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CANOPY FARMING: AN INNOVATIVE STRATEGY FOR THE SUSTAINABLE USE OF RAIN FORESTS

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ABSTRACT. Those developing new strategies for rain forest conservation through sustainable use ascribe a prominent role to forest biodiversity. Faced with the challenge of combining conservation with economic goals, they are aiming their efforts at the ecologically sound utilization of a variety of forest products, both wood and non-wood, thus creating an economic motivation for the total protection of rain forests. The use of select, small products, such as medicinal species and ornamental plants, can offer economic as well as ecological advantages. For example, the low biomass of such products can be paired to high added market value at the same time that their extraction from the forest is least disruptive. Based on the assumption that more valuable forest products likely occur in habitats with higher biodiversity, the innovative canopy farming concept could open up the rich canopy potential for ecologically sound utilization. In a Costa Rican forest, we conducted a feasibility study focusing on ornamental epiphytic orchids as exemplary canopy products. Exploration of in situ orchid production techniques and marketing opportunities suggests concrete possibilities for sustainable utilization of rain forest canopies.

INTRODUCTION

The sustainable-use approach to rain forest conservation follows from the pragmatic notion that these forests might be best protected against destructive logging or total agro-conversion when there is an economic motivation to do so. Making use of a forest's material and non-material goods, including recreational value, yield of wood and non-wood products, and function as a carbon sink, forest managers can generate income in a non-destructive and durable way. Whereas possible ecological and long-term economic advantages of this approach may seem evident, its success is still constrained by limited short-term economic benefits. Hence the need continues for development of new and additional techniques for ecologically sound forest utilization in combination with existing management systems.

Canopy resources are gradually being included in efforts to make rain forests profitable in an ecologically sound way. As with the entire forest, ecotourism plays a prominent role in canopy involvement. At various sites, tourists can access rain forest treetops, for instance at the ski lift-like Rain Forest Aerial Tram in Costa Rica (Perry 1995). Besides research on ecotourism, however, few studies have explored other economic uses of canopies and their possible part in forest conservation. Given their exceptional biological richness, tropical canopies offer high-potential sources of valuable non-wood forest products (e.g., Oldeman 1993). Many traditional uses of canopy species are known (Bennett 1995), yet a majority of items and applications of value to agricultural, horticultural, cosmetic, and pharmaceutical industries, for instance, remain to be explored. A projected increase in bioprospecting activities for natural chemicals and genes by agri-business and pharmaceutical companies (Macilwain 1998) is an indicator of opportunities for sustainable economic utilization of biodiverse systems such as tropical canopies.

CANOPY FARMING: THE IDEA

To aid in opening up canopy potential for sustainable use, Oldeman (1993) advanced the concept of canopy farming by integrating long-term forestry strategies with agricultural approaches (for a description, see Neugebauer et al. 1996). Our paper explores the concept by describing a case study in a Costa Rican forest that illustrates recent efforts to increase the role of canopies in the wise use and conservation of rain forests.

The idea of canopy farming is characterized by the following four recommendations:

Aim at local cultivation and production rather than mere harvesting. Traditionally, utilization of non-wood forest products has emphasized harvesting of items from natural populations (e.g., Peters et al. 1989, Salafsky et al. 1993). The economics of this type of forest use can be made sustainable by artificially, that is agriculturally, increasing yields of selected items in a given area of forest through on-site cultivation and production.

Focus on low biomass, high-value products. The best opportunities for sustainable utilization clearly involve items with high add-

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ed-market values, such as ornamental plants, microorganisms for biotechnology, and plant extracts for cosmetic industries. Such small and unconventional forest products have considerable economic potential and, in addition, can be produced and extracted from the forest with minimized ecological impact.

Focus on small- to medium-scaled production of many different items. To avoid the ecological and economical risks of monocultures and to make full use of the biological diversity in the rain forest ecosystem, cultivation efforts at one location may be best aimed at producing a variety of items in limited quantities, rather than a few items in large quantities.

Involve the natural canopy habitat in the production process. Ex situ production of species from any ecosystem involves, to a certain extent, the mimicking of relevant abiotic and possibly biotic characteristics of the system in an artificial cultivation environment. Especially when various products are produced from a diverse and highly complex system, planners should consider whether cultivation efforts could benefit from making use of the in situ environment. In the original habitat, suitable conditions occur naturally, and natural processes can be used at very low cost to reach cultivation goals.

Methods and Materials

Depending on the type of products, most of the envisioned markets for canopy farming will be in big cities and western countries. These markets include such products as eco-labeled ornamental plants, plant extracts for beauty and care products, and chemicals and genetic resources for high-tech applications in pharmaceutical and agricultural industries. Markets can target local economies, however, with more traditional products such as fruits.

To explore the practical feasibility and economic viability of the canopy farming recommendations, pilot projects need to investigate both production and marketing aspects of selected canopy items. In this context, we initiated a case study at the Rara Avis Rain Forest Reserve at the border of the Braulio Carrillo National Park in Costa Rica. Given the preliminary status of the study, we will describe the project's approach and present a framework for exploring how canopy products might be brought within reach of sustainable use.

In selecting a first and exemplary canopy product, the project focused on ornamental epiphytic orchids. This group combines several advantages: (1) Orchids conform to the low biomass-high value principle reasonably well. (2) They make up an abundant and diverse group of epiphytes at the project site (and typically at neotropical rain forest sites in general, Ingram et al. 1996). (3) A substantial market exists for wild orchid species.

Our initial set of experiments aimed to develop an efficient, local system for the continued yield of orchid seeds from a variety of species, as needed for propagation. For this purpose, stock collections are being maintained of live orchids collected from the forest canopy. Individual orchids mounted on pieces of rooting substrate (tree fern) are fastened to 100 × 150-cm grids of nylon wire netting. To test the suitability of different growing environments for these seed-yielding collections, we placed the grids in different habitats, including a shade-cloth enclosure outside the forest and the high canopy inside the forest, thus covering a range from artificial to natural environments. The grids placed in the canopy are suspended from a canopy branch by a pulley system and can be easily raised and lowered. The pulley enables convenient monitoring of the collections at forest floor level and offers a way to manipulate the exact position of orchids on trees.

Orchids growing in their natural habitat are likely to need little or no tending to grow well and produce seeds, as the natural habitat offers suitable climatic conditions, the presence of the right pollinators, etc. In an artificial environment, plant performance might be sub-optimal or seed production might require hand-pollination and other manipulations. By balancing the advantages and drawbacks of the different techniques, we designed experiments to indicate the desirability of making use of the natural habitat in this stage of the production process.

Having developed an adequate seed source, producers can grow orchids in a conventional way using in vitro germination techniques and subsequent nursing of seedlings (e.g., Arditti 1982). For these stages of the process, however, we also plan to investigate whether production efforts can benefit from making use of a more natural cultivation environment. Use of the natural habitat during critical and ecologically low-impact cultivation steps may prove to be a suitable approach. Adjacent (secondary) forest patches may serve best for the nursing of young plants or for other, higher impact steps.

Parallel to these experiments, we are exploring marketing possibilities for the orchids. If our results suggest commercial viability, the initiative may help establish a local enterprise for ecologically sound, commercial orchid production.

Discussion

With different techniques for local orchid production still being investigated and their commercial implementation as yet untested, the case study at this point does not provide experimentally established, hands-on directives on how to best use canopy items in a sustainable way. Preliminary results indicate vigorous growth of most orchid species on experimental grids in their natural habitat, while those plants grown initially in a shade-cloth enclosure near the forest also established well. Orchids in the shade house environment, however, suffered severe herbivory; whereas orchids on the canopy grids remained virtually undamaged, in spite of repeated defoliation of considerable parts of the host tree's crown by leaf cutting ants. Such observations illustrate that use of the natural habitat can avoid complications of ex situ cultivation, both anticipated and unexpected. Further and fuller testing is necessary to assess the feasibility of this canopy farming technique.

Although the case study focuses on ornamental orchids, the scope of our work goes beyond this exemplary product group. The orchid pilot project allows for relatively straightforward developing and testing of new methods for the utilization of canopy products, emphasizing both production and marketing. With successful development of techniques for local orchid production that make efficient use of conditions in the natural growing environment of orchids, we can envision a commercial venture that, at a regional scale, will maintain production sites at different forest habitats in cooperation with local farmers, villages, or other landowners. From there, building on the knowledge and techniques developed, we can explore the possibilities for the sustainable use of new rain forest canopy items.

The ideas presented in this paper describe one of many possible strategies for the ecologically sound utilization of canopy products through canopy farming. Products other than orchids will require different production techniques and marketing approaches. Exploration and practical development of such innovative techniques and approaches are in order to increase the potentially significant role of canopies in rain forest conservation.

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