

Toward Sustainable Islands

**Approaches to Attaining Agroecosystem Sustainability
in the Caribbean and the Pacific Islands**

**Report on the Review and Research Planning Workshop
Tropical and Subtropical Agriculture Research**

Sponsored by

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and The Pacific Basin Administrative Group (PBAG)

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The workshop entitled “Toward Sustainable Islands: Approaches to Attaining Agroecosystem Sustainability in the Caribbean and the Pacific Islands” was held in February 1997. It was designed as a follow-on conference to the “Agroecosystems Sustainability in the Caribbean and Pacific Islands” workshop held in October 1994. Both conferences were jointly sponsored by the Caribbean and Pacific Basin Administrative Groups (CBAG and PBAG) of the Tropical/Subtropical Agricultural Research Program (T-STAR). T-STAR is a program of the Cooperative State Research, Education and Extension Service (CSREES) in the United States Department of Agriculture (USDA).



Cover image

**View of Hawaii
from *Roughing It*
by Mark Twain,
1872.**

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Foreword

This report summarizes the findings of a workshop on **TOWARD SUSTAINABLE ISLANDS: APPROACHES TO ATTAINING AGROECOSYSTEM SUSTAINABILITY IN THE CARIBBEAN AND PACIFIC ISLANDS** that was held in Orlando, Florida, in February 1997. It was a follow-on activity to a workshop on **AGROECOSYSTEMS SUSTAINABILITY IN THE CARIBBEAN AND PACIFIC ISLANDS** held in October 1994. Both conferences were jointly sponsored by the Caribbean Basin Administrative Group (CBAG) and Pacific Basin Administrative Group (PBAG) of the Tropical/Subtropical Agricultural Research (T-STAR) program of the Collaborative State Research, Extension and Education Service (CSREES) of the U.S. Department of Agriculture.

The workshops reflect CBAG's and PBAG's serious concerns and apprehensions about the decline of the agroecosystems of island nations and their commitment to help provide solutions to the problem.

Executive Summary

Sustainable development, in both environmental and economic terms, is no longer an option but an imperative. Achieving sustainability on small tropical islands is aggravated, however, by stagnant economies, growing populations and fragile environments. CBAG/PBAG therefore addressed this problem and mandated two workshops focused on the agroecosystems sustainability of the Caribbean and Pacific islands.

The first workshop was held in October 1994. It determined the underlying causes of agroecosystems decline in the islands and formulated a series of recommendations. As these recommendations were conceptual in nature, a follow-on workshop was held in February 1997 to translate them into actions that precipitate policies and practices that promote sustainability.

The participants recommended, as a first step, the establishment of an electronic information network accessible through the Internet in order to enhance information flow and create research partnerships. The participants also recommended that research activities should be guided by a systems approach and consider the four major components of sustainable systems: productivity, stability, resiliency and equitability.

Six areas emerged as being of highest priority for research: water, biodiversity, waste, ecotourism, coastal zones and sustainable community development. Each of these areas was examined in terms of the seven recommendations of the previous workshop and research foci were identified. The suggested research topics provide numerous opportunities to engage the resources and energies of all that are stakeholders in ecosystems sustainability.

The proposed research agenda holds much promise as an innovative approach to confronting and solving problems of island agroecosystems sustainability.

Problems and Issues

It is becoming increasingly obvious that sustainable development, in both environmental and economic terms, is no longer an option but an imperative. While clearly an issue of global concern, the small island states of the Caribbean and Pacific Basins have a special and urgent need for greater attention to economic and environmental health. However, stagnant economies, growing populations and fragile environments severely constrain the sustainable development of these islands. Moreover, most of the island states lack the human and capital resources to generate the information needed by decision makers to formulate and implement sustainable practices and policies aimed at improving and sustaining agroecosystems performance.

Agenda 21, formulated at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992, stressed that "...states should cooperate to strengthen endogenous capacity for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies." The paradigms and strategies alluded to in this statement — networking, knowledge sharing, synergisms, technology transfer — are particularly critical for small island nations.

The development strategies must incorporate societal, economic, political and environmental factors and thus require innovative, integrated, participatory and hierarchical approaches. But how can this complexity be assimilated in holistic systems? Can the predictive tools and techniques of the information age facilitate the generation and flow on information and help empower decision makers of the island nations to devise and achieve sustainable development strategies?

Previous CBAG/PBAG Action and Accomplishments

In the context of this perspective, CBAG and PBAG, who jointly manage the T-STAR program, deemed it propitious to sponsor and convene a workshop on AGROECOSYSTEMS SUSTAINABILITY OF THE CARIBBEAN AND PACIFIC ISLANDS which was held in Orlando, Florida, in October 1994. Participants from both the Caribbean and Pacific Basins identified some of the underlying reasons for agroecosystems decline, explored how information science and technology can enhance the biological, economic and social performance of the agroecosystems of tropical islands, and evaluated the utility of the new tools and techniques of information and systems science in addressing problems related to sustainable development.

Participants in the 1994 workshop agreed that the integrity of the agroecosystems in the Caribbean and Pacific Islands was in jeopardy. The underlying causes for this situation were traced to a hierarchy of higher order processes and interactions that affect sustainability: (1) value systems based on misguided incentives and undervaluation of natural resources; (2) modes of thought that evidence an inability to cope with complexities and a dominance of reductionist thinking; and (3) aspects of human organization, including sectoral orientation and disciplinary foci, lack of dynamic perspectives and participatory planning, externally driven research agendas, and lack of primary data in appropriate formats. These predicaments were seen by the participants to result in five principal constraints to agroecosystems sustainability in the Caribbean and Pacific islands:

- ▷ lack of stewardship ethic;
- ▷ lack of systems thinking;
- ▷ dysfunctional institutional frameworks;
- ▷ inadequate policies; and
- ▷ inappropriate research and development strategies.

The participants recognized the pivotal role that systems technology can play in addressing some, but not all, issues of agroecosystems sustainability. They also realized, however, that there exist impediments to application — most critically, the scarcity of reliable environmental and socio-economic data and the lack of maps and databases suitable for geographic analysis. The rapid obsolescence of hardware and software, and the shortage of technical expertise are further deterrents.

Previous Action and Accomplishments CONTINUED

In an attempt to develop an approach conducive to achieving agroecosystems sustainability, the workshop participants recommended that:

- a functional network be established that links institutions within and between the two regions and employs state-of-the-art communications technology to facilitate the flow of information;
- the data and knowledge base required for applying systems technology be improved, expanded, harmonized, and made accessible across the two regions;
- sustainable island agroecosystems be defined and quantifiable indices of sustainability be identified;
- participatory approaches to problem solving be devised by goal-driven teams that involve a critical number of stakeholders in the problem identification, planning, implementation, and evaluation process of research and development projects;
- human resource development and people empowerment be promoted through public awareness initiatives, systems-oriented curricula at all educational levels, and training of scientists in the use of systems technology;
- institutional and policy frameworks be established for resource monitoring, marketing, trade, governance, and environmental regulations and their enforcement; and
- a system of incentives and disincentives be devised that incorporates social and environmental costs into costs of goods and services.

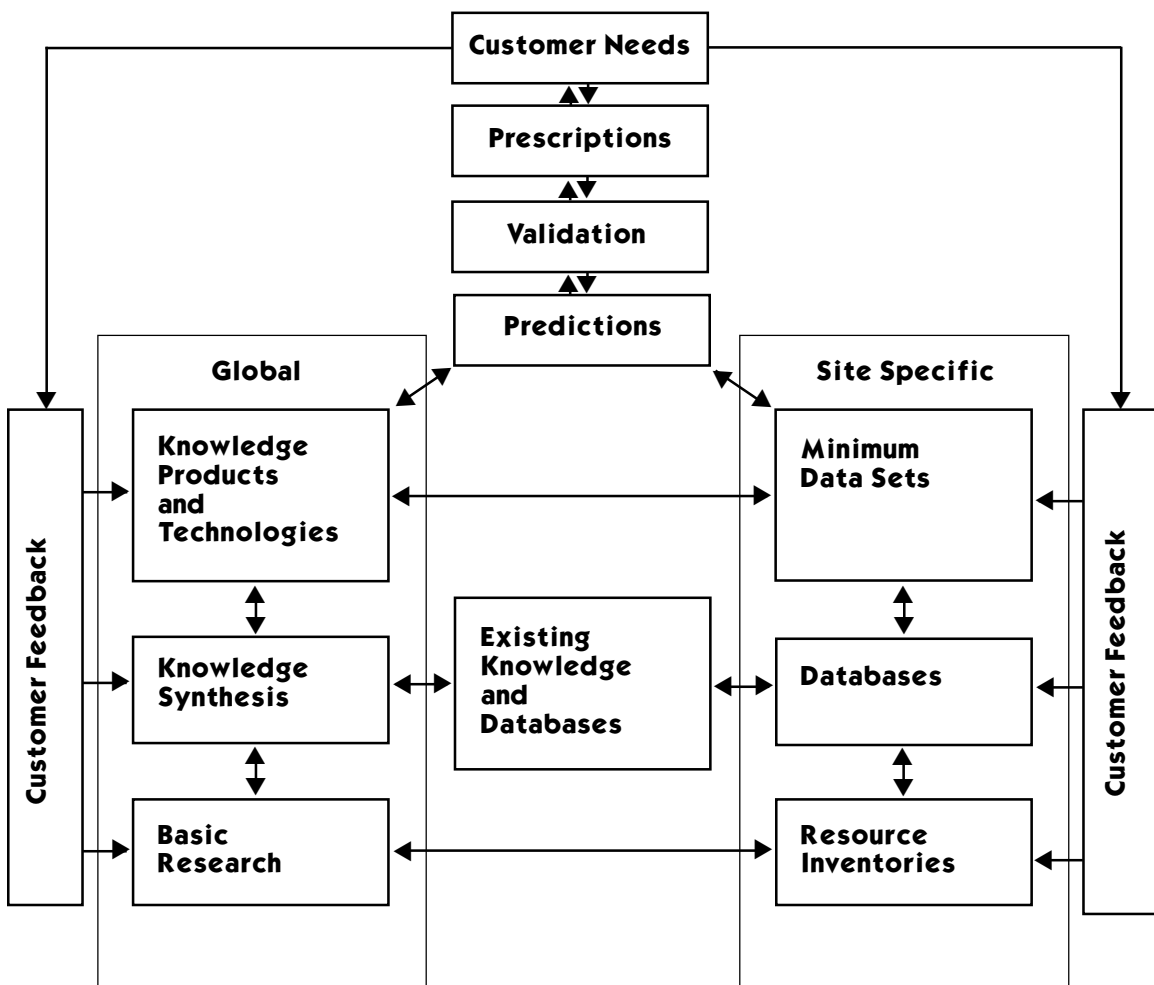
Current CBAG/PBAG Initiative

The above recommendations are clearly conceptual rather than operational. The challenge now is to translate them into actions that precipitate policies and practices that promote sustainability. In an effort to foster the implementation of the recommendations, CBAG/PBAG sponsored another workshop which was held in Orlando, Florida, in February 1997. The purpose and intent of this workshop was to develop a research and development agenda that will serve as a guideline for CBAG and PBAG to solicit and fund future research projects and provide a strategy for long-range planning in the T-STAR program.

The participants in the second workshop recognized the need and opportunity to bring the new information technologies into play as rapidly as possible. The capabilities and availability of these technologies have increased dramatically over the last two years, and hold great promise for raising awareness, reducing duplication, fostering cooperation and provoking insights. The establishment of an information network accessible to many organizations and individuals concerned with sustainability is considered a *conditio sine qua non* in developing the kinds of links necessary for a systems approach to research priorities.

Six areas emerged as being of highest priority for research: water, biodiversity, waste, ecotourism, coastal zones and sustainable community development. We examined each of these areas in terms of the seven recommendations and defined for each a series of research foci. The suggested research topics provide numerous opportunities to engage the resources and energies of all that are stakeholders in ecosystems sustainability, including farmers, donors, regulatory agencies, government organizations, policy makers and researchers. The research and development agenda reported herein reflects an extensive scope of expertise and experience as well as a high commitment to solving problems of island agroecosystems sustainability.

Schematic of Client-Driven Agroecosystems Research



This diagram shows how customers can be engaged in the research process. This systems strategy focuses on basic research and the predictive knowledge tools that are developed from it in the interests of customers.

Framework for Agroecosystems Research

Participatory, Customer-oriented Research for Sustainable Island Ecosystems Development

Agroecosystems research has three purposes:

1. Understand ecosystem processes and mechanisms;

The knowledge of processes and mechanisms gained through basic research, once integrated and synthesized, becomes an understanding of ecosystem performance. This understanding is quantitative and leads to the development of knowledge tools and models which allow customers to:

2. Predict ecosystem behavior and performance;

The knowledge tools give research customers a predictive capability. Because the knowledge tools are based on underlying processes and mechanisms, they can operate globally, that is, they apply to an entire class of problems for which they were designed. But to make site-specific predictions, the knowledge tools require local input data. Once these data are available, the knowledge tools allow research customers to:

3. Control outcomes of policy and management decisions;

Accurate local data are the critical cost of appropriating the power of predictive models. For systems-based research to be effective, customers must participate in the identification of research priorities, and in the design and validation of the knowledge tools.



Proposal for Action and Research Priorities

Electronic Forum on Sustainable Development

Research Priorities

Water — Supply and Allocation

Biodiversity — A Management Approach

Waste — Management and Opportunity

Ecotourism — Benefits of Natural Resource Management

Coastal Zones — Overexploited and Underutilized

Sustainable Communities — Developing Integrated Solutions

Participants in the Electronic Forum on Sustainability

**Institutional
Organization:**

**Leader: CBAG/PBAG
Server: UF/IFAS
Caribbean Node: University of the Virgin Islands
Pacific Node: University of Hawaii**

**Caribbean Basin
Resource
Institutions:**

**CARDI — Caribbean Agricultural Research and Development Institute
CATIE — Centro Agronomico Tropical de Investigación y Enseñanza
CIRAD — Centre Internationale de Recherche en Agriculture pour le
Development
CRDA — Centre de Recherche et Documentation Agricole
EARTH — Escuela Agricola de la Region Tropico Humedo
(Costa Rica)
IICA — Interamerican Institute for Cooperation on Agriculture
INBIO (Costa Rica)
INRA — Institute Nationale de Recherche Agronomique
NARI — National Agricultural Research Institute
UNIQ — Université Quisqueya
UNPHU — Universidad Nacional Pedro Henriquez Ureña
UPR — University of Puerto Rico
UVI — University of the Virgin Islands
UWI — University of the West Indies**

**Pacific Basin
Resource
Institutions**

**ACIAR — Australian Council for International Agricultural Research
ASCC — American Samoa Community College
COM — College of Micronesia
IBSRAM — International Board for Soil Research and Management
Landcare (formerly CSIRO)
NMC — Northern Marianas College
SPC — South Pacific Commission
UGuam — University of Guam
UHawaii — University of Hawaii
USP — University of South Pacific (Fiji)**

Electronic Forum on Sustainable Development

Although island nations may face similar problems, their access to resources varies greatly. Often, communities recognize the need for sustainable development, but lack a critical mass of human, material and financial resources. In the 1994 workshop, information exchange was seen as a top priority, and the Internet was envisioned as an integral part of promoting systems solutions to sustainable development problems. Since that time, the availability and use of e-mail has become widespread, and the World Wide Web has become a standard avenue for providing information — in fact, the Web fosters linking of resources with those who need them. CBAG/PBAG is poised to play an important role in this area.

The electronic forum proposed herein will be a new and important information resource. Beyond this, the sustainability network it seeks to establish will be formed by new collaborations across disciplines and across basins. The electronic network allows people who desire and need models to connect with people who create and use models, and groups facing similar challenges can connect with others who have met such challenges.

Seed money from CBAG/PBAG would be used to set up a home page and listserv on the host server and to support development of content for pages at the Web site. We anticipate that the host server would be located at the University of Florida's Institute of Food and Agricultural Sciences (Gainesville, Florida), and the home page, listserv and newsgroup could be created through their facilities. The University of Hawaii and the University of the Virgin Islands would act as clearinghouses for information coming from their respective regions. Content would be approved by editors designated by CBAG/PBAG.

GOAL

Empower Caribbean and Pacific islanders to attain sustainable development.

OBJECTIVES

1. To facilitate sharing of information, concepts, methodologies, and tools for agroecosystems sustainability between Caribbean and Pacific islands; and to create partnerships for joint research
 - ▷ Harmonized databases and standard reporting formats
 - ▷ Functional information network on the Internet

Electronic Forum CONTINUED

- ▷ Meta-database of tools, contacts, availability, and other elements important to commercial and noncommercial entities relative to agroecosystems sustainability
- ▷ Timely information about opportunities in funding, scholarships, project results, grantpreparation, meetings, training, etc.

Initial activities:

1. Establish World Wide Web home page and associated Internet services, e.g., listserve, newsgroup
 2. Develop a meta-database of systems tools and data relative to sustainable agroecosystems development
 3. Support linkages among ongoing activities of other institutions on sustainability
2. To foster awareness of policy makers and general public in sustainable development
- ▷ Information on sustainability provided to centers of learning, newspapers, research and development institutions, private sector enterprises

Initial Activities:

1. Conduct an awareness campaign on agroecosystems sustainability
3. To support community involvement in sustainable development through access to information
- ▷ Case studies in Caribbean and Pacific islands on agroecosystems sustainability

Initial Activities:

1. Identify and develop case studies addressing one or more of the high priority problem areas
2. Explore funding opportunities and partnerships

Electronic Forum CONTINUED

4. To contribute to human resource development in agroecosystems sustainability

- ▷ Curricula in schools adjusted to include topics on sustainable development
- ▷ Training in systems approach to sustainable development

Initial Activities:

1. Develop education and training programs, particularly programs that train trainers

5. To secure involvement of private sector and non-governmental organizations in national and community-based efforts for sustainable development

- ▷ Increased investment opportunities in sustainable development projects
- ▷ Effective partnerships between governmentally and non-governmentally led activities in sustainable development

Initial Activities:

1. Identify partners in the private sector and non-governmental organizations as participants in the case studies



Priority Research

The four major properties of a sustainable agroecosystem, as postulated by Gordon Conway, are:

- **PRODUCTIVITY** — the yield or net profit derived from an agroecosystem
- **STABILITY** — the constancy of production over time
- **RESILIENCY** — the capacity of an agroecosystem to withstand and recover from stresses and perturbations imposed on it
- **EQUITABILITY** — the equal sharing of benefits derived from an agroecosystem

Ideally, research into agroecosystems sustainability should address all four properties simultaneously so that the tradeoffs among them may be evaluated. Moreover, the research must be participatory, client-driven, customer-oriented, multidisciplinary, holistic, and should, to the extent possible and feasible, employ systems-based information technology.

The workshop participants identified the following six problem areas that should be assigned high priority for research thrusts.

Water
Biodiversity
Waste
Ecotourism
Coastal Zones
Sustainable Communities

In the following pages, each of these areas are discussed and research foci are listed.

Water PROBLEM OVERVIEW

One country has many dams which provide hydroelectric power to help fuel economic growth and increase the standard of living. Nevertheless, people living near these dams often have no supply of fresh water; they simply were not considered in the planning. They must still travel with containers to alternative sources for their daily water supply.

Water is the most limiting resource in agriculture for most island nations. This major constraint is primarily caused by:

1. Variability of rainfall and weather patterns

Natural phenomena such as volcanic eruptions, El Niño, hurricanes and typhoons coupled with global climate change are the principal factors affecting the world's climate.

2. Competition for water between agriculture and development

Dwindling water for agriculture is a major issue on most islands, especially those with large populations. Declining water supplies for irrigation result from competition for water use between agriculture and the growing urban population and industries. The problem is exacerbated in island nations where alternative water resources are limited and where evapotranspiration rates are high.

3. Inefficiency of water use

Water resources for agriculture are sometimes limited by management practices that utilize water inefficiently, resulting in low water supply and seasonal shortages. Improved technologies and water management systems are available, but resources are insufficient to implement them. Inadequate conservation, storage and distribution and crops with high water demands are secondary factors to this problem.

Supply and Allocation

SPECIFIC PROBLEMS AND OPPORTUNITIES FOR RESEARCH AND DEVELOPMENT

- Contamination of water affects agriculture, human health and marine environment.
- Inadequate governmental policies
- Use of farming systems which are very inefficient in use of water, e.g., flooded taro and rice grown in inappropriate locations
- High competition among domestic, agriculture and tourism sectors
- Poor participation of communities in decisions for use and distribution of water

Pesticide use can be determined by cultural as well as practical factors. In one region, chemical use became such a status symbol that if a treatment called for one unit of pesticide, the farmer would apply five units to demonstrate affluence. This resulted in significant contamination of the immediate area as well as to organic crops being grown downstream. The contamination was so severe that the farmers were forbidden to donate blood.

Biodiversity PROBLEM OVERVIEW

By 1666, Barbados had been totally cleared for sugar cultivation. By 1700, one third of the island was derelict and sugar production fell dramatically. Restoration required labor-intensive practices such as minimal tillage, use of inorganic matter and rotation of grass and food crops. These events led to the establishment of forest reserves in Tobago in 1764 and St. Vincent in 1791. The first Botanic Garden in the Western Hemisphere was established on St. Vincent in 1793.

Evolution has filled every ecological niche with a host of remarkable and superbly adapted creatures — each one an experiment in sustainability. Every plant and animal is a successful adaptation to a set of physical parameters and a specific ecological network. Biodiversity has become the term for this rich pattern of organisms. It is important to remember that the diversity of an ecosystem comes from a full range of living organisms; one immediately thinks of mammals, birds and plants, but ecological complexity relates equally to insects, fungi and bacteria.

Many animals and plants have been eliminated from ecosystems of which they were a vital part because they were viewed as pests and, therefore, unnecessary or harmful. Now it is more common to view each component of an ecosystem as a resource to be managed, yet the destruction of habitats and the disappearance of potentially valuable species continues at an unprecedented pace.

Humans often alter their environment in efforts to compel it to adapt to an artificial plan. As communities grow, their activities require ever greater inputs of resources, which damages the environment and requires additional resources. This vicious cycle may increase production in the short run, but it can destroy land and species. The richness and resilience of many ecosystems is being degraded in favor of monocultural farming practices and ill-conceived development among other factors. Even where this state of affairs causes dramatic problems, it is often perpetuated by poverty, ignorance and greed.

RESEARCH PRIORITY

Biodiversity

A Management Approach

SPECIFIC PROBLEMS AND OPPORTUNITIES FOR RESEARCH AND DEVELOPMENT

- Inadequate resource inventories
- Underutilization of indigenous plant and animal genetic resources for medicinal, pharmaceutical, plant breeding and animal husbandry purposes
- Undervaluation of biodiversity in ecosystem stability and resilience
- Lack of legislation on intellectual property and customs rights
- Disregard of sustainability in formulating development schemes and land use plans
- Insufficient human resources trained in proper management of biodiversity
- Inadequate or inappropriate farming systems
- Insufficient protection of crops and livestock due to poor quarantine policies and measures
- Inadequate awareness of and access to germ plasm repositories outside USDA programs
- Accelerated deforestation

Distinctive mountains can become the emblematic feature of an island. On one island, at the base of such a mountain is a beautiful and extremely fragile area. Regardless of this, the area has become more highly valued as an attraction than a symbol. The local government has permitted the building of hotels on this fragile site despite the strenuous objections of local environmentalists.

Waste PROBLEM OVERVIEW

Pigs are very important on many islands. In one case, pig waste was discarded and allowed to foul the environment. This waste is now a valuable commodity which is composted for fertilizer. Not only does this reduce waste and pollution, it's cheaper than shipping the equivalent material from the mainland.

Growing populations and, especially, increasing population densities continue to worsen problems caused by waste. On islands, the difficulties are compounded by small land areas that make massive landfills even less of a solution than they are on the mainland.

Waste has been a hidden cost to most producers and consumers. Consumers at each level of the production-consumption cycle see only the waste they generate. Consumers at all levels must be educated about the consequences of waste generation.

In principle, the solution to the waste problem is simple:

1. Reduce waste throughout the production-consumption cycle
2. Explore the resource potential of materials in the waste stream
3. Dispose properly of unavoidable waste

Each one of these steps means changes in social values and individual behavior. The incentive for these changes is the benefit derived in each case where one of these principles is applied. Reducing waste helps to conserve resources and save money. Discovering the value of cast-off materials in the production process or post-consumer waste can produce new sources of employment, income and prestige. The overall reduction of waste and its proper disposal help to alleviate pollution and contribute to the overall beauty and livability of island nations.

Management and Opportunity

SPECIFIC PROBLEMS AND OPPORTUNITIES FOR RESEARCH AND DEVELOPMENT

- Insufficient education and awareness programs on waste disposal
- Haphazard waste disposal
- Insufficient policies on waste disposal
- Lack of recycling ethic at both the individual and governmental levels
- Contamination of water, soil and air
- Undervaluation and underutilization of biodegradable waste
- Insufficient recycling facilities
- Lack of control of waste from cruise ships
- Negative impact on ecotourism resulting in economic loss

Banana is an important crop on many islands. On one island at harvest, bananas are loaded on trucks and carried to market. Unusable bananas are thrown off the trucks on the way and collect in mounds on the roadside. The piles of bananas can become many feet tall and spill over onto the roads making them almost unpassable. These waste bananas could be seen as a valuable resource.

Ecotourism PROBLEM OVERVIEW

On many islands, tourism competes with agriculture for resources, but there are solutions. One group of island farmers have developed a special blue bell pepper. This product has become highly valued by the local hotels for the beauty and exoticism it contributes to that venerable holiday institution — the buffet.

Many islands are highly dependent on tourist dollars for income. Development for tourism often conflicts with conservation or ethical values, or proceeds without adequate policy or planning. One structure may mar a vista which is a primary attraction for another facility. Unless planned judiciously, local people may lose more than they gain from development.

As the tourist industry develops, it is no longer enough to have another hotel, another casino, another tour. Islands seeking a share of the tourism market must rediscover the value of particular cultural and environmental features that make travel there a distinctive experience. With this cultural self-awareness, island governments seek solutions and guidance.

Implementing solutions quickly shows that changing one part of an integrated system can affect other parts in unintended ways. Solutions which do not take into account the overall system can worsen problems when one sector is deprived of resources in favor of another sector. Some islands are models of economic growth, yet also struggle with severe inequities in resources and opportunities among their citizens.

Ecotourism has great promise for many island nations. While there are few remaining pristine landscapes, numerous efforts to restore nature's beauty have been successful. Restoration is not always the answer — an often overlooked opportunity is *agroecotourism* in which agricultural production on the islands becomes in itself a marketable feature.

Each solution requires a site-specific plan that takes into account local needs and resources. Education in both ethics of conservation and practical methods must be made available at all levels of island societies.

Benefits of Natural Resource Management

SPECIFIC PROBLEMS AND OPPORTUNITIES FOR RESEARCH AND DEVELOPMENT

- Poorly formulated policy on ecotourism
- Poor development of tourist market for local agricultural products
- Underutilization of differentiation of local products versus imported goods
- Insufficient training of farmers to meet market standards
- Poor land use planning resulting in erosion of landscape and degradation of natural beauty
- Conflicting developmental policies
- Insufficient lobbying for proper management of natural resources for tourism
- Lack of appreciation for long-term benefits that can be derived from proper management of natural resources
- Poor linkage/partnership between cruise ship industry and ecotourism developers
- Poor marketing of ecotourism
- Insufficient development of *agroecotourism*

In some cases, a local product is available but not marketable. Though cows on one island were being slaughtered for beef, the meat was being chopped indiscriminately, all parts together as it always had. As a result, the hotels had no interest in local beef and shipped it in from the mainland. When the farmers were trained in meatcutting they found a more lucrative market, and the hotels found a local supply.

Coastal Zones PROBLEM OVERVIEW

Foreign fishing interests pay some island governments a token amount of money for fishing rights in their coastal waters. The nets these fishing boats use can be 10 to 15 miles long, perhaps greater than the dimensions of the island itself. Such nets extract everything possible from the sea and severely damage the ability of fish populations to recover.

A unique feature of island ecosystems is the variety of niches and microclimates that may exist in a small area. Mountainous islands would be extreme examples, but all islands are similar in that their coastal zone forms a relatively high proportion of their available resource space.

Coastal zones present unique opportunities; exploiting the ocean's resources has been an important part of the island sustainability equation — in some cases, the critical part. (The ocean is an overlooked energy source for islands which need additional clean energy to foster growth.) Nevertheless, coastal areas also present unique challenges. Ownership and conservation are not as easy to enforce on the water, and policies governing how offshore waters will be used may not exist or may be circumvented easily.

The capability to harvest the ocean's resources is far ahead of plans to conserve and manage those resources. In addition, the returns from harvesting are immediate, whereas the considerable benefits of management require time to yield dividends.

The overall sustainability of islands includes all ecological zones and resources accessible to the island's population. Fishing fleets deplete, cruise ships foul, and water-borne terrestrial pollutants poison coastal waters reducing their productivity and resilience. The quality of the water determines its suitability as a tourist venue for shore, surface and subsurface activities.

RESEARCH PRIORITY

Coastal Zones

Overexploited and Underutilized

SPECIFIC PROBLEMS AND OPPORTUNITIES FOR RESEARCH AND DEVELOPMENT

- Sand mining
- Inadequate laws and insufficient enforcement of existing law
- Interference with species habitat
- Land-based pollution
- Encroachment of urban development on coastal areas
- Insufficient concern about effects of hurricanes on development resulting in wasted resources
- Destruction of wetlands with impact on water table, water quality, soil conservation and habitat
- Destruction of coral reefs by pollution and sediments with loss of diving venues and damage to food fish populations
- Over-extraction of marine resources
- Destruction of beaches, which reduces ecotourism value of coastal environment
- Dumping raw sewage into the sea
- Insufficient valorization of thermal properties of the sea around the islands
- Weak or non-existent policy on protection of the coastal zone
- Negative impact of poor farm management on coastal zone

Seventy percent of the commercial fish and shellfish in the Caribbean depend on mangroves for some part of their lives. In Puerto Rico, up to 75% of mangroves and wetlands which existed when the Spanish colonized are gone.

On one island, poor zoning allowed several large buildings to be built with inadequate foundations too close to the ocean. A hurricane undermined the buildings and left them unusable and dangerous; they could collapse at any time.

Sustainable Communities PROBLEM OVERVIEW

On some islands, extending manpower resources through cooperation is an established cultural pattern. People pool their efforts to accomplish for each other what one family might find difficult or impossible. Through communal efforts houses are built, and community members gather to work on each other's farms.

The ultimate goal of our efforts is to convert communities based on destruction of habitats and extraction of resources to sustainable communities that coexist with their local environments and optimize use of resources.

In addition to the four major properties of sustainable systems — productivity, stability, resiliency, and equity — three other elements are important to sustainable communities:

ADAPTABILITY — ability of a community system to adapt to rapid external change

AUTONOMY — local control of resources

SOLIDARITY — local control of decision making

Each element of this scheme plays a vital role in the sustainability of a community. Where one element is lacking, or one or more elements are insufficient, the whole pattern can shift from one of sustainability to dependency on external resources. The problem has been analyzed many times. Nevertheless, efforts to institute systems for change are often frustrated by a narrow disciplinary focus or a lack of participation by all parties in the community. Everyone from policy makers and local farmers to hoteliers and researchers requires incentives that evolve from a common vision and promote cooperation.

RESEARCH PRIORITY

Sustainable Communities

Developing Integrated Solutions

SPECIFIC PROBLEMS AND OPPORTUNITIES FOR RESEARCH AND DEVELOPMENT

- Insufficient participation and involvement of community in decision making concerning sustainable development
- Absence of a culture of empowerment (with a few exceptions) and insufficient local leadership development
- Insufficient creation of employment opportunities
- Lack of innovations in delivery of education and information oriented toward valorization of locally available resources
- Insufficient effort for diversification of resource uses
- Insufficient entrepreneurship due to inadequate access to financial resources for investment
- Deficient population, health and human nutrition policies
- Lack of fiscal incentives for sustainable development of agriculture and other rural enterprises
- Poor infrastructure in rural areas — water, electricity, telephone, schools, roads, hospitals, entertainment
- Poor extension support and services
- Inadequate training of public sector professionals and farmers in agricultural sciences and business management
- Insufficient systems-oriented research/development programs
- Insufficient or weak articulation in planning at micro-, meso-, and macro-levels for sustainable development
- Insufficient conceptual and methodological development of sustainable communities
- Outmigration, persistent poverty, unemployment and low-skill and low-wage jobs in rural communities

In many island nations, the younger generations abandon the agricultural communities in search of better job opportunities and a higher standard of living in the urban centers of the islands or in developed countries. The decline in rural population results in a lack of environmental stewardship.

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