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**MANUAL OF RUNNING WATER FISH CULTURE
1. *EUCHEUMA* SPP.**

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FOREWORD

This manual was based on actual seaweed farming development of Eucheuma in Cebu and Bohol by the author with the Genu Products, a private company engaged in seaweed farming. This manual was also used in training contract small scale seaweed farmers as part of the extension training and services conducted by the Bureau of Fisheries and Aquatic Resources.

**ASEAN/UNDP/FAO Regional Small-Scale Coastal Fisheries Development
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1988**

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MANUAL ON SEAWEED FARMING

1. EUCHEUMA SPP.

by

Godardo L. Juanich¹

OVERVIEW

Eucheuma, a red alga, endemic to Philippine marine waters, is the twentieth-century wonder plant. It is so called because of its many important uses in various industries. From this seaweed is extracted carrageenan, a valuable

sustance used in products that need gelling, suspending, thickening, emulsifying and water-holding properties.

Eucheuma thrives in some selected areas in tropical zones. In Asia, the major-producing countries are the Philippines and Indonesia with perhaps a little contribution from Singapore, Japan and Malaysia. Outside Asia, the biggest producer of a similar type of seaweed called Irish Moss is Canada. There had been noticeable decrease in the volume of outputs in those countries due to the indiscriminate harvesting of seaweed by lots of commercial investors.

In the Philippines, the Mindanao-Sulu area is claimed to have the richest source of Eucheuma. Based on the survey of the Bureau of Fisheries and Aquatic Resources on the known Eucheuma resources of the country, the Mindanao-Sulu area occupies 42 percent of the total suitable areas. Visayas takes a share of 28.63 percent, while Palawan is estimated 13.6 percent. Luzon area has 14.68 percent (Reyes, 1977).

Eucheuma in dried form is basically an export product of the Philippines. Most of the country's seaweeds are transported to the United States, while some find their way to Europe and Japan (Reyes, 1977).

In 1966, it was one of the important marine export commodities of the country, totalling 800 tons worth millions of pesos most of which were harvested from the wild. But the export in the five succeeding years decreased, so that its culture was started in 1975 (Borja, 1978).

A survey of the Genus, indicates that there are approximately 48 species described in the literature (Dawes, 1974). Six of these species represent Philippine Eucheuma (Trono, 1974). They are Eucheuma serra, E. arnoldii, E. procrusteanum, E. cottonii, E. spinosum and E. striatum (Figure 1).

Of these six species, Eucheuma spinosum and E. striatum, locally known as "tambalang", are best suited for commercial cultivation, however, the latter is preferred due to its wider range of tolerance to ecological changes and is easier to farm (Trono, 1977).

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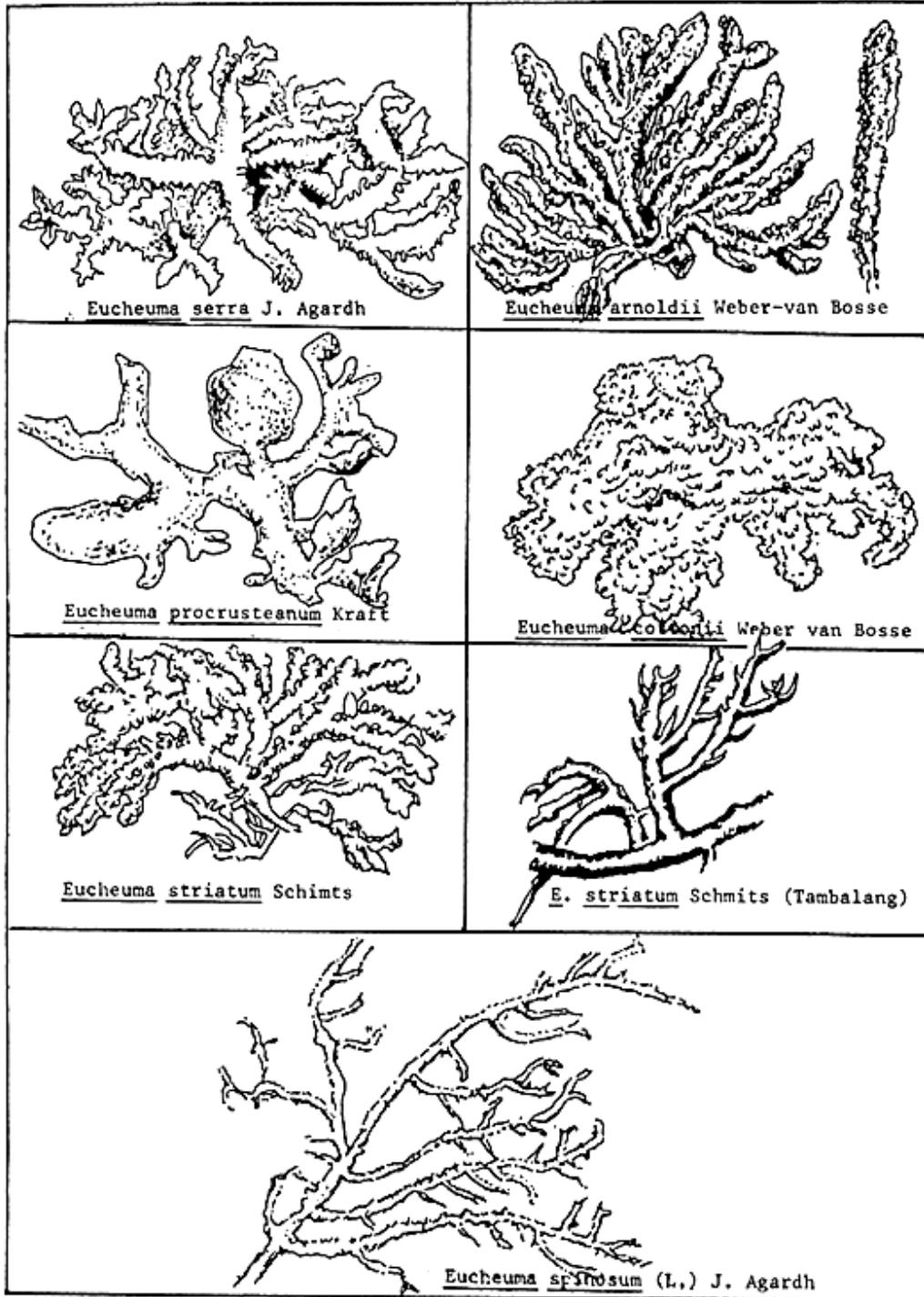


Figure 1. Philippine Eucheuma

1. OBJECTIVES

The purpose of this handbook is to guide the prospective farmers on the proper and the best method of farming seaweeds.

Specifically, the learner will be able to:

- a. Identify the factors in the selection of a suitable site for Euचेuma farming and conduct test planting;
- b. Prepare the farm site and culture materials;
- c. Construct a Euचेuma farm; and
- d. Manage a Euचेuma farm.

1.1 Site selection

The search for a suitable area is the most difficult task encountered in the industry due to the very delicate nature of the plant. The following are some guides in selecting and prospecting areas for Euचेuma farming.

1. Choose a location where there is a good water movement or where there is a rapid water turnover, but not heavy enough to damage the farm. Water current speed should be between 20 to 40 meters per minute.
2. Area should be sheltered from very strong wave action, current and winds.
3. Avoid areas that are near the mouth of rivers or where there is a heavy freshwater runoff. Euचेuma is a purely marine alga. Salinity of the farm area should be from 27 to 35 parts per thousand.
4. The area should have a water temperature range between 25°C and 30°C.
5. Water depth in the farm should not be less than 2 feet during the lowest tide and more than 7 feet during high tide.
6. The ground should be stable enough to permit easy installation of stakes or bamboos.

7. Farm bottom composition should be sandy and rocky depending upon the variety of Eucheuma.
8. If possible, choose areas where Eucheuma is endemic. However, the absence of such is not necessarily a negative sign.
9. Take note of the other marine plants and animals that are associated with Eucheuma, for they are good indicators of possible site for Eucheuma farming.
10. Consider also the availability of labor, materials, accessibility to transportation and communication as well (Figure 2).

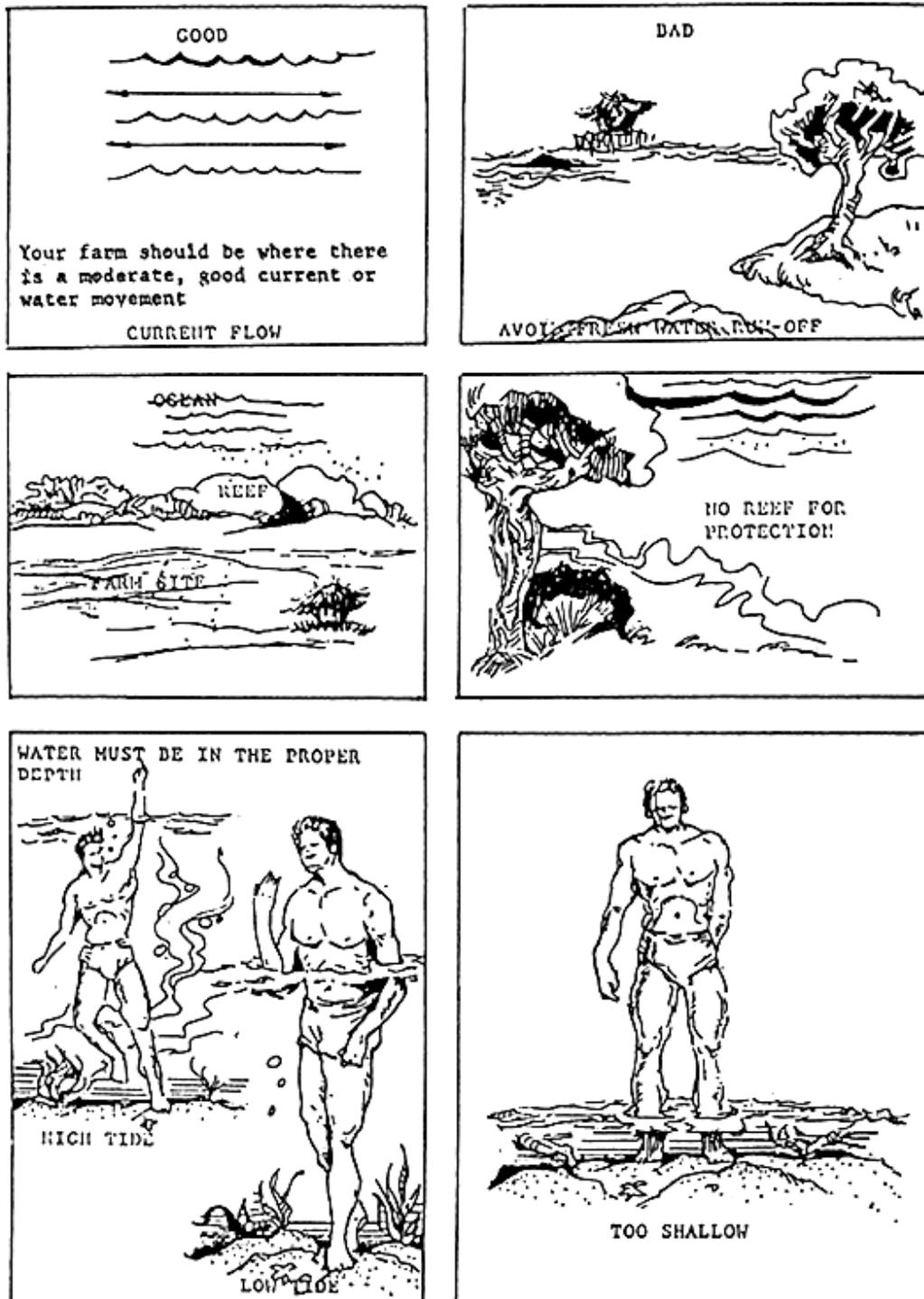


Figure 2. Farm sites

Generally, there is no way of determining the appropriateness of the area unless actual testing is done. The level of productivity of the selected area or locality can

not be accurately ascertained until a history of growth rate has been established. Once the site is pinpointed, the task of production will be relatively easier.

1.2 Installation of test plants

1.2.1 Kinds of test planting

a) Line method

The use of loop or knotted monofilament line or polyethelene rope or any twine (durable enough to last for the duration of the test planting activities) tied end to end of two mangrove stakes installed 12 meters apart from each other, into which test plants are tied to the loop with corresponding numbered rubber sandal tag for identification (Figure 3).

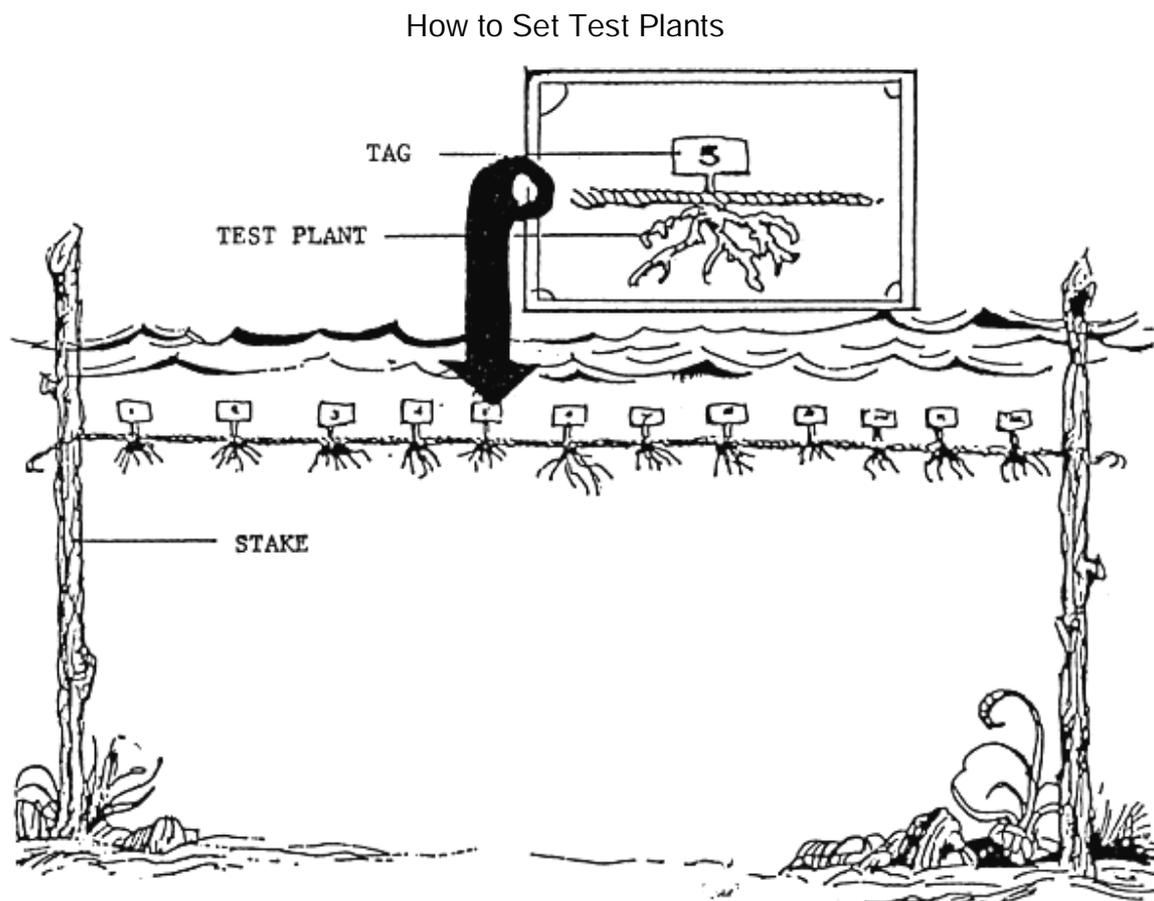


Figure 3. Line method

b) Net method

The use of monofilament or polyethelene net measuring 2.5 meters wide by 5 meters long with a mesh measurement of 60 cm mesh stretch (see Figure 4).

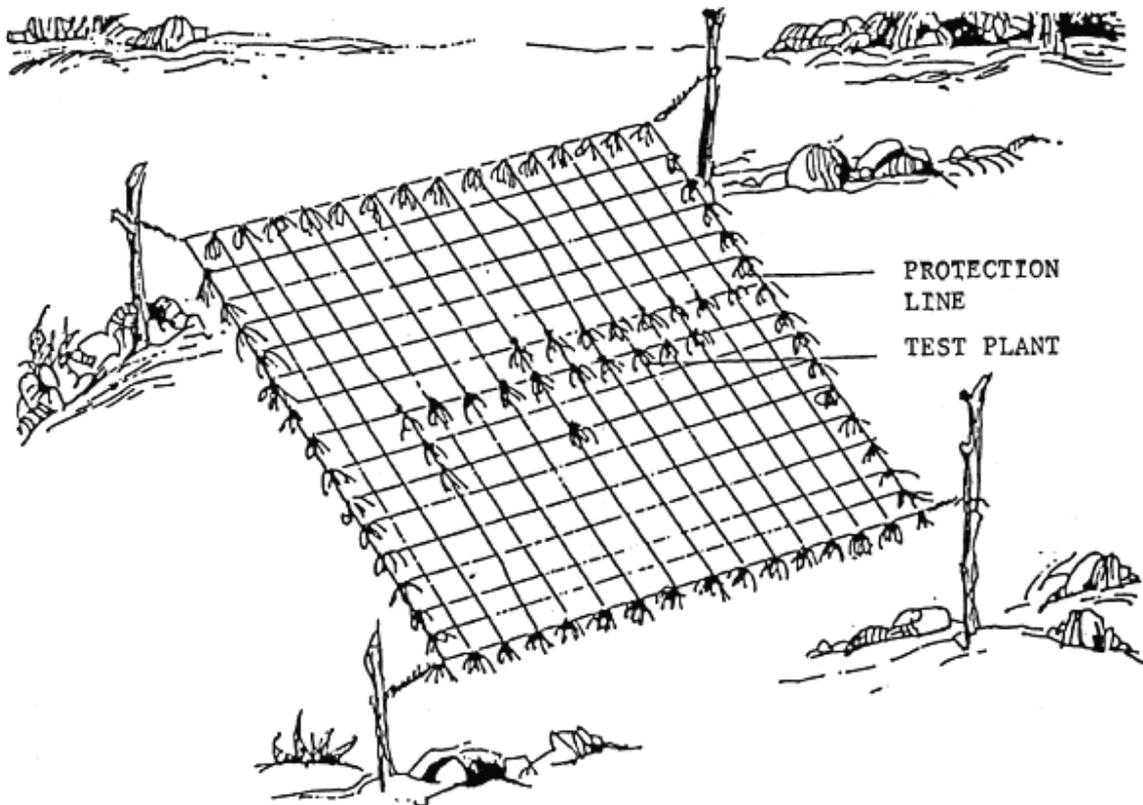


Figure 4. Net method

1.2.2 Introduction of test plants

Seedlings (propagules) used for test planting should come from within the area to avoid stress on the plant.

1. Weigh individual test seedlings before test planting.
2. Undertake actual planting with numbered tag sandals for identification purpose.
3. Clear daily the test plant.
4. Treat test plant individually and avoid direct exposure to sunlight or rain.

5. Weigh plants to get growth rate from the test plant with a duration of at least 6 weeks or more for more reliable data.
6. Weigh test plants weekly or every 15 days to avoid stress on the plants.
7. Check test plants, missing plants should be replaced immediately.
8. Take note of the seedlings growing points for it is one indicator of good growth.
9. Use triple beam balance/string balance or actual calculation in determining the incremental weight.
10. Formula for getting growth rate.

$$\frac{\text{TW} - \text{OW}}{\text{No. of culture days}} = \text{percent daily growth rate}$$

Where:

TW = Total weight of plant after test planting

OW = Original weight of the plant before test planting

No. of culture days = Period of test planting

The data gathered on the proposed site should be carefully analyzed and the result of the test planting will serve as basis in determining the suitability of the area and the desired methods of farming to be used.

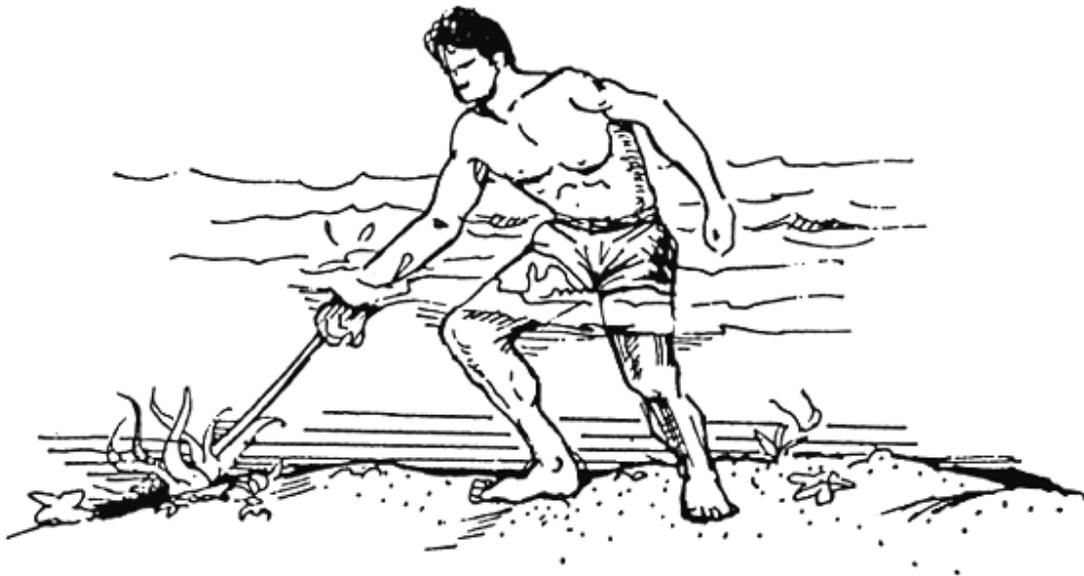
A good seaweed farmer must know first his farm, available resources, the environmental condition as well as its location, boundaries and shape of the area. A knowledge of all these will guide the farmer on the proper construction of the farm.

2. PREPARATION OF THE FARM SITE AND OTHER CULTURE ACTIVITIES

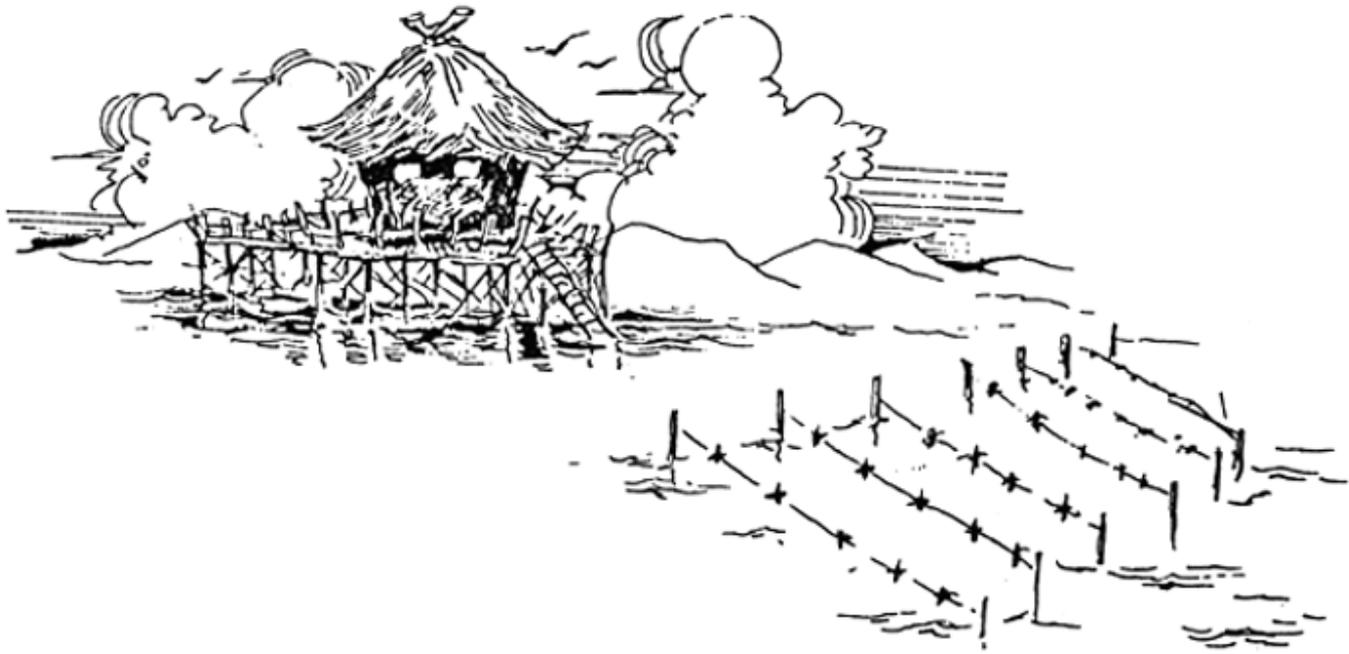
When a site suitable for Eucheuma farming has been selected, secure a permit from the nearest Bureau of Fisheries and Aquatic Resources office which has a direct jurisdiction over the area for legal acquisition. The following are the steps to follow (BFAR, Illustrated Handouts).



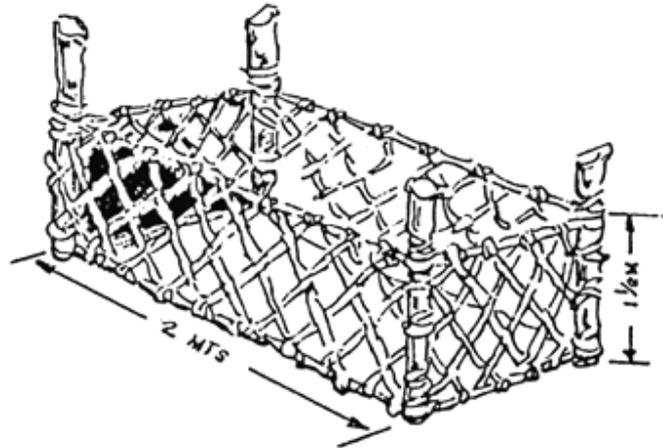
1. Cut all grasses and remove all obstacles from the area (Figure 5).



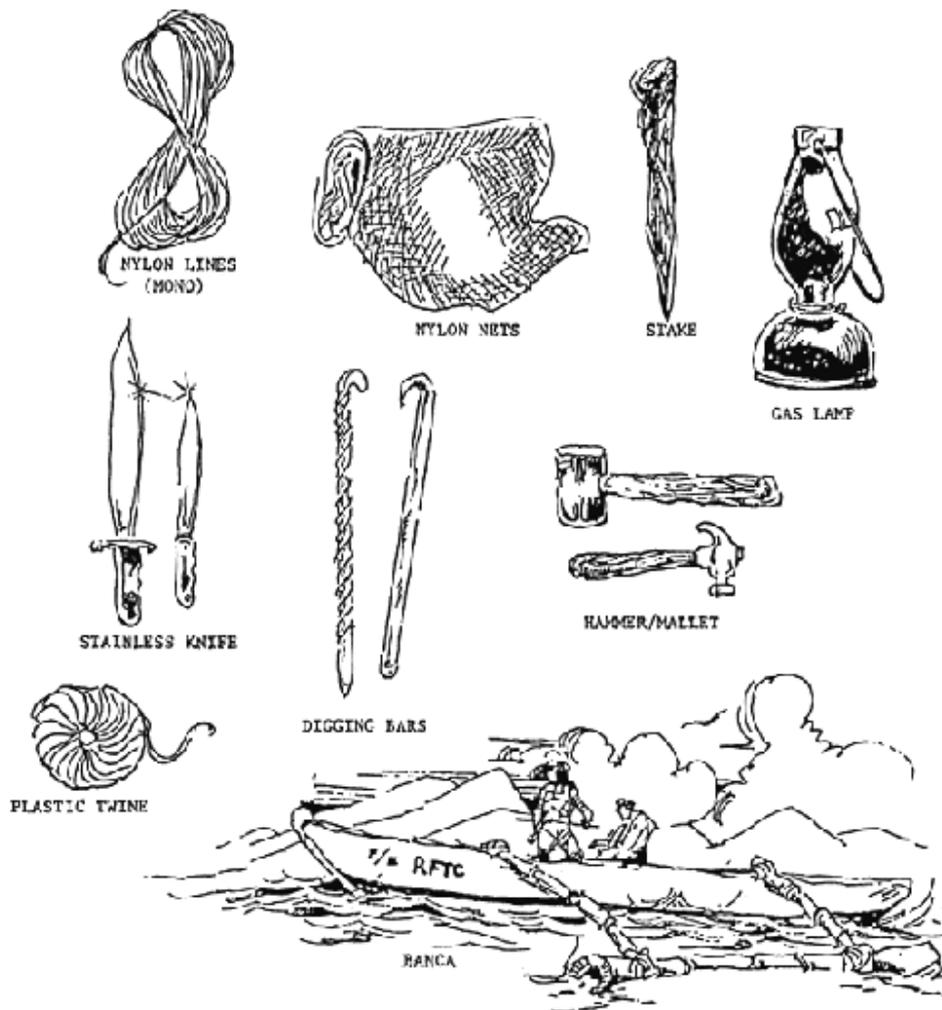
2. Remove the rocks, stones, starfishes, sea urchins and other predators (Figure 6).



3. Construct a farm house with a drying platform on the selected site (Figure 7).



4. Prepare rattan/buri baskets or seed-bin for holding seed stocks (Figure 8).



5. Prepare also other culture materials such as nylon monolines, nylon nets, mangrove stakes, boats dug-out/banca, digging bars, plastic twines, gas lamps, knives, hammer/mallet, etc. (Figure 9).

3. CONSTRUCTION OF A EUCHEUMA FARM

The success of Eucheuma farming depends upon the type of method of farming and its demonstration. This handbook deals only on the methods of farming that are proven to be economical, easy to construct, manage and maintain.

3.1 Net method

It is the first commercially adapted technique in Eucheuma culture. The planting unit is a rectangular net measuring 2.5 × 5 m with a diagonal meshwork having a 25 cm bar length. The net is made up of monofilament nylon or stranded polypropylene lines (110–150 lbs test) for the margin and 30–100 lbs test for the meshwork. The nets are installed horizontally. Their corners, provided with loops are tied to stakes or wire stretched between the stakes (BFAR Handout).

Each net unit has 127 mesh intersections. Eucheuma seedlings are tied at these places using soft plastic straws (tie-tie).

The net farming method has the advantage of intensive production because more plants can be grown in a given area. It is of three types, namely: the floating bamboo method, the mangrove stakes and net method and tubular net method.

3.1.1 Floating bamboo method (Figure 10)

- a. Tie each corner of a 2.5 × 5 m net to a large coral with an evelon cord so that the net is stretched tightly.
- b. Cut one meter piece of bamboo and tie one piece to each corner of the net.
- c. Add additional net to the previously constructed one.

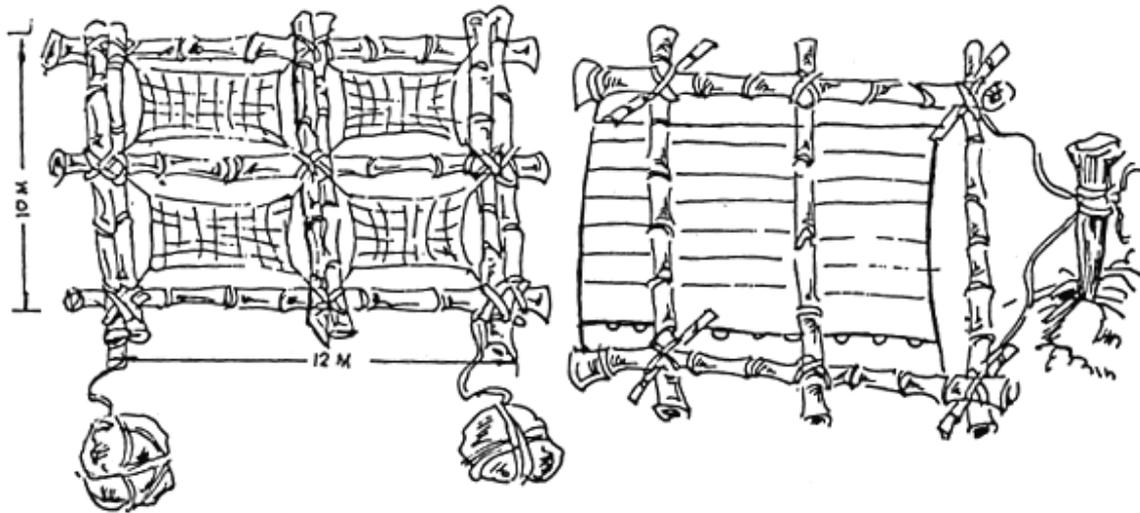


Figure 10. Floating bamboo method

3.1.2 Mangrove stakes and nets (Figure 11)

- a. Install mangrove stake bipod and tripod 6 meters apart in rows with 11 bipods or tripods in each row. The rows should be 6 meters apart (11 rows can hold 20 nets). (BFAR Handouts).
- b. Attach 2.5 × 5 meters net to the bipods and tripods. Make sure all nets are stretched tightly and are at least 2 feet above the bottom but below the lowest tide level.

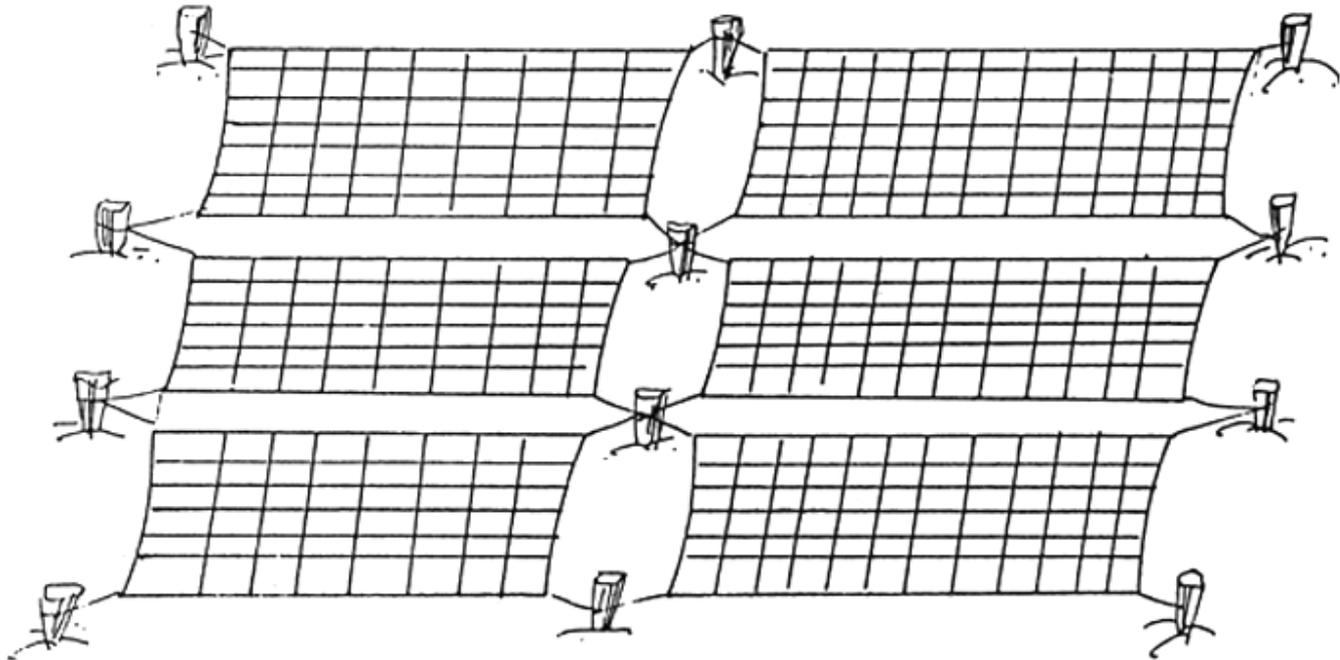


Figure 11. Mangrove stakes and net method

3.2 Bottom monoline method

This is cheaper to establish, easier to maintain and not so prone to surface weather conditions as compared to the raft method.

This method consists of modules which are units of planting in a hectare. A module has 28 monolines (single line) each measuring 30 ft (9.8 m) in length.

About 36 plants can be tied to a monoline. A hectare of 35 modules consequently contains 35 000 plants with about 1 000 plants per module (Genu Manual).

Here are the planting details in bottom monoline method:

Seedling size	- 50–150 g
Total weight or seedling hectare	- 3–5 tons
Plastic tie length	- 6 inches (15.3 cm)
Plastic tying allowance	- 1 inch (2.5 cm)
Mangrove stake length	- 29 inches (74 cm)
Monoline distance from bottom	- 8–10 inches (20–25 cm)
Module dimension	- 20 × 70 ft (10 × 20 m)

Space between modules	- 5 ft (1.6 m)
Nylon line size	- 160 lbs
Plastic tie quality	- soft, flexible, not easily shredded, medium-sized, - 7 mm width

Procedures in the construction of monoline:

1. Using a mallet, drive wooden posts to the bottom one meter apart in rows and 10 meters between rows.
2. Tie nylon monolines at both ends of the posts, parallel to each other.
3. The distance of the line from the bottom should be about 20–25 cm (8–10 inches).

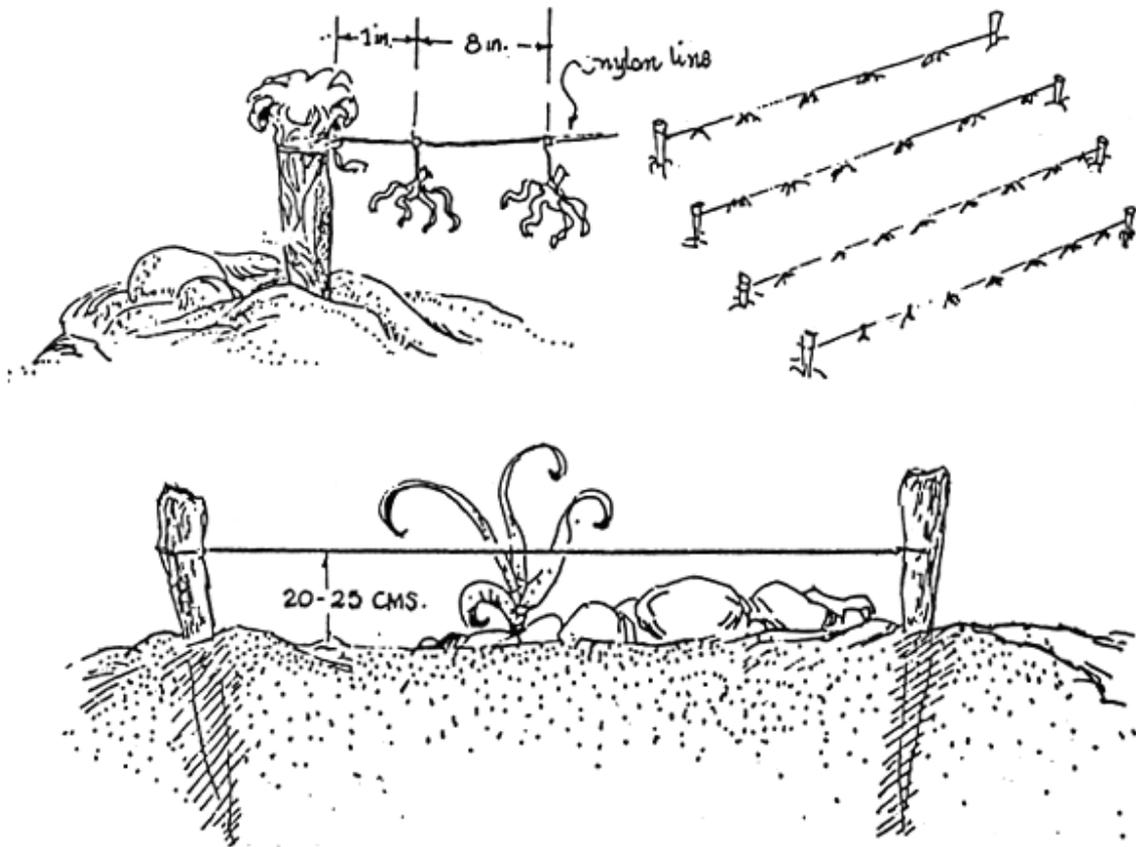


Figure 12. Bottom monoline method

4. MANAGEMENT OF EUCHEUMA FARM

4.1 Seed selection and preparation

Careful selection of seedlings is a must. Healthy strong branches should be chosen. Good seedlings are usually found at the center and near the tip of a healthy plant. The ways to prepare the seedlings are:

- a. Use a clean and sharp stainless knife to cut the branches in order to leave a smooth surface.
- b. Never cut the branch in a slant position.

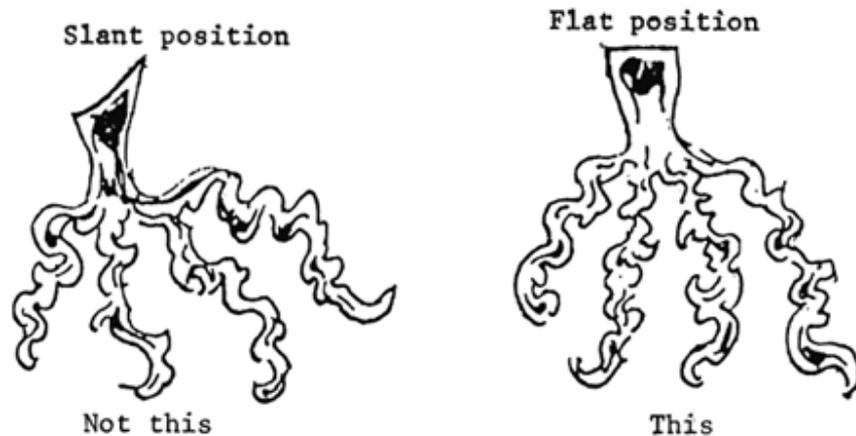


Figure 13. Cutting of seedlings

- c. Do not produce seedlings with any cuts at its branches.

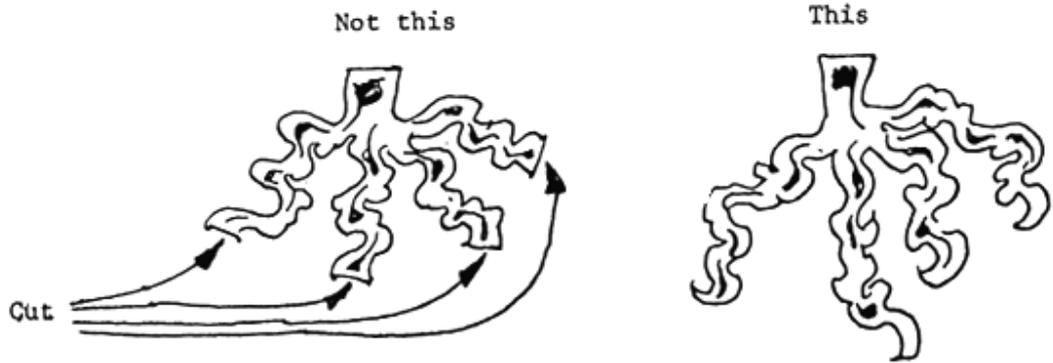


Figure 14.

4.2 Tying of seedlings

Use of soft, flexible, not easily shredded and medium-sized plastic. Tying length will be 6 inches (15.3 cm). The following are the ways to tie seedlings:

- a. Seedlings should be tied at the strongest point where they are well-balanced for free movement. Avoid breakage of the branches.

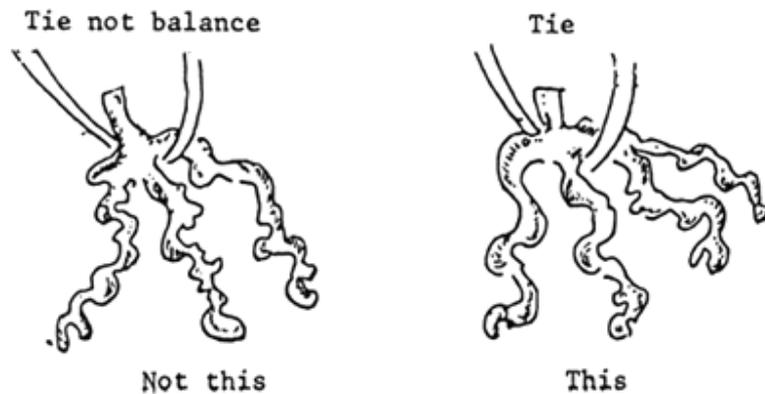


Figure 15.

- b. Tie the seedlings properly with enough allowance for growth.

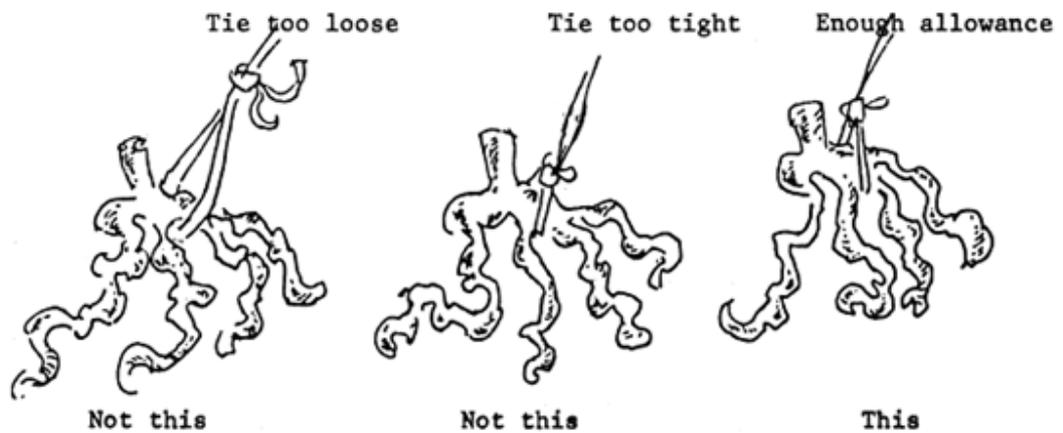


Figure 16.

c. Do not tie two or more seedlings together.

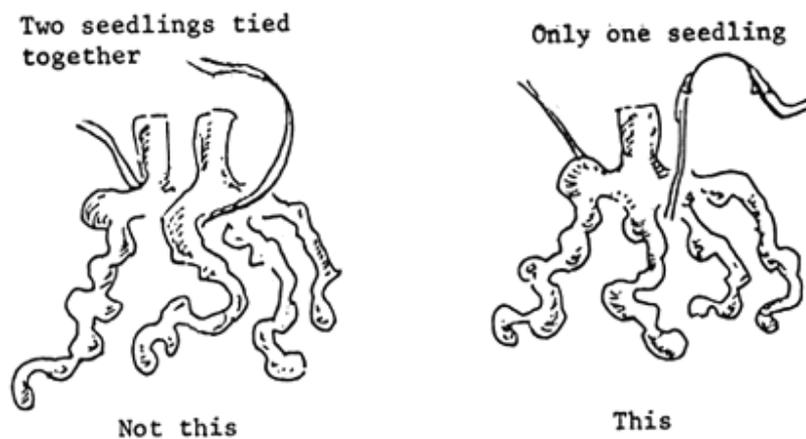


Figure 17.

4.3 Planting

Before planting, clean the seedlings thoroughly by removing dirt, epiphytes and other clinging materials and rinse with sea water. Plant prepared seedlings promptly.

In the net method, seedlings, (80–100 g) are tied to each intersection of the net. Original net can hold about 150 plants (BFAR Handouts).



Figure 18.

In bottom monoline method, the seedlings (50–150 g) are planted by tying to the monoline with an allowance of one inch (2.5 cm) of the tied portion of the nylon line. Plant seedlings at an interval of 8 inches (20–25 cm) between them (Genu Manual).



Figure 19.

4.4 Harvesting

Eucheuma are harvestable when they reach the weight between 750–850 g. Harvesting can also be made a part of the maintenance procedure by pruning the harvestable plants and allowing them to regenerate.

4.1.1 Pre-harvest activities

- a. Prepare all the necessary harvesting materials such as baskets, sacks, knife and goggles.
- b. Prepare the drying area.

4.1.2 Harvesting procedures

- a. Go row by row through the farm, harvest each plant by pruning. Remove branches from each plant using a sharp stainless knife. Leave about 200 g on each plant for regeneration.
- b. In total harvesting, just cut the allowance portion of the tie in-between the plant and the nylon line.
- c. Using scoop nets, scoop harvested plants.
- d. Collect all harvested plants in the banca.
- e. Paddle the banca to the drying area when it is already full.
- f. Unload, weigh and keep a record of all the harvests before spreading them to dry.

4.5 Drying

Recommended practices in drying the harvested plants:

1. Spread the harvested seaweed thinly over the prepared drying site of platform.
2. Use coconut palm as flooring when drying in land. Never dry theseaweed directly on and or soil to avoid contamination.

3. In a drying platform, the approximate amount of wet seaweed should be about 2 lbs/sq ft.

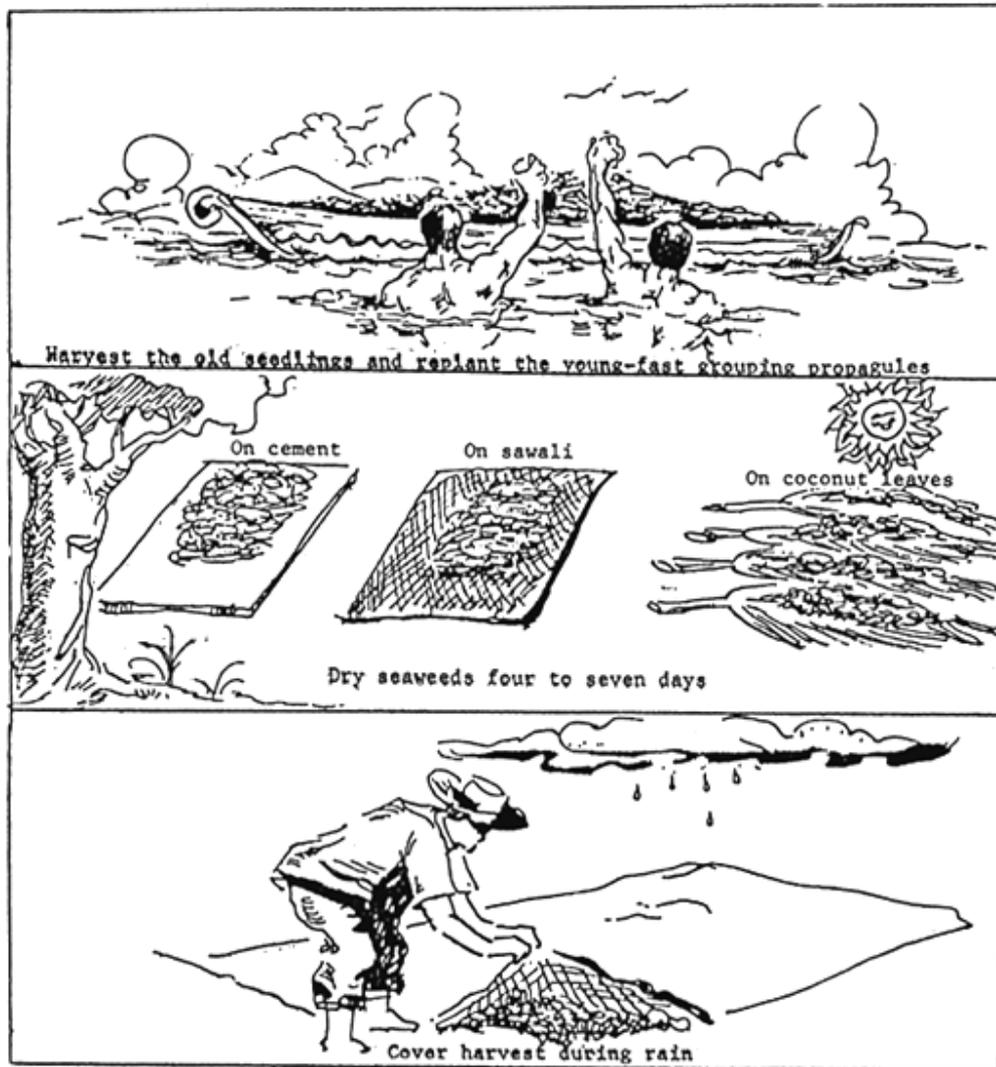


Figure 20. Harvesting and drying

4. Turn the seaweeds at regular intervals under the sun for three days and at the same time removing foreign materials. During summer months, seaweeds can be dried for only 1-½ days.
5. Always cover the harvest to protect from the rain.
6. Separate dried harvest according to the day it was harvested.

7. Seaweeds are considered dry when there are no moist and particles of sand on the surface. They are crispy and have a rubbery touch.
8. Remove salt particles from the dried seaweeds by screening them with meshed screens.
9. Pack, clean dried seaweeds free of salt particles in large sacks and lace them up.
10. Sell the seaweeds and keep a record of all its weight.

5. MAINTENANCE OF THE FARM

Assurance for good farm production largely depends upon farm management, procedures and practices coupled with the farmer's own initiative and creativity (Juanich, G. 1980).

Some ways to maintain a Eucheuma farm:

1. Remove sea urchins, starfishes, rocks, dead corals and other obstacles found inside the farm everyday.
2. A boat (with or without engine) would be required depending upon the distance of the residence to the farm site.
3. Replace missing plants.
4. Never allow the plant to grow more than 5 kgs for it will be destroyed by the water current.
5. Harvest completely all unhealthy and loose plants.
6. Tighten any loose nets and repair any broken lines and destroyed stakes.
7. Always keep the record of the farm such as weekly test plant record, daily harvest record (wet and dry), record of receipts and expenses, etc.
8. When a farm is a hectare or more, it is advisable to install nets in the lower position of the farm to collect seaweeds washed out by the tidal current. The mesh size of net to be used should not be more than 4 inches made of No. 100 nylon line (Figure 21).

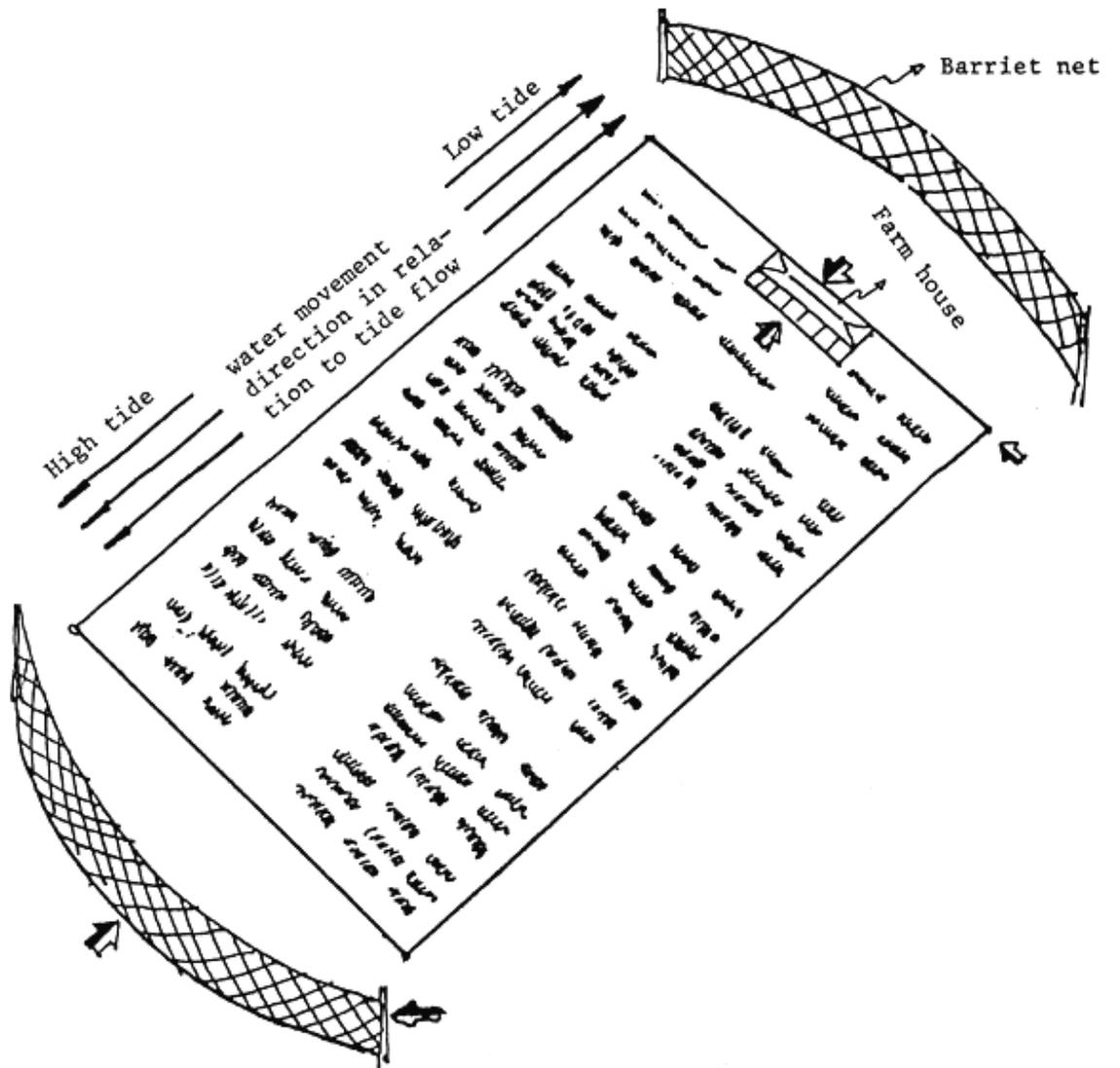


Figure 21. A typical developed one-hectare Eucheuma farm

Producing Eucheuma on Nets

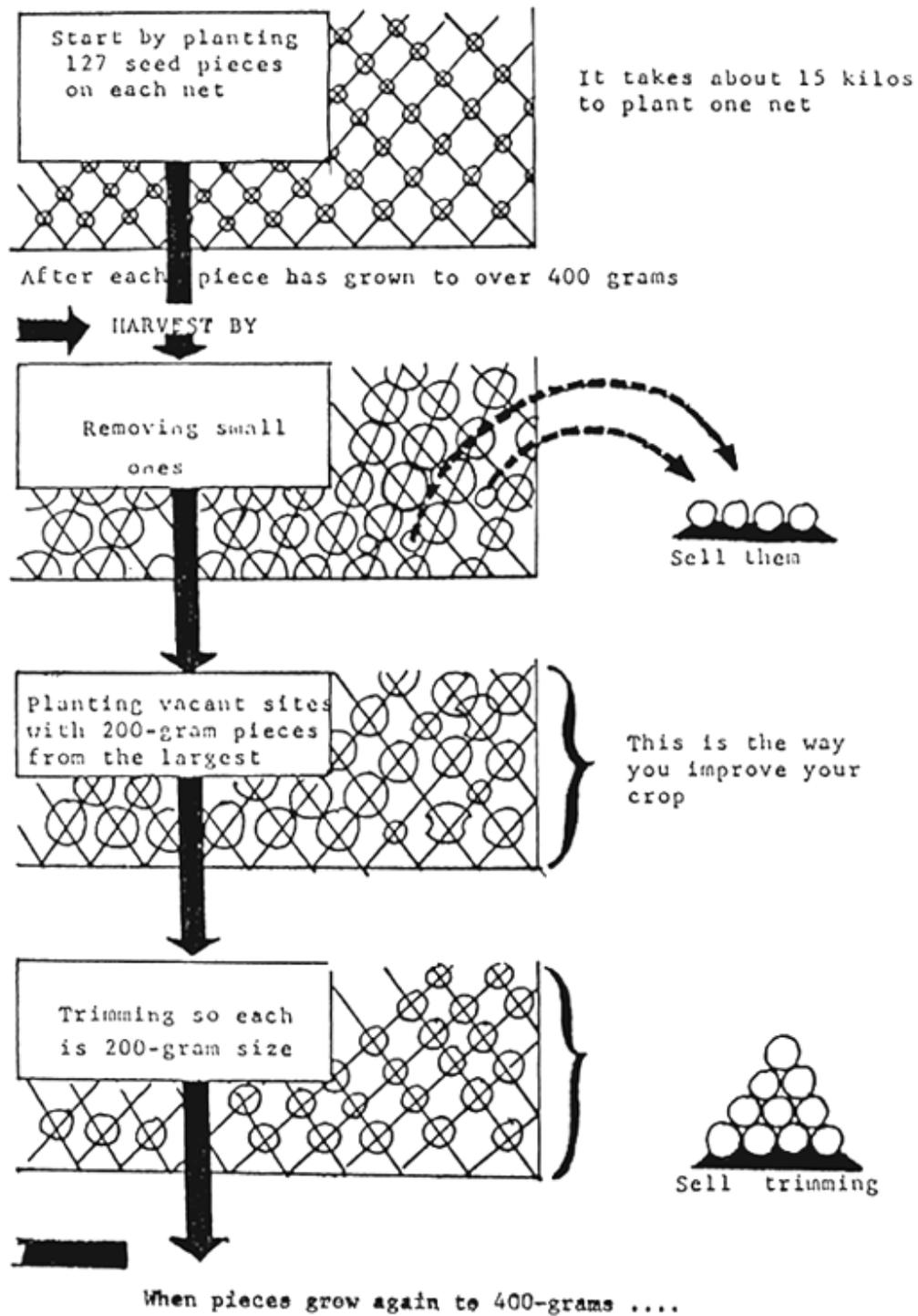


Figure 22. Management of a Eucheuma farm (Using mangrove stakes and net method)

6. SUMMATIVE EVALUATION

1. Prepare a design/program proposal to conduct test plant experiment.
2. Construct test plots using either of the two known methods of test planting.
3. Construct one set of floating bamboo method of seaweeds culture using the monoline.

EXPERIMENTAL COMPONENT

EUCHEUMA SEAWEED FARMING

Assumption - For one hectare Eucheuma farm

Activities	Time Allotment	Persons Involved
Survey/selection of suitable site taking into consideration the following:		
I. 1. Water qualities/properties (current, temperature, salinity, depth, etc.).	2 days	2 persons
2. Farm bottom, presence of vegetation, etc.	1 day	
3. Test planting (with observation).	45 days	
Preparation of farm site and other culture materials:		
Securing permit from the BFAR office and survey of the proposed site by BFAR technicians, preparing/processing of other pertinent papers for acquisition.		
1.	15 days	1 person
II. 2. Cutting of eel grasses, removing of rocks, stones, starfishes, sea urchins, etc.	7 days	2 persons
3. Preparation/purchasing of farm house materials.	15 days	1 person
4. Construction of farm house.	10 days	5 persons
5. Preparation of baskets or seed bin for holding seed stock and other culture materials.	2 days	1 person
Construction of Eucheuma farm		
III. A. Floating bamboo method		

	1. Tying of nets to bamboo and stretching thereon.	40 man-hours*	5 persons
	2. Cutting of 1 meter piece of bamboo and tying them to each corner of the net.		
	3. Adding additional net to previously constructed one.		
	Mangrove stakes and net method		
B.	1. Installation of stake bipods and tripods.	40 man-hours*	5 persons
	2. of nets to the bipods/tripods and stretching them.		
	Bottom monoline method		
C.	1. Driving wooden posts/stakes to farm bottom.	40 man-hours*	3 persons
	2. Tying monolines to both ends of the posts parallel to each other.		
	Management of Eucheuma farm		
	Seed selection and preparation		
A.	1. Selection of healthy seedlings.	21 man-hours*	2 persons
	2. Preparing/cutting of seedlings.	42 man-hours**	1 person
B.	Tying of seedlings	42 man-hours**	1 person
C.	Planting of tied seedlings.	28 man-hours*	2 persons
IV.	Harvesting	42 man-hours*	2 persons
	1. Preparing all necessary harvesting materials.		
	2. Preparing the drying area.		
D.	Pruning the branch of harvestable size		
	3. Eucheuma or cutting the tie in-between plant and nylon line.		
	4. Scooping the harvested plants and collecting them in a banca.		
	Drying	3 days	2 persons
E.	1. Spreading of harvested seaweeds in drying site.		

2. Turning seaweeds at regular intervals at same time removing foreign materials.
3. Separating harvest according to the day it was harvested.
4. Removing salt particles of dried seaweeds by screening with meshed screen.
5. Packing clean and dried seaweeds.

Maintenance of Eucheuma farm Everyday 2 persons

1. Removing sea urchins, starfishes, rocks, dead corals and other obstacles found inside the farm
 2. Replacing missing plants.
 3. Harvesting all unhealthy and loose plants.
 - V. 4. Tightening all loose nets and repairing broken lines of destroyed stakes.
 5. Keeping farm record about test plants, harvest record (wet and dry weights), record or receipts, other expenses. etc.
 6. Installing nets in a leeward position of the farm to collect seaweeds washed out by tide current. 8 man-hours
2 persons
-

* The activities are done during low tide for four working hours only.

** Activities done during high tide for six working hours.

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**PUBLICATIONS AND DOCUMENTS OF THE ASEAN/UNDP/FAO REGIONAL
SMALL-SCALE COASTAL FISHERIES DEVELOPMENT PROJECT**

Working Papers

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