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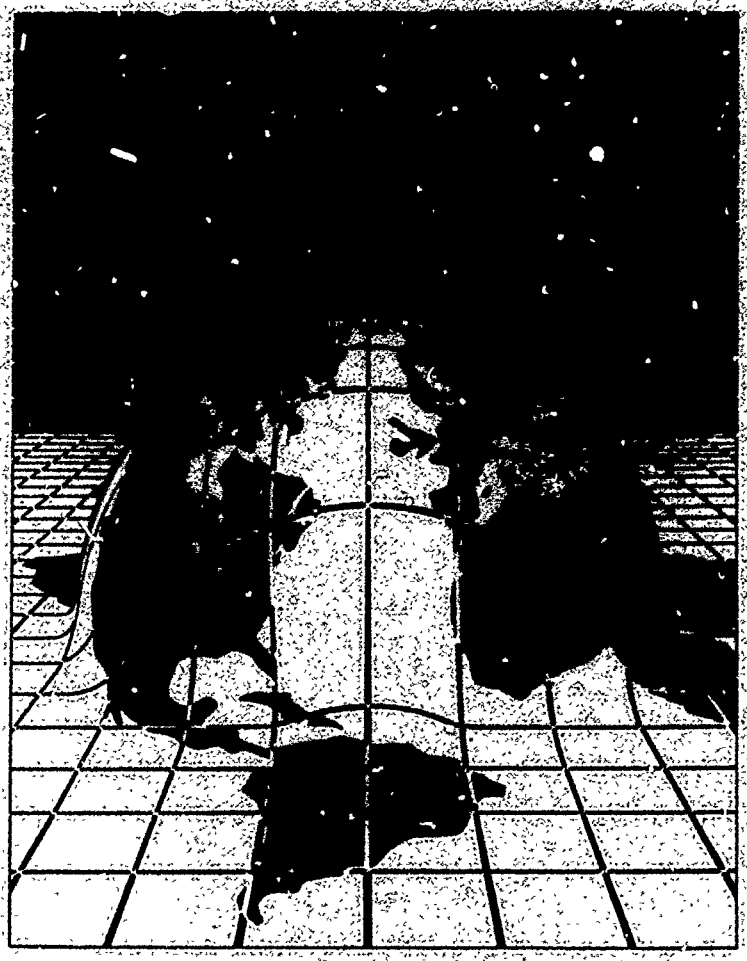
ABSTRACT

This booket contains abstracts of papers presented at a symposium which focused on sustainable development of natural resources in third world countries. The abstracts are organized under these headings: (1) factors affecting individual's resource use decisions; (2) resource conservation and economic development; (3) research on alternative agricultural and forestry systems; (4) renewable energy technologies; (5) fuelwood development: policy issues and case studies; (6) alcohol fuels: policy issues; (7) private sector and government roles in renewable resource development; (8) identifying strategies for renewable resource management in the public sector; and (9) water resource management. Abstracts of keynote presentations and a copy of the symposium program are also included. (JN)

An International Symposium

SUSTAINABLE DEVELOPMENT OF NATURAL RESOURCES IN THE THIRD WORLD

TECHNOLOGICAL AND INSTITUTIONAL CHALLENGES



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Tropical Renewable Resources Program

School of Natural Resources
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SUSTAINABLE DEVELOPMENT OF NATURAL RESOURCES IN THE THIRD WORLD

AN INTERNATIONAL SYMPOSIUM

SEPTEMBER 3-6, 1985
HOLIDAY INN ON THE LANE
328 WEST LANE AVENUE
COLUMBUS, OHIO 43201

SPONSORED BY:

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ABSTRACTS

SOCIAL FORESTRY AND SUSTAINABLE DEVELOPMENT

Hans Gregersen, College of Forestry, Univ. of Minnesota, St. Paul, MN

Steve McGaughey, Inter-American Development Bank, Washington, D.C.

Social forestry is a term which refers to all activities involving trees and forests undertaken by and for rural people — farmers, the landless, communities. By its very nature, social forestry tends to be integrated with other land uses. While various forms have been practiced for thousands of years by rural people all over the world, social forestry has only caught on as a development concept in the international development community during the past 15 years or so.

If properly guided and supported, social forestry can have a critical role to play in alleviating two widespread and rapidly mounting problems in the developing world: i) food crises due to declining agricultural productivity caused in part by poor land use practices and deforestation, which lead to erosion and declining water availability in critical times, and ii) energy crises in many rural areas which in most cases are caused by fuelwood shortages. United Nations agencies estimate that at present about 100 million persons experience hunger and cold because of fuelwood shortages and other one billion persons experience some constraints on fuelwood availability and face severe fuel crises in the next decades.

There are many successful social forestry programs in the Third World. However, they do not affect or involve many families relative to the total number affected by the crises and needs being addressed. Thus, given the mega dimensions of the needs, these projects only represent a very small first step toward solving the problems. Yet it is an important step if we can learn from the current projects how to develop systems that are technically, socially, culturally and economically acceptable and can be easily diffused and duplicated on a very large scale.

Based on review of past project experience, five factors stand out as major prerequisites for significant expansion of sustainable land use systems incorporating social forestry elements. The five prerequisites are as follows:

i) Technologies developed and used must be simple and have high probabilities of successful implementation under varying environmental conditions and levels of skill in application.

ii) Per unit costs should be low so large numbers can be reached or affected by limited and relatively fixed resources available through aid channels.

iii) Programs and projects should take a holistic or systems approach to social forestry and rural development which considers the interaction of all land uses and specifically integration of agriculture and forestry elements.

iv) Programs must have effective and widespread local participation, including that of women who often have the major role to play in tree related activity — fuelwood collection, tree planting and tending, gathering of fruits and nuts, and so forth.

v) Finally, projects must be supported adequately by government resources and institutional structures and administrative mechanisms, including nongovernmental ones. This factor is related to the critical issue of absorptive capacity for investment and the questions of appropriate financing mechanisms and incentives and support for research, extension and training.

The paper discusses these requirements and summarizes the types of actions which have been and could be taken in different situations to meet them.

The lower the per unit cost of implementation is, the larger the population and area are that can be reached with relatively limited aid resources. Similarly, the simpler and more adaptable a social forestry system is, the more likely that it will be diffused, adapted and adopted in a wider area and by a wider cross section of population, including the very poor.

The most widespread sustainable form of social forestry integrated with agriculture is shifting cultivation, which has been practiced successfully for thousands of years. An estimated 250 million persons still practice this form of agroforestry. However, population pressures on the land are such that this form of land use is no longer sustainable in an increasing number of countries or regions. Alternative systems are needed which can increase land productivity on a sustainable basis. That is what the current agroforestry work is all about. Quite beyond agroforestry is the need to better understand the energy relationships involved in local rural communities. Evidence from some studies suggests that many agricultural communities depend on the forest for energy far beyond the narrow confines of fuelwood.

It is clearly evident from past project experience that early and continued local participation is a key to success in social forestry programs. Local participation is achieved through involvement of local people in the initial design of programs. It is also essential that projects be designed to respond to the actual incentive structures of local people, not merely those which might seem relevant to expatriate technicians and other outsiders. Finally, the absorptive capacity of realistically assessed and considered in design and implementation. Too much too soon can spell disaster.

The final ingredient discussed is government support and the need for development of appropriate institutional mechanisms. Consideration is given to the form and continuity of support, including use of non-governmental organizations and desirable levels of government involvement, and to the nature of the institutional mechanisms needed in such areas as research, extension and training and logistical support.

FACTORS AFFECTING INDIVIDUAL'S RESOURCE USE DECISIONS

LEGAL, INSTITUTIONAL AND SOCIAL INFLUENCES ON THIRD WORLD PROGRAMS FOR REFORESTATION OF DEFOLIATED LAND

William C. Siegel, Project Leader, USDA Forest Service, 1D210 P.S.B., 701 Loyola Ave., New Orleans, LA 70113

Richard W. Guldin, Assessment Coordinator, Resources Planning Act Staff, USDA Forest Service, Washington, D.C.

The traditional emphasis of third world forestry has centered on large-scale development and exploitation of forest resources. Until quite recently, most forestry legislation in developing countries was adopted within this context without adequately addressing reforestation. As problems with such an approach became apparent during the last decade, many third world nations reacted by passing regulatory laws that stress reforestation, forest protection, and control of trespass and cutting practices. These attempts have in many instances, however, been less than successful in coping with the issue of defoliation. The reasons are essentially three-fold: (1) the newer statutes have largely ignored the economic and ecological benefits of afforestation to local communities, (2) their enactment and enforcement have lacked involvement by the local people, and (3) many contain clauses that conflict with both established custom and statutory law pertaining to traditional — and sometimes chaotic — land tenure patterns. On the other hand, there have been some success stories. In Asia, particularly, the importance of institutional and social factors has sometimes been recognized and these elements melded into the legislative approach. This paper analyses the institutional - legislative - social interactions associated with third world programs for reforestation of defoliated land, concludes that in many instances new approaches are needed, and presents recommendations for change.

SOME IMPLICATIONS OF SOCIAL STRATIFICATION AND MULTIPLE ENTERPRISES FOR DEVELOPING SUSTAINABLE HILLSIDE FARMS FOR SMALL PRODUCERS

Jill M. Balsky, Department of Rural Sociology, Cornell University, Ithaca, New York 14853

Social stratification and multiple enterprises characterize the livelihood strategies of many smallfarm households, yet how they affect research and development to promote sustainable hillside farming systems are not generally known. One year of field research in the village of Kurila, Central Leyte, Philippines revealed that there are important differences across social strata in how and why lowlanders farm hilly, public forest land. This variation reflects differential household access to on and off-farm earning opportunities in the lowlands and results in different priorities and resource allocation strategies among farmers with respect to hillside farming.

Households that are lesse self-sufficient in the production of lowland wet rice (i.e. they produce none or less than half of their annual rice staple), tend to intensively cultivate hillside farms primarily with annual food crops, specifi-

cally corn and sweet potato. Low stratum hillside farmers emphasize food crop production because they do not have access to other farmland and as a result, must rely on seasonal wage labor and forest product collecting for income to purchase food. Environmental degradation in low stratum hillside farms has led to agricultural intensification in an effort to compensate for reduced productivity, which in turn, has resulted in increased labor demands for both male and female household members. Efforts to improve the sustainability and agricultural productivity of low stratum hillside farms must appreciate the labor shortages and other resource constraints faced by these farmers. Most importantly, they must understand that food crop production is their highest priority.

In contrast, households that are more self-sufficient in rice production (i.e. they produce over half of their annual rice staple) cultivate hillside farms less intensively and are more likely to plant perennial cash crops of abaca (Musa Textilis L.) and fruit trees. Farmers in this stratum have hillside farms to obtain supplementary food, fodder and cash for the purpose of stretching rice supplies between harvests, feeding livestock and purchasing household commodities and chemical inputs required for wet rice production. Programs to improve hillside farms of this stratum would be facilitated by farmers' access to non-household labor and a more steady food supply. Mixed food and tree crop systems would likely be acceptable to this stratum. However, any hillside farm intervention efforts among higher stratum households would have to be coordinated with farmers' other economic activities, especially wet rice production.

Implications of strata-specific differences and multiple enterprise strategies are discussed for designing appropriate agroforestry systems in terms of crops, labor intensity and coordination with male and female farmers' other livelihood activities. In addition, the importance of viewing non-forest, lowland dwelling households as forest resource users is emphasized, as are the dynamics of lowland — upland interaction. Some conceptual and methodological issues for differentiating smallfarm producers are discussed as well.

LAND USE INTENSIFICATION IN PHILIPPINE UPLANDS: EFFECTS ON VEGETATIVE COVER, SOIL FERTILITY AND EROSION

Stephen F. Siebert, Department of Natural Resources, Cornell University, Ithaca, N.Y. 14853

The use of public forest reserves by landless lowlanders is widespread and increasing throughout the tropics. One year of field research in central Leyte, Philippines revealed that public forest lands provide an important source of subsistence food and income to many lowland farmers, primarily through forest product collecting and the cultivation of annual food (corn and sweet potato) and perennial cash (abaca and coconut) crops.

Analysis of aerial photographs, ground mapping and farmer interviews indicated that both forest product collecting and hillside farming activities are intensifying in the study area. The environmental effects associated with land use intensification include the loss of indiganous flora, alteration of soil nutrient and physical characteristics and soil erosion.

The unregulated collecting of forest products, specifically rattan and timber, has depleted all mature, commercially valuable rattan in the watershed and eliminated commercial hardwood species (e.g., Dipterocarpaceae and Pterocarpus indicus) from the lower half of the watershed. Analysis of sample plots in hillside farms indicated that intensified agricultural activities (e.g., shortened swidden fallow cycles) has also resulted in the expansion of a depauperate, exotic, xerophytic, weedy flora dominated by Imperata cyclindrica, Saccharum spontaneum and various Compositae.

Analysis of soil samples collected from hillside farms over the course of one year indicated that continuous cultivation of corn and sweet potato resulted in the gradual depletion of base nutrients (i.e., calcium, magnesium and available phosphorus) and organic matter, and increased soil acidity. However, the data also suggested that sweet potato monocropping may slow soil degradation due to management practices (i.e., mounding and periodic burying of vines), which resemble mulching, and the maintenance of a complete ground cover.

Soil erosion appears to be the most serious constraint to agricultural production in the research area. An average of 3.4 cm of soil (approximately 435 tons/ha) was removed from hillside farm study plots during the first six months of cultivation following the clearing of fallow vegetation. Physical evidence of erosion is widespread throughout the region as is the farmers' concern about the problem.

Recommendations for the development of sustainable and productive forest use and hillside farming include: 1) cultivation of commercially valuable rattan (e.g., Calamus caesius and C. merrilli), 2) planting of cover crops and mulching and 3) construction of live contours (using nitrogen-fixing legumes) and drainage ditches at slope-dependent intervals.

PERFORMANCE CLASSIFICATION OF SOILS: THE FARMERS' PERSPECTIVE—BEHAVIORAL IMPLICATIONS FOR POLICIES OF RESOURCE UTILIZATION

Steven E. Kraft, Agribusiness Economics, Southern Illinois University, Carbondale

Policies fostering rural development whether domestic or international are frequently land based. They implicitly involve efforts to influence farmers' land-use practices. Such policies are usually premised on the recommendations of pedologists, agronomists, agricultural economists, and other specialists in land use. While rural development is necessary, land-based policies to achieve this are commonly disputed or ignored by the farmers affected. This study reveals the information farmers have about land and the way in which this information determines their land-use practices. In addition, farmers' and land specialists' perceptions of land are compared. The effects of disagreement on land-based, rural-development policies are evaluated.

A research framework encompassing concepts of natural resources, economics, and cognitive psychology and anthropology is developed. The conceptual framework, within a phenomenological context, is used to specify a qualitative model of farmer's land-use decisions. The model directs the analysis of data and is used to identify variables influencing farmers' land-use decisions and to hypothesize relationships among these variables. Additionally, the results provide a basis for comparing farmers' and land specialists' perceptions of land.

The farmers' distinct images of agricultural land and the disagreement between farmers and land specialists over their respective perceptions of land have important implications for rural development. First, land-based, rural-development policies premised on perceptions of land that diverge from those held by the affected farmers are doomed to be ineffectual. Second, the formulation and implementation of rural development policies should include the participation of the farmers. At a minimum, efforts must be made to ascertain the farmers' images of land. This knowledge should be used in designing policies and carrying them out. Third, sustained land-based, rural development must be predicated on the maintenance of land quality over time. Hence, attention must be given to factors affecting farmers' decisions to degrade or maintain their land: tenurial arrangements, past and projected land uses, and cost and benefits of land renewal and maintenance.

THE ECONOMICS OF BIOLOGICAL DIVERSITY: APOLOGETICS AND THEORY

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Economists have responded to the current interest in biological diversity with a plethora of apologetics. Species become extinct because they are common pool resources. Since no one can own and manage them over the long run without others enjoying the gains, all exploit them for immediate profit, frequently to extinction. Or species become extinct because they are public goods. All people can 'freely' enjoy the benefits of knowing a species exists or of the knowledge that might be gained through learning from its biochemical and other ecological adaptations. Since none can be excluded from enjoying species existence or sharing in the knowledge that can be learned, a price cannot be charged and there is no private incentive to protect species. Species also become extinct because their natural rates of increase are less than the market rate of interest. Both rational entrepreneurs and responsible public officials divest the species and invest where earnings are higher. Lastly, extinction is forever, but economic decisions are necessarily made over limited time horizons with incomplete knowledge of the future. The 'trouble' with extinction is that it is irreversible.

These arguments are apologetical rather than theoretical. They accept existing economic theory and the conventions that have evolved around it. Existing theory assumes natural systems have separate components that can be owned. Existing theory assumes processes are reversible. Existing theory assumes interest rates are generated in markets where future generations with rights to property — including species and environmental systems — bargain with current generations. For questions where these atomistic-mechanistic and intergenerational assumptions are especially false, new premises and theory should be developed. Instead, economists have explained extinction, developed decision models to optimize extinction, and suggested institutional modifications to rationalize extinction on the basis of somewhat extended, at best, inappropriate theory. If sustainable development and biological diversity are social goals, existing economic theory, itself patterned on the Newtonian view of the world as a machine, is an inappropriate template for economic thought and social prescription.

An ecological-evolutionary world view provides an alternative template. In this view, economic thought and social prescription are premised on the patterns of complex systems and interactive change. A coevolutionary view, emphasizing the evolutionary interaction between social and ecological systems, is elaborated in this paper. This view highlights how most of the past seven millennia of development since the origins of agricultural technologies and social organization was a process of ecological system transformation and adaptive social system response. Development was a process of system coevolution. Cultural knowledge 'explained' people's relations to their environment and prescribed social organization. The coevolutionary vantage provides a good perspective on how the atomistic-mechanistic world view facilitated technologies to exploit stock resources and rationalized both the capitalist system of individual ownership and markets and centralized social organization and bureaucratic authority. With development successfully fed by stock resources and our collective understanding of systems functionally reduced to the formalities of mechanics, systems began to breakdown and species to disappear.

Conventional economists as well as practical people with some of the reins of power might object that coevolutionary theory doesn't answer their questions. And this is true, for world views and evidence, questions and answers, and social organization and possible responses are all bundled. The increasing social dissatisfaction stemming from the incongruities between expectations generated by current world views and outcomes in reality, however, provides hope for a new template and an alternative bundling.

RESOURCE CONSERVATION AND ECONOMIC DEVELOPMENT

ROLE OF THE EXTERNAL DEBT IN NATURAL RESOURCES EXPLOITATION IN LATIN AMERICA

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Increasing population pressures have been mentioned most frequently as a major cause of deforestation of steep hillsides and tropical rainforests in developing countries of the world. This paper examines the impact of the external debt of developing countries in Latin America on natural resource decisions and exploitation. The role of the external debt and the need for export earnings as major factors in resource exploitation are illustrated for several controversial development projects in Latin America. The burden that huge external debts are placing on developing countries must be reduced to ease pressures for exploitation of natural resources that could have long-term detrimental consequences not only for the developing countries but developed countries as well.

ENVIRONMENTAL QUALITY AND INTERNATIONAL DEVELOPMENT: REMOVING THE BLINDERS

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Western industrialized society normally views environmental pollution/environmental quality problems as one of many different and seperable types of problems afflicting developing societies, and of less affordable concern than seemingly more immediate problems of starvation, food production, disease, and societal instability. Yet, environmental problems, in both urban industrialized and rural non-industrialized areas of the developing world, rated as among the most serious of environmental problems facing human society, cannot realistically be separated from problems of hunger and health, disease and poverty, nor even of social instability with which they are closely interdependent. Environmental challenges are also fundamentally interdependent. Environmental challenges are also fundamentally interdependent with increased industrialization, food and fibre production and economic and social planning, and can only be resolved with these interdependent contexts.

In the broader context, problems of environmental quality, environmental health, and environmental planning can only be successfully approached from a knowledge of the anthropological and social context in which they exist. As there is interdependence between environmental and other major social concerns in these societies and, as well, interdependence between environment and the challenges of production, so also there is interdependence between successful resolution of environmental problems and the linkage of that resolution to the sociocultural reality of the society in question.

Western industrial society, and American society in particular, has difficulty in avoiding neat but fatally artificial unrealistic separations and divisions of problems and peoples. Unless "blinders" presently in place are removed, unless conditioned mindsets toward the world and toward

other peoples' conception of life are removed, development, sustainable or otherwise, is doomed to failure.

ECONOMIC DEVELOPMENT AND DEMANDS ON AGRICULTURAL RESOURCES

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Economic development (per capita increase in income) and population growth are two principal factors influencing a nation's needs for food and fiber, and hence the intensity of demand on its agricultural resources. As development proceeds, per capita income grows, and with higher incomes individuals demand more food in the form of improved diets such as milk, meat, wheat, etc. In fact, several FAO studies have shown that at early and mid stages of development, per capita consumption of animal protein always grows with rising GNP. Since livestock products are less efficient convertors of basic grain concentrates, an increase in consumption of these products may double or triple the demand on a country's basic crop agriculture. Furthermore, events in the world food economy over the past decade (e.g., steady rise in per capita food consumption in leading food-deficit, developing countries such as South Korea) have reflected the impacts of economic development on demand for food.

Understanding the dynamics of the linkage between economic development and food consumption patterns would have important implications for the long-term utilization of cropland resources and agricultural trade in both developing and developed nations. The general objective of this paper is to investigate the impacts of economic development on food demand over the past three decades for a selected group of developing and developed countries in the Southeast Asia, the Middle East, Africa, Europe, and North and South America.

The specific objectives are to analyze trends in per capita GNP, food consumption, food production, and population growth in those countries. Furthermore, the changes in ratio of food consumption to production will be used to measure the changes in those nation's dependency on their domestic agricultural resources and/or foreign food imports over the past two or three decades.

Data sources include FAO Food Balance sheets and the World Bank's data on GNP and population which are available for the past twenty-five years.

THE CARIBBEAN BASIN INITIATIVE: WHAT DOES IT MEAN FOR FORESTRY?

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By providing duty-free access and marketing assistance for regional exports to U.S. markets and by encouraging U.S. firms in joint ventures, subcontracting, licensing and other offshore operations in the region, the Caribbean Basin Initiative (CBI) provides opportunities for both Caribbean wood products and producers and U.S. firms. Programs by both the U.S. Department of Commerce and the U.S. Department of Agriculture include marketing assistance to buyers and sellers of wood products, as well as other products. The Agency for International Development has many projects benefiting industries in the region but none specifically directed at the wood products firms and, although wood products producers are not precluded from most private enterprise development projects, none are known to be participating.

A telephone survey of US wood products industry trade associations showed they were aware of the CBI but had no activities in conjunction with it. Furthermore, none of the associations were aware of any of their members initiating or expanding activities in the Caribbean region. A similar survey of advertisers in the CBI Business Bulletin revealed much interest in the buying and selling opportunities advertised but not much business actually consummated. Several stories were found of failures of regional producers to be able to produce products of adequate quality or for the right markets or to make timely deliveries.

If the wood products industry can be said to be typical of small industries in the Caribbean Basin, tariff reduction, general workshops on exporting and development projects aimed at industry in general may be insufficient to stimulate much export activity. The financing, technical production and marketing knowledge needs of an industry may be too specific for effective assistance to be rendered by anything other than an industry-focused and product-specific program.

NATURAL RESOURCE IMPLICATIONS ASSOCIATED WITH AGRICULTURAL DEVELOPMENT UNDER THE CARIBBEAN BASIN INITIATIVE

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The Caribbean Basin Initiative (the Caribbean Basin Economic Recovery Act) was signed into law on August 5, 1983. The purpose of this legislation was to promote economic development in the Caribbean Basin, in part, by granting duty-free status to a wide range of imports originating in the region. Of particular importance to the nations of the Caribbean Basin are agricultural products, most of which (except for sugar, beef, and processed tuna) are covered by duty-free provisions of the CBI.

To the present, there has been little rigorous study regarding the "market windows" for Caribbean Basin agricultural products in the United States' markets, and for the potential impacts on the natural resources of these countries from agricultural development. This paper defines the conditions necessary for the successful penetration by Caribbean Basin agricultural exports of U.S. markets and suggests some issues regarding the natural resource implications of this agricultural development that may occur under the CBI.

The concept of market windows was elaborated by Colette and Wall in 1978 to assist Florida farmers in choosing among alternative crops were:

the actual yield and production potentials of crops in a given region; the prices received for the crops in the markets and the costs of producing and marketing those crops; and, the effects on prices of increased quantities of those crops moving through the markets. The main emphasis of market windows then, is the net return position of producers after all these variables are accounted for.

This study expands the work of Colette and Wall to the Caribbean Basin countries by integrating a multi-market dimension, as well as the effects of the CBI into the analysis of market windows. The duty-free provision of the CBI have great potential for granting a cost advantage to Caribbean Basin Producers over their nearest rival, Mexico, in the form of eliminating the tariffs for their exports (which Mexico is ineligible for) entering the U.S.. Moreover, the Caribbean Basin countries enjoy an advantage over Mexico in transportation costs wherein the latter generally ships fresh fruits and vegetables to U.S. markets via truck whereas the former ships primarily by water, for the most part a cheaper per-unit mode of transportation.

Given the relative comparative advantage of the Caribbean Basin nations, it is most likely that much of the expansion of agricultural production will be in land intensive crops. The question then arises, If the Caribbean Basin nations are successful in their attempt to expand their agricultural production and penetrate U.S. markets under the CBI, what does this augur for the natural resource bases of these countries?

A close parallel to this situation is what occurred in some Caribbean Basin countries during the 1960's when world cotton prices increased. In response to these higher prices, lower value crops such as corn and beans were displaced from the lower valley areas to marginal production areas such as the valley slopes which were more vulnerable to erosion. In addition, cotton producers engaged in overly intensive use of pesticides and fertilizers causing runoff problems, and engaged in highly mechanized cultivation practices which in some cases lead to soil compaction. In sum, higher prices in these areas lead to a geographic displacement of lower valued crops and increased mismanagement of agricultural production which only partly subsided when world cotton prices began to fall in the 1970's.

Caribbean Basin producers are now facing a similar situation: not one in which world prices for their commodities are increasing, but one in which the cost advantages of the CBI are increasing their net returns. Whether or not the above scenario will again take place in Caribbean Basin nations as producers take advantage of the opportunities granted by the CBI remains to be seen. If it does, then the benefits that these nations gain under the CBI could full well be offset by the deterioration in their natural resource bases.

CHEAP CREDIT AND SOIL CONSERVATION: SOME ISSUES

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In general, soil conservation requires that a sacrifice be made in the short run so that future land productivity can be enhanced. For example, when grassed terraces are installed, some land is taken out of production and labor and other inputs are used. Over the long-run, however, this action results in higher yields on land left in production. Similarly, altering land use in order to reduce erosion often involves a trade-off between near-term and long-term benefits; many soil-conserving land uses (e.g., agroforestry and forestry) begin yielding output only after the passage of several years.

When rural financial markets are competitive and when interest rates are not subject to regula-

tion, those markets furnish reasonably accurate information regarding the opportunity cost of capital used to finance soil conservation. In many developing countries, however, rural financial markets are heavily regulated. Real interest rates are often set too low; entry into the formal financial sector is restricted; the costs of financial intermediation are high. Under these circumstances, the cost of credit to be used to fund soil conservation is, in general, too high. Furthermore, many farmers cannot obtain financing for erosion control.

Recognizing the financial impediments to soil conservation that exist in many developing countries, those interested in erosion control often advocate extending subsidized credit to farmers who adopt appropriate management practices and land uses. This recommendation is incorporated in the design of many on-going conservation projects. As we point out in this paper, however, extending subsidized credit is probably an ineffective way to promote erosion control. We base this conclusion on an analysis of lender and borrower behavior when financial markets are regulated. That analysis also suggests that general deregulation of rural financial markets might promote soil conservation more effectively than a "targetted" subsidized credit scheme.

RESOURCE BASED DEVELOPMENT AND THE DUTCH DISEASE: THE RELEVANCE OF LP MODELS

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Resource trade as an engine for growth appears to be the model of development pursued by a number of developing countries, notably some members of the Organization of Petroleum Exporting Countries (OPEC). The resource in the ground is used to generate various types of physical and human capital. The prominent role of trade in this process has produced a somewhat new version of "lagging sectors" phenomenon, with ensuing output and price effects, in a package generally known as the Dutch Disease. Thus, while it is not always recognized as such, the Dutch Disease appears to be, at least in essence, a dynamic problem.

Elsewhere I have delineated the conditions for the viability of the long term development of the non-resource sector of such economies, and also for the emergence of the Dutch Disease price changes, in a general aggregate model. In this paper the consequences of following a strategy of "resource as an engine for growth" in a specific and somewhat disaggregated model are examined. A linear programming (LP) optimal planning model is used. The case considered is a five production sector-three consumer group model of Iran in the 1970's. Thus, the model is also amenable to an optimal-depletion-and-development policy (ODD).

Computible General Equilibrium (CGE) models have now been in use for a number of years in the area of planning for development, particularly in a number of World Bank related investigations. However, the fundamental problem of optimization which, at least in the past, was sometimes implicitly the basis for the very definition of Economics as science, is one thing CGE models are not well suited for. Therefore LP models appear to be a better medium to trace the effects of ODD.

Along with an almost universal linearity assumption, the drawbacks of LP models lie in the remnants of the so called big-bang problem. Even the incorporation of the most relevant economic constraints still leave the solutions susceptible to non-trivial transformations, due to relatively minor parametric changes. In a pragmatic sense this presents a more serious challenge to the applicability of LP models than the requisite assumptions. This paper suggests and applies a procedure to deal with this problem.

THE SUBSIDY FROM NATURE:
SECONDARY SUCCESSIONAL RESOURCES IN RURAL DEVELOPMENT

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Constraints on resource access are making it increasingly difficult for rural populations to survive on the basis of agriculture alone. The two major additional sources of cash income are wage labor and extractive activity. Production of market goods from successional resources constitute one of the few sources of income for rural women, and represent a means for making productive use of female and child labor.

Secondary successional vegetation and fallow management practices have frequently been ignored in development planning. This paper discusses the reasons for this oversight, and suggests that successional systems constitute essential resources for rural development. Palm forests of babassu (Orbignya spp) in Maranhão, Brazil and lontar (Borassus sundaicus) in Eastern Indonesia are treated as case studies to characterize and differentiate the economic and environmental significance of successional palm forests as resources for development.

Their low diversity, ease of management and provision of a variety of subsistence and market goods and services make these palms extremely valuable to the rural poor. However, the degree of pressure they are experiencing from exogenous development forces greatly affect their relative potential for maintenance as essential elements of subsistence agriculture strategies. In the case of babassu, fertile soils and stable moisture conditions have motivated large-scale expansion in cattle ranching on improved pasture. Although not agronomically incompatible with babassu palms, pasture development has frequently implied clear-cutting of palms and expulsion of peasant farmers who rely on babassu for an important part of their livelihood.

In the case of lontar, on the other hand, the dry and infertile conditions of the agro-ecological environment in which palm forests have developed have apparently not been propitious to activities which compete with palm management under traditional systems. In such a situation, there is more time available for work on improvement of management systems and native plant resources. In the case of babassu, it may already be too late for current efforts in palm domestication and appropriate agronomic and processing technology development to make an impact on the resource's degradation and parallel dispossession of peasantry.

PROPERTY RIGHTS AND THE TRAGEDY OF THE "NONCOMMONS":
THE CASE OF THE BRAZILIAN BABASSU PALM INDUSTRY

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This paper provides a theoretical treatment from a resource economics perspective of social equity effects of property rights changes in renewable resource development. The case study focuses on effects of agricultural transformation and industrial innovation on the historical role and

resource potential of forests of babassu palms (Orbignya spp) in an economy of landless shifting cultivators and cattle ranchers in the Brazilian state of Maranhão.

Modern resource economics has tended to pin the blame for resource depletion on an insufficient degree of exclusion over resource use exercised through property rights. Privatization is the neoclassical economists' usual prescription for commons resource depletion. A forceful swing toward barred-entry resources concentrated in the hands of a few has often increased rather than decreased the rate of resource exploitation, however. Property rights delimitation over extractive resources frequently results in population pressures on limited remaining resources traditionally managed in common, thus hastening their degradation.

The objective of this study is to examine how changes in property rights (access to palms and land) and technical innovation in the babassu fruit processing industry may affect the welfare position of the peasantry. The set of circumstances surrounding the dispossession of peasants' property rights, where the gainers are under no pressure to compensate the losers, are defined as a "tragedy of the noncommons." Investments in pasture establishment and whole fruit processing may constrain current land resource users' access to the multiple benefits they have traditionally enjoyed from the palm. The initial rights over palms and land contribute to the ultimate inequitable distribution of rewards from innovation.

One solution to the tragedy of the noncommons is found in the formalization of traditional usufruct, so that those who depend on the resource for an important share of their incomes are those who control its exploitation and management. Such a solution can bring about greater bargaining power over the partitioning of returns from innovation. However, intermediary manipulation of marketing margins and industrialists' efforts to extract rents from processing necessitate that producers gain control not only over the resource itself, but also over marketing channels and decisions regarding subsidized capital investment in processing industries to achieve an equitable solution to the noncommons tragedy.

RESEARCH ON ALTERNATIVE AGRICULTURAL AND FORESTRY SYSTEMS

SUSTAINING THE PRODUCTIVITY OF TROPICAL AGRICULTURAL SYSTEMS

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The management of population growth, crop production and the impact of men's activities on the natural resource base that supports his existence are critical and highly interrelated challenges.

Despite the best efforts of development agencies, more people are starving in Africa today than was the case ten years ago. While many factors are at play, the discrepancy between crop yields on experiment stations and those obtained in farmers' fields remains a particular case for concern. Such data underscore the impact of the stresses at play under tropical circumstances on crop production, and indicate that practices to moderate environmental stress may have a more significant effect on crop productivity than research to raise absolute yield potential of the crops in question.

This paper describes those factors which threaten the sustainability of tropical agricultural systems and appraises measures with the potential to make agriculture more sustainable. In particular, biological sources of essential inputs, management practices requiring minimum inputs and the need for crop varieties which were stress tolerant are reviewed.

The intricacies and sophistication of mixed cropping systems that are commonplace in the tropics are described in comparison with agriculture as practiced in the United States. Progress towards novel crop associations is reviewed, with emphasis on systems involving fast-growing, nitrogen-fixing trees.

The interrelationships of the food and fuelwood demands of rural communities is explored in the context of the negative impacts on land and forest resources.

No strategy for sustained agricultural production is complete without mention of the need for limiting population worldwide. There are finite limits to food production. If we are to avoid the misery of malnutrition and starvation of ever greater frequency, each and every nation must regulate its population to its food production resource.

SEASONAL VARIATION IN PLANT BIOMASS AND NET PRODUCTIVITY OF SOME IMPORTANT MINOR FOREST PRODUCTS

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The studies on biomass production and net productivity of some medicinal and aromatic plants growing in association with the Oak-Coniferous forests of Jammu hills reveal that the aboveground parts show maximum productivity during monsoon and immediate post-monsoon period when the plants are under profuse leafing and flowering. There is a decline in the overall biomass during the autumn months. Exception to this rule is Viola odorata where aerial portion dies off with the onset of rains. The optimum values in this case are recorded towards the end of the annual vegetative cycle in the month of May. Analysis of ash and organic matter content reveal that the species which

chiefly inhabit the forest floor hold comperatively lower concentrations of organic matter, though they are rich in mineral composition.

EFFECT OF SEED RATE AND SPACING ON THE PRIMARY PRODUCTION AND EFFICIENCY OF PHASEOLUS AUREUS ROXB.

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The investigations were made at Government Seed Multiplication Farm, Indore (M.P.), India, by harvest method. In Phaseolus aureus Roxb., a direct relationship significant at 1% is seen between the standing crop (g/m^2) of various spacings and seed rates, and the number of days after sowing. The standing crop (g/m^2) decreased with the increase in row to row spacing (i.e. S_1 = 217.88, S_2 = 194.42 and S_3 = 151.77 g/m^2) and increased with the increase in seed rate (i.e. W_1 = 157.67, W_2 = 186.63 and W_3 = 219.54 g/m^2). The rate of dry matter production between various harvests was slow between sowing to 25 days, then increased and highest was between 40 to 55 days after sowing and then declined. The net primary productivity decreased significantly at 5% with the increase in row to row spacing (i.e. S_1 = 3.112, S_2 = 2.777 and S_3 = 2.168 $g/m^2/day$) and increased with the increase in seed rate (i.e. W_1 = 2.255, W_2 = 2.666 and W_3 = 3.136 $g/m^2/day$).

The efficiency of net primary production of Phaseolus aureus Roxb., decreased with the increase in row to row spacing (S_1 = 0.68%, S_2 = 0.61%, S_3 = 0.48%) and increased with the increase in seed rate (W_1 = 0.50%, W_2 = 0.59%, W_3 = 0.68%).

POTENTIAL FOR TECHNOLOGY TRANSFER OF TWO CALIFORNIA AGROFORESTRY SYSTEMS TO SEMI-ARID MEDITERRANEAN AREAS WORLDWIDE

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Agroforestry systems are presented as effective and sound land-use strategies which hold high potential for sustainable development of marginal semi-arid mediterranean lands. Energy and food needs can be supplemented through the use of non-irrigated agroforestry systems which integrate drought-resistant, nitrogen-fixing woody plants, biomass tree crops, perennial grains and legumes, and livestock.

Demonstration projects of systems are needed to determine appropriate species, establishment and maintenance practices, both short and long-term management practices and potential yields. Two agroforestry species screenings are planned for marginal rangeland sites in the Central Coast region of California. One site is characterized by a cool, coastal mediterranean-type climate and the other site has an inland, winter-rain semi-arid climate with greater extremes of annual temperature and precipitation.

The purpose of this study was to assess the potential applicability of systems of this nature to other regions of the world, particularly those areas of the Third World with similar climatic, soil and vegetative conditions. Recommendations for technology transfer will be made based on both physical and biological data and in addition to

information on the current status of agroforestry research in germane countries. Experimental design and management plans have been prepared for each of the two sites, in addition to funding proposals for project establishment.

FORAGE CROP AGRI-REFINERY: AN ALTERNATIVE FOR PRODUCING FOOD AND FUEL IN DEVELOPING COUNTRIES

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The Tennessee Valley Authority (TVA) is evaluating a system for reclaiming eroded, marginal land by forage crop cultivation and refining of the crops to produce crude protein (suitable for human or animal consumption), fuel ethanol, and chemicals. The system potentially is applicable under a wide variety of agricultural situations and scales, produces marketable products, increases income from marginal lands allowing farmers to enter the cash economy, and contributes to food and fuel self-sufficiency at the national level. Use of the system also could assist in meeting environmental problems associated with some marginal lands as well as sustain its productivity. Successful application requires managerial and institutional capacity to develop internal and/or external markets for by-products.

From the process refining system conceived, the protein would initially be marketed as cattle or poultry feed but with future potential for producing protein isolate for human food. The cellulosic material could be processed into ethanol for use as a motor fuel or fuel additive, utilized for direct combustion, or processed into chemicals such as acetic acid.

TVA has designed and constructed an experimental unit capable of processing about 4 tons per day of nonwoody cellulose materials such as forage crops into ethanol. Initial testing underway utilizes a low temperature, concentrated sulfuric acid hydrolysis process which is relatively simple. Operation is at atmospheric pressure and sophisticated control systems are not required. No toxic by-products to inhibit fermentation have been detected in initial tests, which achieved 80 percent conversion of cellulose to sugars.

Successful completion of TVA's development and implementation of this ag-processing technology for an integrated forage refinery system in appropriate less developed countries could result in efficient and sustainable use of the soil resource, new cash markets for crops, economic activity, and jobs in rurals areas. Domestic production of important feed, food, and fuel supplies necessary for sustainable growth would be realized and an improved standard of living obtained for Third World countries.

OPTIMAL FOREST ROTATION WHEN ILLEGAL EXPLOITATION BY NON-OPERATORS DEPLETES RESOURCE STOCK

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The Faustmann model has played a key role in determining the optimal forest rotation period. The optimal rotation problem, as viewed by him, is a timber management problem when knowledge of the forest operation about the resource biomass is certain, depending on the biological characteristics of growth of the tree population.

In many parts of the third world countries, local inhabitants of forested areas resort to illegal and indiscriminate felling of trees. From the viewpoint of a private forest owner this is a depletion of resource stock caused by human agents. To a great extent it is predictable.

This paper represents an attempt to account for this predictable depletion of tree population caused by human agents in determining the optimal rotation. Our simple and modified Faustmann model shows a shorter rotation period to be optimal, which also seems intuitively apparent. We attempt also, to explore the implication of this shorter rotation period for the third world countries in terms of a loss of positive externalities which flow from more mature forests.

DETERMINING FOREST ENERGY BIOMASS

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Forests are an important energy source for developing countries of the third world. Land management of these forests requires a forest inventory methodology that will assess the total forest biomass; the biomass usable for fuel; and the potential energy of the biomass.

A comprehensive energy biomass inventory system was developed for the dry land forests of The Dominican Republic. The system consists of two stages, supported by biomass regression equations and energy values. A stratification of the forests based on visible human interactions was conducted using aerial photographs. Within each stratum, sample plots were established and all trees greater than five centimeters in diameter at 0.5 meters above ground were measured.

Energy values at oven-dry, 14 percent moisture, and green moisture content levels were determined to be 591.5, 508.5, and 314.0 x 10^6 BTU/hector; this converts to 102, 88 and 54 barrels of oil energy equivalent, respectively. For The Dominican Republic the total energy available at 14 percent moisture from the dry land forests represents the energy equivalent of 52 million barrels of oil.

SEEDLING PRODUCTION AT TROPICAL NURSERIES AND SOME SUGGESTIONS TO IMPROVE QUALITY

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In several tropical species, seedling tops are pruned off when the trees are lifted from nursery beds to product "stump" stock. During lifting, grading and transporting operations, seedlings often lose most of their smaller roots and growing tips. When outplanted, timely root regeneration is required to prevent critical water stresses and dieback in the new shoots.

Certain hormones can stimulate root development if properly applied at appropriate concentrations. Experiments were carried out at CATIE, Costa Rica in which root regeneration of "stump" seedlings of pochote (Bombacopsis quinatum) and melina (Gmelina arborea) was greatly increased by soaking roots of trees in solutions containing indoleacetic acid (IAA) prior to planting. The optimum hormone level for root regeneration appeared to be near 300 ppm IAA. Other hormones and methods of application were either of no benefit or less effective.

Some species may have an optimum nursery size for outplanting. Pochote "stump" seedlings with taproot diameters near 30 mm grew better than seedlings with larger or smaller taproot diameters. Nursery schedules could be adjusted to produce this size of seedlings during the planting season.

Cuttings from seedlings may be an excellent way of increasing nursery production. Cuttings taken from the pruned-off tops of pochote "stump" seedlings quickly rooted and grew vigorously in containers, effectively doubling the number of plants available for outplanting.

Results of these experiments indicate that additional research, especially in the area of seedling physiology, could greatly improve nursery efficiency and quality of stock.

COMPARISON OF THE EFFECTIVENESS OF VARIOUS PRETREATMENT METHODS ON THE ENZYMATIC HYDROLYSIS OF SWEET POTATO (IPOMOEA BATATAS L.) BIOMASS

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Lignin, phenolic substances and other interfering constituents in agricultural biomass act as physical barriers and diminish the rate and extent of hydrolytic degradation of cellulose. In order to enhance the enzymatic susceptibility of cellulose substrates, a variety of pretreatment processes prior to cellulose hydrolysis have been investigated. Leaves and stems of sweet potatoes produced as waste at harvesting the potatoes, have been examined as cellulosic substrates for the production of fermentable sugars for conversion into ethanol. This investigation considers the effect of a wide variety of single and multiple pretreatment methods on the rate of subsequent enzymatic hydrolysis of pretreated stems and leaves by cellulase from Trichoderma viride.

For the single pretreatment, each substrate was either treated with 2.0% or 4.0% (w/v) sodium hydroxide at room temperature (24 hours) or 70% (v/v) ethanol at 60C (3 hours) of extracted directly in 75% zinc chloride (w/v) solution in 0.5% hydrochloric acid at 140C (12 minutes). The multiple pretreatments consisted of a series of methanol-acetone, sulphuric acid (1%, v/v), sodium hydroxide (2.0% of 4.0%, w/v) and ethanol (70, v/v)

pretreatments in various combinations followed by zinc chloride-hydrochloric acid treatment.

The yield of enzymatic hydrolysis was mainly dependent on the type of pretreatment and the kind of substrate (leaf or stem) used. It is interesting to note that, in general, single pretreatments were not promising, since the hydrolysis rates did not exceed much compared to multiple pretreatments when leaves were used as substrates. However, single or multiple pretreatment of leaves enhanced the enzymatic hydrolysis and yields of glucose as compared to untreated ones. Neither single or multiple pretreatment was found to be effective for stem substrates, and overall glucose yields did not increase much as a result of pretreatments. Among all the pretreatments, those involving zinc chloride-hydrochloric acid treatment generally resulted in higher glucose yields in all the cases. Other factors which influence the extent of saccharification of pretreated sweet potato biomass were enzyme-substrate ratio, the enzyme concentration and period of incubation.

DISTRIBUTION AND CYCLING OF POTASSIUM IN SOIL-VEGETATION COMPONENTS AROUND PILANI, RAJASTHAN, INDIA

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The distribution and cycling of potassium in the herbaceous vegetation in sand and dune regions around Pilani ($28^{o}.37'N$, $75^{o}.37'$, elevation 350 m) have been studied from June, 1973 to May, 1974. Four sand dune sites, viz. Site I (windward), Site II (top), Site III (leeward), and Site IV (interdunal lows) were selected on sand dunes at Narhar, 10 Km from Pilani and Site V (exclosure) at Central Electronics and Engineering Research Institute (CEERI), Pilani. The concentration (%) and standing state (g/m^2) of potassium in sand and dune herbaceous vegetation fluctuated between sites and months. Only 3-7 % of the total potassium was involved in biological circulation and the rest (93-97%) was retained in the soil. Maximum uptake of potassium (3.00 g/m^2) occurred in Site IV (interdunal lows) during the rainy season, out of which 83% was reflected in aboveground live shoots and about 17% in roots. The transfers were higher during the winter season. Annually, on all the five sites, the total potassium absorbed by the vegetation ranged from 1.45 g/m^2 to 3.35 g/m^2 of which 47-70% was returned to the soil through litter and root decomposition.

SUSTAINABLE DEVELOPMENT OF NATURAL RESOURCES - THE HUMAN EQUATION:

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Based on experience working with a Rural hospital and on village development, and in assessing the environmental impact on life support systems of foreign aided projects both officially and unofficially, the paper analyzes the relationship between the attitudes of the people involved and the successful implementation. It starts at the project formulation stage, covers the kind of personnel selected and their prior briefing, and only then deals with the structural aspects, local government regulations, and government officials, field personnel and local communities.

Projects are too often formulated by scholars in affluent societies with little understanding and regard for the people affected. They are discussed with and cleared by officials in national or state government capitals who have little, if anything to do directly with implementation. Their role is to relate the project and to identify funding for officially decided priorities. In this process, there is a dilution in the real benefits for local communities. It is almost invariably at a disproportionately higher cost and tends to benefit the already more prosperous elements.

The degree of understanding between the foreign personnel and local government officials and field workers is related to anticipated benefits. A view is offered on the choice of in-coming personnel (where applicable the influence of wives) and their capacity to function in an alien environment, working with local individuals and groups who often combine a measure of chauvinism and self-importance with resentment at the implication of their lack of expertise and of the abundant funding.

There is an in-built communication gap bordering on hostility between officials and local communities and sometimes even between field personnel and senior officers. This has a counter-productive impact on all projects and emphasizes the critical importance of perceptive liaison by the project director and his colleagues. There are no easy answers as conditions vary not only in countries but in different areas. An Indian and an African comment best reflect an aspect of the field reality.

We need outside help for analysis and understanding of our situation and experience, but not for telling us what we should do.

An outsider who comes with ready-made solutions and advice is worse than useless. He must first understand from us what our questions are, and help us articulate the questions better, and then help us find solutions. Outsiders also have to change. He alone is friend who helps us to think about our problems on our own.

The baobab contributes daily to the life of the village, with its bark for medicines, its delicious fruit for the children, and its precious leaves for the sauce made every day to go with the millet porridge.....there is a square of eucalyptus trees planted by the people from the Waters and Forests Department nearly two seasons ago. There were some whites with them when they came to ask the villagers what they should plant. Nikiema said: "Neres, kerites for their fruits, oil and butter, and acacias for the animals in the dry season, where there is no more grass".

The whites wrote everything down in a notebook, but when they came back they brought eucalyptus trees, ... Those thin, sickly trunks will not provide more than poles for huts. Furthermore, the wood does not burn well and the leaves are good for nothing. The people from the Department asked a lot of questions but they did not listen.

In the past, the village had asked the agronomist for a grain bank to store their millet at the end of the harvest, some small dikes to prevent the earth from being washed away by the rain, some fencing, and a well to do some market gardening during the dry season.....Nothing ever arrived. The extension agent explained later that none of that was important and that the whites preferred to build a new road and dig wells.

RENEWABLE ENERGY TECHNOLOGIES

SOLAR POND COSTING IN THE DOMINICAN REPUBLIC

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Figures on the engineering design and costing of a large solar pond project for the production of electricity in the Dominican Republic are presented together with the criteria for pond siting in the island. The island has a 100% reliance on imported fuels for electricity production, and a system for producing electricity locally, from local resources (the sun and salt), will enhance the security and balance of payments of the country. Thus the question of producing electricity from solar energy is not solely one of cost, but one of security and employment as well.

This paper demonstrates the interplay between system costs and a), the parameters which describe the physical environment, and b), the engineering design parameters. For example, the financial structure of this solar pond project depends heavily on the price of salt and a pond liner - either plastic or clay. The correlation between the capital costs and the thermal conductivity of the soil under the pond is discussed to demonstrate the value of soil insulation under the solar pond.

A listing of research and engineering problems is presented that is prioritized on the basis of cost of electricity. Furthermore, there is an indication of the payback associated with a given problem resolution.

Finally, the future of solar ponds in the environments encountered in many tropical countries is discussed, together with any advantages or disadvantages that the authors see in the use of these devices for the production of energy in the tropics.

REGIONAL APPLICATION OF SOLAR PONDS

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Solar ponds combine low-cost solar collection with long-term storage for a variety of low-temperature thermal applications. At first glance, solar ponds are relatively simple in concept, consisting mainly of a hole in the ground, water, and some salt. In many locations excavation, salt, and water are readily available, resulting in low cost plus the use of indigenous resources. Operating costs are expected to be low. While fluid pumping is usually necessary to extract heat from the solar pond, collection and storage are completely passive.

In this paper the general features of the solar pond are briefly described and research activities around the world are summarized. A survey of potential applications in different parts of the world is made based on selected examples. At higher latitudes the seasonal storage capability suggests use as winter space heating. In temperate agricultural areas where salt is plentiful, such as Tux Golu, the great salt lake in Turkey, heat from the pond may be used for grain drying at harvest time. In humid tropical areas, such as Togo, the solar pond has good potential for grain drying on a

more or less continuous basis. In sunny and dry climates, such as Cape Verde Islands, heat from the pond may be used for water desalination. Under some circumstances, solar pond techniques can be adapted to solution mining, as demonstrated by a sodium sulphate pond in Argentina. In some very special circumstances, such as the Dead Sea, the cost of energy from the solar pond may be low enough to justify converting the low-temperature heat to electricity, even though the total efficiency is only a few percent.

Several emerging solar pond technologies hold promise for areas where salt is not available or where traditional solar pond salts would impose too large of an environmental hazard. Several researchers have investigated floating honeycomb structures over fresh water bodies, and development of inexpensive gels that float at the surface of solar ponds is making steady progress. In addition, it is suggested that several ammonium salts are candidates for salt gradient solar ponds in agricultural areas, where the salt runoff can be used as fertilizer.

PHOTOVOLTAICS AS A COTTAGE INDUSTRY

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Photovoltaic systems very often are the best sources of electric power in rural areas of developing nations but the cost of the systems, the unfamiliarity of the new technology and the need to use up valuable foreign exchange currency to import the expensive modules has to date kept the use of solar cell PV systems to a few demonstration projects funded by outside sources. It is now possible in small scale labor intensive plants to make PV modules from purchased cells and even to make the cells themselves from industrial grade silicon using fabrication techniques that have recently been developed. The economics of using a few extra workers to replace a large capital investment in automated equipment is very favorable. A detailed analysis of a 1/2 megawatt PV fabrication plant now being planned for India will be given, showing how 11 extra production workers can displace about $900,000 of capital investment. The production of small solar cell modules to charge batteries for portable lights, radios and other small electric appliances can be accomplished using even simpler shops and can be done on a village level.

Three examples of "cottage industry" plants at different scales of production are given below:

I. A SMALL SHOP PRODUCING 5 TO 10W SOLAR BATTERY CHARGERS
Solar cells, plastic for cases, etc. purchased.
Output: 1000 charges per year, 4 per working day
Personnel: 1 to 2 persons
Capital: $15,000 startup, $16,000 per year material cost

II. LABOR INTENSIVE FACTORY MAKING 40W LAMINATED PV MODULES
Solar Cells, glass and other supplies purchased.
Output: 1/2 MW per year (12,500 modules), 50 per day
Personnel: 18 production workers
Capital: $150,000 startup, $2,000,000/year material cost

III. PLANT MAKING SOLAR CELLS FROM INDUSTRIAL GRADE SILICON
Casting polysilicon shapes from cheaper grade silicon, cutting into square wafers, doping, adding metal contacts anti-reflection coating, etc.
Output: 1 MW per year (1,000,000 wafers), 4000 per day
Personnel: 20 workers (8 highly skilled)
Capital: $1,500,000 startup, $3,000,000/year operating.

BIG BOON OF THE BIO-GOBER GAS PLANT - THE CASE STUDIES IN SANDUR TALUK, KARNATAK, INDIA

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Dr. H. Basenna, Veerasaiva College, Bellary

The non-conventional scurces of energy are of vitel importsnce in the present situetion of energy crisis in the Third World Countries as well es for protecting the environment. They are non-polluting and non-exheusting in nature, end they are ideally suited for rural Indie, becsuse of their decentralized end small scale energy systems.

Biogas is one such important component of renewable supply of energy. The by-product of biogas is a very veluable enriched fertilizer. It reduces the demand for firewood and helps women in cooking emicably. It can also be used for lighting and other purposes.

In the present study, the authors have investigated the state and stetus of the Gober-bio-gas plants in Sandur Taluk of Bellary Dist., Karnetake State (India). The specific objectives of the study relete to the examination of the economic compatibility of the technology, problems feced by the owners, and subsequent attempt to solve them, end exemine the organizetionel network for the speedy execution of the scheme.

The study is beesd on both primary and secondery deta collected through personal interview and questionnaire method. Out of eighteen commissioned plants in Sandur Taluk, ten have been selected randomly representing four small, four medium, and two big plants. The analysis of the data revealed that these plants have proven to be e boon to the owners, because, they help in saving time, money end cost. Besides they also help in lighting the houses, getting enriched manure, saving denudation of forests and thereby help in maintaining the ecological equilibrium.

However the study also revealed that plant owners have confronted some problems such as low production of gas during winter, frequent replacement of mantle for lighting purpose, etc. Based on the identification of the problems the authors have suggested remedial measures to improve the operational efficiency of the plants.

FAMILY-SIZED METAL GRAIN STORAGE BINS OF CENTRAL AMERICA: A CASE STUDY

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This paper will summarize recent findings about the family-sized metal grain storage bins which are a widespread, little-known appropriate technology in Central America. Around 150,000 and 100,000 of these inexpensive, locally-produced post-harvest storage systems are currently in use in El Salvador and Guatemala, respectively, with limited use also in Honduras and Costa Rica. In the first two countries, bins are produced and distributed without development programs or subsidies to local

farmers by itinerant tinsmiths or small-scale sheet-metal industries. In the latter countries, national government and bilateral aid agencies are attempting to promote dissemination.

This technology provides significant social and environmental benefits which have been largely overlooked by national planners, agricultural ministries and international development agencies. Properly managed, this technology enables excellent conservation and storage of basic grains (maize, beans, and sorghum) for over 2 years to farmers with limited resources. With proper drying, handling, and fumigation, losses due to rodents, birds, insects, fungi, and other pests can be reduced to a minimum.

Based on recent field research, the paper clarifies the agroclimatic, financial/economic, environmental, and institutional factors which favor the technology's adoption and sustained use in Central America. The paper will also review and compare various current research, development and dissemination techniques employed in the transfer of the technology and present useful policy guidelines to decision makers.

UTILIZING WAVE POWER

Research and development by Kim Nielsen

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A method of converting ocean-wave-power into electricity is proposed and initially described. The principle is based on floating bodies, damped by single-working piston pumps, placed on the sea-bed and connected to a central submerged water turbine.

An experimental investigation concerning the ability of floating bodies to absorb wave power has been carried out. Experimentally determined efficiencies are presented for different body shapes and mass distributions in head and beam seas. A comparison with efficiencies obtained by other elongated wave-power converters show that the peak values compare well, but the band-width of high efficiencies are much broader in the principle investigated.

With regard to future development of the wave-power converter, a dimensioning procedure is proposed. The procedure takes into account the long term Weibull distribution of wave heights of a chosen ocean location and is based on general empirical relations, derived from the model experiments combined with ISSC spectrial description of the sea surface.

During the project, mapping of Danish wave potential has been carried out, too. The potential is 25,000 GWh/year equal to a year's consumption of electricity in Denmark.

The above described wave-power absorber has the advantage of being made of simple concrete construction, easily adaptable to most parts of the world . There is no patent on the principal, and the submerged turbine and generator is a standard product.

The best way to spread knowledge of the utilization of wave energy is to demonstrate how it works, and to improve the construction.

Other types of wave power systems are placed on the coast in a very vital environment for wildlife. This is not the case with this wave power converter, which in order to work must be placed in a minimum of 100 feet, deep water, offshore. In this way it will not pollute the shoreline, but preserve it, and help to prevent erosion.

ECONOMIC ANALYSIS OF RENEWABLE RESOURCE CONSERVATION IN THE THIRD WORLD

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Estimating the benefits and costs of an environmental improvement usually requires resolution of complex issues, regardless of whether one is working in the developing world or in an affluent country. It is a challenge to model well the physical impacts created as humans alter their interactions with the natural environment. Furthermore, assigning economic values to physical impacts like amelioration of acid precipitation problems in Europe or North America or reduced sedimentation of a tropical reservoir is rarely a straightforward exercise.

To be sure, the research agenda for resource economists working in wealthy countries differs from the agenda of their counterparts in the developing world. Because the share of income spent on services derived from amenity resources tends to increase as income grows, estimating recreational benefits is a major research area for resource economists in the wealthier countries. By contrast, resource economists in poorer countries focus more on cases where environmental degradation is affecting or will affect the flow of natural resource inputs used in agriculture and industry.

In spite of this difference in research agendas, there is substantial correspondence between what resource economists in affluent and developing countries do. Estimating the on-site and off-site costs of soil erosion, for example, is a major topic of study throughout the world. Recognizing this correspondence causes one to consider the following question: how well do the techniques developed in wealthy countries to analyze environmental problems transfer to the developing world?

While studying the economics of renewable resource conservation in Latin America, West Africa, and the Pacific Basin, the authors have encountered three limits on the transferability of analytical techniques utilized in affluent countries.

A. Data are generally not readily available in third world countries as in developed countries. Furthermore, due to communication costs and bureaucratic constraints, primary data are difficult to obtain.

B. Given scientists' rudimentary understanding of tropical and subtropical ecosystems and sediment delivery systems, it is difficult to precisely model the physical impacts of a change in resource management.

C. Conceptual frameworks developed in affluent, industrialized countries must often be extensively amended to reflect social and political institutions that are particular to developing countries.

Any resource economist who has worked in a developing country is intimately familiar with the first limit. Features of third world bureaucracies that impede coordinated management of resources also constrain collection of data needed for economic analysis. What one encounters in most countries is a series of agencies, each with a narrow policy mandate, that do not communicate regularly and well with each other. One often experiences frustration trying to collect data from several such agencies.

Watershed management is a good illustration. Quite often there is more than one entity utilizing water from a reservoir. One agency might be in charge of running an irrigation system while another is trying to produce hydroelectricity. While the two agencies might have evolved a mechanism for allocating water in times of scarcity, neither is likely to be doing much about erosion in the region upstream from the reservoir. The mandate for watershed management is often split among a forest service (which plants and/or protects trees), a parks department (which protects wildlife), and an agriculture ministry (which is not apt to be familiar with farming systems that conserve soil). Entering this milieu, one must expend a lot of

effort obtaining reliable information on how (a) soil conservation affects farm income, (b) erosion control affects reservoir sedimentation, (c) sedimentation affects hydroelectricity production at the dam and irrigation water withdrawals from the reservoir, and other related topics.

The second limit on reliable estimation of the benefits and cost of resource conservation is easily appreciated by natural scientists. To continue with the watershed management example, it is only now becoming clear that sediment travels through tropical watersheds and reservoirs in ways unfamiliar to sedimentologists who have worked exclusively in North America. For another example, a tropical rainforest is more species-rich than forests in more northerly or southerly latitudes. Accordingly, predicting the effects of tropical deforestation is more difficult than predicting the effects of clear-cutting in a temperate climate.

Perhaps the least well understood impediments to resource conservation in the developing world fall in the category of institutional factors. Models developed to analyze resource use under the institutional conditions found in Europe or North America often do not facilitate understanding of the institutional roots of environmental degradation in Africa, Asia, and Latin America. To cite an important case in point, resource management decisions made by agricultural colonists in those parts of the third world where land is treated as an open access resource cannot be described well by referring to a model developed to explain conservation/depletion decisions made by a U.S. landowner.

Obviously, the research agenda is full for economists interested in third world renewable resource depletion. As environmental degradation creates higher social costs in developing countries, government agencies ought to have a stronger incentive to coordinate policy making and data collection. Similarly, improved understanding of tropical and subtropical environments will allow for more precise analysis of resource management options. Finally, because policy makers must know how individuals will respond to conservation projects, there exists an opportunity for economists to develop models of individual conservation/depletion decisions that reflect better the institutional realities now prevailing in the third world.

FUELWOOD DEVELOPMENT: POLICY ISSUES AND CASE STUDIES

THE INFLUENCE OF MARKETING AND GOVERNMENT POLICY ON BIOMASS WASTE CONVERSION TECHNOLOGIES IN LDCs

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Agriculture and forestry process wastes represent a major renewable energy source in the Developing World. Generally, the quantity of wastes produced at a typical processing plant contains energy far in excess of that required to power the plant. From a national perspective, full, efficient utilization of these materials is mandatory. Therefore conversion technologies such as pyrolysis, digestion and fermentation which can efficiently convert all the wastes while providing liquid or gaseous fuels for plant needs and an array of easily transportable by-products such as char, tar, fertilizer, etc., probably offer the most attractive means for utilization. This is in contrast to technologies such as direct burning and gasification which intrinsically require only a fraction of the wastes available, thus frequently leaving the remainder practically unavailable as fuels and simultaneously producing a serious disposal problem.

However the difficulty with the technologies for fuel utilization of the wastes is the marketing problem, since for them to be economical the char, tar, fertilizer, and other by-products, must be sold to the public. The lack of a proven market demand has seriously inhibited development of these technologies and unless something is done soon, these wastes will remain unavailable economically due to growing use of combustion and gasification conversion technologies.

Thus there appears to be no practical alternative but for government intervention. In a related situation, the Indians reached a similar conclusion 25 years ago with the formation of permanent, government-owned corporations to provide supply-side support to their fledgling soft coke industry. The results have not been completely satisfactory. For this and other reasons it appears that demand-side support would be better with assistance initially provided in the form of guaranteed prices, tax incentives, government purchase of by-products etc. that could be phased out gradually as the industry prospered.

Likewise, the Indian experience teaches that medium production scale conversion systems utilizing mid-level technology and an Intermediate Capital Intensive design approach - as opposed to the opposite extremes - is perhaps most appropriate to LDCs. This is because practical marketing of the by-products demands a phased production program which itself requires a technology applicable at small and medium production scales. That does not produce too wide a variety of by-products and is environmentally acceptable.

Because the seriousness of the Energy Problem in LDCs can only increase with time, there is a pressing need for recognition of these factors and for the implementation of government programs to overcome the marketing problems described.

FEASIBILITY OF A SHORT COPPICE ROTATION PLANTATION, A CARBONIZATION SYSTEM, AND THE CONVERSION OF A CEMENT PLANT IN CENTRAL AMERICA

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After analyzing several alternatives to fuel-oil, charcoal was selected as being the optimal solution to a Cement Plant conversion problem.

The project has been scaled to satisfy the energy needs of a cement factory producing 360,000 tonnes of clinker per year. To meet the factory's charcoal needs, fuelwood will be produced from plantations covering an area of 11,000 hectares. The main tree species to be planted will be Eucalyptus sp, Leucaena leucocephalla and Gmeline arborea, in a four year rotation system over a project life-span of 23 years.

The carbonization will be done in two production centers, made up of 8 beehive kiln's batteries. Total annual charcoal production will be around 48,000 tonnes, including losses.

The cement factory conversion will be set into a unique process of preparing and handling charcoal and fuel. The new installations are calculated on the basis of a maximum capacity, without precalcination, of 1,400 tonnes of clinker a day.

Feasibility studies were carried out on:

- the establishment and management of short coppice rotation plantation, near the current factory.
- the establishment of efficient, continuous and high quality carbonization system.
- the conversion of the plant's clinker kiln, so as to maintain current efficiency while keeping production process, security and quality standards.

The project presents the following benefits:

- contribution to regional economic balance and lessening of out-migration,
- introduction of new technology,
- foreign currency saving in the order of 5.5 million $US,
- create in a short period a large plantation in a zone where the vegetation cover is either poor or lacking,
- the protection of remaining native forests by reducing wood felling,
- the development of various forestry techniques and activities (nurseries, plantation, management systems, etc.).

ECONOMIC STRATEGIES FOR LOCATING FUELWOOD PLANTATIONS

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The availability of land for afforestation is a socio-economic issue of great importance world-wide, and is rapidly becoming a critical concern in many of the less developed countries (LDCs). The uniqueness, scarcity, and accessibility of suitable lands for tree planting projects must be addressed in the early stages of planning strategy if the investment is to meet its socio-economic objectives.

Von Thunen's classic model of land allocation provides important considerations for the selection of afforestation project sites. Because charcoal is readily substituted for wood as transportation distance increases, and because charcoal production wastes half of the potential fuel value of the wood resource, the location of afforestation projects close to the center of consumption is suggested.

SCARCITY OF WOODFUEL ENERGY: THE TANZANIAN CASE

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Current levels of woodfuel consumption in Tanzania are too high for the indigenous forest resource base to support on a sustained basis. Continuation of this level of consumption will drastically reduce the natural woodland area of the nation and present associated problems in agricultural production and environmental protection. Large scale fuelwood plantations would be required to meet projected fuelwood requirements. Investments needed to develop such large scale fuelwood plantation projects would be high and compete directly with development projects that could earn foreign exchange capital. Alternatively increased management and protection of the indigenous forest resource could meet projected requirements within a 20 year time period. This management program would reduce the need for major fuelwood plantation programs and yet provide an adequate supply of wood for rural consumption.

DECENTRALIZED PRODUCTION AND DISTRIBUTION OF AN APPROPRIATE TECHNOLOGY FOR A CONSUMER DURABLE: THE KENYAN CHARCOAL STOVES EXPERIENCE

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Efforts at promoting more fuel-efficient charcoal stoves to replace traditional charcoal stoves in Kenya offer some lessons for the dissemination of appropriate technologies in energy and also in other sectors. A market-based approach has made the Kenyan charcoal stoves project much more successful than most of the improved woodstoves projects throughout the world. The lessons from this exper-

ience are of broader significance than the particular designs of a charcoal stove. A large number of different designs have been tried in Kenya and although the technology is relatively simple, it is still evolving.

The Kenyan experience shows the desirability of relying on local artisans to manufacture consumer durables and using existing private sector channels to market these goods. It also highlights the importance of going beyond a laissez-faire approach and supporting training, demonstration, and publicity to facilitate the workings of the private sector. In the Kenyan case, technology choice was relatively unsubsidized and left to the choices of consumers. Since many different characteristics of a technology affect its acceptance by consumers, designs should not be optimized for a single characteristic alone.

The relative success of the design, development, and early production and dissemination efforts for charcoal stoves in Kenya does <u>not</u> mean that further efforts are unnecessary. In fact, the time is ripe for infusion of additional resources to extend production and servicing especially outside of Nairobi. Even in Nairobi, a system to ensure better quality control would be desirable and consumer education and marketing activities should be expanded.

THE 'OTHER' ENERGY CRISIS AND ECONOMIC DEVELOPMENT: THE ROLE OF NONCOMMERCIAL FUELS IN INDIAN SUBSISTENCE AGRICULTURE

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For many subsistence agricultural economies, the "other" energy crisis <u>is</u> the only energy crisis of any relevance today. The major thrust of this paper is to analyze, assess, and evaluate the dimensions of the "other" energy crisis. In Indian villages, this is seen as a replacement of fuelwood by dung in the household's energy budget. While relying mainly on descriptive statistics obtained from different village and household surveys, correlation analysis and multiple regression techniques are also used.

First, while Indian consumption and supply of noncommercial fuels is determined by socio-economic conditions, the noncommercial fuel mix is dependent on the agro-ecological resource base and use in and around villages. Second, shrinking resource bases, due mainly to a change in Indian rural development and economic policy, have effected not only the total amounts, but also the mix, of noncommercial fuels. Third, the regression results confirm the above findings by showing that mix of noncommercial energy is negatively and significantly related to the level of economic development. On the other hand, the mix is positively and significantly related to the resource base and use in the village.

Thus, in attempting to provide a smooth transition from noncommercial to other fuels through "new" energy technologies and systems, LDC policymakers may have failed to take into account the role of noncommercial energy in the rural subsistance's household decision-making process.

BIOMASS AS ENERGY RESOURCES IN INDONESIA

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Indonesia is covered with approximately 143 million hectares of tropical forested land producing from 2 to 10 m3/ha/yr of biomass resources. In addition to this, land for food production as well as for estate plantations are also producing biomass in the form of waste at reasonable quantities each year.

The current issues on energy problems in Indonesia are focused mainly on determining the best strategy to: a). assure a gradual shift from a mono-energy to a poly-energy economy, b). ensure the availability of energy at reasonable prices for domestic market and c). ensure a continuous and positive contribution to the balance of payment and public revenues.

Biomass in Indonesia had played an important role in economic development particularly in supplying basic energy need for the rural and even to the urban household, agro and small scale rural industries.

In 1972 the estimated consumption of biomass in the household sector was 89.2 million m3 or equivalent to 117.3 million BOE. This amount is about 58.7% of the total national energy consumption. In 1983 the amount increased to 133.1 million m3 which is about 34% of the national consumption. Many attempts had been made to obtain more reliable figures for future forecasting by conducting an integrated survey using a standardized methodology. As a result a combination of econometrics and engineering model had been proposed by some researchers although some key problems are remains to be solved such as those related to the impact of kerosas subsidy reduction on the degree of deforestation.

In this paper, the author described a different approach to the problem by establishing a macroscopic model by taking into account the various factors related to the supply-demand balances of biomass resources such as the reforestation program, forest conversion to new settlement in the outer island of Java, shifting cultivation, food production and estate crop plantation and industrial purposes. In addition to this, the model can also be used to study the impact of future bioenergy development for power supply, the impact of interisland import/export of biomass and other related problems.

Preliminary analysis indicated that bioenergy development is still possible in Indonesia. To support this idea further, it was suggested that more basic data such as the forested land area, species and its productivity (e.g. the mean annual increment), standing biomass, similar data for the home yards all in terms of quantities measured over a certain time span should be provided. To do this the utilization of the remote sensing technology, now already available in the country, was recommended and an experiment with LANDSAT imagery for Northern West Java had been conducted. More ground truth data are still required to obtain better correlation and the comparison of the above test result with data from the NOAA-AVHRR is now under study.

ALCOHOL FUELS: POLICY ISSUES

THE BRAZILIAN ETHANOL PROGRAM: AN OVERVIEW

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Brazil is faced with a growing number of complex economic problems. Recently the issue of energy has taken on a central role in Brazilian affairs, rapidly becoming a major economic concern. In order to wean itself from expensive imported oil, the Brazilian government has launched a bold fuel substitution program (Proalcool) which is primarily directed toward turning sugar cane into ethyl alcohol. The government's objective is to power the nation's entire automobile fleet with pure alcohol by century's end.

Ostensibly, Proalcool has been quite successful; its 1982 ethanol production accounted for 23.6 percent of Brazil's automobile fuel. The program is, however, fraught with problems, and an increasing number of Brazilian scientists claim that its costs will outweigh its benefits. It is said that the program changes the pattern of land use and employment, concentrates economic power in the hands of a power elite, adds huge amounts of pollution to the environment, destroys virgin tropical forests, is too energy intensive and wasteful so that a net energy gain is questionable, and competes with food crop production.

Under Brazilian conditions, it is necessary to use one hectare of land to feed an average size family (five people). The average Sao Paulo family requires two kilowatts of power for transportation which is mainly by automobile. This energy could be obtained from one hectare of land if ethanol were produced from sugar cane. To achieve self-sufficiency in automobile fuel by century's end through the use of sugar cane would require the use of one-half of all the land in Brazil that is presently under cultivation.

Meanwhile, scientists are searching for new and less costly ways to produce energy from biomass. Recent research in the production of biofuels has included the use of cassava, hydrocarbon producing trees, wood cellulose, grass, and stillage waste. It was found that liquid stillage waste from ethanol production when subjected to anaerobic fermentation produced a by-product that could be turned both into a methane fuel and a nitrogen rich slurry that could be used as a liquid fertilizer. If Proalcool is willing to search, it would most undoubtedly discover a large warehouse full of untapped biomass energy resources.

Soft technology energy resources are not broad spectrum ones like oil or natural gas and should be utilized in smaller packages. Perhaps Brazil could get 20 percent of its automobile fuel from sugar cane, another 20 percent from hydrocarbon producing trees, and so on. Ethanol production should be considered together with other forms of biofuel production to help establish a more stable, complete and efficient fuel producing infrastructure. This would be especially true if cellulosic materials from well managed forest plantations were used.

If the Brazilian government follows a single-minded sugar cane oriented path in its biofuel program, it could lead to the destruction of irreplaceable primary forest ecosystems, soaring food prices, increased urban migration, and increased social inequality. The program's costs would most undoubtedly outweigh its benefits. If they, however, follow a path based on environmentally sound planning and a diverse and decentralized energy infrastructure, the program could become a positive force with a bright energy future.

SUGARCANE-BASED ETHANOL: POTENTIAL CONFLICTS FOR CARIBBEAN COUNTRIES

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Many Caribbean countries depend on sugar for their economic prosperity. Sugar is a valuable source of foreign exchange earnings, government revenue, employment and rural incomes. The current situation in the preferential (EEC and US) as well as world markets necessitate alternative uses for sugarcane. Production of ethanol (fuel alcohol) from sugarcane provides one alternative for sugar exporting countries. Ethanol as an energy source offers advantages and for countries in the Caribbean, the Caribbean Basin Initiative offers possibilities for exporting ethanol to the U.S.

Assuming transferability of alcohol technology to the Caribbean and ethanol being priced competitively with petroleum, this paper examines potential impacts of a sugarcane-based ethanol program in Jamaica and the Dominican Republic. These impacts will be analyzed at two main levels - changes in the demand for resources, mainly land due to adjustments in agricultural production and net impacts on foreign exchange earnings.

Both countries have small land areas with pressures from population growth, deficit agricultural production and have large areas of marginal land. Land is therefore a critical factor and policies should aim at maximizing net returns to land used in agricultural production. Given domestic and export demands, several production activities are modelled to determine each country's comparative advantage, and tradeoffs involved in the production of food, sugar and ethanol.

The paper also examines the opportunity costs from trade in food, ethanol, sugar and petroleum and their net impacts on foreign exchange earnings. These include replacement of exports of sugar and molasses with exports of ethanol to the U.S. market, partial substitution of imported petroleum with domestically produced ethanol and importing food to meet each country's food requirements.

BIOGAS AND FERTILIZER FROM BIOMASS IN DEVELOPING COUNTRIES

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This project is an engineering technology element of a USAID Title XII Strengthening Grant to the University of Illinois. Our project is entitled Microbial Conversion of Biomass into Fuels, Feed, and Fertilizer in Developing Countries. We are presently working with Egypt and Kenya.

Fuel, feed and fertilizer are critical resources that in many instances must be imported at a great expense. The high cost of these resources along with high interest rates are major economic problems for agriculturalists, especially in developing countries. Conversion of locally available by-products (biomass) to fuel, feed and fertilizer

can greatly improve community development and welfare. Waste materials and by-products have at least four advantages as sources of biomass: (1) they are available nearby, (2) they are continuously available, (3) they generally have negative value and may be a source of pollutants, and (4) they are amenable to biological upgrading to useful products.

The objective of this study, is to provide fuel, feed, and fertilizer by utilizing the wastes and by-products from a Kenya farm service center. Each farm service center is planned to operate a 4 hectare farm; 1 hectare of corn, 1 hectare of wheat, and 2 hectares of legume/grass mixture. There would also be 10 dairy cows, 35 pigs, and 300 chickens. Wastes and by-products from these crops and livestock can be used to produce methane and possibly alcohol to supply locally needed fuels and to help operate a food processing plant.

We are collecting background information on the quantity and characteristics of the wastes and by-products. We are performing laboratory research on mixtures of the wastes and by-products to match biogas production with energy requirements. Finally, the residues from biogas production will be used to provide feed and/or fertilizer to be used on the farm service center or in the local community.

PRIVATE SECTOR AND GOVERNMENT ROLES IN RENEWABLE RESOURCE DEVELOPMENT

THE JAMAICA FOREST INDUSTRIES DEVELOPMENT COMPANY: A UNIQUE PROGRAM FOR IMPROVING A DEVELOPING COUNTRY'S TIMBER PRODUCTION

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In March 1985, two of the authors conducted a one week tour of Jamaican forestry, hosted by the Jamaican Department of Forestry and Soil Conservation, and by the government-owned, Forest Industries Development Company (FIDCO). The tour and literature provided a basis for outlining issues associated with this unique approach toward timber self-sufficiency, combining a government-owned company with a more traditional government agency.

The goal of the two organizations is to reduce the island nation's 60% dependency on wood imports to a point of self-sufficiency. FIDCO's own goal is economic solvency. The company has exclusive rights to the harvest and primary processing of all softwood in the country. To carry out its mission, it manages nurseries and softwood plantations, harvests with sophisticated highlead equipment, and processes the timber in a modern sawmill. The more traditional Department of Forest and Soil Conservation is responsible for the timber resource and the land on which this timber is grown. Before FIDCO's creation in 1976, the Department was responsible for all timber. Now, because of the authority over softwood vested in FIDCO, the Department's purview is primarily the hardwood resource which is subsequently processed by the private sector.

This unique approach has brought to light issues which can aid other developing countries considering similar approaches. By granting sole rights to softwood to FIDCO, this more profitable timber resource is taken from the private sector. Also, there is potential for conflict between the two organizations. Both organizations draw from the same professional forestry labor pool and land resource which is capable of growing either hardwood or softwood. Finally, the objective of self-sufficiency may encourage a sub-optimal use of the land.

SUSTAINABLE RESOURCE EXPLOITATION AND MULTINATIONAL BEHAVIOR

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Because an optimal process is conditioned by the agent or agents attempting to optimize, optimality for one agent need not be optimality for another. This can lead to misallocation in countries which are pursuing development objectives by attempting to attract multinational corporations. Soil fertility and forests may be managed as renewable resources, and it is optimal to do so if the

social discount rate is low, as it should be with forward-looking development plans. Multinationals, however, maximize income streams with a much higher discount rate, which transforms renewable resource stocks into inferior assets, and thereby promotes depletion. At the same time, multinationals introduce new technologies and improve the human capital of the work force. In attempting to attract multinationals, planners should consider these benefits, but should also take into account possible depletion effects brought about by multinational behavior. This paper presents an analytical framework whereby benefits and costs of multinational siting can be ascertained.

AN EVALUATION OF EQUITY AND NON-EQUITY ORGANIZATIONAL ARRANGEMENTS USED BY U.S. WOOD-BASED FIRMS IN THEIR FOREIGN OPERATIONS

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Research supported by the National Timber and Wood Requirements Project, Forest Products Laboratory, USDA, Madison, Wisconsin; and the College of Forestry and the Agricultural Experiment Station, Institute of Agriculture, Forestry and Home Economics, University of Minnesota, St. Paul, Minnesota.

The United States contains the largest wood-based companies in the world. Of the world's 27 largest multinational wood-based companies, 14 of them are U.S. firms. These companies lead the world's wood-based industry with respect to total sales. The U.S. companies have a firm foundation on which to compete — the U.S. market. But they have moved abroad and established operations in foreign countries.

The presence of foreign companies within their borders is a concern to most third world countries. A strong sense of nationalism and a distrust of foreign involvement within their countries are common sentiments. Forestry operations are especially visible. The operations require the ownership or control of vast tracts of land. This can create conflicts between the companies, which need stability for long-term sustained-yield forestry, and the foreign governments, which do not wish to relinquish control of their natural resources.

This paper contains a discussion of the types of organizational arrangements which may be used by the U.S. wood-based industry abroad — the types of operations established, the reasons these organizational forms were utilized, the types of organizations which would be preferred by the companies, and where the industry appears to be headed with respect to its foreign involvement.

There are 10 basic ways of organizing foreign operations. They may be divided into two types — those not requiring equity investment and those requiring equity investment. Each type of operation has advantages and disadvantages from the viewpoint of both the parent company and the host country. Each operation is a compromise between parent company and host country desires. The major influencing factors dictating the type of organization established are discussed.

INFRASTRUCTURE ISSUES IN PRIVATE SECTOR FINANCING OF RENEWABLE ENERGY TECHNOLOGY AND FUELS IN THE THIRD WORLD

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Because of current debt and foreign exchange problems, developing countries are having difficulty in locating capital for new projects much less for improvement of existing operations which may be impacting the issue because of inefficient energy consumption. Decrease in foreign aid acerbates the issue. Public sector ownership or control of the energy/power sector also provide potential obstacles both from a bureaucratic and technical perspective.

A unique program is currently under development in Latin America which has the following elements:

1) an infrastructure team of policy makers, civil service personnel and private sector entrepreneurs,

2) use of the extant foreign debt to leverage third party investments, and

3) a private sector technical/business management team and educational program.

This approach is being used for production of energy and conventional agricultural crops as well as for improvement in productivity of extant processing operations. An example will be provided utilizing one specific country.

DEVELOPMENT OF AN INTERNATIONAL COOPERATIVE FOR THE CONSERVATION OF THREATENED CONIFEROUS SPECIES IN CENTRAL AMERICA AND MEXICO

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The Central America and Mexico Coniferous Resources Cooperative (CAMCORE) was formed at the School of Forest Resources, North Carolina State University in 1980. Its objective is to conserve and study threatened populations of conifers in Central America and Mexico by making seed collections in the region and planting the genetic material in protected field trials throughout the Tropics and Subtropics. The program is unique because the primary driving force behind its formation was private forest industry in North and South America. Presently, the Cooperative has 11 corporate members representing Brazil, Colombia, South Africa, the United States and Venezuela. Host country forestry organizations in Guatemala, Honduras and Mexico are honorary members of the program. CAMCORE's success demonstrates the value of an international collaborative effort that includes researchers from the private sector, the academic/scientific community at the university and government officials in host countries.

The CAMCORE Cooperative is governed by an Advisory Board made up of one representative from each member organization. The director of the program, who is an university employee, has broad based power and makes decisions on technical matters and helps formulate policy for the program with the assistance of the Advisory Board. Annual meetings are held to discuss proposed budgets, vote on the applications of new members, and appraise the status of the work being conducted in the field.

International cooperatives patterned after CAMCORE should work well in other biological/agri-

cultural fields. The objective(s) for the formation of the cooperative program should be simple and straightforward. Private industry, not the university, should be the one that initiates the cooperative's formation. If not, industry support will decline during periods of economic instability or when the excitement of the new program wears off. The work load for each cooperative member must be the same. Good communication between the university and cooperative members can not be over stressed. This not only includes constant correspondence, but annual, personal visits by the director or his staff to inspect field activities of each organization. Results of the cooperative's work are shared by all members and made available to the public.

ENVIRONMENTAL MANAGEMENT EDUCATION: A MODEL FOR SUSTAINABLE RESOURCES DEVELOPMENT

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Global concern about environmental problems, quality of human life and the impact of development led to the convening of the United Nations Conference on the Environment in Stockholm, Sweden, in June of 1972. The recently concluded tenth anniversary of the Stockholm Conference stressed the need and role for environmental education.

Recommendation 96 of the Stockholm Conference called for the establishment of an international program in environmental education that would be interdisciplinary in approach, formal and non-formal, encompassing all levels of education and directed toward the general public.

Against this backdrop, the focus on resources, economics and the abilities of developing countries to cope with escalating problems was increasing. It can be concluded that essential environmental resources of developing countries are subjected to stresses of unprecedented magnitude and the health, nutrition and general well-being of large portions of the population are directly dependent on the integrity and productivity of these resources. Governmental ability to manage resources effectively over time may be the most important prerequisite to the eradication of poverty, the fulfillment of basic human needs, obtaining a quality life and the ultimate achievement of sustained development.

While the natural resources of most developing countries are being rapidly depleted by general deforestation, habitat destruction, desertification, soil erosion, and the pressures of rapid population growth, government agency and non-government organization ability to educate and inform the people about the effective management of natural resources may be the most important prerequisite to achieving a quality life.

A model for the strengthening of developing countries'Environmental Education and Information capabilities for building an appropriate institutional framework to deal with conservation problems and sustainable renewable resource and energy development is presented. Examples from the Dominican Republic and Barbados will be discussed. Public environmental management education and training programs will be discussed in relation to the establishment of sound renewable resource management plans, developmental goals, and the establishment of an environmental ethic. Evaluative approaches are presented in relation to program and workshop effectiveness and knowledge gain and attitude shift in relation to selected environmental management and energy issues.

Environmental Management education is concerned with an individual's self understanding, an understanding of the co-inhabitants of the Earth, and interrelationships within and among each of these constellations of concern. A major goal is to encourage the individual to develop the ability to make thoughtful decisions which will create an environment that allows one to live a quality life. Specifically, environmental management education is concerned with developing a citizenry that is:

1. knowledgeable about the biophysical and sociocultural environments of which man is a part;

2. aware of environmental problems and management alternatives of use in solving those problems; and

3. motivated to act responsibly in developing diverse environments that are optimum for living a Quality Life.

(Roth, 1989)

Thus it can be seen that environmental management education is concerned with knowledge of the universe, society, and the individual, in that it not only attempts to provide the individual with environmental understandings, but also views one as

e potential creative being and encourages acceptence of the responsibility for decision-making which is ours by virtue of being human.

Another characteristic of environmental management education is that it deals with attitudes, the attitudes people hold about themselves, toward other individuals and groups of individuals, and toward their environment. These constelletions of ideas greatly affect our level of living and quality of life.

Because environmental management educetion is not just ecology, resource-use, sociology, art appreciation, philosophy, or management, an interdisciplinary focus is required that embraces the sciences, humanities, social science, and technology in like measure for purposes of developing cognitive understanding, belief and attitude change, and providing motivation for behavioral change and effective action.

The proposed model hes the edventege of being concise, graphic, end logical in its epplicetion. It provides an easily visualized guide to the proceese of program development in both formal and nonformal educational settings regardless of cultural and netionel context. The program developer is reminded thet the identification of appropriate environmentel menagement/educetion goels, objectives with e behevioriel or meesureble orientetion, end well definad and implemented communicetions or teaching strategies ere essentiel for echieving e "Quality Life." Feedbeok of both e formetive and summative nature ere to be utilized in relation to impact on the recipient or terget audience. Through rigorous evaluetion strategies involving pre end poet testing of concepts and attitudes assessment of skills end performance, and the echievement of enticipeted goels in documentable form, it will be possible to demonstrete achievement of intended goels in reletion to the improvement of the "Quality of Life."

The proposed model for Environmentel Menagement Education has been utilized in both the Spenish end English speeking Caribbeen for the implementetion of treining end educetion programs. Concepts eppropriete for the development end implementetion of both conservetion and environmentel menagement educetion eppeer to be relevent. The veriety of methodologies employed for the formel and non-formel educetion settings have been effective. The estebliched goels end objectives of the program exemples ere being echieved es evidenced by the verious preliminery evaluetive strategies. It is suggested that the model for Environmentel Menagement Education be utilized es e guide for the development of either formel or non-formel environmentel menagement/ educetion programs in developed es well es developing countries.

IDENTIFYING STRATEGIES FOR RENEWABLE RESOURCE MANAGEMENT IN THE PUBLIC SECTOR

TRAINING AND INSTITUTION BUILDING A KEY TO NATURAL RESOURCE DEVELOPMENT

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The "Sustainable Development of Natural Resources in The Third World" initially and ultimately should focus on people; on the rural inhabitants that are a part of the human ecology which links them to natural resources; and on urban people who work in factories based on these resources and/or consume resource based products. The focus of this paper is on the former group. The view is taken that sustainable development of natural resources is a component of sustainable rural development which is part and parcel of the sustainable development of people.

Any effort designed to impact change should always consider "who" is impacted: who gains, who loses, who bares risks and what is at stake. Webster defines sustain as "To maintain, keep in existence, keep going, prolong...." Conservation is defined as "protecting from loss, waste." In applying these concepts to rural development, it is important to consider who gains and loses from "sustaining" and "conserving." In essence, who is the "customer," who is the major actor in rural development? The answer is, of course, the land user, the farmer.

The extent to which small farmers in developing countries act economically rational has been debated considerably. If a consensus view exists, a more recent one is that: they are rational, but fear change due to their perception of high risks related to their subsistence level. Farmers often view innovation as placing them in more vulnerable positions such as reliance on outside markets, conserving a given section of land, or changing practices that are unproven to them.

However, in order for meaningful progress to be made to sustain natural resources in many areas of the developing world, land use techniques must change. Farmers must adjust their attitude toward the land and land use decisions. This difficult behavioral change will require long term commitment and support, innovative strategies, and strengthening institutions that interface with the land user. To be effective, this change will require that the farmer be a central participant in the design of any change.

The farmer has often not been a key participant in the development of strategies for addressing the degradation of natural resources. Some institutions that act as "change agents" exclude farmer input. The approach suggested here proposes the inclusion of the farmer in the evolution of the product. This will require that institutions, dealing with farmers, undergo an institutional metamorphosis in order that their approach to program development meets the needs of their customer, the farmer.

A framework is suggested for bringing about this metamorphosis. The foundation of this framework is that the institutions have to perform the change themselves. By working within groups and with "sister" agencies, institutions are encouraged to collectively develop approaches that will work for them and encompass the concept of high farmer involvement. The approach involves a progression of phases and will require at least 2 years to complete. A specific example is discussed regarding erosion control and land restoration in the Andean Region of South America.

COMMUNITY PARTICIPATION TRAINING FOR EXTENSION FORESTERS IN INDIA

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In the fall of 1984 three two-day workshops in community participation techniques were conducted in Madhya Pradesh, India, with support from the Consortium for International Development/Women in Development Project and USAID, New Delhi. The primary focus of the USAID-Madhya Pradesh Social Forestry Project is the establishment of tree plantations that will meet the villagers' needs for fuelwood, fodder, and a variety of minor forest products. The purpose of the project is to create the institutional capability to assist villagers to manage communal and private land for sustained production of these products. Based on a questionnaire given to workshop participants, they do understand the goal of increasing the flow of forest products to villagers through social forestry, but they do not understand the purpose is institutional development.

Sixty-two Social Forestry Extension Foresters in the Madhya Pradesh Forest Department completed the workshops. The focus of the workshops was on group decision-making and consensus-reaching techniques that can be used by forest extension workers to increase community participation in social forestry projects. The Nominal Group Process was used to achieve consensus on the major factors influencing villager participation. The 5 most important factors given were: villager apprehension that community forests will take land currently being used for grazing; village politics; uncertainty about the distribution of the benefits from the community forest; villagers' lack of knowledge about forestry; and difficulty in getting community forest land from the Revenue Department. It should be remembered that these factors represent what a selected group of foresters say are the problems. They may not be the factors that would be mentioned if villagers themselves were asked.

Techniques to increase participation of target groups were developed with attention given to techniques directed towards village women and the landless. Informal discussions held with various women associated with the project indicate research is needed before the role of women forestry extension workers and village women involved in community forests can be adequately assessed.

The information gained from these workshops should be used to make project modifications and to design future training opportunities which minimize the lecture mode of learning and concentrate on problem-solving and interpersonal communication skills. Because community forestry world-wide is in the pioneering stage, extension foresters and villagers must learn to be their own problem-solvers through creativity, experimentation and risk-taking. These characteristics should be encouraged by the Social Forestry Directorate to enhance the probability of success for the project.

WOMEN STILL DENIED ACCESS; AN INSTITUTIONAL CHALLENGE TO SUSTAINABLE DEVELOPMENT IN THE THIRD WORLD

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One of the greatest institutional challenges faced by developing nations is their effort to do sustainable development of natural resources and to do sustainable development of human capital. Both

are required for successful development. They have an interlocking and synergistic relationship with progress. Human capital invested generates fiscal capital which in turn unlocks access to natural resources, and a major part of Third World human capital is being wasted.

The blocking of access of women by LDC's to receive advanced education is still a major problem of the LDC's that clearly impacts sustainable natural resource development. Easily overlooked, it is one that is seldom addressed by institutional infrastructures, be they governmental, donor agencies, or private sector organizations. UNESCO, U.S. Government, The Institute for International Education, and other statistical documents show that still today only 5-7% of the enrollment of U.S. graduate schools are women from Third World countries. There is an ever increasing number of males from LDC's entering U.S. higher education, but that picture is not changing for females from those nations.

Many of us may overlook their plight and fail to realize that despite the achievements of many women there still are those who exist within systems where the economy and education available offer to those women only about three choices: (1) physical labor in the fields; (2) production of babies for additional labor availability or bartering; and (3) slight possibility of becoming an elementary teacher if "born well."

Oil dollars, money from the sale of precious minerals, dollars from multinational corporations, U.S. foreign aid — all have made available to these intellectually gifted males loan funds, scholarships, grants, and training dollars that enable them to pursue postsecondary education in their own countries (or in the U.S.). With good records they may also be able to pursue that ultimate entry into the elite of their nations, those who have benefitted from graduate education in the U.S.

The individual returns to his country a "specialist," destined to become part of an elite. We are talking about such sophisticated areas as remote sensing; international banking and finance; agronomy; macro-economic planning; industrial and production management; farm management; soil testing; civil, electrical, petroleum and nuclear engineering; land development; and the like.

Whereas about 30% of the international students in higher education in the U.S. are females, the Institute for International Education estimates that only 5-7% are studying at the graduate level. The passage and funding (in 1975) of Title XII, an amendment to the Foreign Assistance Act of 1961, portends a sizable increase in the involvement of Land Grant and other "eligible" universities in the training of international students to solve problems of famine, nutrition, and food scarcity. One success model is the AAUW International Fellowships Program.

FIRE IN THE FOREST IMPLEMENTING AGROFORESTRY IN A PHILIPPINE VILLAGE

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The introduction of agroforestry as an alternative land management system for rural communities is influenced as much by the structures and processes of implementation as by the community's structure and organization. Bottle-necks in the flow of resources are traced to problems in inter-agency coordination and to the ethos of hierarchical control, conformity to procedures, and personal aggrandizement which characterize the supra-local bureaucracy. In turn, in the arena of the local implementing organization, alliance groups headed separately by the mayor, the project manger, and the deputy manager, are seen to compete for the project's limited resources, including the staff's support. As a result, inefficiencies in project administration and management as well as in the extension and delivery system are exacerbated. On the other hand, the farmers' condition of uncer-

tainty and their limited access to resources also bear upon their responses to agroforestry. Their decisions, however, are not simply the result of expediency but the outcome of a rational calculus of economic, political, and social costs and benefits.

SUSTAINABLE DEVELOPMENT OF FRAGILE LANDS: DIFFERING AGENDAS IN THE WEST AFRICAN SAHEL

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This paper will examine the institutional challenges to sustainable development of fragile lands in the Third World from the differing perspectives of the principal parties involved: the local population, governments and their ministries, and the international donor community. These parties, both institutional and individual, try to achieve different and sometimes contradictory ends. When agendas differ, sustainable development will rarely receive priority attention. As a result, differing agendas have been a recurring source of problems in the implementation of a variety of development projects.

Furthermore, it is only recently that the issue of sustainability and the factors that can contribute to its achievement have been seriously addressed - at least by the international donor community. The same holds true for fragile lands and their development: the relevant, appropriate technologies are still in their infancy. To clarify the importance of these three issues - differing agendas, sustainability, and the development of fragile lands - case study material will be presented from the Sahel of West Africa. Particular emphasis will be placed on the experiences of nomandic herders and sedentary farmers.

This area of the world is of particular interest for the following reasons:

In order to survive both groups developed extensive, rather than intensive strategies for dealing with environmental uncertainty;

The famine of the 1970's indicated that, to a certain extent, such strategies were becoming redundant - a lesson reinforced by the present experiences of several countries in sub-Saharan Africa. The factors contributing to this redundancy - political, economic, demographic, and social - will be examined; and

As a result of the famine, in which both herders and farmers were often directly blamed for degrading their environments, various developmental efforts were mounted to protect these fragile lands. Ten years later such efforts appear to have had little effective impact. The paper will attempt to explain why these efforts have been so fruitless.

The final section of this paper will examine what donors, governments, and local populations have learned from these experiences and what steps, if any, have been taken to ameliorate the situation. Recommendations will be made in terms of research needs, policy implications, and strategies for implementation.

A LAND-USE ALLOCATION MODEL FOR DEVELOPMENT OF NATURAL RESOURCES IN NEPALESE HILLS

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A typical Nepalese hill farm is an integrated system producing food, fuelwood and fodder simultaneously. Local people abuse the inefficiently administered forest-covered government land by extracting fodder and fuelwood and cultivating it for food production. Absence of a rational land-use allocation scheme and the government land's common property nature have caused forest resource depletion and serious soil erosion problems.

Programs to increase crop yields take 10 or 20 years before becoming effective due to several organizational and institutional limitations. Forest resource depletion problems are serious and need to be addressed quickly. They cannot be postponed until crop yield programs reduce on the land. Short-term programs, viable within the local technological capacity, need to be developed to complement the time lag in crop yield programs.

Land is divided into land classes based upon the variability in soil depth, slope, physical and chemical properties. Various land-use options and their management level are identified within the local technological capacity. A multi-objective programming model allocates land classes to meet the local demand for food, fuelwood and fodder within resource and soil loss constraints. The variation between optimum land-use and existing land-use identifies the land-use changes needed for the local hill community.

Parametric linear programming is used to generate the multi-objective solutions to avoid the prior judgement about the relative values of different objectives. This provides an explicit analysis of trade offs among the conflicting objectives.

The land-use allocation model is a useful tool to (1) evaluate the potential of increasing the local production of food, fuelwood and fodder through land-use changes, (2) analyze the impacts of policies or programs which directly or indirectly change land-use, and (3) help determine the size and scope of each government agency's program by estimating program outputs.

The model is demonstrated with data from Phewa-Tal watershed covering 117 square kilometers of typical Nepalese hill agro-ecosystem.

IMPLEMENTING THE WORLD CONSERVATION STRATEGY: SUCCESS STORIES FROM CENTRAL AMERICA AND COLOMBIA

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Severe environmental degradation is occurring in Latin America, including deforestation, soil depletion, mis-management of watersheds, destruction of coastal environments, and overharvest/underutilization of wildlife and fisheries resources. These trends reduce options for sustainable development in the region, are destroying its biological capital, and are major factors promoting civil strife.

However, a number of successful pilot conservation for development projects are underway in the region. These include the La Planada Ecodevelopment Project, Colombia; Kuna Indian Wildlands

Project, Panama; Costa Rican National Park System; and the conservation training program of CATIE. Each project deals with priority themes identified in the World Conservation Strategy.

La Planada is a combined wildlands conservation-rural development project of the Colombian Foundation for Higher Education (FES). FES has developed La Planada as a model private preserve to protect its extremely diverse ecosystems and promote scientific research. To eliminate reserve degradation and improve resource utilization and living standards of colonists and Indian neighbors, FES carries out extension and environmental education programs, and contributes to improvemsnt of infrastructure and social services.

The Kuna illustrates the possibilities for conservation based development of Indian reserves. With considerable outside assistance, they established a 60,000 ha protected area within their reserve, to protect downstream agriculture and fisheries, maintain water supplies, and prevent invasions by colonists. A team of Kuna professionals is finishing a reserve management plan, a Kuna ranger force is in place, resource inventories are under way, boundaries are being surveyed and basic infrastructure to promote scientific and natural history tourism is being constructed. Environmental education and agroforestry projects have been initiated in buffer zones.

Costa Rica is one of the smallest, yet most ecologically diverse nations on the American mainland. A large part of its heritage is protected in a model national park system, covering over 8% of the country. The 14-year old park service has a highly-trained staff, basic infrastructure has been established in all parks, most inholdings have been purchased, and environmental education has increased public and political support for the system, now emulated by many countries. The parks are a mecca for researchers, have increased foreign exchange earnings through nature tourism, and protect watersheds which provide potable water and electricity to much of the country's population.

The support of CATIE's Wildlands and Watershed Programs has contributed to the success of these projects. Since 1976 it has trained over 1200 Latin Americans in short courses on wildlands and watershed management, interpretation and environmental education, ranger skills and similar themes. Over 20 students have graduated from its M.S. program in wildlands and watershed management; most hold key positions in natural resources agencies in their countries. This program has created a critical mass of trained and motivated conservationists responsible for major extension of protected areas systems in the area.

In addition to these efforts, other projects to put the world conservation strategy into action in Central America and Colombia are briefly mentioned.

AGROFORESTRY EXTENSION FOR THE INDIVIDUAL SUBSISTENCE FARMER: A STRATEGY FOR SAHELIAN REFORESTATION

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Desertification caused by population pressures and triggered by recurrent droughts is currently reaching catastrophic proportions in many areas of the sahel region of Africa. The degradation of arable land and the permanent loss of range and forest land threatens the very existence of millions of nomadic herders and sedentary farmers.

Sahelian reforestation projects have historically been in various forms of industrial large-scale plantations or more village-level conservation and woodlot plantings. In almost all cases, an under-staffed local government must maintain the plantations following establishment. Consequently, the stands are often unmanaged with seedling mortality and stand protection as major problems.

and at maturity the wood is often not openly accessible to the local population. Needless to say, the local villagers' support for and participation in these projects has often been minimal at best.

Based on the general hypothesis that local people will respond best to projects which show them the most direct real benefit, several projects have been started recently by non-governmental organizations to provide individual farm families with the means to establish perennial tree crops in their own fields in conjunction with their normal subsistence agriculture. The author will present a strategy which is based on six years of experience in the region and which was tested for projects in northern Cameroon and Mali during 1983 and 1984 respectively.

The strategy is composed of six basic elements as follows: 1) Direct involvement of the local population in the diagnosis of their agroforestry needs and the design of a workable scheme on the individual farm level, based largely on the model described by Raintree[1]. 2) Agroforestry training and extension work at all levels from elementary school children to the farm families to local foresters to government leaders. Material developed by GRAAP[2] has proven to be an excellent teaching aide. 3) Silviculture emphasizing decentralized seedling production and natural regeneration. 4) Seedling protection and survival is assured by the families themselves without the provision of wire fencing. 5) Frequent follow-up visits by extension agents to encourage farmers and monitor map progress. 6) At each juncture project participants must be assured that the management and harvest of the trees is entirely at their discretion and for their direct benefit. Operational constraints of land tenure and program organization will also be addressed.

1. Raintree J.B. (1983) I.C.R.A.F. working paper no. 6, Nairobi.

2. G.R.A.A.P. (undated) Live in a Green Environment, flannelgram series (in French), B.P. 785, Bobo-Dioulasso.

WATER RESOURCE MANAGEMENT

APPLICATION OF WATER MANAGEMENT OPTIONS IN ARID LANDS AGRICULTURAL DEVELOPMENT

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The key to agricultural development of arid lands is water. The ability of farm families to manage the water resources available to them is the primary limiting factor in their production systems.

In this paper the range of water management activities from resource development through water application to waste water disposal is examined in the context of the spectrum of average annual precipitation vs. potential evapotranspiration as it varies from extremely arid to semi arid.

Appropriate water management technologies for various portions of the spectrum are described including conventional irrigation, water harvesting and runoff farming, recession farming and rainfed farming. Examples from the developing countries are given.

Opportunities for large scale water projects are discussed, and the technical and social advantages of small scale water management systems are presented. Ways to preserve large systems are suggested.

Farming systems research (FSR) has been recognized as a methodology to be used in development projects. The close relationship of the proposed water management technologies to the FSR approach is demonstrated.

DEVELOPING A SELF-SUSTAINED FOREST COVER IN THE MAHAVELI CATCHMENT OF SRI LANKA: PROBLEMS AND SOME SOLUTIONS

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The Mahaveli is the largest river in Sri Lanka and the most important in terms of irrigation, hydroelectricity and community settlements. The catchment of Mahaveli occupies about 5% of the land area of the island and is situated in the central highlands. Forested area in this catchment at present is only 13% of the catchment area. Intensive grazing and fuelwood gathering and sporadic clearing for cultivation could lower this area further.

Sites available for afforestation have inherent problems. Abandoned agricultural lands are infertile and severely eroded after years of neglect. Imperata and Cymbopogon, the dominant grass species in savanna-type grasslands are strong competitors with tree species. These grasslands also experience recurrent fires which favour grasses. Some denuded lands are difficult to reforest simply due to rugged terrain and inaccessibility. Most of local tree species have not been studied for their silvicultural characteristics. As a result, the man-made forests are composed exclusively of two exotic genera, Eucalyptus and Pinus. These monocultures, though established well, do not appear to regenerate in situ. Forest fires are frequent because the slow-decomposing litter of both genera is inflammable. Regeneration of other tree species also appears to be scarce which could be attributed to inadequate seed supply and forest fires. Resul-

tant single-storied forests are hydrologically inferior to multi-storied forests and raise questions about the self perpetuity of the forest cover.

Popularizing agroforestry practices in arable lands of the catchment area seems to have advantages. Presumably, they will relieve the pressures on existing forests for grazing and fuelwood and also contribute to tree cover. A good foundation is found in agroforestry techniques already traditional to the area (e.g., Kandyan forest gardens and cardomum-high forest system). These could be extended to plantation forests to increase their canopy complexity and to provide an incentive for fire protection. It is imperative to screen native tree species for competitiveness, adaptability, fire tolerance and most importantly, for ease in self regeneration. Some potential candidates are Alstonia, Albizia, Carya and Acacia species. Thus selected species may be used to underplant/seed existing plantation forests and to establish mixed species forests in the future.

TROPICAL STORMS AND THE PROBLEM OF EROSION IN PUERTO RICO

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Puerto Rico, like many tropical developing countries, experiences high rates of erosion and sedimentation due to its mountainous terrain and to deforestation. The sedimentation creates numerous problems, including flooding, the loss of reservoir capacity, the destruction of coral reefs, and the subsequent threats to fishing and popular beaches. Although concern abounds, relatively few hydrological and empirically-based economic studies exist on the effect of afforestation/deforestation on the rate of sedimentation in rivers and the economic impact thereof in the tropics. This paper attempts to fill a portion of that gap.

The principal previously published paper dealing with erosion and sedimentation in Puerto Rico failed to find any significant relationship between land use and sedimentation, a finding that runs counter to theory and the results of studies elsewhere. However, the methodology used in that paper is unclear. The article does point out that tropical storms constitute the major factor in the production and transport of sediments.

This working paper represents the first part of a study of several watersheds in Puerto Rico. The authors are working toward a relatively simple method of predicting the impact on downstream reservoirs of afforesting a portion or all of a watershed in mountainous Puerto Rico, a method which takes into account the impact of tropical storms. This, of course, would allow the estimation of downstream benefits from decreasing erosion. It also could prove useful in environmental monitoring.

The authors review the problem of erosion on the island, selected studies dealing with the determinants of erosion, and studies of the sediment/discharge relationship in the tropics. They discuss the problem of seasonality and of storms in estimating the sediment/discharge relationship for one watershed. The authors then present the results of analyzing approximately fifteen years of daily discharge and sediment data for one watershed in Puerto Rico. The paper ends with a discussion of the direction of the authors' ongoing research.

RAINWATER COLLECTION AND STORAGE TECHNOLOGY DISSEMINATION IN NORTHEASTERN THAILAND

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Over the last ten years, the poor drought-prone region of Northeastern Thailand has witnessed a remarkable effort to extend rainwater collection technologies to village families. Various Thai government agencies, non-governmental organizations (NGO's), and entrepreneurs have mounted programs throughout the region successfully disseminating appropriate cistern designs providing for domestic drinking water needs. Although available data is incomplete, it appears that over 100,000 individual rainwater tanks and jars appear to have been built to date. This large-scale effort is continually expanding according to local and international observers. Evidence suggests that within two decades a majority of villagers in many parts of Northeast Thailand will have access to this relatively sanitary form of water supply.

This case study will review the various technologies, institutions, and promotional approaches behind the Thai Rainwater Collection phenomenon. This experience appears to be among the foremost examples of its kind in the world. The technologies and approaches promoted in Northeastern Thailand have broader relevence; and applications in other areas. Most of the dissemination programs have used cost-recovery or market-oriented approaches, which is an uncommon practice for water supply programs. In this report, special emphasis will be placed on the particular programs of the Population and Community Development Association (PDA), a Thai NGO which has effectively combined technical assistance, user involvement, and financial and organizational support.

WATERSHED MANAGEMENT FOR INTEGRATED DEVELOPMENT OF MORNI HILLS IN NORTH-EAST HARYANA

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Morni hills represent an ecologically important natural habitat in north-Eastern Haryana (30° 35' to 30° 45'N, 70° to 70° 15' E). The diversified and multiple resources of Morni hills have a potential to provide timber, fuelwood, food, fodder, fruits and minor forest products. This paper discusses watershed management approach to conserve and utilize the resources in a sustained manner for integrated development of the area. The importance and need for conservation of excess rain-water in small storage structures for controlling soil erosion, ameliorating water scarcity, crop production, horticulture, forestry development and livestock production are discussed. The social and economic benefits of watershed management to provide increased economic opportunities to rural people, achieving productive land use systems, increased food supply to people and maintaining satisfactory health and nutritional levels are projected. The importance of people's participation for improving the natural environment and maintaining ecological balance in this region of unstable Siwaliks is also emphasized.

A TWO-COMPARTMENT CEMENT BLOCK TANK FOR FIELD MEASUREMENT OF RUNOFF AND EROSION

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This work is part of the USAID-Government of the Dominican Republic Natural Resource Management Project (MARENA) and is excerpted from the M.S. Thesis of the senior author, Department of Agronomy, The Ohio State University

A design of equipment for collecting and measuring runoff and sediment from erosion plots on steep land (~30%) in the southern Cordillera Central of the Dominican Republic is described. Each plot (3 m x 15 m) is connected downslope to a two-compartment cement block tank; each compartment is 1.0 m wide, 1.2 m long and 1.0 m deep. Fifteen tubes at a height of 0.7 m in the first (sediment) compartment allow runoff in excess of the capacity of the first compartment to overflow, with one of the tubes connected to the second compartment which can effectively hold up to 28 cm of runoff. Most of the sediment is retained in the first compartment and tubes placed in the side of the tanks permit sampling and draining after each event. This facility has been in operation since October 1984 and the equipment has been shown to work according to design specifications.

EFFECT OF THE SUB SAHARAN DROUGHT ON WATER RESOURCE MANAGEMENT IN EGYPT

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The current drought in East Africa and the Sahel has effected nearly 14 million people living in nine countries. Ethiopia and Somalia have been especially hard hit with famine and related disease.

Approximately 80 percent of the Nile river's discharge into Egypt derives from the highlands of Ethiopia. Over the past six years this watershed has received only about half the normal rainfall. This charge has resulted in reduced inflows to the Aswan Reservoir in Upper Egypt and the Sudan.

Operating procedure modifications for the Aswan High Dam will have to be initiated soon, should the drought continue. Outlined here are some of the options open to Egypt to mitigate losses from a prolonged drought.

WHAT ARE THE SOIL AND WATER BENEFITS OF PLANTING TREES IN DEVELOPING COUNTRY WATERSHEDS

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There are many excellent reasons for foresting upland watersheds and both present programs, and the projected large increases in global forestation over the next decade, make good sense. These programs are needed to establish "wood factories" for fuel, timber, and other wood projects, and to reduce the harvesting pressure on ever-diminishing resources of natural forests. Forestation is a proven means of rehabilitating degraded, unproductive land, and eventually restoring productivity to levels where useful crops can be produced, even though the economic viability of such projects may be questionable on poorer sites.

Once understory plants and/or leaf litter are established, forest plantations provide good protection against surface erosion. Once substantial root biomass has developed, especially in the subsoil, greater resistance to mass movement erosion also develops. Both of these erosion-protection functions can be lost temporarily if harvesting is done carelessly, if litter is removed for fuel or livestock bedding, and if rapid regeneration or replanting is not achieved.

Other justifications for reforestation, based on other aspects of water and soil conservation or protection, are often claimed. Many of these are unrealizable, and may be mutually contradictory. Such claims must be avoided if watershed planners and foresters are to retain their credibility over a lifespan of more than one forest rotation. Forestation has <u>not</u> been shown to increase rainfall, to reduce the size of major floods, to increase the flow of springs and streams, or to increase groundwater levels. Localized increases in streamflow and groundwater levels may occur in forests planted where cloud or fog occurs for hundreds of days per year. Under these conditions, additional occult precipitation may be intercepted. Open sites that have been long abused and have eroded or compacted soil surfaces may eventually have their infiltration capacity improved by forestation, and hence permit greater groundwater recharge. If this more than balances the extra evaporation and transpiration losses, then there could possibly be some higher groundwater levels and increased base flow.

Reforestation may greatly decrease both peak flow rate and runoff volume in small rainstorms that occur every few weeks or months, may significantly decrease peak flow and runoff volume in storms that occur every few months to every few years, but will not substantially reduce either peak flow or runoff volume in storms that occur only once every decade or even less frequently. Reforestation will almost always decrease total streamflow over the course of a year, and the largest proportional decreases will be during dry seasons or periods of low flow. Reforestation will generally lower water table (and well) levels, and may reduce the discharge from springs.

Watershed management planners may not have been aware of many of the real effects of forestation, or may have been prepared to accept the support of folkloric beliefs or myths to achieve the desirable effects of forestation. In either case, the time has come for honest and forthright presentation of both the desirable and less-desirable effects of forestation to policy makers. If we reforest watersheds and yet still have floods, and if the streams yield less water or even dry up in some seasons, then there will be a well-deserved backlash against forestation and its proponents. The credibility of watershed management professionals will be rightly called into question, and decades of progress toward better and more rational land use could be lost.