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1

Seamoss Cultivation in the West Indies

Caribbean Natural Resources Institute
Guidelines Series

Seamoss Cultivation in the West Indies

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Front cover: Illustration by Marcia Jameson
Opposite: Mathias Burt, CANARI's Rural Development Coordinator with a line of *Gracilaria* GT.
Photographs: Allan H. Smith

SEAMOSS CULTIVATION IN THE WEST INDIES

FOREWORD

It is a credit to the people of the Caribbean that they can point to the success of the production and use of seamoss as being the result of combining traditional and modern approaches and knowledge. The use of seaweeds for food continues to be popular throughout the region and the combination of growing demand and decreasing natural populations has become a concern from both the economic and conservation perspectives. In acknowledgment of the need to make the harvesting of seaweeds more sustainable, men and women in the coastal communities of St. Lucia have been participating in the development and refinement of seamoss cultivation techniques. The outcome has been the first example of artisanal mariculture in the region that has been successfully adopted by coastal people as a viable occupation.

The cultivation of seamoss involves men and women in science, business, processing and farming. Over the years, experience that has included working on the science of identifying and improving seaweed stocks and obtaining high quality yields after processing has contributed to the development of a practical mechanism for resource management in the region. The people have benefited economically from their approach to the management of this valuable resource, and the environments of the bays have not been placed under any significant stress. The results of cooperation among partners from government agencies, the Caribbean Natural Resources Institute, the farmers and the processors has been the refinement and improvement of all aspects of seaweed use and production.

The techniques and information provided in this booklet are designed to offer an example of appropriate technology for the region. It is the result of much hard work on the part of all of the partners in the project. The Institute is grateful to all those who supported the work and made the results possible through their contributions. We hope you will find it useful to your efforts to participate in sustainable resource management.

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THE USE OF SEAWEEDS IN THE WEST INDIES

The Caribbean Sea contains many hundreds of species of seaweeds. About 10 of these are used for food in the region. The most popular are various species of *Gracilaria* and a species of *Eucheuma*. Each of these produces a carbohydrate that dissolves in hot water and then thickens or gels when cooled. In the case of *Gracilaria* species, the carbohydrate (a polysaccharide) is agar. The *Eucheuma* species has a different carbohydrate, known as carrageenan.

These seaweeds are known by different names in different parts of the Caribbean. In most places they are known as seamoss. In Jamaica, where the greatest variety of species is used, they are known as Irish moss. In Belize they are usually simply known as seaweed. The traditional use is the preparation of drinks and puddings, but many new products have appeared on the market in recent years. There are some recipes from around the region in Appendix 1.

People in the English-speaking Caribbean have a very favourable opinion about the nutritional value of seamoss. Chemical analysis shows that these species contain high levels of carbohydrates, particularly agar or carrageenan. People who don't eat these types of seaweeds regularly have little ability to digest these complex sugars, but this ability increases when seaweeds are a normal part of the diet. There is also a variety of valuable amino acids and minerals, but these are easily lost if the plants are washed in fresh water after they have been dried.

Until the 1980s, all seaweeds used in the Caribbean were harvested from wild populations. However, like many other natural resources, the demand exceeded the supply, and the wild stocks dwindled almost everywhere they were harvested. For this reason, the Government of St. Lucia began a research programme to develop methods for cultivating seamoss. The programme began in 1981, and in 1985 a group of seamoss farmers made their first harvests from a farm on the southeast coast of the island. Since then a number of individuals and families in St. Lucia have taken up seamoss farming as a profitable occupation. The technology has also been transferred to people in Grenada, St. Vincent, Dominica, Barbados, Antigua, Jamaica and Haiti.

A BRIEF BIOLOGY OF SEAMOSS

Seaweeds belong to three main groups that can be distinguished by their dominant pigments. Seamoss species such as *Gracilaria* and *Eucheuma* are reds, and the other two groups are the greens and browns. However, while the greens and browns are generally easy to recognise, the colour of a species of red seaweed may be different from one site to another, varying from yellow to light brown to purple. Genetic variants of some of the seamoss species may not have the red pigment and are bright green. The shape of the plant and the type of branching is affected by water conditions, which adds to the difficulty in identifying many of the red seaweeds.

Most of the world's commercial seaweed species are reds or browns. Only reds are used in the Caribbean. Like all seaweeds they have no true roots, leaves or flowers; plants consist of branched fronds attached by a holdfast to a substrate such as rock or dead coral. The holdfast anchors the seaweed, but does not absorb nutrients like the roots of flowering plants. The entire seaweed plant absorbs nutrients that are dissolved in the surrounding seawater. This is an important feature in the farming of seaweeds, as cuttings from plants can be anchored to any substrate, such as rope or nets, as long as the water conditions are suitable.

Seamoss has a complex life history which includes both sexual and asexual phases. There is an alternation of generations, from identical-looking male and female plants, which produce gametes for sexual reproduction, to another identical-looking generation which produces spores. In addition to the free-living plants, which grow mixed in wild populations, there is a small parasitic phase that develops in the female plant. This phase can be seen in reproductive female plants as small lumps on the branches.

Spores are released into the water and drift until they come into contact with a surface that is suitable for them to attach and germinate. The settlement and germination of spores is the means by which the species spread and colonise new substrates. The most common substrates for spore settlement are rocks, stones, dead coral and shells, but some species can be found growing on almost anything, such as discarded cloth, plastic, tyres, rope, bricks and wood.

While the plants are growing, they may change colour. The amount of the red pigment in the plants is affected by the amount of sunlight that they are exposed to, and the amount of nitrogen (a nutrient) that is available. Bright sunlight bleaches the plants to a pale straw colour. A good supply of nitrogen, for example from run-off after heavy rain, allows the plants to produce more of the red pigment. Thus at any time, the final appearance of the plants is a balance between the effects of sunlight and nutrient availability. This is often seen on bushy lines where the upper plants may be very pale but the shaded plants on the underside of the line may still be deep red. If the shaded plants are also pale, then the site most likely has a low level of nitrogen available for growth.

FARMING SEAMOSS

The cultivation of crops in the sea is known as mariculture. Like agriculture on land, mariculture includes a range of activities such as selecting a good site, identifying suitable seed material, regular maintenance of plots, correct harvesting procedures, post-harvest processing, and marketing. The details in this section are based on the development of seamoss cultivation in St. Lucia, but the methods have been tried successfully in a number of islands.

1. Site selection

The different seamoss species grow wild in a wide variety of habitats and it is not always possible to farm them in their natural habitat. On exposed windward coasts, where some of the *Gracilaria* species are harvested, the water may be too rough for installing lines on rafts or stakes. At the opposite extreme, very sheltered bays may not have enough water movement to keep plants free of sediment, particularly after heavy rainfall when runoff from land carries large amounts of mud and silt into the sea.

The sites that have been most successful so far have been on windward coasts where areas with shallow seagrass beds are protected by offshore reefs that reduce the amount of wave action. All of the species listed in this manual have been grown successfully in such sites. However, there may be seasonal changes in the conditions that affect growth. During heavy rains in the wet season,

species such as *Gracilaria* GT can tolerate a drop in salinity due to freshwater runoff from a normal level of around $35^0/_{00}$ down to $15^0/_{00}$. On the other hand, *Eucheuma* is much less tolerant of lowered salinity and is best cultivated where salinity does not drop below $30^0/_{00}$.

Because of the likely variation in conditions at a site, and the requirements of the different species, it is only possible to give some general guidelines to selecting a site. In all cases, the best way to test a site is to do some trials to monitor the growth and survival of the plants there. Procedures for measuring productivity and growth rate are described in Appendix 2.

2. Materials and methods

All seaweed farming in the West Indies is based on using cuttings as the planting material. This is known as vegetative propagation.

At the start of a cultivation programme, there are two options for obtaining seed material. The first is to collect it from local wild populations. The second is to get it from established farmers. Farmers in St. Lucia have often sent plants to people in other islands to help them get started with good quality cuttings.

When collecting from wild populations, only the healthiest-looking plants should be selected. Wild populations of some species include plants with very different shapes and textures and some may not be suitable for planting. For example, short bushy plants of *Gracilaria cornea* were found to be very brittle and difficult to insert into ropes, compared with longer and more flexible plants. The plants may also change their form when moved from their wild habitat to a farm with different water conditions. For example, *Eucheuma* grown on lines in St. Lucia is much bushier than the plants growing in their original habitat near mangroves on the Belize Barrier Reef.

There is an alternative to vegetative propagation, which uses the seaweeds' ability to produce large numbers of spores. These spores are released and drift in the currents until they attach to something suitable, like rock. Once they have attached they germinate and grow into new plants. Spores can also attach to artificial materials, such as nets and ropes. The process of getting spores to

attach to ropes or other cultivation structures is known as spore recruitment. This is described in Appendix 3. Although the method has been used successfully with some species in St. Lucia, it has not yet been adopted for commercial production in the region.

3. Seeding

The most popular method of seeding is to weave bunches of seamoss between the strands of polypropylene rope (Fig. 1). The rope has three strands and is usually around 8 or 10mm in diameter. Note that there is no need to leave spaces between the bunches of seamoss. This method works very well for the type of *Gracilaria* that is shown in the picture, which is known as GT because the species identification is still uncertain. The seeding method will depend on shape and texture of the particular species.

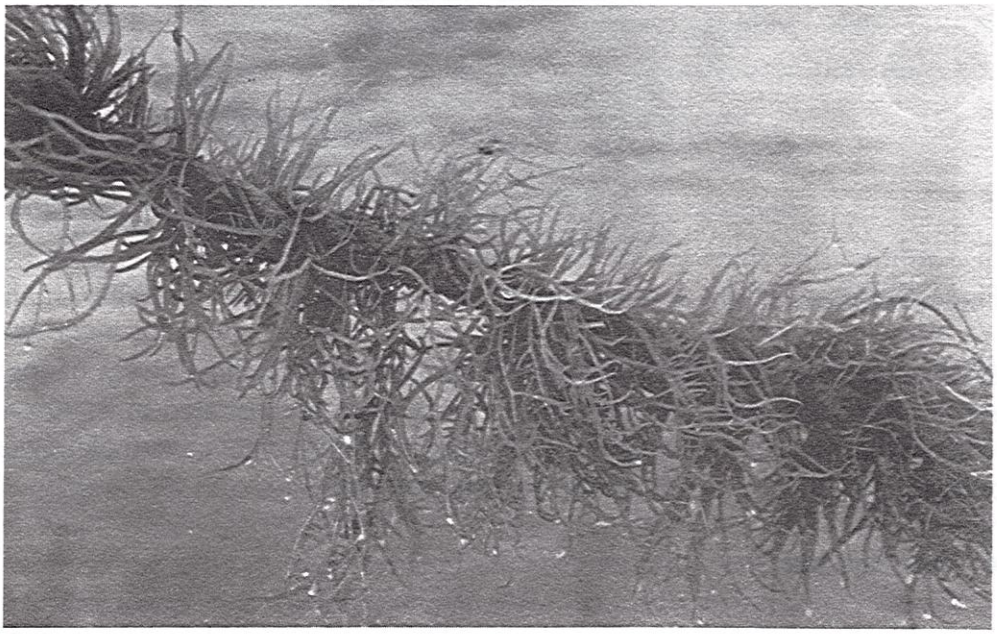

Fig. 1. Three-strand line seeded with *Gracilaria* sp. GT.

Eucheuma can be grown in plastic mesh tubes or bags (Fig. 2). This type of mesh is commonly used for packaging vegetables and is easy to find in the region. The branches grow out through the mesh and can be trimmed when

they are long enough. At times when the fine green drift seaweeds become abundant, they quickly become entangled on the spiky *Eucheuma* plants and eventually pull them out of the rope.

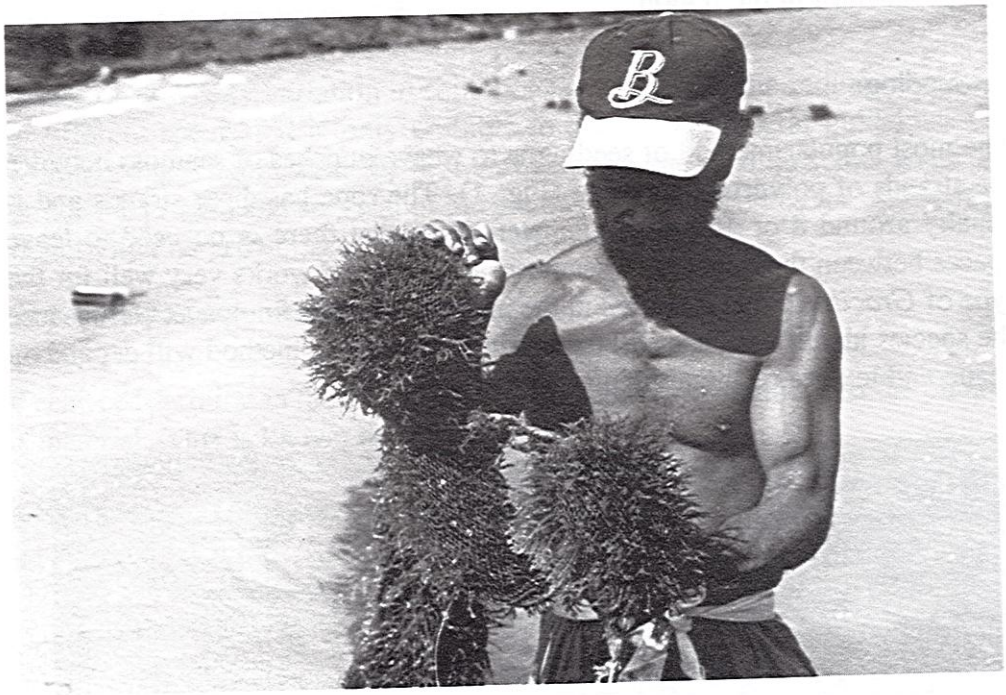

Fig. 2 Seamoss farmer Ainsley John with *Eucheuma* grown in mesh.

Another method of planting is to insert the cuttings into short pieces of rope and to hang these from the long line. This method is illustrated in Figure 8. When plants are ready for harvest they may either be removed completely or pruned and allowed to regenerate for later harvests.

4. Out planting

Seeded lines are anchored at each end, and have floats such as plastic soft-drink bottles tied every three feet to keep them at the surface. Some farmers prefer to tie each end of the line to a stake driven into the sand. White mangrove stakes of 2-3 inches diameter are suitable for attaching lines. A few turns of tying wire around the top end of the stake will prevent it from splitting when it is being hammered down.

5. Care and maintenance of the plot

If the farm site has been well chosen, and cuttings are securely attached to the lines, then maintenance is simple. The lines should be checked regularly to make sure that they remain tied to the rafts or stakes. This is particularly important before bad weather and rough water. When a line comes loose at one end it will wrap itself around other lines and stakes, and in the resulting tangle plants will be pulled out and lost. A piece of driftwood or other floating debris that drifts into the farm can also do a tremendous amount of damage if it is not removed quickly. In muddy areas it will be helpful to shake the lines regularly to remove the silt that will cover the plants.

PESTS AND DISEASES

No diseases have affected the seamoss species that have been cultivated in St. Lucia. However, there are some pests that can affect a farm, including drift seaweed, epiphytes and grazing animals.

1. Drift seaweed

At certain times of the year, floating masses of seaweeds can be blown inshore, especially on windward coasts. The brown seaweed *Sargassum*, which has small gas-filled floats on its branches, is a common drifting species. Another is a fine hair-like green seaweed, a species of *Chaetomorpha*, that forms large tangled clumps (Fig. 3). Both of these can become entangled with the seamoss plants and lines. As the seamoss becomes more heavily covered, these drifting plants can pull the seamoss loose from the lines. In St. Lucia the green entangling seaweed is particularly troublesome during the rainy season. During this time daily weeding helps to prevent a build-up and reduces the loss of seamoss plants. It is also important to place lines parallel to the direction of the wind and surface water movement. Placing lines across will mean catching much more of the drifting seaweeds and anything else that is floating by.

Fig. 3. Drift seaweed (*Chaetomorpha*) entangled on lines.

2. Fouling by epiphytes

This problem is the fouling of the seamoss by fine red filamentous seaweeds. These grow from spores that attach to the seamoss, and are therefore epiphytes, rather than just entangled plants as in the examples above. The epiphytes can form a thick layer that traps silt. The seamoss fronds covered by this muddy layer may bleach and die. Also, if the plants are harvested and dried, they look dirty and are almost impossible to clean. Some communities in St. Lucia have given up cultivation of seamoss because of the seasonal invasion of epiphytes. However, this problem affects some seamoss species more than others. *Eucheuma* grown in St. Lucia is totally resistant to epiphytes, due to its very smooth surface texture.

3. Grazers

It is important not to try farming too close to reefs, where there will be populations of fish that feed only on seaweeds. Over seagrass beds, grazing fish will be a problem if the lines are too close to the bottom. White sea urchins, or sea eggs, live in seagrass beds and they will very quickly eat the seamoss on

any lines that touch the bottom. Farmers in St. Lucia have occasionally seen turtles grazing on the seamoss on their floating lines.

HARVESTING

There are two methods that can be used for harvesting lines. The first is to cut the branches leaving the base still attached to the rope or net. The base will then regenerate new shoots for the next harvest. The second method is to remove the plants completely and then re-seed the lines.

Which method is chosen will depend on the species of seaweed and the conditions at the site. Where the water is muddy, the bases of the plants and the ropes will become covered in silt and fouling seaweeds, and it is better to harvest completely and re-seed them. Farmers prefer this method when growing *Gracilaria* in St. Lucia, and some leave the harvested lines in the sun for a day to ensure that any fouling seaweeds are killed. If the ropes are clean and the plants are healthy then harvesting by pruning may be more efficient. This method suits *Eucheuma*, as the plants grow a holdfast to attach to anything they touch, including the ropes.

PROCESSING

The first stage of processing is cleaning. The plants should be cleaned as much as possible in seawater, while they are still alive. Once the plants have been dried, any mud or silt is much more difficult to remove without soaking the plants again. If the plants are washed after they have been dried, most of the nutrients will be washed out and lost.

Drying and bleaching are done in the sun. Farmers in St. Lucia begin the process by laying the fresh plants in clear plastic bags and leaving them in the sun for a day (Fig. 4). The inside of the bag heats up and the heat bleaches the pigments in the seaweed and drives off a lot of the water. After this treatment the plants are spread out in the open, either on specially-built racks (Fig. 5) or simply on palm leaves on the ground.

Fig. 4. Bleaching the plants in clear plastic bags in the sun.

Fig. 5. Drying the harvest on a rack.

It is very important to protect the plants from rain while they are drying, either by moving them to shelter or covering them with a tarpaulin. This is particularly important with *Eucheuma*, which turns to porridge if it is rained on, and can't be used again.

As the plants dry, salt crystals form on the outside and must be removed by shaking. Any other impurities must also be removed at this stage. The seaweed is now ready for sale.

MARKETING

Seamoss sold in a shop or supermarket must be packaged attractively. If the packaging is not as good as the other products on the shelf, then customers will assume that the contents are not as good. Most of the farmers in St. Lucia sell bags of 100g, or about four ounces, with a label that includes a recipe. The dry seamoss must contain no more than 25% moisture or it will go mouldy in plastic bags.

Many different seamoss products are now available in the region, including bottled and canned concentrates, and bottled drinks (Fig. 6). Packaging may not be an issue if dried seaweed is being sold in bulk to a processor, but any producer must be aware of the competition and aim at high standards.

No matter where the crop is sold, it is very important to maintain a high quality. It is very easy to get a bad reputation from one poor delivery, and very difficult to win back the customers' confidence. It is particularly easy to make a mistake with bottled products, especially when they contain milk. Unless the drink is being prepared for immediate use or sale, it is essential to get some instruction in the preparation of bottled drinks that need to have some shelf-life (Fig. 7).

Fig. 6. A variety of seamoss products.

Fig. 7. Proper training in processing methods is essential.

MANAGING A SEAMOSS BUSINESS

Seamoss cultivation and processing in the Caribbean is a business and anyone entering into any stage of this must have business skills. The purpose of the business to make a profit, but many small businesses founder because there is no record of expenses and returns. Without good records there will be no way of knowing just how profitable the business is, or where it may be possible to reduce expenses. There will also be no way to know if any new techniques or methods are more efficient or productive than others.

Training courses in seamoss cultivation should, therefore, include a class in small business management, conducted by the appropriate business development agency, to make prospective producers aware of both the skills that are needed and the type of assistance that is available to them. As an example, in St. Lucia the National Research and Development Foundation conducts such sessions for the regional training workshops that are held on the island.

LEGAL ISSUES

In most of the Caribbean, access to the sea is open to all. This is not the best legal situation for establishing a farm, as a farmer will obviously need some exclusive rights to the area in which he or she is investing time and money. Before beginning to use an area for farming it is important to be sure that this will not conflict with other people who may already be using it for some other activity, or who may need access through that area. In response to the need that was identified during the early stages of the seamoss cultivation project in St. Lucia, new legislation was enacted that now allows a farmer to lease a portion of the seabed for mariculture. This facility was included in the harmonised OECS fisheries legislation, and therefore applies to all OECS states.

There will be legal requirements for marketing or exporting food products, including health standards, and requirements for correct labelling of these products. The necessary information will be available from government departments, such as the Ministry of Health for food processing standards, Ministry of Trade for export requirements, and the Bureau of Standards or Food and Drug Administration for identifying product ingredients and correct labelling.

SOURCES OF INFORMATION

Fisheries Departments in each country

The Chief Librarian
David Lubin Memorial Library
Food and Agriculture Organisation of the United Nations
Via delle Terme di Caracalla
00100 Rome, Italy
Tel: (39) 652251 53707

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Institute of Marine Affairs
Hilltop Lane
P.O. Box 3160
Carenage Post Office
Trinidad and Tobago
Tel: (868) 634-4291; Fax: (868) 634-4433.

Discovery Bay Marine Laboratory
P.O. Box 35
Discovery Bay
St. Ann
Jamaica
Tel: (876) 973-2946; Fax: (876) 973-3091

FURTHER READING

Littler, D.S., M.M. Littler, K.E. Bucher and J.N. Norris. 1989. **Marine plants of the Caribbean.** Smithsonian Institution Press, Washington, D.C., USA. 263 pp.

A field guide to the common species of algae and seagrasses in the region, illustrated with a colour photograph of each in its natural habitat.

Ohno, M. and A.T. Critchley. (eds.) 1993. **Seaweed cultivation and marine ranching.** Japanese International Cooperation Agency, Yokosuka, Japan. 151 pp.

Complete coverage of theoretical and practical aspects of seaweed cultivation, with chapters on *Gracilaria* and *Eucheuma* that include Caribbean developments.

Smith, A.H. (Comp.). 1990. **Annotated bibliography of the seaweeds used for food in the West Indies.** OECS Fishery Report No. 3:76pp.

Acknowledgements

This booklet was prepared as part of a project to enhance production and returns from seaweed farming in St. Lucia, with financial support from the German Appropriate Technology Exchange of GTZ. Seamoss farmers Ainsley John and Lena Francis assisted in maintaining growth experiments with new species on their farm, and with the documentation of farming methods. Lori Lee Lum at the Institute of Marine Affairs, Trinidad, and Tighe Geoghegan, CANARI, provided helpful comments on content.

Appendix 1.

POPULAR RECIPES

Seamoss drink (St. Lucia)

2 quarts of water
10 ounces of dry seamoss
1 egg
2 cloves
1 tin evaporated milk
ground nutmeg
cinnamon
6 drops Angostura bitters
2 limes
1 bay leaf

Soak the seamoss overnight in fresh water with the juice of one lime. Rinse and boil in two quarts of water, adding the cinnamon, cloves, nutmeg and bayleaf. Boil until the seamoss has disintegrated, and blend any undissolved seamoss. Add the milk and egg. The drink can be served hot or chilled with ice. Chilled seamoss may have to be diluted with more milk and water as it may set into a gel.

Irish moss pudding (Jamaica)

Clean 8 ounces of Irish moss and boil in 2 quarts of water. Simmer for one hour or until tender. Strain through muslin and allow to cool. Add sugar, rum, vanilla, and nutmeg to taste. Pour into a mould. Chill until firmly set, and decorate with crushed nuts. This pudding emits delicate flavours as it melts in your mouth.

Seamoss drink (Trinidad and Tobago)

1 lb dried seamoss
juice from 2 limes & water
a stick of spice
a few cloves
bayleaf
1 tin condensed milk
1 tin evaporated milk
1 teaspoon vanilla essence
sugar to taste
a dash of Angostura bitters
Pick seamoss clean, soak overnight in lime water. Remove from water.
Boil seamoss with spices until soft. Strain seamoss, leave liquid to set in refrigerator until gel forms.
Use 4 spoons of gel and mix with milk, essence, bitters and sugar.
Yields one jug of seamoss.
Serve with ice.

Seamoss ice-cream (Trinidad and Tobago)

1 cup of seamoss gel (1 handful of dried seamoss boiled in approximately 2 litres of water, then strained)
2 eggs
1 tin condensed milk
1 tin evaporated milk
a dash of Angostura bitters

Beat mixture well, set in freezer until mixture just begins to gel,
beat mixture again in mixer, set in freezer for at least 2 hours,
scoop out, garnish with a cherry and serve.

Appendix 2.

MEASURING GROWTH RATES

Two methods are described here. Which one is used will depend on the equipment and facilities that are available. Measuring the growth by weighing single fronds is more precise and more accurate than weighing lines, but both methods are useful in determining how well the plants are doing.

1. Lines

Lengths of seeded line can be weighed in the field for quick estimates of productivity. It is best to use manageable lengths, such as 3 - 4m, which can be easily untied. The line can be placed in a mesh bag and allowed to drain for a few minutes, then weighed with a spring balance. This is referred to as drained fresh weight. The results can be used to calculate the rate of increase of seamoss fresh weight per metre of line per week.

For example, on Day 1 a 4m length of line weighed 4.0kg. On Day 8 it weighed 6.0kg. Thus in one week there was an increase of 2.0kg. Productivity was therefore 0.5kg per metre per week.

2. Single fronds

This method is more precise than the line method, but requires more expensive equipment for weighing the plants, and more elaborate calculations. A Lotus 123 spreadsheet that automatically calculates these variables from the raw data is available from CANARI.

Fig. 8 shows fronds of *Eucheuma* inserted into short (10cm) pieces of 5mm diameter rope which are knotted at one end. The ends are melted over a candle to prevent the strands unwinding. Each piece is tagged with a number.

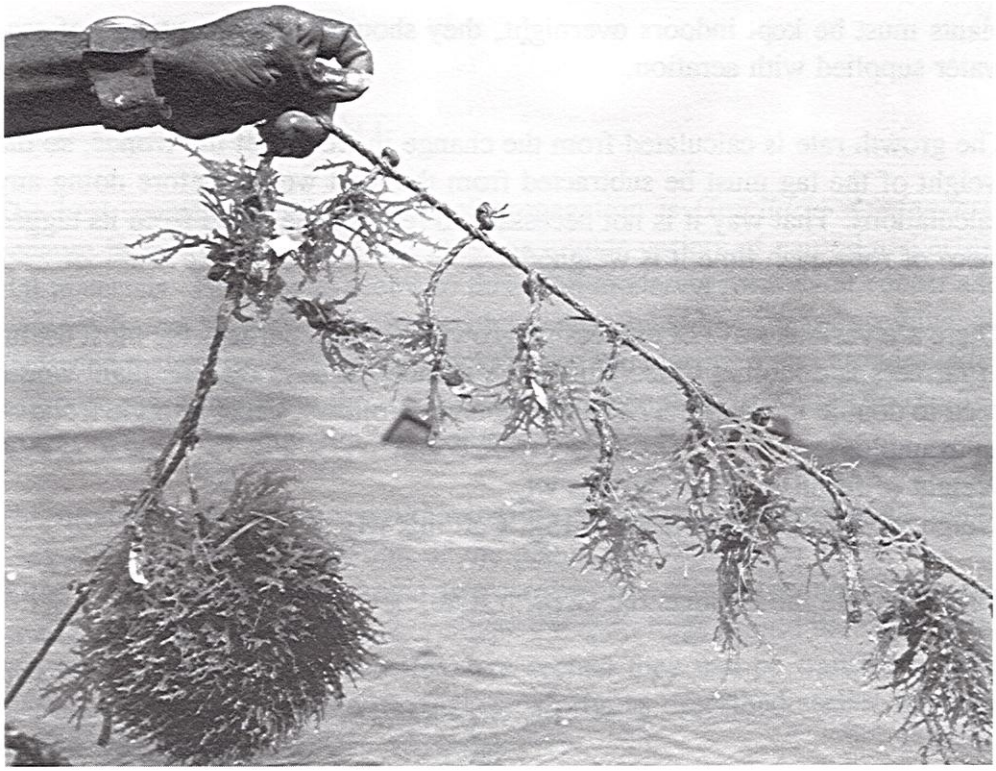

Fig. 8. *Eucheuma* fronds prepared for growth rate experiment.

Start by weighing the tagged piece, and recording the weight. Then insert a frond of between 5 and 10g, and weigh again. The number of tagged fronds will depend on the design of the experiment, but 10 - 20 per treatment variable should be sufficient. The tagged fronds are then attached to floating long lines in the sea (an un-seeded portion of a culture line in a farm, for example) by inserting the knot between the strands of the long line. These tagged fronds need to be weighed regularly, every one or two weeks for example. Before weighing, the tagged fronds must be removed from the culture line, cleaned, and the surface water blotted off with a cloth or paper towel. A top-loading balance is best for weighing, and battery powered units are available for use in the field. If the plants are weighed in the field the balance must be sheltered from the wind. If the plants are to be weighed indoors, they can be transported in a cooler, covered by wet cloth or paper. They do not need to be in water, but should be returned to the field site as soon as possible after weighing. If the

plants must be kept indoors overnight, they should be in a container of sea-water supplied with aeration.

The growth rate is calculated from the change in weight of the fronds, so the weight of the tag must be subtracted from the total weight before doing any calculations. That way it is not necessary to remove the frond from its tagged piece of rope each time it is weighed.

There are various ways of expressing growth rate, but perhaps the most useful to farmers is doubling time. This is the number of days that the plant would need to double in weight. The calculation is as follows, using a single frond as an example:
Weight of frond = 10g. Call this wt_1
Weight of frond 1 week later = 15g. Call this wt_2

First calculate the Exponential Growth Rate, k

$$k = \frac{\log wt_2 - \log wt_1}{\text{days}}$$

then multiply k by 3.322, and divide the result into 1. In this example,

$$k = \frac{\log 15 - \log 10}{7} = 0.025$$

$0.025 \times 3.322 = 0.083$

Doubling time = $1/0.083$ = 12 days

Appendix 3.

SPORE RECRUITMENT

The best species for this method of propagation is *Gracilaria domingensis* because its spores will settle and grow on a wide variety of natural and artificial materials. The species seems to thrive on moderate freshwater runoff and is often found in shallow protected bays near inhabited areas, growing on discarded materials such as cloth, sacks, tyres and plastic. These are ideal sites for spore recruitment but the seeded lines will then need to be transferred to a more suitable farm site with less polluted water.

The procedure for spore recruitment (Fig. 9) begins with anchoring empty lines within a dense population of the plants and waiting for the spores to settle, which usually takes about two weeks. The spores themselves are too small to be seen but after they germinate the sporelings should be visible after two to four weeks. Once the lines are seeded they can be transferred to a mariculture site and attached to stakes or rafts as described earlier for lines seeded with cuttings.

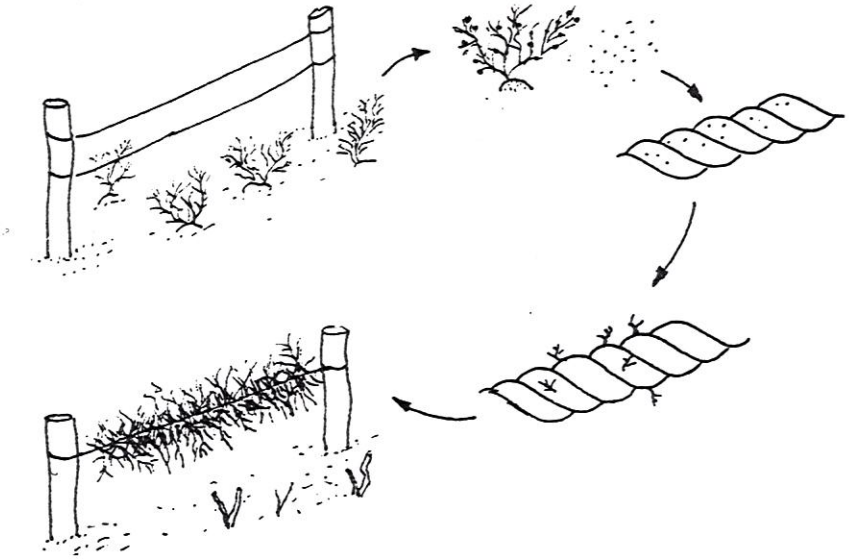

Fig. 9. Seeding ropes by spore recruitment.

Caribbean Natural Resources Institute

The Caribbean Natural Resources Institute (CANARI) is a regional non-governmental organisation concerned with issues of conservation, environment, and sustainable development in the insular Caribbean.

CANARI's mission is to create avenues for the equitable participation and effective collaboration of Caribbean communities and institutions in managing the use of natural resources critical to development.

With offices in St. Croix, U.S. Virgin Islands and St. Lucia, the Institute has specific interest and extensive background in the identification and promotion of participatory and collaborative forms of management.

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