER TOTAL COSTS										
(RTC=GVP-TC)	a)	(145,056)	(165,970)	(87,656)	(156,501)	12,146	550,111	(256,689)	(186,216)	(58,501)
	b)	(145,107)	(169,296)	(99,122)	(153,601)	(79,525)	314,211	(273,409)	(242,376)	73,459
	c)	(147,513)	(182,866)	(138,195)	(207,051)	(187,504)	28,261	(292,891)	(312,802)	(104,845)

First year activities include the pre-investment and investment activities, and three cropping seasons. Starting with the second year, positive returns over cash cost and over total costs can be obtained from all three methods. This is mainly due to lower production costs in the second and subsequent years, and the stabilization of production at seven crops per year.

D. Financing of Seaweed Farms:

The raft method of culturing Eucheuma cottonii and proves to be the most technically and economically viable against the monoline and net method in the long-run. Initial investments in materials and labour costs during the first crop, when planting frames are prepared, may hinder entrance into seaweed farming. However, others may opt for the less expensive monoline method. The limitation, however, of the monoline system is that the planting density is much lower than the raft method. This also implies that the farm area is used below its optimum capacity.

Cognizant of the advantages of using the raft method for a longer period of farming operations, a summary of financing and repayment schedules for a one hectare farm using this method is presented in Table 5. Hypothetically, the farm will apply for an agricultural/fishery loan from a bank in an amount equal to 70 percent of the capital requirement during the investment and first cropping period. Assuming that the farm will be planted to the fast-growing E. cottonii which was found suitable to the coastal areas of northeast Sorsogon (Alvarez, May 1990 informal conversation), then a one hectare farm will receive P137,573.

Table 5. Summary of income and expenses.

Year	Major Activity	Capital Req't.*	Total Cost**	Income **	Net Return	Return/ Capital	Duration (Days)	Month Number
1	Investment activity	137,243	194,843	0	(194,843)	(137,243)	222-82	1-6;8
	First crop	84,053	135,653	150,000	14,347	65,947	372	7-9;11
	Second crop	34,553	74,153	150,000	75,847	115,447	40	10-10.5;12.5
	Third crop	34,553	74,153	150,000	75,847	115,447	40	10.5-12;14
	Total	290,402	478,802	450,000	(28,802)	159,598	452	
2	1st»»7th crop	241,872	519,072	1,050,000	530,928	808,128	280	

* Includes material cost, wages and miscellaneous expenses.
** Includes cash and non-cash items.

A moderately higher amount may be required for E. spinosum farmers due to the higher cost of labour associated with longer culture periods (approximately 50 days). Most often, interest on agricultural loans are deducted from the principal immediately upon release of loans. The financial analysis showed positive returns over cash cost in year one. Hence, this would allow the farmer to repay one-third of his loans and the balance could be repaid in the second year.

Financial analysis, therefore, shows high returns from seaweed farming. The future of the seaweed industry in the Philippines appears to be encouraging in view of the growing demand for seaweeds, primarily as food additives and as ingredients for industrial products. This is mainly attributed to the relatively low (cash) cost of production in the country. Specifically (?), material inputs are locally available and labour is not a problem in the coastal communities. Hence, seaweed production in the Philippines will be highly competitive in the world market.

Recently, there has erupted a controversy over the safety and quality of the Philippines' seaweed' natural carrageenan. This issue was apparently raised by two American companies (FMC Corporation and Hercules, Inc.) which requested the U.S. Food and Drug Administration to restrict the entry of Philippine carrageenan through the tactic of raising acceptable import quality standards above WHO-standards. These firms say that Philippine carrageenan is unfit for human consumption. The Seaweed Industry Association of the Philippines (SIAP), however, is optimistic that the controversy will be resolved in favor of status quo: that Philippine carrageenan is appropriate as a food additive because of its high molecular wight. In comparison, the American firms' more highly processed carrageenan is reported to have a lower molecular weight, and, hence, the tendency to stick to body tissues. This is generally undesirable characteristic for carrageenan which is used as food additives because of its possible carcinogenic correlation.

In view of the optimistic perceptions of the leaders of the Philippine seaweed industry, local production should continue in order to be more competitive and obtain larger share of the international market. Although there are large expanses of open reefs in the Southern Philippines, seaweed farming can also be introduced in other suitable areas in order to increase production and to guarantee adequate supply for export and local markets. Seaweed growing is highly affected by weather disturbances, a fact of life in the country. Undeniably, the supply of seaweeds at reasonable prices could be guaranteed if production is suited in several areas. Supply gluts might then be avoided when a natural disaster affects one production site, such as the Southern Philippines.

Northeast Sorsogon has approximately 300 hectares of open reef suitable for seaweed farming, E. alvarezii in particular (Alvarez, 1990 informal conversation). This is less than 86% of the locality's reef area. Private test plots in Barangay Dancalan in Bulusan and Barangay Bagacay in Gubat have given encouraging results, and are now engaged in multiplying the seeds in preparation for an intensive farming operations. Table 6 shows the comparison of the requirements of Eucheuma farming and the characteristics of the Northeast Sorsogon reef.

Table 6. Summary of Financing and Repayment Schedule

	Year 1		Year 2	
FINANCING:	Month 6	Month 12	Month 6	Month 12
Loan receipts *	137,573			
Interest **	24,763		16,509	
Repayment of capital	0	45,858	45,858	45,858
Total Debt Service	24,763	45,858	62,367	45,858
Net Finance Available	112,810	(45,858)	(62,367)	(45,858)
Outstanding balance	137,573	91,715	45,858	0

* 70% of capital requirement during the investment and first crop period.
** 18% interest per annum on agricultural loans.

Bureau of Fisheries and Aquatic Resources, through its regional and municipal offices, put-up test plots in four sites in Bulusan, Matnog and Sta. Magdalena in 1989, but only the plots in Matnog survived to May 1990. The others were destroyed by typhoons and were not replaced. Nevertheless, BFAR technical staff believes that seaweed farming has great potential in the wide reefs of Sorsogon if technologies suitable to the rigorous climate and the characteristics of the reef area.

Unlike residents of Gubat, Barcelona and Bulusan, the residents of the coastal barangays in Prieto Diaz do not gather seaweeds for (extra) cash income. BFAR's biological survey [reference] disclosed that Prieto Diaz has the fewest seaweed species collected (Tables 7 & 8). However, the municipality's wide reef area (___ha.) is characterized by physical features suited for seaweed farming; this has persuaded BFAR to include the municipality as a potential area for seaweed cultivation in Sorsogon.

TABLE 7. COMPARISON OF FARM SITE REQUIREMENTS FOR EUCHEUMA CULTURE AND THE CHARACTERISTICS OF THE NORTHEAST SORSOGON REEF

Farm/site Requirements	Characteristics of the Sorsogon reef area
Species	
There are several species of Eucheuma but only two Philippines; namely, *Eucheuma cottonii* (=E. stiatum, = *E. alvarezii*) and *E. spinosum* (= *E. denticulatum*).	**Eucheuma alvarezii* being grown on private trial plots in Dancalan, Bulusan. *BFAR maintains trial plots also in Matnog. *A local official in Prieto Diaz has trial plots on the municipality's reef.
Location:	**Characteristics of the Sorsogon Reef:**
Grows well in tropical regions on coral reefs and on the rocky and sandy bottoms of marine waters in intertidal or subtidal zones.	Extensive area with sandy-corraline substrate & variety of seaweed species; some nearshore areas with mangroves & seagrasses, Gubat in particular.
Water quality:	
Clear, constant motion for continuous nutrient flow; Salinity: 28 ppt, relatively salty, purely marine; Depth: at least 30cm during low tide; Temperature: 27° to 30°C; Current: 5-10m per minute	Strong current especially along the reef
Land Quality:	
Substratum - Sandy/rocky	Sandy-coralline and coral rubble substrate
Fauna:	**Local seaweeds species:**
Presence of natural seed stocks and other vegetation, eeg, eel grass or sargassum.	*Caulerpa racemosa, C. okamurai; Padina* sp.; *Galidiela acerosa; Gracilaria firma; Enteromorpha intestinales; Turbina ornata;* and *Ulva reticulata*
Climatic Factor:	
Reef areas to protect the farm from typhoon, strong waves, etc.	
Other:	
Free from industrial and domestic pollution. Far from freshwater sources.	The area has no large factories or other likely sources of industrial effluents. Resident population is quite small to put pressure on the environment.
Socio-Economics & Marketing:	
The farm should be relatively accessible to output market and input sources. Price should be attractive and stable. High demand for the product.	The coastal towns of NE Sorsogon (except Prieto DIaz) are accessible by paved roads. The Legaspi airport is about 80 km away.
Farm management operations:	
The best agronomy for seaweed farming involves the manipulation of the plantings to attain minimal losses due to adverse effects of environmental and climatic changes (Doty, 1986). For instance, plants should be adjusted with changes in water levels such that the plant would not be muddy.	

References:

Doty, M. 1986.
Barraca, R.T. Undated.
Seaweed/Seagrass/Mangrove Fishery
Resource Section-BFAR-DA March 1989.
Travel Report..

Table 8. Species of Seaweeds Collected from Coastal Waters of Eastern Sorsogon (March 1989)

SPECIES	GUBAT		PRIETO DIAZ	BARCELONA	DANCALAN, BULUSAN
	PROPER	BAGACAY			
CHLOROPHYCEAE					
Dictyosphaeria cavernosa	x			x	
Valonia sp.	x		x		
Caulerpa racemosa			x		
C. serrulata					x
Halimeda opuntia	x		x	x	x
Ulva sp.		x		x	x
Enteromorpha intestinalis	x	x		x	
Halicoryne wrightii	x				
Acetabularia sp.	x			x	x
Neomeris annulata	x			x	
Chaetomorpha sp.		x			
PHAEOPHYCEAE					
Sargassum spp. (7)	x	x	x	x	x
Padina crassa		x			x
P. japonica	x			x	
Colpomenia sinuosa		x		x	
Turbinaria spp. (2)	x	x	x	x	x
Hydroclathrus tenuis			x		
Dictyopteris sp.					x
RHODOPHYCEAE					
Gelidiella acerosa	x	x		x	x
Digenia simplex	x				x
Desmia sp.	x				
Gracilaria eucheumoides	x	x		x	x
G. salicornia		x		x	x
G. firma				x	x
G. spp. (5)	x	x		x	x
Laurencia spp. (4)		x			x
Actinotrichia fragilis	x	x		x	x
Halymenia sp.		x			
Grateloipia filicina*					x
Jania sp.	x				x
Mastophora rosea					x
Galaxaura spp. (2)	x				x
Acantophora specifera		x			

Liagora sp.	x

*Abundant in Sabang, Bulusan.
Source: Seaweed/Seagrass/Mangrove Fishery Resource Section-BFAR-DA

IV. Problems, Potentials and Support Services for Seaweed Culture

A. Problems and Potentials

1. Financial
2. Technical
3. Marketing
4. Risks and uncertainties

B. Considerations for Community Organizations

1. Financing
2. Marketing
3. Technology/Information Dissemination

V. Assessment of Existing Government Policies on Exploitation and Use of Seaweed Resources

VI. Research Gaps and Policy Considerations

In view of the dearth of documented information on seaweed farming in Northeast Sorsogon, there is a need for baseline information on the coastal environment and a profile of the communities of Northeast Sorsogon. The data should include biogeographical, social, economic, legal and institutional attributes of these communities in order that comprehensive and specific policies on seaweed cultivation can be formulated for the area.

Specifically, biogeographical studies would identify sites suitable for seaweed culture by species. Such a study would examine the characteristics of the coral reels, the types of marine life existing in the reef areas, the effect of seaweed farming on the marine ecosystem and on the productivity of other (fishery) resources.

Social and economic studies, on the other hand, would deal with the appropriate delivery of economic and social services to support the communities' participation in development programs. The structure of existing local and international seaweed market links and their relationship with the production sector in Northeast Sorsogon needs detailed evaluation, considering the intricacies of seaweed marketing channels and the distance between the site and processing centers in Central Visayas.

The biological survey conducted by BFAR reported an abundance of wild species in Northeast Sorsogon. Undeniably, potential seaweed farmers have to equal if not surpass the performance of the seaweed growers in Southern Philippines whose homes are more proximate both to the reefs and to processing sites. Studies on the propagation and non-traditional uses of species other than Eucheuma could be undertaken so that the seaweed farmers are not dependent on Eucheuma alone. Non-traditional uses of seaweeds (such as fertilizer components, soil conditioners, animal feeds, food additives and other industrial uses) should be developed. Processing these products might be viable in the Sorsogon or Bicol area. This could be a more economical alternative than establishing firms intended for semi-processed carrageenan production similar to those in Central and Southern Philippines. This implies that feasibility for such processing centers for non-traditional seaweed uses are likewise necessary. The lack of studies on the marketing and processing of higher-valued products most often limits the agricultural and fishery sectors (REFERENCE? GENERAL KNOWLEDGE?)

Legal and institutional studies would assess the structure of the community and the informal organizations which could be harnessed in the selection, design and implementation of development programs. Legal aspects seem to be the most urgent since functional culture technologies have already been developed. Use of these technologies on seaweed farms will largely depend on appropriate access to and prices for rights to use the resource. In this regard, coordination between various national government agencies and local officials are necessary and is a delineation of each level's responsibilities and authorities. Possibly, a reformulation of regulations and policies on coastal resource use and management would result.

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