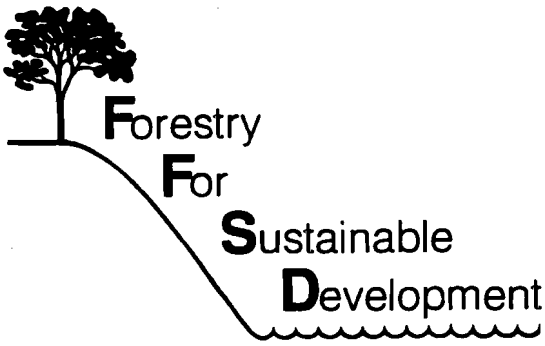

WORKING PAPER 5

Agriculture and Forestry In the Context Of Sustainable Development

by

Dietmar W. Rose

November 1989

Forestry For Sustainable Development Program
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AGRICULTURE AND FORESTRY IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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PREFACE

This is the fifth in a series of working papers produced for the Forestry For Sustainable Development (FFSD) Program at the College of Natural Resources, University of Minnesota. This paper discusses the close relationship that exists in many countries around the world between agriculture and forestry in promoting sustainable development.

The major objectives of the FFSD Program are to:

i) mobilize, synthesize and disseminate existing technical knowledge in such a way that it can be used effectively in planning and implementing development projects that will contribute to sustainable development; and

ii) identify and develop effective institutional mechanisms, both at the policy and project levels, for introducing sustainability strategies into the development planning process at an early enough stage to influence project or program design.

The focus of the FFSD Program is on social forestry and related strategies within a watershed management framework as an integrating mechanism for moving toward sustainability in land use and in natural resource-based development projects.

The FFSD Program is supported by a grant from The Pew Charitable Trusts, and by the University of Minnesota Agricultural Experiment Station and Department of Forest Resources, College of Natural Resources. It involves an interdisciplinary group of faculty from the University of Minnesota, and collaborators at the University of Arizona, Yale University, Oxford University, the InterAmerican Development Bank and other development groups.

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ABSTRACT

Sustainability questions related to agriculture, forestry, the environment, and economic development have gained a great deal of attention in research and in public policy discussions. While technical solutions to achieve sustainable agriculture and sustainable forestry exist, additional research, extension, and education efforts are needed to bring about sustainable development in agriculture and forestry. Development of sustainable technologies is only part of a solution. Sustainable development will not take place unless an appropriate social, economic, and political environment is created. This environment frequently does not exist and contributes towards a general decline in resource sustainability. Creating a favorable environment will require changing many existing agricultural, forestry, and other land-use policies throughout the world. Increased cooperation and coordination in research and in national and international policy decisions will be needed to halt the degradation of natural resources.

AGRICULTURE AND FORESTRY IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

Dietmar W. Rose[1]

INTRODUCTION

Growing world populations require ever increasing production of food, energy, and other resources such as water and timber. There are increasing concerns that current agricultural production technologies are degrading natural resources and will not be able to sustain world populations. Questions are being raised about how economic growth, necessary to provide for increased production levels, can be in harmony with sustainable development. Sustainable development is more than economic growth. Economic growth is a necessary but not sufficient condition for development. Sustainable economic development has gained widespread attention in the context of global warming, loss of biodiversity, acid rain, land erosion, and in questions related to energy policies. Sustainable agriculture, forestry, and other land-use practices are an essential component of this larger problem of sustainable development.

DEFINING SUSTAINABLE DEVELOPMENT

One of the earliest uses of the term "sustained yield" (nachhaltige Bewirtschaftung) can be found in 18th century Germany where foresters, facing a timber famine due to the long-term exploitation of forests, developed the first sustained yield models for regulating the flow of timber and other products and services from the forests. These early models, still used today by many forestry agencies, established allowable cuts that would build up depleted growing stocks and lead to fully regulated forests as quickly as possible. These early efforts recognized the important dimensions of time and space and dealt with the difficult question concerning at what level yields ought to be sustained, the latter being influenced strongly by management decisions on rotation ages, management intensity, technical innovations, and utilization standards.

The definition of "sustainable development" has been the content of several recent papers. Brown et al. (1987) examined the varied uses of the term "sustainability" and offered a social, an ecological, and an economic definition of sustainability. The common themes that these authors found in many uses of this concept were the continued support of human life, long-term maintenance of biological resources and agricultural productivity, stable human populations, limited growth economics, emphasis on small-scale and self-reliance, and continued quality in the environment and ecosystems.

This physical input-output concept of sustainability is an important but only partial measure of sustainability. Gregersen and Lundgren (1989) define sustainable development as:

> *"development involving changes in the production and/or distribution of goods and services which result, for a given target population, in an increase in welfare that can be sustained over time."*

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These authors recognize that technology, institutions, wants of society, and the definition of welfare are changing over time and that the relative importance of different resources is changing as is their desirable sustainable level.

Even with the general definition by Gregersen and Lundgren (1989), many questions arise when one talks about sustainability. How do we measure it and what is the time frame for achieving it? What are the costs of achieving sustainable development and how do we maintain sustainability? Do we mean steady state when we talk about sustainability and are we evaluating it on each site or over whole regions? Are we dealing with the question of maximum sustainability or with optimal sustainability? Can we identify indicators of sustainability or non-sustainability? Answers to these questions will be needed to describe specific programs that can lead to sustainable development.

SUSTAINABLE AGRICULTURE

Generally, sustainable agriculture is used synonymously with the term "low input agriculture." It refers to land use practices that avoid use of chemicals and do not degrade land through erosion or other problems like salt build-up in soils due to overirrigation. Such sustainable techniques include crop rotation, minimum tillage, contour ploughing, and use of organic materials for soil improvement.

Globally, much of the increase in agricultural production prior to World War II resulted from bringing more land under cultivation. Since then there has been a sharp decline in the rate at which new land has been cultivated (CGIAR 1988). Agriculture has had, nonetheless, an impressive record of increasing food production from a shrinking land base. Food production in the developing countries from 1950 to 1980 grew at a compound rate of 3 percent annually; per capita production grew at 0.6 percent (CGIAR 1988).

The increasing world population has, however, led to changes in agricultural practices which are detrimental to the quality of natural resources and raise serious questions about our ability to maintain agricultural productivity in the future. Increasing world food production will become more difficult with droughts, land degradation, and continued population growth (Brown 1988). Sustainable agriculture is being promoted as one way to avoid the problems of traditional agricultural technologies while maintaining or even increasing agricultural production.

Sustainable agriculture must conserve the land resource and must be economically viable as well as socially acceptable (Brown et al. 1987). Goals for maximizing production and goals for sustainability might well be conflicting goals. Discussion of sustainable agriculture cannot, therefore, deal solely with the technical aspects of growing crops without jeopardizing the long-run productivity of soils and protection of the environment.

Some technical know-how for sustainable agriculture exists in both developed and developing countries, but these technologies are not being utilized because of policies that discourage their practice. Technology to sustain increased levels of production may not be well known anywhere. Much of the more primitive agriculture (shifting cultivation) was sustainable at lower population levels. Rice paddy farming for example has been sustained for thousands of years. Much of the technology of developed countries is based upon high levels of petroleum-based energy inputs. These levels of inputs might not be sustainable. For developing countries, where overuse of land resources has led to serious soil degradation, much needs to be learned about sustainable agricultural technologies. New

approaches will be needed for agricultural productivity increases in Third World countries (Wolf 1986). In these developing countries, land reform is a key component of sustainable development (Eckholm 1979).

Agroforestry and Sustainable Agriculture

Agroforestry, the purposeful growing together of woody/nonwoody interacting plant combinations, will be an essential component of developing sustainable agricultural systems, especially in tropical countries of the world. Trees are introduced into agricultural production systems to decrease soil erosion, to maintain soil moisture, and to produce useful products (fuelwood, nuts, fruits, building materials) for the rural household and commercial markets (Wolf 1986). Flowering trees provide honey to attract and maintain bee populations which pollinate and thus increase crop production. A number of papers compiled by the International Council for Research in Agroforestry (ICRAF 1989) provide insights into the role of agroforestry in sustaining and increasing agricultural production.

Forestry can play an important role in developing sustainable agricultural systems especially in tropical countries. The term "social forestry" has been created to differentiate traditional production forestry from the concept of forestry to meet specific local needs. Gregersen (1988) and Gregersen et al. (1989) provide many examples of the role of social forestry in rural development (figure 1). It has important connections with environmental protection, agricultural productivity, the fuelwood crisis, and the generation of employment opportunities. Social forestry refers to farm or community forestry or forestry for local community development. Social forestry can help improve the environment, increase food and energy supplies, and reduce unemployment, three key issues preoccupying most world leaders according to Gregersen (1988). Gregersen et al. (1989) in their book People and Trees describe the role of social forestry in sustainable development with respect to environmental protection and stability, agricultural production, the fuelwood crisis, and farm employment and income generation.

Sustainable production alternatives such as agroforestry practices often require accepting at least a short-term sacrifice in agricultural output and usually require additional inputs such as tree seedlings and planting tools. Agroforestry techniques will need to be promoted among rural farmers in developing countries by demonstrating the benefits of various options (Casey 1985). Swaminathan (1987) discusses some of the challenges that need to be faced to gain acceptance of agroforestry techniques. A complete package would include technology options, and a set of government policies that encourage agroforestry systems, and would provide services in the form of seed, seedlings, and credits or some other form of financial assistance.

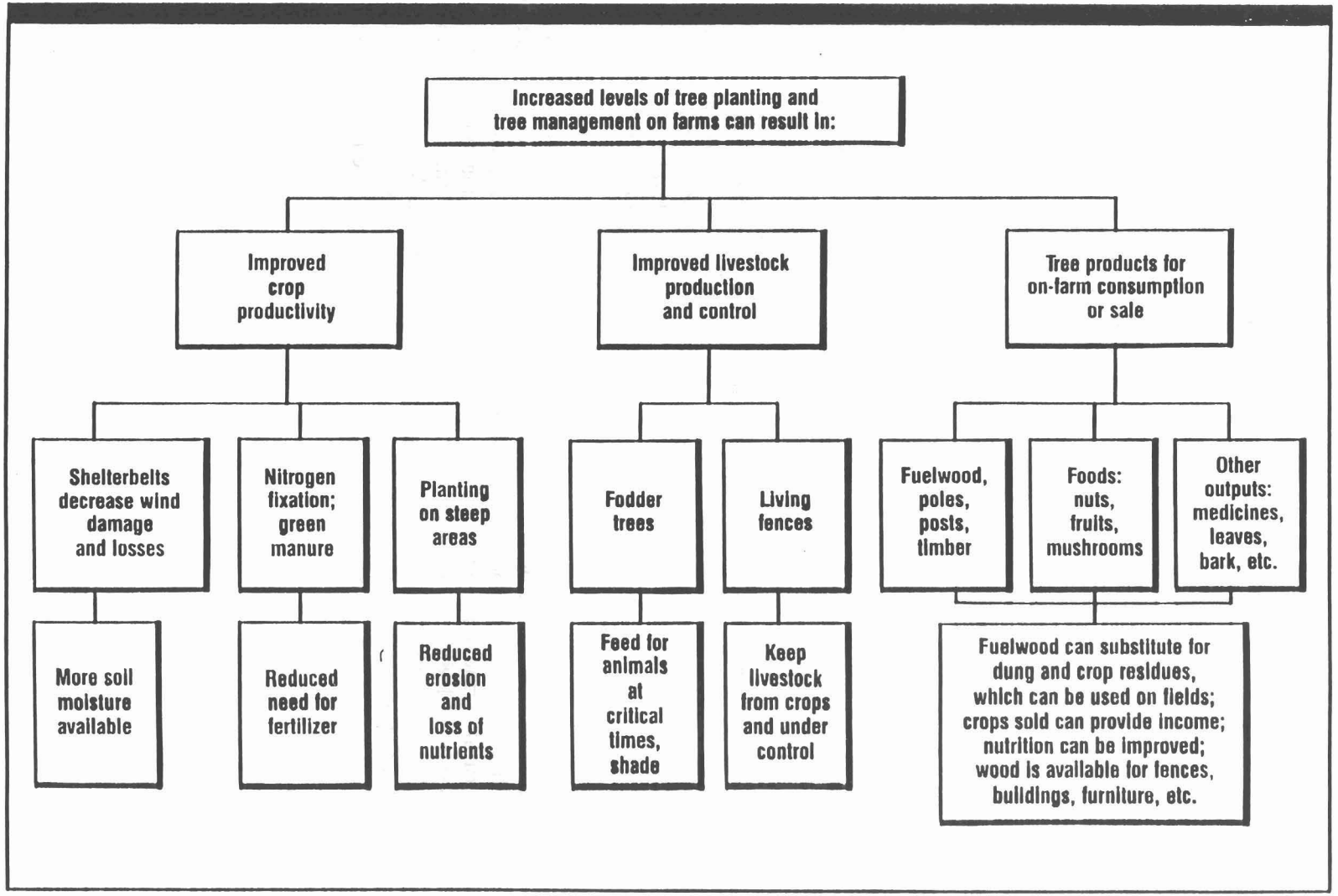

Figure 1. On-farm benefits from trees in the farming system. *(from Gregersen 1988, p.24)*

CREATING CONDITIONS FOR SUSTAINABLE DEVELOPMENT

Factors of Nonsustainability

In dealing with sustainable development in practice, Gregersen and Lundgren (1989) recommend focusing on means for avoiding nonsustainable development. This is a more useful operational goal than prescribing conditions required for sustainable development. This approach involves the identification of indicators of nonsustainability. These indicators fall into physical, economic, social, institutional, and political categories. Examples are soil productivity, water quantity and quality, biodiversity, population density, health and education levels of the population, the size of the external debt, and others. Indicators should be identified that act as warning flags that current land uses and development activities are not sustainable. Loss of species, high levels of erosion and sedimentation, decreasing water quality, increased human mortality, decreasing soil productivity, high incidence of pests and diseases and decreased per capita availability of goods and services are potential warning flags.

Rapid population increases are the most important contributor to nonsustainability of development projects (Brown et al. 1976). Agriculture must produce enough to feed 80-100 million additional people each year (CGIAR 1988). Growing populations add pressure to take land out of forests for agricultural production. Deforestation is, therefore, directly linked to increasing population pressures. This linkage implies that the already strong pressure on remaining forested lands will continue to increase. The linkage of deforestation and population growth becomes clear when one examines the principal causes of deforestation. Shifting cultivation, use of wood for energy, conversion of forests for cash crops and cattle ranches, and timber logging are the major causes of deforestation worldwide. Much of future production increases will need to come from intensification of production on existing lands.

While generally agricultural production will decrease with overuse or misuse of the resource base, increased production is possible, utilizing irrigation technology, improved production methods, and improved plant materials. But this requires more and reliable sources of water, the supplies of which are threatened by deforestation. Globally, agriculture is the principal user of accumulated reserves of water (CGIAR 1988). Irrigation agriculture has contributed to the vast production improvements in agriculture, but poor irrigation practices are resulting in land degradation through water logging of soils and salinization. Deforestation and soil erosion lead to decreased water availability, increased flooding potential, and reduced water quality. Reduced water production capacities impact directly on irrigation and hydroelectric power production potentials. Decreased water quality negatively impacts human health, which in turn impacts human productivity.

Erosion problems that go hand in hand with deforestation are most prevalent in areas of high population densities. Other key factors contributing to erosion are the inadequate practices used in annual crop production on steep slopes, the lack of appropriate land conservation practices, and the susceptibility of certain soils to erosion. Soil erosion is a serious problem in many agricultural areas in the world with erosion losses exceeding soil formation processes (Brown 1978, Brown and Wolf 1984). The fuelwood crisis has led to the burning of crop residues and animal manure and is leading to soil productivity declines because traditionally these residues were incorporated into the soil. The FAO (nd) report Protect and Produce provides a good overview of the problem of soil erosion, its prevention and repair, and the organization of soil conservation.

The maintenance of biological diversity is of great importance for sustained agricultural production and is considered one key factor for guaranteeing our future survival (U.S. Agency for International Development 1987). Most of our important food crops are derived from plants in tropical ecosystems that are being destroyed at an alarming rate. The conservation of genetic resources is paramount for future breeding programs and for dealing with unforeseen outbreaks of disease and pests.

The institutional capacity to evaluate, implement, and monitor protection projects is extremely low in many developing countries. Existing policies encourage farmers to use methods that produce immediate returns but that degrade the environment. In most developing countries a weak infrastructure is a major constraint to agricultural productivity improvements.

One of the factors contributing to global deforestation and the accelerated liquidation of natural resources by many developing countries is their need to service the large external debts. The external debt of developing countries had reached $1.2 trillion by the end of 1988 (Cody 1988). To meet interest payments on the debt and repay loans, forests are cleared to make way for cattle ranching and raising of export crops. Most of these activities are nonsustainable, and carry a high social cost (Browder 1988).

Strategic Actions

Many international development efforts of the past have failed to establish sustainable projects. The Sierra Club (1986) documented several of these international development debacles. At the same time, international development agencies have learned from past mistakes and some success stories of sustainable development projects can be reported (Reid et al. 1988).

One element of an international plan to build sustainable systems is to save the tropical forests. The Food and Agriculture Organization (FAO), the World Bank, the World Resources Institute (WRI), and the United Nations Development Programme (UNDP) developed the Tropical Forestry Action Plan (FAO 1985). This plan described a framework for coordinated action to incorporate forestry into land use, to create forest-based industries, to deal with the fuelwood crisis, issues of conservation, and to involve people in the solution. Gregersen (1988) describes the role of social forestry as a change in land use so that people get what they need on a sustainable basis from a relatively fixed or even shrinking land base. One of the key factors in the success of social forestry programs besides technically sound practices is local participation. Gregersen and Lundgren (1989) also examine the kind of incentives that need to be provided to get the necessary local participation.

The World Wildlife Fund is the lead organization in a joint venture with the WRI Center for International Development and Environment (CIDE) and the Nature Conservancy (TNC) to implement a US Agency for International Development (USAID) centrally-funded program for the conservation of biological diversity. Goals are to promote sustainable economic development through better conservation and the use of biological resources and to identify critical needs for realizing the economic potentials of conserving and wisely managing biological resources, protecting ecological processes, and maintaining genetic diversity.

In the search for sustainable development, three aspects need to be dealt with: a) the technical/operational level, b) the national policy level, and c) the international level. The first deals with technical aspects of sustainable agriculture and agroforestry including considerations of questions related to water, energy, and environmental quality. The second area includes analysis of alternative policies including regulations and incentive mechanisms for encouraging sustainable land-use practices. Finally, the third aspect expands this policy view to the international arrangements that exist for trade.

The critical importance of supporting agricultural policies at the regional, national, and international levels have been discussed by Runge (1988), and Reichelberger (1989). Sustainable agricultural techniques that generate fewer off-farm externalities, that are cost competitive on a per planted acre basis, and that provide a better quality of life for participating producers are not being adapted very rapidly by farmers. According to Taff (1989), three major factors delay the wide-scale adoption of low-input agricultural techniques: 1) the government insurance of crop risk but not income risk, 2) the farmer's right to pollute under U.S. laws, and 3) the government subsidy of crop production and not farming per se. Changes in these policies will be required if sustainable agriculture is to be adopted widely.

Gregersen and Lundgren (1989) state that three key elements need to be considered to create sustainable development. **Continuity** is needed to sustain a positive project and technologies after project termination. **Diffusion** is needed to spread appropriate ideas and technologies outside the project boundaries. **Externalities** or the positive and negative effects of actions in a location on other locations (spatial externalities) or on another time (temporal externalities) need to be considered.

Role of Information

The linkages among social, economic, and environmental factors are complex. There is a need to know how these activities impact natural resources and how one can identify and measure and compare the outputs of sustainable and nonsustainable land-use practices. To develop sound sustainable land use practices, we need to understand what these linkages are. Because of the complexities involved, it is essential that a systems analysis approach is used to study and to describe the system(s) in which development projects take place. For making sustainable land-use decisions, data summaries, mathematical models, and other analytical tools will be needed.

While much information concerning the factors of success and failure of development projects may exist, this information is often not documented. Even if documented, essential information such as descriptions of the social, economic, and physical environment are often missing but may exist in the heads of development experts. It will be necessary first to assess the information needs for making specific project decisions. This process will involve database-management procedures including the definition of minimum data sets and standardized data measurement and analysis procedures. A database approach ensures that only data relevant for decision making are considered. After the establishment of these standards, information should be extracted from existing published sources and entered into the established information framework. The same procedure could also be used to get information from experts in development projects, scientists, and endusers. This process can reveal the major information gaps. It is only at this point that organized data collections should be started.

In the design of sustainable practices, the formulation of appropriate questions is essential because it forces the identification of a specific problem, e.g., how much fodder and fuelwood will a tree species produce? For each question, a number of variables can be identified that would help provide an answer directly or indirectly via an appropriate model based on these variables. Data are transformed into information (outputs) for decision making utilizing scientific methods and models, e.g., simulation, statistics, and economics. It is, therefore, necessary to identify potential models that can generate answers to questions; however, before setting up experiments, the relationship between key dependent and independent variables must be understood (Rose and Ugalde 1988). Once outputs or models have been selected, a minimum data set needs to be developed, i.e., the variables that need to be measured in the field.

Role of Research

To propose cost-effective and implementable actions to assess the sustainable use of tropical forests requires a description of technically and economically feasible resource alternatives and a comparison of them on the basis of accepted measures of project performance. Several analyses have demonstrated that sustainable extraction alternatives exist for tropical forests that are economically superior to agricultural alternatives which are often nonsustainable (e.g., Hecht and Schwartzman 1988). Much research is needed to develop sustainable agricultural practices and to compare the impacts of traditional and sustainable agriculture. Research will play an important role in finding sustainable technologies. The recent report of the Technical Advisory Committee to CGIAR (1988) recommended a number of strategies for international agricultural research centers, related to the sustainability of agricultural production. It focused on the sustainability perspective through a greater emphasis on both the short- and long-term aspects of agricultural production, through considerations of equity questions, and through training and extension programs. Standardized information collection can contribute to a more efficient use of limited resources and generate solutions in a shorter time. The International Task Force on Forestry Research (1988) is following up on the Tropical Forestry Action Plan with special emphasis on research.

Role of Education

While immediate actions to halt environmental degradation and implementation of sustainable land-use practices are urgent, long-term educational efforts must be an integral part of national and international policies. A raised awareness to environmental problems has been responsible for many of the positive changes brought about by pressure put on legislators and corporations by environmentally conscious groups.

MONITORING SUSTAINABILITY

Currently, the Forestry For Sustainable Development Program, funded by the PEW Charitable Trust, is underway at the College of Natural Resources of the University of Minnesota. Focusing on social forestry and watershed management projects and policies, it is producing training materials and management information to enhance the planning and implementation of forest-based projects and activities for sustainable development.

The Worldwatch Institute is active in monitoring resources worldwide. Its annual "State of the World" report has appeared since 1984. Special topics related to resource sustainability are covered in its Worldwatch Paper Series. The 1989 State of the World

(Brown 1989) discusses the threats from climate change and land degradation, and prospects for world food supplies.

The CGIAR is putting stronger emphasis on the sustainability aspects of agriculture and is developing appropriate programs for its international agricultural research centers. Forestry or agroforestry will be playing a much greater role in these research efforts. The International Task Force on Forestry Research through its follow-up on the Tropical Forestry Action Plan is assuming a greater role in promoting sustainable practices beyond protection of remaining tropical forests.

SUMMARY

Sustainable agricultural and forest-based development are receiving more attention both nationally and internationally. Slowing natural resource degradation has become urgent while its achievement is becoming more difficult with increasing world populations. Individual countries cannot continue to develop projects without some thought of sharing and exchanging information. No single organization or country has the resources to find answers to the many complex questions. Only by pooling data from well coordinated experiments will it be possible to develop models of sustainable land-use systems within the next decade. It will be necessary to pool data from many sources so that better models can be developed more rapidly. A basic and fundamental aspect of this task is the collection of information by standardized methods. Such information can then be effectively transferred between countries (Rose and Ugalde 1988). To overcome obstacles of time and money for development of models, it is essential that research experimentation be coordinated and that research findings be shared. This approach avoids duplication of effort and leads to better coverage of species, sites, and treatments. Coordination requires establishment of standards of measurements, of minimum data sets for modeling, and of efficient storage, organization, and retrieval of data. Databases will simplify the efficient exchange and transfer of research information among scientists and in various regions of the world. International cooperation and information exchange are strongly endorsed by the International Task Force on Forestry Research (1988).

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