Seaweed FARMING

Kappaphycus and *Eucheuma*

Bureau of Fisheries and Aquatic Resources
REGIONAL OFFICE NO. 8
http://region8.bfar.da.gov.ph

Fisheries Technology Series 1 November 2014

The Cover

Harvest of seaweeds at the Regional Seaweed Nursery Farm, Brgy Ngolos, Guiuan, Eastern Samar. This seaweed nursery is one of the BFAR 8-maintained nurseries in the region. Harvested seaweeds are distributed through the Bureau's seaweed dispersal program and roll-over scheme.

Fisheries Technology Series 1
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Seaweed Farming
Kappaphycus and *Eucheuma*

Department of Agriculture
Bureau of Fisheries and Aquatic Resources 8
Tacloban City

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REGIONAL SEAWEED NURSERY FARM
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Introduction

Seaweeds are macro-benthic algae. They are plants that are found in marine waters. They are non-vascular plants, which means they do not have roots, stems and leaves. Like any other plants, they use light energy and convert it to utilizable energy in the process called photosynthesis.

The importance of seaweeds can be viewed into two perspectives: ecological value and economic uses. It serves as habitat and breeding ground for many marine organisms. Depending on the species, it is also a healthy source of human food and raw materials for phycocolloid products such as agar and carrageenan. These products are used in food industries, cosmetics, pharmaceutical, household products and biotechnology.

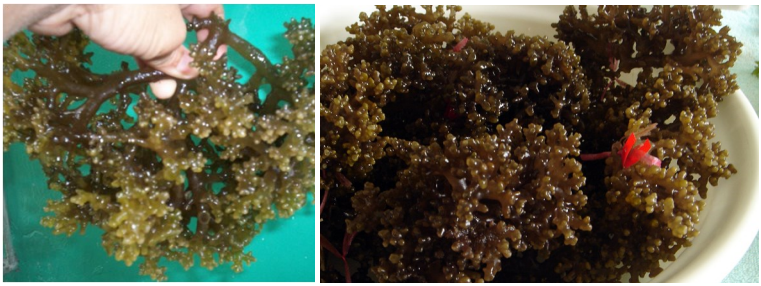
In the Philippines, the farming of seaweeds is an established industry. It is now emerging as an important and a major livelihood among coastal communities. It is also one of the top export products of the country. Based on the report of BAS (2011), seaweeds contributed about 1,840,832.86 metric tons or 70.58% of the country's total aquaculture production. Most of these seaweeds were farmed using economically-feasible culture methods.

This manual provides basic information and important instructions in the farming of *Kappaphycus* and *Eucheuma*. This will surely assist seaweed farmers and technicians, particularly in the Eastern Visayan region, which the industry currently needs.

Species of seaweeds to culture

Kappaphycus alvarezii
- locally known as *tambalang* or *guso*; cultured varieties of this species are in brown, dark or lighter green

Eucheuma denticulatum
- locally known as *spinosum*; cultured varieties are in brown, green and red varieties



Kappaphycus striatum
- locally known as *sacol*

Where to get your ‘seedlings’

Seedlings may be acquired to any of these BFAR-maintained seaweed nurseries in the Region.

Where to culture seaweeds

The most important aspect in developing a productive seaweed farm is site selection. The farming site must be assessed prior to culture and should conform to the following criteria:

- moderate water movement and free from big waves
- adequate light penetration, not turbid
- sufficient water depth; to culture seaweeds in shallow areas, the planting materials should not be exposed during low tides as this is damaging to the farmed seaweeds
- the substratum or bottom should be coarse sand-rocky to corally
- optimum temperature range 27-30 ºC
- salinity level of 30-35 ppt; far from freshwater source (river mouth) or brackish water areas should be avoided
- clean and clear seawater; free from siltation and pollution
- for fixed-bottom method, the site should be subtidal and shallow; in deeper areas, floating monoline is recommended

How to culture seaweeds

PREPARATION OF PLANTING MATERIALS

Any of the following materials can be used

Cultivation line

- monofilament (nylon) no. 80 and 300
- polyethylene rope no. 24 & 18

Tying material

- softie plastic twine (straw)

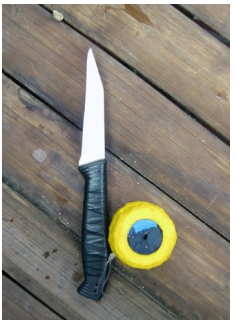
Support materials

- bamboo poles
- sinkers
- Sandbags
- Knife
- Counter weights

Floaters

- buoys
- empty plastic bottles






PREPARATION OF 'SEEDLINGS'

- Select good quality seedlings. Choose luxuriant and young branches (thalli) with sharp pointed tips for planting.
- Seedlings should have no traces of grazing or early signs of *ice-ice*. Use a clean, sharp-edged, stainless steel knife for cutting to leave a smooth surface on the branch.
- Clean the seedlings and remove all attaching debris.
- Seedlings or cuttings are approximately 200 grams.
- Tying of seedlings should be done in the shore. Tie the plant at its strongest branch using an 8-inch soft plastic twine. The weight should be balanced on both sides of the *tie-tie*. Provide a 1.0 cm space in tying the plant for growth.
- Immerse the seedlings in seawater to prevent from drying before planting.

Preparation of the seedlings for planting

CULTURE METHODS

Bottom monoline method

The bottom monoline or fixed off-bottom method is used in shallow areas near shore. This method requires low investment, easy to install and farm maintenance is cheaper.

Site

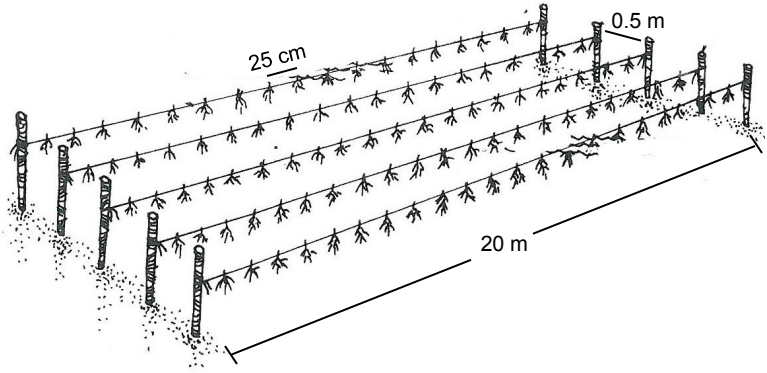
- shallow water; water depth should not <0.5 m
- sandy-corally bottom
- presence of other seaweeds as indicator of growth
- clean and clear water

Construction

1. Clear the site of undesirable organisms.
2. Stake the poles into a strong substrate (steel bars or bamboos) for about 20 m apart.
3. Tie the monofilament nylon or polyethylene ropes in the stakes. The cultivation lines are installed perpendicular to the prevailing water current and tied at fixed intervals to allow water movement and passage. The lines are also hanging and not touching the bottom.
4. Distance of rows of stakes is 0.5 m apart. The cultivation lines are 30-40 cm from the bottom at the lowest tide.

Tying

1. Tie the seedlings or 'tie-tie' firmly to the cultivation lines at 25 cm intervals.



Seaweed farming using bottom monline method in Dawahon, Bato, Leyte

Floating monoline method

This method is used in deep waters (5-10 m high). It needs a good anchorage to avoid the farm to be carried away in times of strong currents.

Grazing by benthic (bottom) animals is minimized or eliminated in this method. The seaweeds are raised above, approximately 30 cm submerged in the water from the surface.

1. Modified single floating monoline

Site

- moderate water movement
- protected from big waves
- availability of good anchorage
- deep water (>10 m high) or water depth of 5 fathom or more at the lowest tide

Construction

1. Install 95 m (1 kg monofilament nylon) cultivation line parallel to the prevailing water current.
2. Anchor the cultivation line using sandbags on both ends and provide buoys as markers.
3. Tie empty plastic bottles (floaters) at close intervals along the cultivation line. The floaters are tied in the line to keep it afloat at approximately 0.5 to 1.0 cm below the water surface.

Tying

1. Tie the seedlings or 'tie-tie' firmly to the cultivation and buoy lines at 25 cm intervals.

Modified single floating monoline method in San Julian, Eastern Samar

2. Modified modular floating monoline

One modification of the floating monoline method is by using PE rope no. 26 as mother line.

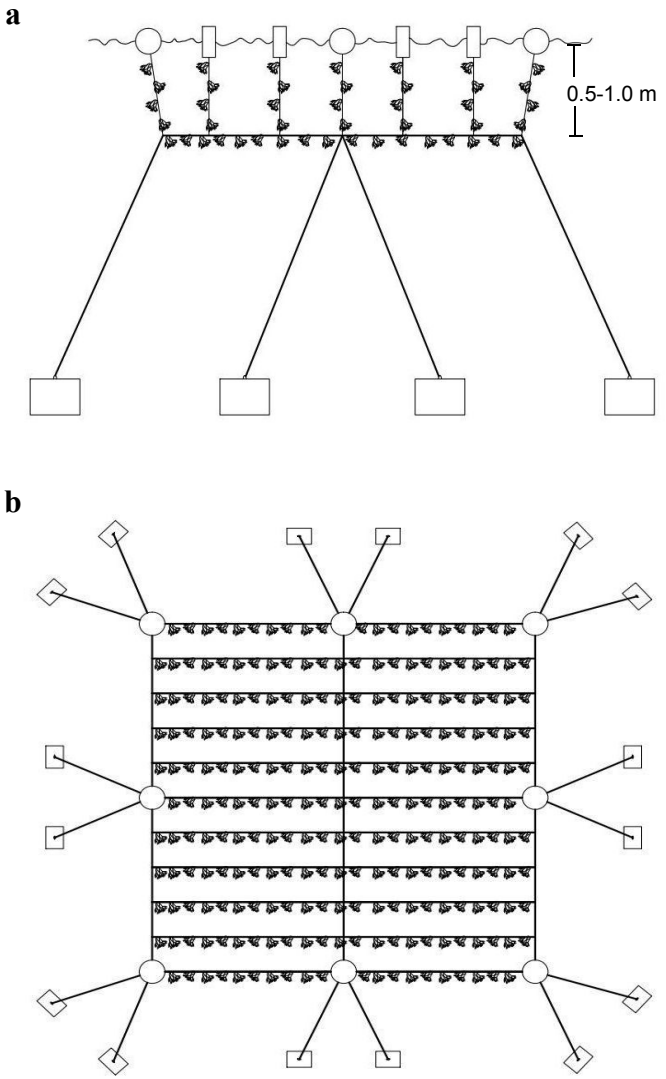
Site selection ollows the same criteria as the single floating monoline.

Construction

1. Install mother lines using PE rope no. 26 making a 50 x 20 m rectangular plot. The 20-m mother lines should be parallel to the water current.
2. Place sandbags and buoys at the corners and in between as anchorage and markers, respectively.
3. Tie empty plastic bottles (floaters) at close intervals along the cultivation line. The floaters are tied in the line to keep it afloat at approximately 0.5 to 1.0 m below the water surface.

Tying

1. Tie the seedlings or 'tie-tie' firmly to the cultivation and buoy lines at 25 cm intervals.



Modified modular floating monoline: a) side view; b) top view

FARM MAINTENANCE

The seaweed farm should be cleaned and cleared of silt, floating debris, tying materials and macrograzers that adhere to the seaweeds. This is done by shaking the cultivation lines regularly. Epiphytes or species of algae other than the farmed seaweed should be removed as these compete for nutrients, light and space.

Undesirable materials and seedlings which look diseased should be removed. Poor-growing and lost seedlings should be replaced immediately. When a disease spreads in the farm, total harvest is recommended.

HARVESTING

Harvesting of seaweeds is a simple work to do. Harvest is done after 50 days of culture. It can be harvested by:

- untying both ends of the cultivation lines from the stakes and the lines with seaweeds are brought to the shore (fixed off-bottom monoline method)
- cutting the straws with seaweeds individually from the cultivation lines (floating monoline method)
- partial harvesting or pruning

Post harvest

CLEANING

After harvesting, the seaweeds should be washed with clean seawater to maintain a high quality product. Avoid contact with fresh water as this will reduce salt content, degrade carrageenan and storage quality.

Remove the following materials:

- non-cultured seaweeds
- Silt, sand and stones
- plastic straw twine
- wood and dead leaves
- other foreign material that adhere to the harvested seaweeds

DRYING

It is recommended to dry seaweeds off the ground right after cleaning and sorting. This method allows air to circulate more rapidly, thus shortening the drying period.

Drying is done for 2-3 days during sunny days and 4-5 days when cloudy. Harvested seaweeds should be laid down in platforms or spread in hanging lines for fast drying. Turn-over the seaweeds for consistent dryness.

Drying of seaweeds in hanging lines and platforms

TOP QUALITY DRIED SEAWEEDS

A top quality dried seaweed has an average moisture content of 35% (range, 30-39%). It has been sorted in one species only, consistently dried, free of sand and foreign materials, stored properly, protected from rain and transported within several days to prospect buyers.

STORAGE

Dried seaweeds must be stored in the shortest possible time in a clean, dry and well-ventilated place. Pack dried seaweeds in clean sacks. Never store wet seaweeds.

Storage of dried seaweeds in sacks and polyethylene bags

Marketing

There are many seaweed traders/buyers in the country. The common practice in the marketing of seaweed is from farmer/producer through local traders to exporters or processors. It is channelled to several buyers before it reaches the processors.

Some of the traders and exporters of seaweeds are listed at the last pages of this manual.

Problems in seaweed farming

DISEASES

Health management in seaweed farms is primarily done with proper site, species selection and farm maintenance. However if not properly managed, various diseases may invade the farm.

There are two important diseases encountered in the farming of *Kappaphycus* and *Eucheuma* that have especially caused detrimental problems to farms. These are:

***Ice-ice* disease** - characterized by general paling or loss of color in the early stages of infection. It is caused by low salinity, temperature and light intensity. When the plant is under these stressful conditions, it exudes an organic substance which is muscilaginous in nature, and the presence of opportunistic bacteria in the water column aggravates the whitening of the branches

Epiphyte infestation - epiphytes refer to organisms, small or large, that colonize or attached to the surfaces of seaweeds. It becomes harmful when it causes considerable damage to the cultured seaweed such as creating wounds and fragmentation or disintegration. Possible factors that trigger the occurrence of epiphytes include:

- state of health of the seaweed
- no water movement
- extreme water temperature
- low salinity
- highly turbid waters

Seaweed diseases: ice-ice and epiphytes infestation

Thallus color and growth rates are indicative of the health of the cultured seaweeds. Aside from *ice-ice*, the following are the commonly encountered thallus conditions that every farmer should be aware of:

Pitting - usually occurs at the cortical layer wherein a cavity is formed mainly due to mechanical wound, however, the cortical layer is regenerative

Tip darkening - this is due to senescence (old-age) and cold water which result to loss of color and consequently disintegration, however, seaweed tips can grow back

Tip discoloration - is due to aerial exposure and intolerance to warm waters; there is a change toward pinkness and eventual softening of the tips, followed by further discoloration, finally becoming white, and later dissolving away

Slowing of growth (stunted growth) - this is mainly due to 1) appearance of epiphytes, 2) pigment loss, 3) tissue softening, 4) general decay, 5) poor season and 6) poor site

Die-off - is initially manifested by discoloration which is mainly brought by pools of freshwater run-off

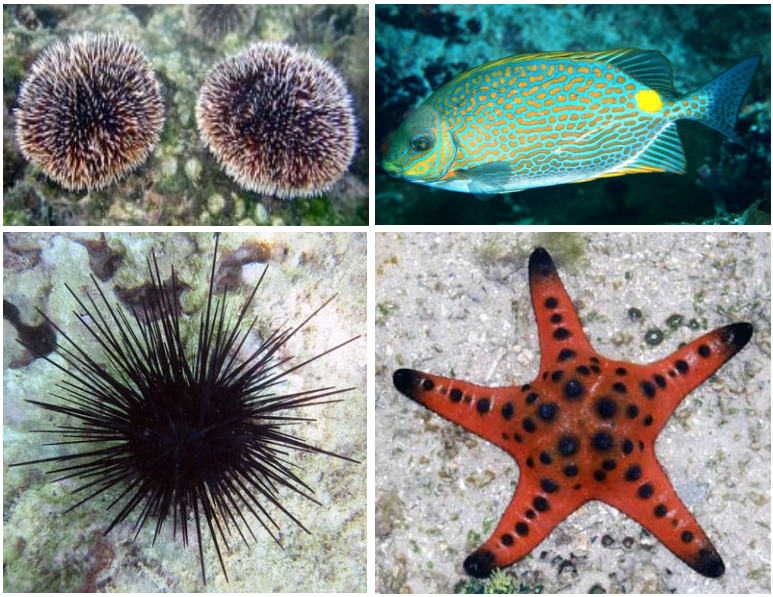
Seaweed diseases: tip discoloration and stunted growth

GRAZING

Aside from diseases, grazing is one big problem in seaweed farms. If not minimized, it can wipe out a whole farm. Grazers come in two forms:

Micrograzers - animals less than 2 cm long which take up residence feed on the thallus. These are nematodes and planktonic stage of marine invertebrates)

Macrograzers - in general, animals that are bigger than 5 cm (fish and adult marine invertebrates). Rabbitfish, sea urchin and starfish are common macrograzers.



Macrograzers: Rabbitfish (danggit), starfish and sea urchins

Economics

Bottom monoline

ASSUMPTIONS

Area	2,520 m^2
Description	20 m/line x 250 lines
Seedling requirement	4,125 kg (20 m/line x 5 tie-tie/m = 100 tie-tie/line x 250 lines = 25,000 @ 150 g tie-tie = 3,750 kg + 10% biological loss
Culture period	50 days
Cropping/year	5
Total harvest per cropping (wet wt)	16,500 kg
Less	
Seedling for the next cropping	4,125 kg
Biological loss	1,650 kg
Yield (wet wt)	10,725 kg
Drying ratio	7:1
Dry wt/cropping	1,532.14 kg
Price/kg	Php 50.00

Items	Quantity	Unit Cost (PhP)	Total Cost (PhP)	Economic Life (Year)
Polyrope No. 7	25 rolls	400	10,000	3
Dug-out banca	1 unit	5,000	5,000	3
Bull hammer	2 pcs	350	700	3
Stilt dryer (with guardhouse, 200 m^2	1 unit	4,000	4,000	3
TOTAL			**65,700**	

DEPRECIATION

Economic life	**3 years**
Total cost	65,700
Depreciation cost (DC)	21,900

OPERATING COST

Items	Quantity	Unit cost (PhP)	Total cost (PhP)
Seedlings	4,125 kg	12.00	49,500.00
Plastic straw (soft tie)	25 rolls	80.00	2,000.00
Wooden posts (1/2 m)	750 pcs	30.00	22,500.00
TOTAL			**74,000.00**

Total operating cost

= P74,000 per 1/4 ha + P600 (knives) + P24,000 (salary of 1 person for 8 months)
= **P98,600**

Total sales

= P1,532.14 kg/cropping x 5 croppings x P50.00/kg
= **P383,035**

Transport cost

= P1.00/kg x 7,660.7 kg
= **P7,660.7**

Total projected cost

Fixed cost	P65,700.00
Operating cost	98,600.00
Transport cost	7,660.70
TOTAL	**P171,960.70**

PROJECTED INCOME STATEMENT

	Year 1	Year 2	Year 3
Revenues			
Sales of seaweeds	383,035.00	383,035.00	383,035.00
Gross revenues	383,035.00	383,035.00	383,035.00
Less			
Fixed cost	65,700.00	-	-
Operating cost	98,600.00	98,600.00	98,600.00
Depreciation cost	21,900.00	21,900.00	21,900.00
Transport cost	7,660.07	7,660.70	7,660.70
Sub-total	193,860.70	128,160.70	128,160.70
NET INCOME	**189,174.30**	**254,874.30**	**254,874.30**
Average Net Income			**232,974.30**

A. Return of Investment

= (Ave. Net Income / Initial Investment) x 100
= (232,974.30 / 171,960.70) x 100
= **135%**

B. Cash Payback Period

= Total Projected Cost / Ave. Net Income
= 171,960.70 / 232,974.30
= **0.74 year**

C. Break Even Price

= (Total Variable Cost + DC) / Transport Cost
= (171,960.70 + 21,900) / 7,660.70
= **P25.31**

D. Break Even Production

= (Total Variable Cost + DC) / Unit Selling Price
= (171,960.70 + 21,900) / 50
= **P3,877.21 kg**

Modified single floating monoline

ASSUMPTIONS

Area	2,520 m^2
Description	84 m/line x 15 lines
Seedling requirement	154.0 kg (84 m/line x 5 tie-tie/m = 420 tie-tie) (Horizontal) + 5 tie-tie/float x 56 floats = 280 tie-tie (Vertical) x 200 g/tie-tie + 10% biological loss
Culture period	50 days
Cropping/year	5
Total harvest per cropping (wet wt)	616.0 kg
Less	
Seedling for the next cropping	154.0 kg
Biological loss	61.6 kg
Yield (wet wt)	400.4 kg
Drying ratio	7:1
Dry wt/cropping	57.2 kg
Price/kg	Php 50.00

Items	**Quantity**	**Unit Cost** (PhP)	**Total Cost** (PhP)	**Economic Life** (Year)
Polyrope, 9mm	4 rolls	1,300	5,280	3
Empty Plastic jug, 20 qts. cap	45 pcs	150	6,750	3
Empty rice sacks	285 pcs	12	3,420	3
Dug-out banca	1 unit	5,000	5,000	3
Dryer (2 x 5 m)	1 unit	5,000	5,000	3
Nylon (260 lbs, 300 mm, 95 m)	20 kg	295	5,900	2
Nylon # 80	1 kg	290	290	2
TOTAL			**P31,640**	

DEPRECIATION

Economic life	**2 years**	**3 years**	
Total cost	6,190.00	25,450.00	
Depreciation cost (DC)	3,095.00	8,483.34	**11,578.34**

OPERATING COST

Items	Quantity	Unit cost (PhP)	Total cost (PhP)
Seedlings	154 kg	12.00	1,848.00
Plastic twine (soft tie)	1/2 roll	180.00	90.00
Empty plastic bottles	56 pcs	2.00	112.00
TOTAL			**2,050.00**

Total operating cost

= P2,050/line x 15 lines + P600 (knives) + P48,000 (salary for 2 person for 8 months at P3,000/monthly)
= **P79,350**

Total sales

= P57.2 kg/line x 15 lines x 5 croppings x P50.00
= **P214,500**

Transport cost

= P1.00/kg x 4,290 kg
= **P4,290**

Total projected cost

Fixed cost	P31,640.00
Operating cost	79,350.00
Transport cost	4,290.00
TOTAL	**P115,280.00**

PROJECTED INCOME STATEMENT

	Year 1	Year 2	Year 3
Revenues			
Sales of seaweeds	214,500	214,500	214,500
Gross revenues	214,500	214,500	214,500
Less			
Fixed cost	31,640	-	-
Operating cost	79,350	79,350	54,600
Depreciation cost	11,578.34	11,578.34	12,560
Transport cost	4,290	4,290	4,290
Sub-total	126,858.34	95,218.34	71,450
NET INCOME	**87,641.66**	**119,281.66**	**119,281.66**
Average Net Income			**108,735.00**

A. Return of Investment

= (Ave. Net Income / Initial Investment) x 100
= (119,281.66/115,280.00) x 100
= **104%**

B. Cash Payback Period

= Total Projected Cost / Ave. Net Income
= 115,280/119,281.66
= **0.97 year**

C. Break Even Price

= (Total Variable Cost + DC) / Transport Cost
= (115,280+11,578.34) / 4,290
= **P29.57**

D. Break Even Production

= (Total Variable Cost + DC) / Unit Selling Price
= (115,280+11,578.34) / 50
= **P2,537.17 kg**

Modified Modular Floating Monoline

ASSUMPTIONS

Area	1,000 m^2 50 m/line x 20 lines @ 1 m distance
Description	Between lines
Seedling requirement	1,760 kg (48 m/line x 5 tie-tie/m @200 g/tie-tie x 20 lines = 960 kg (Horizontal); 32 floats/line @ 5 tie-tie/float x 20 lines @ 200 g/tie-tie = 640 kg (Vertical) + 10% biological loss
Culture Period	50
Croppings/year	5
Total harvest per cropping (wet wt)	7,040 kg
Less	
Seedling for the next cropping	1,760 kg
Biological loss	704 kg
Yield (wet wt)	4,576 kg
Drying ratio	7:1
Dry weight/cropping	653.71 kg
Price/kg	

Items	**Quantity**	**Unit Cost** (PhP)	**Total Cost** (PhP)	**Economic Life** (Year)
Polyrope, 9mm	2 rolls	1,320	2,640	3
Empty plastic jug	9 pcs	150	1,350	3
sacks	220 pcs	12	2,640	3
Dug-out banca	1 unit	5,000	5,000	3
Dryer (2 x 5 m)	1 unit	5,000	5,000	3
Nylon (260 lbs, 300 mm, 95 m)	16 kg	285	4,560	2
Nylon # 80	1 kg	290	290	2
TOTAL			**P22,230**	

DEPRECIATION

Economic life	**2 years**	**3 years**	
Total cost	5,600.00	16,630.00	
Depreciation cost	2,800.00	5,543.34.00	**8,343.00**

OPERATING COST

Items	Quantity	Unit cost (PhP)	Total cost (PhP)
Seedlings	1,760 kg	12.00	21,120.00
Plastic straw (soft tie)	2 rolls x 5 crops	180.00	1, 800.00
Empty plastic bottles	640 pcs	2.00	1,280.00
TOTAL			**24,200.00**

Total operating cost

= 24,200/module + 600 (knives) + 48,000
(salary for 2 persons for 8 months at P3,000/monthly)
= **P72,800**

Total sales

= 653.71 x 5 croppings x P50/kg
= **P163,427.50**

Transport cost

= P1.00/kg x 3,268.55 kg
= **P3,268.55**

Total projected cost

Fixed cost	P22,230.00
Operating cost	24,200.00
Transport cost	3,268.55
TOTAL	**P49,698.55**

PROJECTED INCOME STATEMENT

	Year 1	Year 2	Year 3
Revenues			
Sales of seaweeds	163,427.50	163,427.50	163,427.50
Gross revenues	163,427.50	163,427.50	163,427.50
Less			
Fixed cost	22,230.00		
Operating cost	24,200.00	24,200.00	24,200.00
Depreciation cost	8,343.00	8,343.00	8,343.00
Transport cost	3,268.55	3,268.55	3,268.55
Sub-total	58,041.55	35,811.55	35,811.55
NET INCOME	**105,385.95**	**127,615.95**	**127,615.98**

A. Return of Investment

= (Ave. Net Income / Initial Investment) x 100
= (120,205.95/49,698.55) x 100
= **242%**

B. Cash Payback Period

= Total Projected Cost / Ave. Net Income
= 49,698.55/120,205.95
= **0.42 year**

C. Break Even Price

= (Total Variable Cost + DC) / Transport Cost
= (49,698.55+8,343) / 3,268.55
= **P17.76**

D. Break Even Production

= (Total Variable Cost + DC) / Unit Selling Price
= (49,698.55+8,343) / 50
= **P1,160.84 kg**

Market outlets for dried seaweeds

Tacloban

TBK manufacturing Corporation
Brgy Hollywood, Nula-tula, 6500 Tacloban City
Product line: dried Kappaphycus and Eucheuma
Mr Peter Gan (Manager)
(053) 321-6720

Cebu

Shemberg Corporation
Jayme St., Pakna-an, Mandaue City 6014 Cebu
Product line: carrageenan
Mr Bensoy U. Dacay (CEO)
(032) 346-0789; 345-1045
(032) 346-1892; 346-0863

MCPI Incorporated
1. Tugbongan, Consolacion 6000 Cebu City
2. Suite 301-32 Casa Mendoza Bldg., A Cortes Ave., Mandaue City 6014 Cebu

Product line: carrageenan
Mr Maximo A. Ricohermoso (President)
(032) 346-3566
0912-501-0890
(032) 346-0138; 346-0588

FMC Corporation
Ouano Compound, Looc, Mandaue City 6014 Cebu
Product line: seaweed flour
Ms Tita Tomayao (General Manager/VP)
(032) 346-0882
(032) 346-1182

CP KELAW
Sibonga, Cebu

Genu Philippines, Inc.
6/F Metrobank Plaza, Osmeña Bldg., 6000 Cebu City
Product line: dried and alkali-treated seaweeds
Mr Anastacio Camboanga (President/General Manager)
(032) 253-3053
(032) 253-0773

Biocon Philippines/Deltagen, Inc.
1. Mactan Export Processing Zone, G/F SFB Pt. 1,
   Lapu-lapu City 6015 Cebu
2. Tabuk, Mandaue City 6014 Cebu
Product line: carrageenan
Ms Ernestina Elizalde
(032) 340-0322; 340-0319; 340-0764
(032) 340-0328; 340-0324

Geltech Hayco, Inc.
Cebu Office
2/F GCH Bldg., Tres Borces St., Mabolo 6000 Cebu City
Engr Go Ching Hai
(032) 231-0388
(032) 231-0103
hayco@geltech-hayco.com

Manila Office
2. 5/F Prosperity Bldg., 395 Banaue St., 1100 Quezon City
(02) 731-7714
(02) 740-5916

Manila

Marcel Trading Corporation
5/F First Marcel Tower, 926 Araneta Ave., 1104 Quezon City
Product line: carrageenan
Mr Michael Tan (President)
(632) 712-2631
(632) 712-1989; 712-5879

Individual (roaming) buyers

Mr. Maximo Cabanatan
Sitio Converse, Brgy. Ngolos, Guiuan, Eastern Samar

Mr Claudio Rey Daño
Shellcraft Products
Brgy Campoyong, Guiuan, Eastern Samar
09215631981, 09066418857

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