SEAWEED CULTIVATION AS A LIVELIHOOD IN CARIBBEAN COASTAL COMMUNITIES.

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Abstract

Seaweed cultivation has been tried in the Caribbean since the 1970s, largely inspired by the advances in labour-intensive and low cost methods in various Pacific countries. Efforts in the region have been aimed at two distinct applications. The first is the production of agarophytes and carrageenophytes as raw material to be exported for industrial extraction of phycocolloids. The second is the smaller scale production of various red algae that are the basis of traditional foods in the region and whose supply has declined due to over harvesting of natural stocks. This paper focuses on the latter application, and looks at the requirements for developing artisanal seaweed cultivation as a source of income for coastal communities.

The experience of the past 20 years shows that development projects in the region have focused mainly on technological aspects of cultivation and have been successful in addressing issues of species and strain selection, propagation methods and materials, site requirements, plot maintenance and initial post-harvest processing. Despite these advances commercial development has been slow but it remains apparent that there is potential for expansion of this activity. In order to realize this potential the transfer of the technology needs to be supported by a better understanding of the institutional, social and economic factors that are critical to its success. These include the identification of appropriate target groups for extension projects, the availability and type of training and technical support needed, the securing of rights of access and tenure, the management of potential conflicts over the use of sea space, and the identification of local and export markets and mechanisms to access them. A research project underway in St. Lucia includes an experiment that is testing the cultivation of species currently in high demand in the region and formulating a plan to define how a coastal community can maximize the benefits generated from seaweed cultivation. The paper describes the main questions addressed by the project, and the method and process used in this research.

Introduction

The Caribbean has a diverse seaweed flora that includes many economically important genera, particularly in the Rhodophyceae, but there has been little industrial exploitation of this resource (Smith 1998). The most widespread use is the harvest of various red algae for the preparation of locally-important drinks and desserts. This use is common in the West Indies where the different species and the products are known as seamoss. The most important of these species are the agarophytes *Hydropuntia cornea*, *H. crassissima*, and *Gracilaria domingensis*, harvested throughout the English-speaking Caribbean, *Gelidium serrulatum* harvested in Trinidad, and the carrageenophyte *Eucheuma isiforme* harvested in Belize and in the past in Antigua and Barbuda prior to its over-exploitation there.

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Until the 1980s, seamoss was marketed mainly in a bleached and dried form. In recent years there has been a trend toward the processing of bottled and canned products, with processing facilities in many islands, particularly Jamaica, Barbados, Dominica and Grenada. The supply of raw material from natural stocks has often limited the output of these facilities and at present all factory-produced output in Jamaica is based on cultivated *Kappaphycus* imported from the Philippines.

The development of cultivation in the region

The potential for producing raw material for industrial extraction of phycocolloids, and the rising prices and diminishing availability of dried seamoss for traditional processing, both provided incentives for research on cultivation, beginning in the late 1960s. Production for the extract industry requires a relatively large scale of operation and has not been successful in any islands in the region. However, commercial-scale production has been started in Venezuela, with *Gracilariopsis lemaneiformis* (Dawes 1995) and in Panama with *Kappaphycus*. For many of the islands successful cultivation of Caribbean species for the extract industry is unlikely because of the competition for use of inshore areas, the very low costs of large-scale production in other parts of the world, and the generally poor quality of the extracts relative to the current industrial standards. There is greater potential for small-scale production of the species used in seamoss products as these can be marketed in much smaller quantities and fetch much higher prices than those produced for the extract industry.

This type of small-scale production will necessarily be part of multiple-use coastal resource use systems that include reef uses. Seamoss production can provide additional options for income-generation for coastal communities and help address issues of poverty and the over-exploitation of reef resources that is increasingly apparent.

In 1981 a research project was started in the Department of Fisheries in St. Lucia, with support from the International Development Research Centre of Canada, to develop low-cost cultivation methods for species used for local consumption. The most successful methods were based on vegetative propagation of *Gracilaria* spp. on ropes attached to bamboo rafts or tied between fixed stakes, following the methods in use in the Philippines for *Eucheuma* and *Kappaphycus*. The first small commercial plots were established in 1985 on the southeast coast of the island and in the following years these served as demonstration sites for technology transfer.

The initial research phase had tested various species with commercial potential, including *H. cornea, G. domingensis* and an unidentified terete verrucosoid type referred to as GT. This last species grows fast and is well suited to propagation in ropes, and by the mid 1990s was the only species being cultivated in St. Lucia. Regional training and extension resulted in its being cultivated in other islands as well, including Jamaica and Barbados. The production of this species alone had a number of disadvantages. Firstly the quality of its agar is poorer than that of the species most commonly harvested from natural stocks, notably *H. cornea* and *H. crassissima*. Secondly it is susceptible at some sites to seasonal epiphytism by filamentous algae that trap silt and make the crop unusable.

A number of alternative species were tested in an effort to address these problems. The most promising of these was *Eucheuma isiforme*. Although it had not been cultivated commercially, a pilot project carried out in Barbuda by the Fisheries Division of Antigua and Barbuda in the 1980s had shown that it responded well to cultivation there. Results in St.

Lucia showed that the species grew fast and was resistant to epiphytes, and it was quickly introduced to cultivation in a number of islands. While this solved one of the problems of cultivating *Gracilaria*, *Eucheuma* had its own disadvantages. While it is a part of the Caribbean flora, it is not found naturally in some of the islands. Processors accustomed to using *Gracilaria* and *Hydropuntia* found that their methods were not suitable for *Eucheuma* due to the fact that its iota-carrageenan behaves differently to agar when processing milk-based products. As a result, farmers have not been able to sell *Eucheuma* to processing facilities in Barbados, Grenada and Dominica, where the demand for raw material is greatest.

Factors affecting development

The development of the seamoss industry has benefited from the technological advances in cultivation methods and species selection but its slow expansion indicates that there are a great many other factors that need to be addressed if its potential as an economic activity is to be realised.

Identification of appropriate target groups for technology transfer

It has commonly been assumed that professional fishermen are the most appropriate people to adopt seaweed farming because they are accustomed to making a living from the sea. In practice this has not often been the case. The most successful farmers have been men and women whose livelihoods include a range of income-generating activities, allowing them to survive the first harvest cycle when there are no returns as well as the periodic losses associated with rough seas, seasonal fouling of the crop by epiphytes, spoilage of drying crops in wet seasons, and difficulties in marketing during times of high production and competition with other producers.

Site selection

The scale of farming in the region is still relatively small and issues of access to sea space and competition with other activities that have characterised the uncontrolled expansion of seaweed farming in such areas as Tanzania and Indonesia have not yet been significant problems. However, even at the present scale it is apparent that multiple use of inshore areas needs careful planning and that the zoning of uses that is common in marine protected areas may be appropriate whether or not there is a formal management arrangement in place. Site selection also has social and economic implications. In order to guarantee access to poor people (who may not be able to own or use boats) and to those who are less comfortable working in deeper waters, including women and children, there is need to ensure that some of the nearshore areas remain available for farming, and that farms are not confined to more distant and less accessible zones.

Species and strain selection

Based on past trials it appears that most of the seamoss species can be cultivated. However, among *Gracilaria* and *Hydropuntia* species, those with the highest growth rates have the poorest agar quality and vice versa. Farmers have selected species primarily on their productivity, such as the fast-growing *Gracilaria* GT which has limited appeal to processing facilities. The species with the best quality of agar are *Gelidium serrulatum, Hydropuntia crassissima* and *H. cornea*. The morphology and habitat requirements of *Gelidium* make it an unlikely candidate for cultivation and *H. crassissima* grows extremely slowly so the present

focus is on the cultivation of *H. cornea*.

Once a suitable cultivation system has developed for a species the next step is usually the selection and vegetative propagation of clonal strains with desirable characteristics. This can be a difficult process as a strain with an improved feature may be inferior in another. For example, a strain of *Gracilaria* GT with greater resistance to fragmentation produces an agar with poorer gel strength than plants harvested from natural stocks (Smith 1992).

Economics of production

The economics of the various stages of production have not yet been studied in sufficient detail to describe the viability of the different components of the industry. The little information that is available applies to cultivation only, focusing on one species of *Gracilaria* over a limited period of time (Evans 1995). There are no data on the costs and returns from post-harvest processing of different products, or the relative benefits of local versus export marketing.

Analysis of market options and potential

Most development projects for seamoss production have focused on training in cultivation methods. Because the traditional products are well known and popular there has been less attention given to studies of the market structure and potential. In St. Lucia the marketing of the output from farms has largely been left to the farmers themselves. Occasionally there have been efforts to provide assistance in identifying local and export marketing opportunities but the few market surveys that have been conducted have done little to provide farmers with new marketing opportunities or the means to access them.

Technical assistance

There have many attempts to transfer the technology developed in St. Lucia to other islands, primarily through training workshops. While these have had some success, the rate of uptake and application of new skills has been low. The main reason has been the low level of support to potential producers and an assumption that transfer of cultivation technology is sufficient for the development of a new livelihood.

Risk management

The Fisheries legislation of most islands where seamoss cultivation is being tried includes the facility for the lease of marine areas for mariculture. In practice this has not been used effectively and no farmers have formal rights to their plots.

The loss of crops or entire farms as a result of tropical storms and hurricanes has been a recurring problem in some islands, including Jamaica, Barbados, Antigua and St. Lucia. There are no systems for insurance or compensation equivalent to those available in the agricultural sector.

The case of Laborie, St. Lucia

In order to address some of these issues and to define the requirements for successful commercial cultivation, a case study is being conducted in St. Lucia as part of a research

project entitled *People and the Sea: a Study of Coastal Livelihoods in Laborie.* This project aims at testing and developing tools, methods and approaches critical to the sustainable development of coastal communities in the Caribbean and other parts of the world. It is implemented by the Caribbean Natural Resources Institute (CANARI) in collaboration with the Laborie Development Planning Committee, the Department of Fisheries in the Government of St. Lucia, and a number of other governmental and community organisations. *People and the Sea* is funded by the United Kingdom Department for International Development under its Natural Resources System Programme, and receives technical assistance from the Institute of Development Studies at the University of Sussex in the UK.

The primary focus of this initiative is on developing specific tools and methods in participatory planning, institutional design and sustainable use. *People and the Sea* therefore tests, develops, refines and documents methods that aim at increasing effective participation of stakeholders in all stages of planning and management. It also explores and documents technologies and management tools which can enhance the social and economic benefits derived from the sustainable use of coastal resources, and particularly from the reef fishery, sea urchin harvesting, seaweed cultivation and heritage tourism. At the end of the project early in 2003, results will be analysed, documented and disseminated for the benefit of resource managers and policy makers within and outside the Caribbean region.

With respect to seaweed cultivation, the project aims at testing its viability as a source of income and revenue in a small coastal community. In order to achieve this, the project involves six main components:

- A base line study, which was carried out in late 2000 (Smith and Gustave 2001)
- Planting trials of *Hydropuntia cornea* within one pilot experimental farm
- Provision of extension services to (a) this experimental farm, in order to diversify its production and to ensure that it maintains complete records of inputs and outputs, and (b) people interested in beginning seaweed farming as a commercial activity
- Conduct of an institutional analysis
- Conduct of a comprehensive economic and marketing study
- Formulation of a plan for the development of seaweed cultivation in the Laborie Bay.

The institutional analysis is based on the methodology developed by the Institute of Development Studies, which defines institutions as the rules and norms of society, both formal and informal (Leach et al 1999), and proposes that institutions influence the use and management of natural resources at four levels:

- *Access to marine resources*. In the case of seamoss, the main institutions that determine conditions of access include: attitudes to innovation, novelty of farming as a commercial activity, perceptions that women can be affected by work in the sea (Brown 1999), and the absence of sustained extension services.
- *Rights to marine resources*. At this level, the main institutions include the provisions of the Fisheries Act governing leases for aquaculture, the difficulties in accessing certain planting materials, particularly rope and nets, and the over-exploitation of natural stocks which provide the initial planting material and the genetic diversity for strain selection (Buschmann et al 1995).
- *The ability to convert natural resources into economic resources*. The main institutions include marketing opportunities, requirements and arrangements, including the varying demands for the cultivated species, product quality and standards, the ability to take risks, and the ability to invest financial resources in a new venture.

- *The ability to turn these economic resources into household welfare*. Gender relations, and different roles that can be played by men and women at different stages in the production, processing and marketing of seamoss and its products.

This framework is particularly useful in helping to identify the "bottlenecks" and other institutional obstacles to effective, sustainable and equitable resource use. In this instance, the analysis points to attitudes (to change and innovation) and marketing arrangements as the main institutional constraints.

The preparation of the seamoss development plan for Laborie Bay will provide the first compilation and analysis of all the main issues relevant to the establishment, expansion and management of this new industry. It will examine the following:

- *The economics of production and processing*. The study will compile and analyse production (farming of different species and various types of processing) costs at the experimental farm, and will compare these results with data already available from other seaweed cultivation initiatives in St. Lucia (Nightingale 1988, Evans 1995).
- *Marketing issues*. The project will commission a regional marketing study that will examine demand for the various species and products, the procedures for export, and other key aspects of the marketing arrangements.
- *Product definition.* The study will conduct a review of the various products that have been introduced and tested in the market over the past few years, including packaged dried and bleached seamoss, bottled concentrates, desserts, and bottled and canned drinks, and will compile experiences and lessons learned. It will establish the comparative advantages of each cultivated species for the various products. In addition, the implications of local, regional and international standards will be examined.
- *Environmental quality*. A number of environmental issues need to be taken into account in the development of seaweed farming, as they relate to (a) productivity, (b) the safety of the producer, and (c) the safety of the consumer coupled with the quality of the product. Laborie provides a good case where these issues can be examined because levels pollution are high, as indicated by sampling for faecal coliform bacteria, but vary greatly among sampling stations in the bay (Hutchinson 2001).
- *Social and cultural issues.* Experiences in St. Lucia and other regions will be analysed in order to identify and test some of these issues, with particular attention to the role of women (Brown 1999, Perera 1994). Options will be examined for reducing the risks inherent in establishing farms in inshore areas that are heavily used with potential for conflict with established users.
- *Property rights and other access issues*. These issues have not yet been examined in detail, but preliminary studies suggest that conditions of access can be determinant in the success of commercial cultivation (Berkes and Smith 1995). In the experience of the Laborie project to date, it has become clear that the expansion of seaweed cultivation cannot be conceived in isolation from other coastal uses, especially tourism, fishing and transportation. Recent technological changes in the fisheries industry in the eastern Caribbean have placed a greater demand on coastal space, as the newer fibreglass fishing boats can be anchored near the shore, instead of being pulled onto the beach like the wooden canoes that they have largely replaced. The study will therefore look at: (a) the potential conflicts among uses of coastal areas, (b) the processes through which these conflicts can be avoided, resolved or managed, and (c) the legal and institutional instruments available to secure and regulate access and property rights.
- *Other policy requirements*. This project is aware that the development of seaweed farming depends on a favourable policy environment. In addition to those that govern

marketing and access, which have been mentioned above, there are other policy instruments that can have positive or negative impacts on the development of this economic activity. Using Laborie as a case to study, the project will identify these policies and make specific recommendations in this regard.

- *Organisational capacity*. On the basis of the results of the broader institutional analysis, the study will examine current and potential roles of all relevant organisations, including the Department of Fisheries, banking and financing institutions, community development organisations, the local Fishermen's Cooperative, the national Bureau of Standards and other bodies. For each of these, it will identify the main capacity-building requirements that may be needed to enhance their efforts to develop the seamoss industry in St. Lucia.

The results of these various components of the study will be brought together at a workshop to be held in late 2002. The workshop will bring together local stakeholders as well as external resource people, and will engage them in a participatory definition of the local development plan, which will hopefully serve as a case study to assist the development of seaweed farming in other parts of the region.

Conclusion

The rapid expansion of artisanal seaweed farming in the tropics, and particularly in the Indo-Pacific, has largely been led by the seaweed extract industry, based on the increasing demand for phycocolloids from red algae, and frequently involving the introduction of proven species and strains to new areas. The scale of production is large and production costs are very low. Even if high-value exotic species were introduced to the Caribbean (as has been tried in Cuba and Venezuela) it is unlikely that production could be competitive except in a few areas of very depressed economy and very low income levels. The potential for seaweed production lies instead in the market for traditional seamoss food products that exists throughout the English-speaking Caribbean and is in recent years gaining popularity in the French islands for the first time. At a time when the traditional use of seaweeds for food is declining, seamoss has retained its popularity in the Caribbean, as shown by the recent development of new products of increasingly high standards and the maintenance of high prices for the commodity.

Given the development needs of Caribbean countries and their coastal communities, the demand for seamoss products and the availability of appropriate technology for crop production, there is evidently a potential for expansion of a range of income-generating activities, from cultivation to processing. These activities are not necessarily alternative livelihoods for those who depend on reef resources but they can provide additional options for people who traditionally prefer to diversify their sources of income and they can support new entrants into the marine resource use sector. For this potential to be realized it will be necessary for all actors involved in this promising opportunity to apply a strategy that integrates technological, ecological, social and economic issues in a way that has not been yet been done.

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