MAXIMIZING OPPORTUNITIES IN SEAWEEDS FARMING

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This small-scale seaweeds culture project, explained in detail in this article has been initially put forward as an option to provide investment opportunity for the Overseas Filipino Workers as they do their share in boosting the Philippine economy. Nevertheless, the project could also serve as reference for fisherfolk in the ASEAN region wanting to invest in seaweeds farming.

The international food additives (e.g., carrageenan, agar, hydrocolloids, WSPs, etc.) market is valued at USD 3.0 billion a year. To fisherfolk in Southeast Asia, this presents a huge opportunity to cross the poverty line. The question is what kind of immediate opportunity and how can they exploit it? One product the region has a competitive edge in is carrageenan, a colloid from red seaweeds. The expanding uses of seaweeds extract, particularly the carrageenan, either as hydrocolloids or natural water soluble polymers (WSP) in human and pet food industries and in pharmaceuticals, have spurred the development of seaweed culture technology. The rising cost of production and failure to find low-priced suitable substitutes has driven demands and opened opportunities for developing nations in the ASEAN and some African countries to develop their seaweeds industry.

The Nature and Uses of Carageenan

Carrageenan (**Box 1**) is almost synonymous to agar, which is also derived from another red algae, the *Gracilaria* spp. Agar is used more in microbiology for bacteria culture because of its gel-like substance, which is most suitable for testing bacterial presence. Agar is also used in medical preparations as it tends to produce a laxative effect. Like carrageenan (**Box 2**), agar is also used in the preparation of ice cream, soup, jelly or even in brewing wine or beer. Carrageenan and agar are classified as hydrocolloids.

Hydrocolloids (**Box 3**) are hydrophilic polymers of vegetable, animal, microbial or synthetic origin that are naturally present or added to control the functional properties of aqueous foodstuff (i.e. it keeps them firm or consistent). The most important properties of hydrocolloids are viscosity (including thickening and gelling) and water binding. Other significant properties include emulsion stabilization, prevention of ice recrystallization as well as having organoleptic properties (refers to any sensory properties of a product, involving taste, color, odor and feel).

Alternative Livelihood for Poor Fishers and Coastal Dwellers

Red seaweeds can be farmed in most coastal areas in the Southeast Asian region. It is necessary that the coastal people have the capacity to farm the seaweed in a sustainable,

Box 1. Carrageenan

Carrageenan is a polysaccharide prepared by alkaline extraction from red seaweeds (*Rhodophycae*), mostly of genus *Chondrus, Eucheuma, Gigartina and Iridaea*. Its name is believed to have been derived from a type of seaweed that is abundant along a coastline near the village of Carragheen in Ireland, where the red seaweed is also known as the Irish moss. Some marine biologists and seafarers also called this the "sea lettuce". Gelatinous extracts of carrageen seaweed have been used as food additives for hundreds of years. Chinese culinary experts used to make sweets from the seaweeds, served after a meal for special guests. There are five species of seaweeds commonly found in the ASEAN region. These are: *Eucheuma* spp. (usually eaten fresh or processed for export), *Caulerpa* sp. (exported fresh or in salted form), *Sargassum* sp. (as meal additive in animal feeds), *Gelidiella* sp. and *Gracilaria* sp. (both exported dried and/or alkali-tested). *Eucheuma* spp., which has a number of uses and is most in demand in the export market, can be farmed in most of the region's coastal areas.

Carrageenans are large and highly flexible molecules having curl-forming helical structures and the ability to form a variety of different gels at room temperature. It is for this reason that they are widely used in the food and other industries as thickening and stabilizing agents. There are three main commercial classes of carrageenan: Kappa – strong, rigid gels; Iota – soft gels; and Lambda – form gels when mixed with proteins rather than water, to thicken dairy products.

Box 2. Some of the many uses of carageenan

- Gelatinous extracts as food additives and home made sweets
- Preparation of ice cream, soup, jelly and in food processing
- Brewing and wine making
- Control of functional properties of aqueous foodstuff (i.e. it keeps them firm or consistent)
- Emulsion stabilization, prevention of ice recrystallization
- Pharmaceuticals and personal care
- Manufacture of adhesives, pulp and paper, textiles, paints and coatings
- Water treatment in the oilfield, and in biodegradable products

Box 3. Hydrocolloids and WSPs

Foodstuffs require a number of different hydrocolloids; the most important of which are Agar, Alginate, Arabinoxylan, Carrageenan, Carboxymethylcellulose, Cellulose, Curdlan, Gelatin, Gellan, ß-Glucan, Guar gum, Gum arabic, Locust bean gum, Pectin, Starch, and Xanthan gum. In 2001, the total world market for hydrocolloids was USD 3,000 M which comprised 25% starches (USD 675 M), 21% gelatin (USD 635 M), 16% carrageenan (USD 435 M), and others 40% (USD 1205 M). "Others" include pectin, xanthan, gum arabic, agar, locust bean gum, etc.

There is also an emerging industry for water soluble polymers (WSPs), which has a USD 3.0 B market. WSPs are used in almost all food processing industries and in pharmaceuticals and personal care, adhesives, pulp and paper, textiles, paints and coatings, water treatment, in the oilfield, and in biodegradable products. There are two main types of WSPs, natural and synthetic.

Natural WSPs are derived from vegetable and animal sources. The vegetable sources include sap of trees (e.g. arabic gum), seed extract (e.g. guar carouba gum), algus extracts (e.g. agar-agar, alginates), plant extracts (e.g. pectins), starches (e.g. potato starch, corn starch), and dextrin (e.g. xanthan gum). Animal sources include milk (e.g. casein) and fishes, skin, bones (e.g. gelatin glues). Synthetic WSPs include vegetable derivatives such as starch derivatives (e.g. acetate), cellulose derivatives (e.g. sodium carboxymethykcellulose or CMC), guar derivatives (e.g. HP guar). Another class of synthetic WSPs are the petrochemical derivatives, such as acrylics.

environmentally friendly manner and are provided the incentives in doing so. This condition requires rational approaches to the development of the industry that includes farming, processing, marketing and trade.

In the Philippines, where seaweed contributes the majority of the total mariculture production, the government considers it as a major commodity, along with milkfish and tilapia that has the potential to generate food and income for poorer groups. The Philippines is the largest producer of

Table 1. Seaweeds resources as raw materials for carrageenan (as of 2002)

Country	Production (mt)	% of total resource
Philippines	80,000	50%
Indonesia	60,000	38%
Malaysia	10,000	6%
African and other countries	10,000	6%
TOTAL	**160,000**	**100%**

cultivated seaweeds; it used to provide 80% of the world's raw materials supply but this dipped to 50% in 2002 with lower production and Indonesia increasing its output (Table 1). The Philippine Government's support to the country's seaweed industry is exemplified in **Box 4**.

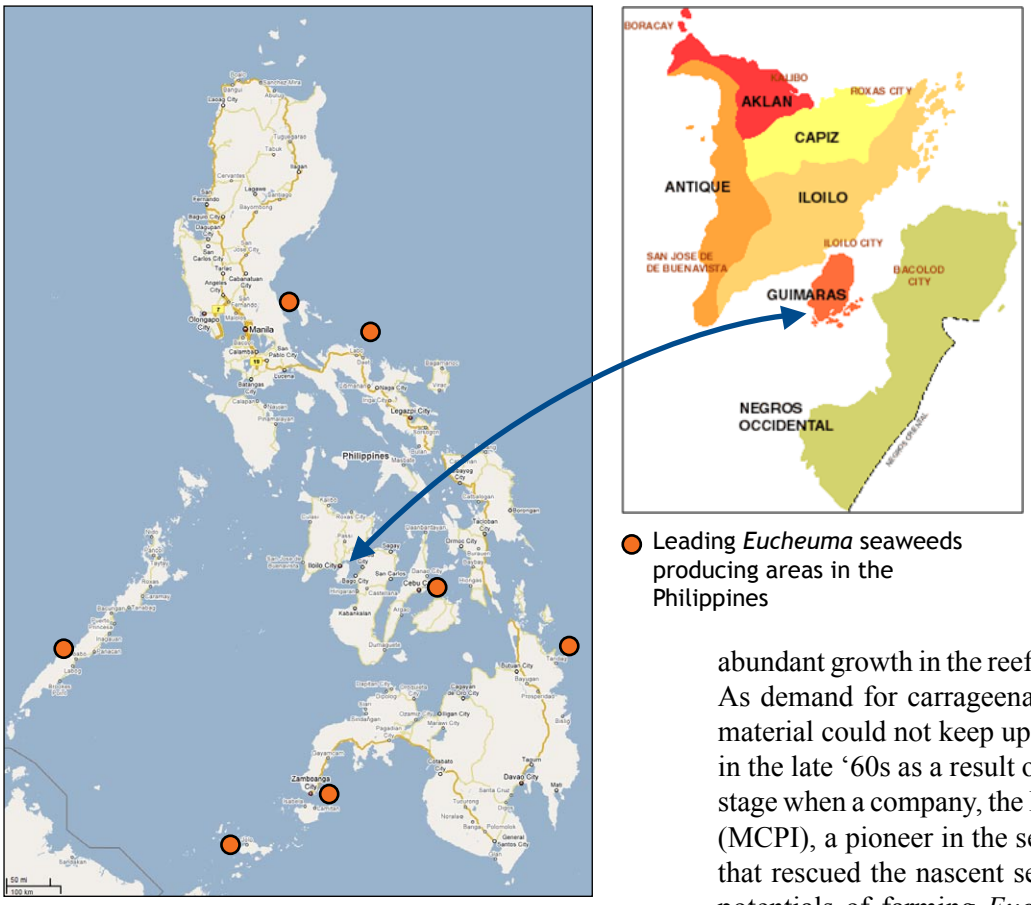
Commercial Seaweed Resources

The seaweeds industry emerged in the Philippines in the mid 1960s. It now forms the backbone of the world's USD 500 M carrageenan industry. It has contributed an average of USD 150 M annually to the Philippine economy giving 60% direct benefits to the seaweed farmers by providing direct livelihoods to over 150,000 families. The five leading Eucheuma seaweeds producing areas in the Philippines are: (1) Tawi-Tawi, Sulu, Basilan, and Zamboanga in southern

Box 4. Seaweed (*Eucheuma*) culture in Guimaras Island, Western Visayas, Philippines

In 2001, the local government unit of San Lorenzo (Guimaras Island in central Philippines) requested BFAR Region 6 to introduce seaweed farming in Nadulao Island as a potential alternative to blast fishing in the area. A fishers' organization with 17 members was formed to be responsible for four seaweed farms. Under the GMA (Ginintuang Masaganang Ani) program, the Seaweed Culture Project was created in collaboration with the Office of the Provincial Agriculturist and the Office of the Municipal Agriculturist. The site was expanded to include three other villages in San Lorenzo and 19 additional villages in the municipalities of Buena Vista, Nueva Valencia and Sibunag (all in Guimaras Island).

In April 2004, a Provincial Seaweed Development Council (PSDC) Technical Working Group (TWG) was formed comprising representatives from government and commercial institutions. The PSDC-TWG then created the Seaweed Growers and Traders Association (SGTA) which now sells their products directly to Cebu-based processors and exporters. As of 2006, there were 16.65 ha under cultivation and benefiting 162 farmers. In 2005, the beneficiaries sold over 6.0 mt of fresh and 22.0 mt of dry seaweeds valued at USD 14,977.00. Farmers said the supplementary income from seaweeds culture has kept them away from their illegal fishing activities and enabled them to send their children to school (G. Gonzales, 2006).



Leading *Eucheuma* seaweeds producing areas in the Philippines

Map of the Philippines showing Guimaras Island and leading Eucheuma producing areas

Philippines; (2) Palawan and Polilio (Quezon Province) in Luzon area; (3) Danajon Reef in the Visayas area; (4) Masbate, Camarines Norte and Sorsogon in Bicol region; and (5) Surigao Provinces in northern Mindanao. The major carrageenan processing companies are located in the Visayas (6) and in Mindanao (6).

The first commercial seaweed farming in the country was introduced in Sulu Sea in the 1960s. But it was not until 1966 that the Philippines received recognition of its seaweed processing as an industry. Initially, no attempt was made to cultivate the *Eucheuma* spp. in the country, with its abundant growth in the reefs, fishers simply collected them. As demand for carrageenan increased, the supply of raw material could not keep up and in fact dropped alarmingly in the late '60s as a result of over-harvesting. It was at this stage when a company, the Marine Colloid Philippines, Inc. (MCPI), a pioneer in the seaweed industry, did something that rescued the nascent seaweeds trade – it explored the potentials of farming *Eucheuma*. Their successful trials led to the establishment and promotion of seaweed farms and a processing industry specializing in the manufacture of the Philippine natural grade (PNG) carrageenan, which is mainly from the Eucheuma species. Since then the Philippine seaweeds industry has been dependent on the *Eucheuma* spp. as the major source of raw material for carrageenan. In early 2000, dried harvest of the seaweed was about 110,000 mt but this decreased to about 90,000 mt in 2002.

In order to sustain production of *Eucheuma* spp., new farming areas were developed throughout the country with technical assistance from MCPI and other exporting and processing firms. Thus far, the Philippines is now considered one of the world's few countries, which has successfully

Table 2. World supply of *E. cottonii*, MC=38-42% (in '000 mt)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Philippines	110.0	108.0	93.0	116.0	114.0	99.0	90.0	90.0	96.0	108.0
Indonesia	27.0	27.0	25.0	28.0	30.0	31.0	35.0	47.0	55.0	66.0
Malaysia	3.6	4.2	4.8	5.4	6.0	4.9	1.8	3.0	3.0	3.0
Indochina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	3.4	6.0
African and other countries	1.2	1.2	0.8	0.7	2.0	2.4	1.5	2.2	2.4	2.4
World Total	141.8	140.4	123.6	150.1	152.0	137.3	128.3	142.6	159.3	185.4

Source: 6th Mindanao Seaweed Congress, May 2006
* estimate

cultivated *Eucheuma* spp. on a commercial scale. The most important species for raw materials for carrageenan are: *Eucheuma cottonii* and *E. spinosum*.

Other seaweed species with commercial importance are: *Gracilaria* sp. and *Gelidiella* sp., which are still mostly harvested from natural growth; and *Caulerpa lentillefera*, which are cultured in ponds and lagoons. Of the estimated annual *Eucheuma* spp. harvest of 130,000 mt, 95% is *E. cottonii* (producing kappa carrageenan) and only 5% *E. spinosum* (iota carrageenan). The estimated annual market demand according to the Seaweed Industry Association of the Philippines (SIAP) is 165,000 mt by domestic processors and another 240,000 mt by processors in other countries, and this demand is expected to increase by at least of 10%. By 2005, the world's supply of *E. cottonii* had reached 185,400 mt (**Table 2**).

Concerns

The Philippine Government recently designated the National Fisheries Research and Development Institute (NFRDI) to include in its medium-term plan the National Seaweeds Development Program. The program aims to generate baseline information of the country's seaweed resources as a basis for formulating management policies for the utilization and conservation of the resource and to address industry constraints. Major issues include the alleged environmental effects of seaweed farming; the strong competition among players in the industry; and the soaring market prices, which is keeping foreign buyers away.

In the 60s, the seaweeds bonanza in the Philippines triggered a "gold rush" to the coralline areas of Sulu Sea. The fisherfolk in the areas built houses on stilts in the middle of the seaweed farms. In two decades, farmer colonies grew exponentially and the reefs became polluted. This contributed to the degradation of the reef environment and the quality of the crop. At this point, an international seaweeds expert warned that traces of metals were approaching the tolerable limit of 10 ppm as the clean anhydrous yields (CAY) in recovered Philippine carrageenan continued to decrease. Goaded by traders to produce more on a very short pre-planting time, farmers were not taught or did not pay attention to recovering, recycling or properly disposing non-biodegradable plastic tying materials used in the culture. These were left to form large piles of rubbish on beaches or settle on the bottom of the reefs. The piles became so thick as to jeopardize the ability of the resource to recover. That said, seaweeds farming as a livelihood could still be a boon if properly managed and regulated. As farms are generally sited in open reef areas, it was feared to cause adverse effects on the coral reef environment. The influx of farmers to the site did create adverse effects on the local marine life. Extensive method of seaweed farming as practiced is still subject to certain constraints, in particular the access to and availability of sites. Due to their extensive nature, such practices require large areas of near-shore and coastal land and therefore tends to exclude the landless. It can also lead to conflict over resource use.

Box 5. Major threats to the industry

- Product is priced out of the market
- Shift by users to cheaper substitutes
- Illegal exports of seed and raw materials, i.e. smuggling
- Quality deterioration from pollution
- Competition from other producing countries
- Non-tariff trade barriers

Understanding sustainable seaweed farming and its ecological role in the marine environment is vital. Farmed in shallow water coastal environment, seaweeds serve as primary agents for the production of organic matter and energy on which the planktons, which provide the base for the productivity of the marine communities, thrive. Seaweed utilizes and dissolves carbon dioxide and water as raw materials in the production of organic matter through photosynthesis. It absorbs nutrients directly from seawater for growth. Thus, the presence of seaweed enhances the environmental condition for the other members of the marine community. Seaweed beds also serve as shelter and habitat for many associated marine animals.

The road traveled by Philippine seaweed industry has not been smooth. The years 1991-1993 were its most uncertain period, when the US was looking at the possibility of banning the Philippine Natural Grade (PNG) carrageenan. The issue whether PNG was safe for human consumption was later resolved in favor of the Philippines' claim that PNG is a natural food grade substance by the United States Food and Drug Authority (FDA).

Today, the Philippine's highly profitable seaweed export industry is facing stiff competition from other Asian countries, particularly Indonesia. The Philippines' annual production of 120,000 mt is second only to China's 275,000 mt. Although Indonesia's export of seaweed is still relatively modest, it could become the second largest producer in the near future. The Seaweed Industry Association of the Philippines (SIAP) has reported that there has been rampant smuggling of dried seaweeds in recent years in southern Philippines, a serious issue which the Philippine Government should address. The smuggled materials usually obtain better prices so that there is incentive to smuggling. If this continues, SIAP fears that Philippine processors will face high prices of raw materials.

Ironically, the high world market for processed seaweeds is creating some concerns (**Box 5**). The fear is the very high prices could pressure foreign buyers to find cheaper alternatives, leading to the possible "pushing out of carrageenan from the market". The existence of other raw materials in the world's "gum" market, which could be substitutes to carrageenan, is a major issue. Carbon methyl cellulose (CMC) and santhan could very well replace carrageenan if its price remained high or goes higher. The industry thus needs to exercise vigilance among its ranks and make sure that opportunism does not reign, with certain members setting the price of their products too high, which could prompt food additive users to shift from carrageenan to other materials.

Other issues are the shortfall of supply in the world market, and degeneration of raw seaweeds quality resulting in low carrageenan yield. The causes include premature harvesting, adulteration and bad post-harvest handling. The industry should also address possible trade barrier measures, which link environment, consumer and anti-poverty issues in the overall fisheries development policies of producing and exporting countries. For poverty to be alleviated among the poor dwellers in reef communities, seaweed farming must be made profitable to farmers, sustainable, competitive and made to come up with products of long-term and proven acceptability and utility.

Private Sector Initiatives

In the Philippines, it was the private sector that rationalized the seaweed industry. In the early 80s, some 18 small to medium-sized companies banded together to form the SIAP, turning SIAP into a national organization to promote the seaweed and carrageenan industry. Of the 18 companies, 11 were in processing. SIAP's aims include resolving issues, such as maintaining the quality of seaweeds produced in the country, price stability and efficient infrastructure for moving dried seaweeds from marine farms to processing plants and on to international ports.

Since the 60s, it took two decades for the Philippine seaweed industry to make a leap forward. This was realized through the efforts of Shemberg Marketing Corporation, a Cebu-based exporter of seaweed products, which established the first full-scale carrageenan refinery in the Philippines. Since 1986, Shemberg Marketing Corporation has penetrated the carrageenan markets of Western Europe, Japan and Australia. Shemberg predicts that carrageenan exports will increase by 15-20% annually, boosted by demand for the product from Europe.

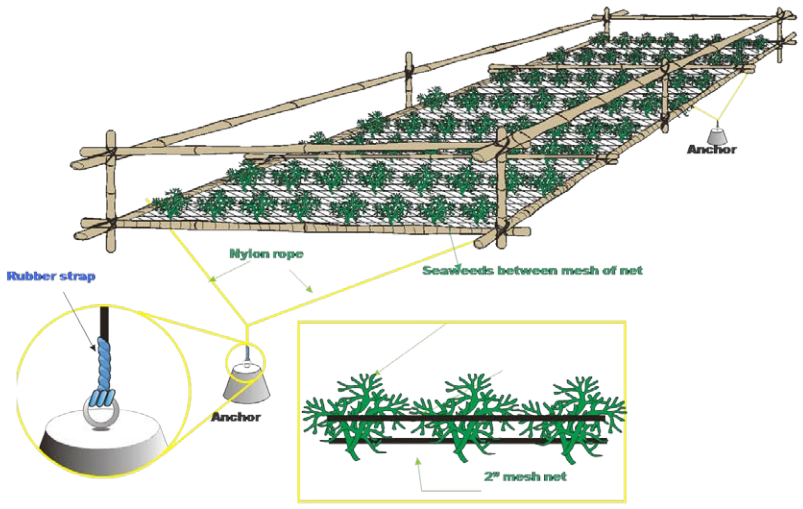
MCPI on the other hand, was instrumental in making the seaweed industry in the Philippines sustainable. Aside

Harvesting seaweeds (top) and drying seaweeds (above)

from trading carrageenan, it also promotes environmental conservation and coastal fisheries management in the seaweed farm areas. The once troubled and imperiled Danajon Reef has been transformed into a booming area for sustainable seaweed farming because of MCPI efforts. Danajon Reef is one of the few double barrier reefs in the world. Lying north of Bohol island in central Philippines, this double barrier reef comprises two sets of large coral reefs lying side by side. It occupies a total area of about 272 km^2 and measures 382 km long. The reef is dotted with some 18 islands and islets serving as breakwaters shielding mainland Bohol from strong winds and typhoons.

Until the mid-60s, Danajon Reef harbored a rich diversity of marine species. The rapid population increase in the whole country led to its coral reef kingdoms being subjected to intense commercial activities. Cyanide-using fishers destroyed the priceless cowries, abalones, tridacnas and sea horses in Danajon Reef. The lucrative business in tropical food and aquarium fishes nearly obliterated their once teeming population. Dynamite and fine-mesh fishing became the most popular means of fishing practices employed. The result was near destruction of a once pristine reef community. Impatient with the slow and little efforts from government to curb further despoliation of the once fertile spawning and municipal fishing grounds of Danajon Reef, the MCPI and other members of the private

Box 6. Lantay Method developed for Eucheuma farming by MCPI and promoted by DFI



Cage dimension:	Materials:		
Width: 2 m	2 bamboo poles	2 iron bars	anchors
Length: 5 m	10 m net (2" mesh)	10 m nylon rope	
Height: 1 m	1 ball plastic straw	1 m rubber straps	seedlings (25-35 kg)

sector in Bohol and nearby Cebu, conducted consultations with the fisherfolks. The consultations resulted in a "collective declaration of intent" advocating pro-active and concrete measures to stop illegal fishing practices. This development also led to the establishment of the Ocean Farming Research and Extension (OFRE) by MCPI and Datingbayan Foundation, Inc. (DFI). These organizations are responsible for the implementation of programs on seafarming supported by continuing education of the coastal community inhabitants on the problems posed by illegal and destructive fishing especially in Danajon Reef. OFRE promoted seaweed farming in Danajon Reef as an alternative source of livelihood. Under the arrangement specified in the "collective declaration of intent," the operations of OFRE became a responsibility of DFI, a non-profit organization working and assisting the fisherfolk in seaweeds farming and sea ranching in the Philippines.

The DFI has introduced viable economic endeavors through resource-based R&D incorporating the culture and processing of marine products of high commercial value. This approach saved the Danajon Reef from further deterioration and improved the livelihoods of the fisherfolk who depended on the reef, through seaweed farming. Today, Danajon Reef is among the high-producing areas for *Euheuma* spp.

Opportunities

Seaweeds farming is innately sustainable and environment-friendly. Seaweed biomass attracts various marine species and provides sanctuary and breeding grounds for marine life. It also contributes to ecological stability and sustained productivity in the reef areas. Eucheuma farming is a highly viable alternative source of livelihood, which fairly fits into the socio-economic circumstances of coastal dwellers. Often faced by declining catches and high cost of inputs, many fishers in the region usually resort to illegal or over-exploitative fishing. Seaweeds farming is an economic activity in which all members of the family, particularly the women, can take part. However, there is still lack of cohesive organization and trickling of benefits from better world prices down to the farming communities. The economic agenda of DFI are specifically tailored to remedy the problem of wealth-sharing by giving due reward to the farmers' toil.

Table 3. Standard quality requirements for marketing seaweed products

	Local Processor		Export Market	
	MC	Debris	MC	Debris
E. cottonii	35-42%	1%	35-38%	1%
E. spinosum	35-38%	1%	32-35%	1%

Common debris and foreign matters include: intentionally added salts, sand and gravel, plastic from tying materials used during culture

MC -- Moisture Content

Box 7. Lantay Eucheuma Seaweed Production System

I. "Lantay" Construction and Seaweed Planting

1. Straighten and cut bamboos or round wood to desired dimensions:
2 pcs. 5.2 m x 0.100 - 0.l20 m diameter
2 pcs. 5.2 m x 0.050 - 0.070 m diameter
4 pcs. 2.2 m x 0.080 - 0.100 m diameter
6 pcs. 1.0 m x 0.050 - 0.070 m diameter
2. Assemble the various pieces to form the "Lantay" bed using soft plastic straw "ties" or nylon twines
3. Cut 5m plastic 2" x 2" mesh net and spread one half across the "Lantay", tying with soft plastic straw
4. Spread evenly about 50 kilos of Eucheuma seedlings over the net bedding
5. Put the other half of the net as overlay on seedlings, effectively providing holdfast to avoid losing them from strong currents and wave actions
6. Fasten the net overlay with bamboo slats at 1 meter interval or as needed
7. Install the seeded Lantay in an appropriate location using nylon rope to anchor on rocks or anchor devises
8. Install a train (series) to form a module of twenty (20) "Lantays" set by pair of fives (5)
9. Watch the plantation with TLC (tender-loving-care) until harvest.

II. Harvesting & Post-Harvesting

1. Harvest the seaweed not less that 60 days from the date of seeding
a. Prune the seaweed leaving a part of main stem (thalli) to grow again; or
b. Harvest the whole bed.
2. Dry the harvest in an elevated platform made of bamboo slats. Cover the seaweeds with transparent plastic to bleach
3. The "Lantay" itself maybe used as a drying bed should a "total" harvest is done
4. Dry the seaweed harvest to about 35% MC, bag and store in a dry clean place

The prevalent culture systems for seaweed farming include: monoline method (bottom farm or floating long lines); modified net system (hanging nets, "lantay" (bamboo bed); and "sabwag" (broadcast), the most expensive but the most profitable. "Lantay" method is a recent innovation in seaweed farming developed by MCPI. "Lantay" is a Visayan word that means a bed made of bamboo. The "Lantay" Method (**Box 6**) makes use of an inverted bamboo bed. One advantage of this method is "lantay" can also be used later to dry the seaweeds after a complete harvest. The detailed production system and projected income of farmers for seaweed farming using "Lantay" are shown in **Box 7** and **Box 8**, respectively.

With the monoline method, an area of 2500 m^2 (0.25 ha) is the ideal size for one family to operate; 500 monolines of 10 m length, spaced 0.5 m between lines can be accommodated. This would give a harvest of 12,500 kg fresh seaweeds a month on a 60-day harvest cycle. This can provide a family an annual income of USD 4000 from an investment of USD 800.

A large portion of the costs in seaweeds farming is taken up by the initial planting because planting materials are bought from suppliers some distance away from the coastal areas thus, involving high transport costs. In the succeeding planting seasons, the operating costs become much less as the materials can be recycled. Fixed costs constitute mostly of operator and family labor and hired caretaker(s) as well as some workers. Other expenditures include capital expenses for the farmhouse and drying platform, pumpboat, dugout canoe, hand tools, and other equipment, and interest on loans, depreciation charges, municipal fees and other fishing permits, as well as maintenance and repair of equipment. Processing of seaweed into semi-refined carrageenan involves simple technology. With the exception of Shemberg Marketing Corporation, the industry has limited itself to the production and export of semi-refined product where quality control is not as stringent and demanding as that for refined carrageenan.

Servicing the Seaweed Farmers

Among the other commitments of DFI is the provision of technical training and seedling sourcing, formation of cooperatives, institutional capability building; linking farmer organizations to funding sources; and assisting farmers in marketing their produce. The MCPI on the other hand, assists the farmers in marketing their produce upon compliance with its requirements, i.e, adopting prevalent cultivation system that are environment-friendly; proper post-harvest processing and handling; market classification and standards; and raw seaweeds quality standards set by MCPI. Seaweeds should be sun-dried with moisture contents (MC) not to exceed 38% and impurities or foreign matters not more than 1% (**Table 3**).

Fresh seaweeds are also sold in local markets as these form part of a salad delicacy known as "guso" salad. Semi-dried produce could also be sold to local carrageenan

Box 8. Farmer's Projected Income (20-"lantay" module, occupying about 300 m² of ocean space)		
Lantay Costs (in PHP)	Per lantay (PHP)	Per Module (20 lantay), PHP
Bamboo (2 Poles)	100.00	2,000.00
Nylon Nets, Nylon Rope, Nylon twine/straw, etc.	200.00	4,000.00
Anchor (cement blocks or steel bars)	200.00	4,000.00
Seedlings (35 kg @8/kg), etc.	280.00	8,000.00
Total Initial Cost	**780.00**	**18,000.00**
Income (Dried Harvest): Starting 3rd month, 10 lantay@50kg = 500 kg		500 kg
Gross Revenue Per Month (Farm Gate Price: PHP 35/kg),		17,500.00
Total Income Per Year (No. of Harvest-1st year: 10X)		**175,000.00**
Net Farmer's Income		**157,000.00**

manufacturers. In any case, MCPI sees to it that the producers comply with the basic standard requirements. MCPI reported that there has been records of recent substantial export from the Philippines that were rejected and returned by Chinese and European buyers due to poor quality.

The complex market structure through which the produce is channeled could contribute to the deterioration of the quality of the product. The market channel starts from: (1) the farmer-producer who may also serve as collector or assembler; (2) to the small traders who act as middlemen or perhaps small-scale assemblers or wholesalers; (3) to the large traders who are mainly agents; and finally (4) to the exporters or the processors sometimes serving also as exporters.

Some progressive farmers who have the means to transport and sell directly to the big exporters and/or processors pass through a shorter route than the small-scale farmers. The produce of the small-scale farmers usually goes through a series of middlemen before reaching the exporters and/or processors. Since the exporters or processors determine the buying price, the small-scale farmers who represent the majority of the producers receive only a small share of the profit. A large chunk goes to the middleman, assembler or wholesaler. The large-scale exporters/processors serve sometimes as subsidiaries of foreign processors or independent exporters or processor-exporters.

Conclusion and Recommendations

The increasingly diversified applications of carrageenan have expanded the market for seaweed and carrageenan. Recently, it has been utilized in medical syrups as it provides excellent suspension of the antibiotic ingredients. The gel foam in air fresheners has been added to the list of carrageenan's industrial uses. These and the other uses mentioned earlier will continue to raise demand easily doubling or even tripling in two to five years. The Philippine domestic market for carrageenan is also expanding. Local food and toothpaste manufacturers have begun using carrageenan. SIAP estimates that the annual requirements of the ham industry alone (carrageenan is a binder in ham-making) for carrageenan will reach 2000 mt, which is valued at PHP 375 million.

The local processing plants have established state-of-the-art processing plant facilities, but there is need to promote vigorously the product in world markets. In order to meet the growing demand for seaweed, the country needs to develop new farming areas. In addition, the Philippine Government should promote improved production and culture techniques, and uniform quality standards in seaweeds buying. The private sector needs assistance in improving product quality. This would include research on seedling selection, better techniques for productive and environment-friendly culture systems, and quality improvement. There is need to establish common harvest facilities and promote cooperative marketing. The private sector needs logistics support to continue bridging the link between the farmer beneficiaries with reliable exporters so that the farmers can obtain a fair price for their product.

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