PN-AAY-447

Discussion Paper D-73F
ENERGY IN DEVELOPING COUNTRIES SERIES

Social Forestry in Developing Nations

Douglas F. Barnes, Julia C. Allen and William Ramsay

A Discussion Paper from the Center for Energy Policy Research
RESOURCES FOR THE FUTURE / WASHINGTON, D.C.

9365703 97-

PN-AAY-447
ISN=52760

Discussion Paper D-73F

ENERGY IN DEVELOPING COUNTRIES SERIES

SOCIAL FORESTRY IN DEVELOPING NATIONS

Douglas F. Barnes
Julia C. Allen
William Ramsay

The Center for Energy Policy Research issues this paper in the Energy in Developing Countries Series. Presentation of this Paper does not constitute formal publication, and references to this work should cite it as "unpublished" material.

AID/DSAN-CA-0179

RESOURCES FOR THE FUTURE/WASHINGTON, D.C.

April 1982

ACKNOWLEDGMENT

The research for this study was funded under Cooperative Agreement No. AID/DSAN-CA-0179 established between Resources for the Future and the U.S. Agency for International Development, Office of Energy (Director, Alan B. Jacobs). Pamela L. Baldwin is the AID Project Officer for this Cooperative Agreement. The research staff at RFF is headed by William Ramsay, Project Officer and Principal Investigator, and Joy Dunkerley, Co-Principal Investigator.

We would like to thank John Miranowski and Mark Lyons for their valuable comments on an earlier version of this paper. We would also like to thank Elizabeth Shue and Michael Coda for their valuable reseach assistance in the project. Douglas McDonald of the Center for Energy Policy Research staff verified this report; Angela Blake and Lee Carlson were responsible for the typing, and manuscript preparation was coordinated by Marilyn M. Voigt and Linda Walker.

The views expressed in this paper are those of the authors and should not be interpreted as representing the views of either AID or Resources for the Future.

Contents

	Page
INTRODUCTORY NOTE	v
INTRODUCTION	1
RATIONALE FOR SOCIAL FORESTRY	5
TYPES OF SOCIAL FORESTRY PROGRAMS	10
Organization: Scope of Projects	11
Preparation: Mass Media Campaigns for Reforestation	
Seedling Distribution	
Establishment of Village Woodlots	
Completely Integrated Programs	
Administrative Options for Different Project Types	17
Social Forestry as a Component of Other Projects	
Direct Forestry Department Planting Without Village Cooperation	
Forestry Department Planning With Village Cooperation	
Multi-purpose Social Forestry Programs	
LAND LEGISLATION, TREE TENURE, AND OTHER CONSTRAINTS ON SOCIAL FORESTRY	22
ECONOMIC FACTORS IN SOCIAL FORESTRY	25
Dynamic Changes in Benefits: The Wood Scarcity Problem	27
Review of Evidence of Costs and Benefits	30
Social Forestry as a Component of a Larger Project	
Social Forestry as Community Woodlots	
Social Forestry on Marginal Lands	
Multiple Product Schemes and Species Selection	
Summary of Economic Issues	36
THE HUMAN AND INSTITUTIONAL PARAMETERS AFFECTING LOCAL PARTICIPATION	36
Awareness: Perception of the Need for Social Forestry	37
Evaluation: Local Opinion Leaders	39
Trial: The Demonstration Effect	39
Adoption/Discontinuance: Local Determination of Success or Failure	40

CONCLUSIONS AND POLICY RECOMMENDATIONS 41

Appendix 1 43

REFERENCES 52

RFF Discussion Papers 55

List of Tables

		Page
Table 1a	Current (1979) and Planned Expenditures on Forestry Related Projects in Developing Areas: Donor Activities	2
Table 1b	Current (1979) and Planned Expenditures on Forestry Related Projects in Developing Areas: Activities by Region (thousands of U.S. dollars)	3
Table 2	Cited Actual or Potential Impacts of Deforestation for Developing Nations	6,7
Table 3	Types of Social Forestry Administration and Activity for Villages Not Located in Forests	19
Table 4	Real Fuelwood Prices in Selected Developing Countries (1975 dollars per cubic meter)	28
Table 5	Distance Walked for Firewood Collection or Traveled for Wood or Charcoal Transport (kilometers one way)	32,33
Table 6	Labor Expended in Fuelwood Collection (Man Hours per Household per Week)	34

List of Figures

		Page
Figure 1	Social Forestry Programs	12
Figure 2	Mean Yearly Price for Fuelwood in 19 countries--Current and Real Prices (dollars per cubic meter)	29

INTRODUCTORY NOTE

Communities in such diverse locations as Upper Volta in Africa and Nepal in Asia have one thing in common--a diminishing biomass energy resource base. In the past staple traditional fuels such as fuelwood, charcoal, and dung have been locally available for collection by those in rural areas. These fuels provide light and heat for a large proportion of households in developing nations. This source of non-commercial energy is an important but little understood component of natural consumption.

Recently, the adequacy of the rural national regeneration cycle to supply traditional biomass energy fuels has been questioned, especially in the context of the growing population pressures in many developing countries. Even though the share of traditional fuels has been trending downward, population growth has insured that the pressure on traditional fuels is likely to increase in both the near and distant future. For some regions, this relationship between population growth and increasing scarcity of traditional fuels such as fuelwood focuses attention on the linkage between demand for traditional fuels and deforestation. As a consequence, many multilateral and bilateral donor agencies, along with some private and public foundations, have implemented innovative social forestry programs to improve local availability of traditional fuels. Programs are typically less than 10 years old. As with many innovations, implementation of these social forestry programs has proved difficult.

"Social Forestry in Developing Nations" is an analytical survey of existing social forestry programs in various parts of the world. A typology is presented classifying programs according to their organization and administrative structure which takes into account the cultural, geogrpahic, and climatic diversity of developing areas. The report reviews all aspects of social forestry and focuses in some depth on economics, political-legal structures, and community participation. Analysts interested in biomass energy programs will find information on general project design and the problems and prospects of social forestry.

The study is an outgrowth of research on biomass energy in developing countries at Resources for the Future. The work was funded by the Agency for International Development under the ARDEN (AID-RFF DEvelopment and ENergy) Cooperative Agreement No. AID/DSAN-CA-0179. Related work in progress includes a review of deforestation in developing countries and case studies of social forestry programs in Tanzania and the Sudan.

We issue this report on work in progress with the multiple purposes of informing the policy community of the state of knowledge, of stimulating research elsewhere, and of eliciting comments on our own efforts.

Milton Russell
Director, Center for
Energy Policy Research

Introduction

Rural social forestry programs have been initiated in many developing countries to counteract the multitude of problems associated with a shrinking forestry biomass resource base and consequent loss of sources of fuelwood. Social forestry is a very broad term which includes programs as diverse as watershed protection, village woodlots, and seedling distribution. But the underlying principle of social forestry is that the programs should improve the quality of life and economic conditions of those who are dependent on local trees for fuelwood, lumber, medicines, and other biomass products. Social forestry, which has been called a variety of different names including "forestry for the people" and "forestry for the masses," contrasts sharply with conventional industrial forestry, with its typical orientation to national and international commercial markets and often to multinational sources of management and capital. While industrial forestry could indirectly benefit local villagers, social forestry is designed explicitly to make use of local resources such as village labor and to provide local benefits--especially fuelwood.

In response to the shrinking forestry biomass resource base, numerous donor agencies have expanded funding for forestry. In 1976 the World Bank, which is the largest donor for forestry related activities, predicted that they would increase funding for forestry five-fold for the coming decade (World Bank, 1978, p. 51), and to date they have met or exceeded this goal. Industrial forestry is clearly the most heavily funded forestry activity as of 1979 (see table 1). The $524 million in the industrial category in table 1b represent lending for capital-intensive pulp mills and saw mills rather than for improving the management of existing forests (USDA, 1980, p. 30). By comparison, funding for reforestation in 1978 totaled $87 million. Although social forestry funding is even a much smaller fraction of this $87 million for reforestation, major multipurpose social forestry programs are now under way within Asia in India, Nepal, and Korea, and in many parts of Africa. The most recent figures from the World Bank (World Bank, 1981, p. 69) indicate that lending for fuelwood development was stepped up to $50 million in 1981.

Table 1(a). Current (1979) and Planned Expenditures on Forestry Related Projects in Developing Areas: Donor Activities*
(thousands of US dollars)

Donor Nation or Organization	Industrial		Conservation		Reforestation/afforestation	
	Current	Planned	Current	Planned	Current	Planned
IBRD	18,665	833,500	2,613	--	30,493	125,230
Sweden	369,400	36,000	--	--	--	--
USA	--	--	30,626	2,094	11,210	29,228
Germany	19,600	43,183	6,481	8,133	5,454	3,550
UNDP/FAO	23,861	233	17,038	2,440	1,905	2,938
Norway	35,239	36,000	--	--	--	--
World Food Program	--	--	20,426	--	9,104	--
Kuwait Fund	--	36,000	--	--	--	--
Nordic Investment Bank	--	36,000	--	--	--	--
OPEC	--	36,000	--	--	--	--
Asian Development Bank	25,100	--	--	--	--	--
Japan	--	--	--	--	750	--
Switzerland	--	--	1,170	6,000	1,029	209
Great Britain	16,000	--	160	--	--	--
France	--	--	5,702	--	6,335	2,880
Canada	4,090	--	5,283	--	--	2,218
IDB	--	--	--	--	--	14,500
European Development Fund	10,389	--	1,373	--	1,038	1,925
Australia	1,332	300	--	--	--	--
Philippine Development Bank	--	--	--	--	8,200	--
Netherlands	--	--	220	--	5,102	--
Lutheran World Service	--	--	--	--	6,129	--
Belgium	--	--	518	--	915	--
African Development Bank	--	--	2,613	--	--	--
IUCN/WWF	--	--	1,721	--	--	--
UNESCO	--	--	--	--	--	--
Finland	1,000	--	--	--	--	100
Denmark	--	--	--	--	--	--
Church World Service	--	--	--	--	245	--
TOTAL	524,676	972,052	95,944	18,667	87,909	182,778

*For projects with multiple donors, an average was calculated from the total contributions and their average was allocated to each donor.

Source: United States Department of Agriculture, Forest Service 1980, Forestry Activities and Deforestation Problems in Developing Countries, Report to Office of Science and Technology, Development Support Bureau, USAID, Washington, D.C., 1980.

Table 1(b). Current (1979) and Planned Expenditures on Forestry Related Projects in Developing Areas: Activities by Region

(thousands of US dollars)

Region	Industrial		Conservation		Reforestation/afforestation	
	Current	Planned	Current	Planned	Current	Planned
Sahel	180	6,083	36,908	13,033	30,573	31,982
Other West Africa	13,544	53,100	874	--	901	54,700
East Africa	56,849	906,000	22,285	3,194	18,373	47,083
North Africa and Middle East	10,509	24,000	--	--	588	100
Africa-wide	--	--	--	--	--	8,300
Latin America and Caribbean	50,631	30,000	22,946	2,440	3,912	16,150
Asia and Pacific	392,963	38,033	12,931	--	33,562	24,463
TOTAL	524,676	1,057,216	95,944	18,667	87,909	182,778

Since social forestry is such a new concept, the implementation of programs is accompanied by many problems. In the African Sahel, the tree survival rate of the early programs typically has been very low. Tanzania has been frustrated by the low levels of local response to its reforestation programs. A report from the United States Forest Service (1980, pp. 34-37) lists both recipient and donor agency constraints on forestry programs. Recipient countries have been unable to respond well to forestry programs because of population pressure, inappropriate land use planning, insecure land tenure systems, preoccupation with traditional forestry management objectives, and lack of trained foresters. Donor agencies have been hindered by failure to appreciate the role of forestry in integrated rural development projects, a bias against long range forestry projects, inadequate budgets (especially for private donor agencies), and lack of coordination between various donors. These constraints--along with the almost bewildering variation in types of social forestry programs--make the critical analysis of social forestry projects an important but difficult task.

This review examines social forestry projects from several different perspectives and reaches several conclusions. (1) Most rationales for social forestry projects are almost identical, while (2) the organization and administration of projects is quite diverse. (3) Land tenure systems, the legal structure, and informal tradition regarding tree use all place important constraints on social forestry programs. (4) The economics and benefit-cost analyses of social forestry reveal that a substantial government and donor commitment is necessary for most programs. Finally, (5) local participation, which is a key to successful social forestry, has lagged behind expectations because of inappropriate or inadequate forestry extension services, lack of local incentives, or other faults in project design and implementation. In this review diffusion of innovation research provides the framework for examining local participation in social forestry projects.

Rationale for Social Forestry

Social forestry can be a useful economic development strategy. True, it is handicapped because the returns from most forestry projects take a number of years to materialize. It is also burdened with the general problems that arise in economic development projects, including insufficient local capital, skilled labor and essential infrastructure. But social forestry does have promise for alleviating both the environmental and the rural energy problems facing many developing nations.

First of all, social forestry is designed to supply a sustained yield of fuelwood, poles, and other forest products. As such, it promises to help alleviate specific problems at the national level--especially energy crisis-related problems, such as balance of payments deficits. At the same time, social forestry could counteract trends toward deforestation and resulting environmental degradation. Many areas in developing countries have been deforested both through agricultural or pastoral techniques that lower soil quality and reduce vegetation and by overharvesting of wood for local energy use. In a recent fuelwood market survey for Hyderabad (India), fuelwood was being privately harvested without replanting from individual farms up to fifty miles away from the city (Osmania University and Resources for the Future, 1980).

Controversy still exists regarding the extent and seriousness of deforestation in developing countries (see Allen and Barnes, 1982 for a detailed review). Many studies have conveyed the impression that developing countries are on the verge of being turned into barren deserts or eroded mountain watersheds (see Eckholm, 1975, 1976; Daniel and Kulasingan, 1974), while others have concluded that mankind will have abundant forest resources in both the near and distant future (see Simon, 1982, p. 13). Since deforestation is a rather location specific problem, both trends may be occuring in different regions of the world. Destructive deforestation can occur when factors such as population growth, wood fuel use, and expansion of farmland cause an over-exploitation of the natural resource base, resulting in a subsequent decline in available forest products and environmental quality. Some of the cited adverse impacts of deforestation are listed in table 2. On the other hand, deforestation which is not destructive might include the gradual clearing of land to increase its

Table 2. Cited Actual or Potential Impacts of Deforestation for Developing Nations

Impact	Reference
A. Water Related Impacts	
1. Rapid, increased, and irregular water runoff	World Bank, 1978; U.N. FAO; Eckholm, 1976; Mikesell
2. Stream, river, and reservoir siltation	World Bank, 1978; U.N. FAO; Eckholm, 1979; Ranganathan; World Bank, Malawi
3. Blockage of irrigation and drainage systems	U.N. FAO
4. Flooding	World Bank, 1978; Eckholm, 1976; Ranganathan; World Bank, Malawi
5. Lower water yield and water quality	Kartawinata
B. Soil Related Impacts	
6. Soil erosion	All
7. Lower soil fertility from switch to crop residues and dung instead of wood	U.N. FAO; Eckholm, 1979
8. Damage to land and crops downstream	U.N. FAO
9. Desertification and dunes formation	Ranganathan; Darkoh
10. Change in chemical and physical properties of soil	Kartawinata
11. Prevention of formation of deep residual soils	Mikesell
C. Economic and Human Effects	
12. Lower crop yields	World Bank, Rwanda
13. Rising imports of forest products	Eckholm, 1979
14. Increase in wood fuel prices	Eckholm, 1979
15. Less frequent cooking	World Bank, Rwanda
D. Others	
16. Micro-climate changes	U.N. FAO; Ay
17. Higher intestinal parasite loads in water	U.N. FAO
18. Increase in atmospheric carbon dioxide	Eckholm, 1979
19. Species extinction or changes in animal behavior patterns	Eckholm, 1979; Kartawinata
20. Changes in vegetation regeneration patterns	Kartawinata

Table 2 (Continued)

Sources: Peter Ay, "The Rural Energy System of Nigeria Part 2: Firewood and Charcoal in the Humid Tropics - Field Research in Western Nigeria" (Draft report prepared for the United Nations University, Tokyo, January 1979), p. 71.

M. B. K. Darkoh, Man and Desertification in Tropical Africa, Inaugural Lecture Series, no. 26 (Dar es Salaam, University of Dar es Salaam, 1980), p. 23.

Eric P. Eckholm, Losing Ground Environmental Stress and World Food Prospects, Worldwatch Institute with the support and cooperation of the United Nations Environment Program (New York, W.W. Norton and Company, Inc., 1976), p. 91.

Eric Eckholm, Planting for the Future: Forestry for Human Needs (Washington, D.C., Worldwatch Institute, 1979), pp. 26-33.

Kuswata Kartawinata, "An Overview of the Environmental Consequences of Tree Removal from the Forest in Indonesia," in Stephen G. Boyce, ed., Biological and Sociological Basis for a Rational Use of Forest Resources for Energy and Organics, proceedings of an international workshop sponsored by The Man and the Biosphere Committees of Canada, Mexico, and the United States held at Michigan State University May 6-11, 1979, p. 129.

Marvin W. Mikesell, "Deforestation in Northern Morocco," Science, vol. 132, no. 3425 (August 19, 1980), pp. 441-447.

Shankar Ranganathan, Agro-Forestry: Employment for Millions (Bombay, India, Tata Press Limited, November 1979), p. 11.

U.N. Food and Agriculture Organization, The State of Food and Agriculture 1979, World Review Forestry and Rural Development, FAO Agriculture Series no. 10 (Rome, FAO, 1980), pp. 2-8.

The World Bank, Forestry Sector Policy Paper (Washington, D.C., World Bank, 1978), p. 15.

The World Bank, "Malawi Phase II of National Rural Development Program," Staff Appraisal Report, Eastern Africa Projects, Southern Agriculture Division (Washington, D.C., World Bank, February 8, 1980), p. 6.

The World Bank, "Rwanda Integrated Forestry and Livestock Development Project," Staff Appraisal Report, Eastern Africa Region, Central Agriculture Division (Washington, D.C., World Bank, May 9, 1980), p. 8.

productivity through cultivation or forest plantations, all within the context of proper land management. However, most recent evidence suggests that deforestation is a real trend; forest area is declining in most developing countries. This trend is cause for serious concern in the most severely affected regions, since loss of forest cover can have adverse effects on the supply of woodfuels for household energy, for local industries such as brickmaking and tobacco curing, and for the general quality of rural life.

Both the fuelwood and deforestation problems are of critical importance and are cited in project documents as a rationale for investments in social forestry. For example, on average, forests in developing countries are diminishing by as much as 1.3 percent per year, while populations typically are increasing by 2.5 percent. Projections based on average current per capita consumption and the average increment of existing forests and plantations indicate that demand and supply for wood fuels would require the planting of an additional 50 million hectares by the year 2000 (World Bank, 1980). In particular countries, one can estimate that the effect could be quite large. For instance, a wood energy project in Malawi was justified on projections which indicate that the supply of wood is expected to decline from 9 million cubic meters per year in 1980 to 3.7 cubic meters by the year 2000, while during the same period demand is expected to exceed this supply by 3 million to 14 million cubic meters per year (World Bank, 1980, p. 33).

Rural households which use wood fuels can respond in several ways to wood scarcity or to the rise in the real price of wood. Households may continue to consume the same amount of wood by spending a larger fraction of their income. Subsistence households, which have no source of additional income, may devote more labor to wood collection, thereby sacrificing the food or other goods that their labor might have produced. Rural or urban households which have no flexibility in income or labor will simply consume less wood. Households can reduce wood consumption through the use of more efficient stoves, or through reductions in energy-consuming activities such as cooking. More meals may be eaten cold if cooked meals can be prepared once rather than twice or three times during the day.

A rise in the price of wood also may cause households to substitute other fuels for wood. High income families may switch to commercial fuels

such as kerosine or coal, while the vast majority of poorer households probably would tend to substitute agricultural wastes or dung for wood (Cecelski and coauthors 1979, p. 24). Clearly substitution is only possible when an affordable substitute is available. Moreover, it is important to recognize that switching fuels and conservation are not mechanical responses; they may involve difficult social and technical adjustments.

Social forestry has the decided benefit--from the point of view of many analysts--that the wood products are to be provided at the local level directly to villagers that are in need of them. In this sense, social forestry is really a program to decentralize the benefits of forestry programs. This new approach stresses the involvement of individuals and communities in planting, protecting and harvesting their own trees. In this way, the communities most affected by deforestation can be the communities helped most by forestry programs. Since the rural poor are the class most reliant on wood as an energy source, social forestry might possibly help improve fuelwood supply to the rural poor and lead to the more efficient use of local resources.

Social forestry projects also may include some very important spinoffs. National social forestry programs encourage more rational land use in rural areas and in the nation as a whole. Presently uncultivated but arable land comprises a significant percentage of total land area in developing nations, and in the past most land policy has been directed toward agriculture (see Romm, 1979). Social forestry programs focus attention on the management of village land not under cultivation, thus improving total land use practices. With proper management, uncultivated land can be quite productive, yielding fodder, fruits, woodfuels, and poles for local purposes along with regional environmental benefits.

Another incidental spinoff might be the strengthening of government agencies involved in forestry, agriculture, and the environment. As will be argued below, strong support from some kind of government extension service probably is an essential factor in successful social forestry programs. Social forestry does not in any way threaten or replace existing functions of the forestry department, but rather adds a new component which involves a sensitivity to rural development issues. In social forestry the role of the forester changes from policeman to extension agent--a source of

information, expertise, and technical assistance to rural communities. It is therefore to be expected that forestry departments in developing areas, which are often understaffed and undertrained, would benefit by their participation in new national programs of social forestry.

Despite these hopeful reasons for social forestry, in practice many programs have been unsuccessful. In some cases, problems have plagued every stage in the reforestation process from seedling distribution to harvesting trees. Trees may be planted, but local participation by villagers in reforestation efforts often lags behind expectations. The reasons for this can be many, including organizational, administrative, economic, political or legal. Given the novelty of trying to introduce rational management of biomass through social forestry programs, such problems are not surprising. We now examine how such problems arise in various types of forestry programs, and investigate some aspects of successful and unsuccessful approaches to social forestry.

Types of Social Forestry Programs

Social forestry has been organized and administered in a variety of ways. Programs can range from small scale projects which involve distribution of seedlings with no administrative support, to large scale projects which encompass the supervision of planting and harvesting trees supported extensively by forestry administration. Organization and administration also must take into account that social forestry programs are located in quite diverse regions including the humid tropics, the semi-arid tropics, alluvial plains, and mountainous areas. Through a review of the spectrum of social forestry programs (see Appendix 1), a taxonomy has been developed which covers the organizational and administrative activities involved in social forestry. The organization of social forestry involves fairly concrete steps from seedling distribution to the harvest and use of forest products. By contrast, administration can take a number of forms, including social forestry as a component of other projects, direct forestry department planting with or without village cooperation, and multiple purpose programs. We will first consider the

organization and then turn to the administrative aspects of social forestry programs.

Organization: Scope of Projects

Social forestry projects can involve a number of discrete phases, which include generating information about the program to elicit support, growing and distributing seedlings, planting the seedlings, and maintaining and harvesting the trees for local use or for selling to a market. These steps are cumulative, and most social forestry programs begin with seedling programs. But depending on the program, official and administrative responsibilities may stop at any one of the stages in this cumulative process. Thus a social forestry program may include or lack official support at any step from planting to harvesting. In figure 1 we illustrate the stages of tree growth in a hypothetical social forestry program, the corresponding project coverage, and the activities involved in each stage. Seedling growth and distribution programs obviously take place only at the very beginning of the tree growth cycle. Many tree planting projects typically involve seedling growth and direct planting by the forestry department, but may not extend beyond actual planting. Social forestry extension services, although not strictly a program, can cover all phases including seedling growth to harvest. Finally, completely integrated programs even might cover the distribution and marketing of the wood products. However, before turning to the programs involving the physical steps included in social forestry, we now direct our attention to mass media campaigns which aim to raise the general level of awareness of forestry-related problems.

Preparation: Mass Media Campaigns for Reforestation. Campaigns to promote the importance of trees and forestry have become quite popular in some developing countries, but the means of publicizing the deforestation problem can be quite diverse. The Government of Tanzania has started a mass media campaign advocating tree planting that declared that "Woodlands are Wealth." The government has placed messages on billboards and printed slogans on kanga skirts (Skutsch, 1981). At rallies villagers are warned about the problems of deforestation and instructed in ways to combat deforestation. In the early 1970s Korea started its massive reforestation efforts by making social forestry one of the first priorities for the

Figure 2. Social Forestry Programs

ORGANIZATION

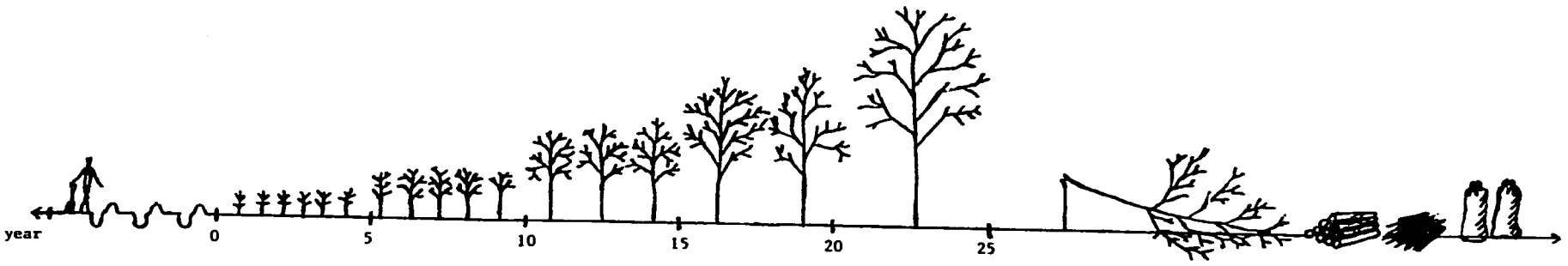
Mass Media Campaigns*

Seedling Distribution Programs

Tree Planting Programs

Forestry Extension Services

Integrated Social Forestry Programs



ACTIVITY

- site selection
- site preparation
- species selection

- tree planting
- intercropping
- limited grazing
- weeding, watering, protection from pest and poachers, thinning, applying fertilizers

- selective harvest

- selective harvest

- selective harvest

- final harvest
- drying, storage
- charcoal production
- transport to markets

*May be undertaken at any stage of social forestry.

saemaul movement, a community development program in which village participation was a major goal (Gregerson, 1979, p. 1).

Obviously the success of mass media campaigns depends on whether villagers perceive deforestation as a real threat or a minor inconvenience, and whether the group supervising the social forestry has the technical capacity to deliver the necessary program inputs. The media campaign in Korea was backed up by investing in nurseries, training foresters, and in general by reorienting the forestry department to its new role; whereas in Tanzania the mass media campaign was not accompanied by careful planning to meet the demand for seedlings on a large scale, one of the first steps necessary in any successful program.

Seedling Distribution. Seedling distribution is the first physical stage of a social forestry program. In Malawi a seedling distribution pilot program was appended to a large scale industrial and commercial forestry program (World Bank, 1980, p. 11). The primary purpose of the industrial project is to meet industrial and commercial demands for fuelwood and timber. In the seedling distribution project the forestry department is establishing a national network of 88 nurseries, but planting, maintaining, and harvesting the trees is the responsibility of the rural residents. The Tanzanian social forestry program also is mainly a seedling distribution program. The forestry department raises the seedlings and distributes them free of charge, but all the remaining operations must be carried out by the villagers (Mnzava, 1980, p. 22). Schools and villages are encouraged to establish woodlots through the promotional campaigns mentioned above. While social forestry stops at the seedling distribution stage in Mali and Tanzania, in India seedling distribution is only one part of a more comprehensive social forestry program. Seedling distribution in the Gujarat social forestry program has reportedly been quite successful (see Noronha, 1981, p. 7). But while there has been a large demand for seedlings by villagers, the establishment of village woodlots has fallen below expectations. Villagers apparently are planting trees on their own property near their houses and along the borders of their farms.

The difficulties of social forestry programs that stop at the seedling distribution stage are manifold. No particular group is responsible for assuring when, how, or if the trees are planted, not to mention whether the

trees are maintained or harvested. Seedling distribution programs are based on the premise that villagers will have the desire to grow trees and the knowledge regarding proper methods of planting and maintaining the trees. However, the seedlings available to the villagers often are species exotic to them (such as eucalyptus or pines) which may require special care. More important, exotic species may not provide the kind of wood, food, medicine or fodder that the villagers need from trees (see Noronha, 1980, p. 23). Poorly chosen species may be responsible for little local interest in seedling programs. It is also somewhat rashly assumed that villagers voluntarily will perform the bulk of the reforestation work with little or no supervision. This is not to say that seedling distribution programs by themselves do not work; after all, the seedlings are distributed and presumably planted. However, as of yet, no one knows how many of the seedlings actually survive, and if they do survive, the extent of their impact on local deforestation problems.

In addition to organizational factors, careful site selection and species selection are important for successful social forestry projects. An appropriate match of site characteristics and species requirements is necessary for high tree survival rates and high yields.

Proper site selection is particularly important since social forestry projects typically do not involve elaborate site preparation or soil improvement. In many cases plantations are located in the least productive land locally available. Site selection involves evaluating the physical, chemical and biological properties of the soil and water available and matching them to the requirements of the species. For example, the seedlings and young trees of some eucalyptus species are very susceptible to attack by termites and ants which proliferate in many tropical soils. Limited water availability in shallow soils, on steep slopes, or in soils with hardpans have also prevented the establishment of tree seedlings root systems. In other cases, tree growth has been restricted by low nutrient levels. On highly weathered, nutrient-poor soils, choice of a nitrogen-fixing tree species may be an effective strategy to combat nitrogen shortages. In fact, plantations of legumes or other nitrogen-fixers may improve soil nutrient levels and contribute to higher crop yields on the site after harvesting of the trees for fuelwood or poles.

Species selection involves simultaneous consideration of potential yields and local needs for forestry products. Different tree species produce different products at different rates. Given proper site conditions, eucalyptus or pine may provide a quick source of fuelwood and poles for some local communities, but species which grow more slowly but also provide fruit, fodder, or green manure may be preferable for other villages. Although we do not examine these technical aspects of social forestry in this paper, we are convinced that a careful examination of the water and soil characteristics of proposed social forestry sites, combined with species selection to match site characteristics and local needs for forest products, greatly enhances the viability of social forestry projects.

Establishment of Village Woodlots. Some social forestry programs carry the reforestation process past mere seedling distribution to actual tree planting or supervision of tree planting. Many programs sponsored by private donor agencies and multilateral lending institutions have focused on village woodlots, which are supervised up to the point when the seedlings are planted, with little or no support once the seedlings are in the ground. Tree planting need not be limited to village woodlots, but may also take place along roads, canal banks, and in other locations. However, in all too many cases maintaining and harvesting of the trees is left entirely to the villagers with no support once the trees are planted. Village woodlot plantations in the Sahel are typical of efforts that terminate at the planting stage (Winterbottom, 1980). Most past programs in the Sahel involved planting of seedlings in village woodlots through the supervision of local forestry departments, with little or no participation by or communication with villagers. After the woodlot was established the planting team moved on to the next village to establish a new woodlot. These early projects in the Sahel have a very low tree survival rate.

Some of the factors inhibiting the programs in the Sahel have been a shortage of local personnel, government inability to cover recurrent costs once the planting is complete, and a lack of logistical and forestry extension support for the program. Within such a context, how could one expect self-motivated villagers to expend extensive efforts in maintaining the project? Winterbottom (1980, p. 26) recommends that in designing social forestry programs donors should avoid the temptation to plant as

many trees as quickly as possible, and they should pay more attention to how the trees are planted, and to long term planning for future reforestation. Likewise in Indonesia the results of a social forestry program have been very poor, in part because planting targets were too high, village cooperation was not forthcoming, and institutional support was inadequate (Montague Yudelman, private communication, 1980). Efforts to plan for the longer term have been stressed in China, Korea, and India.

Completely Integrated Programs. The most successful social forestry programs have included all the cumulative steps for growing trees, but these also are the largest and most costly programs. The Chinese contend that 30 percent of local reforestation effort should be devoted to planting, and 70 percent to the subsequent tree tending operations (FAO, 1978, p.37). However it has been reported that this Chinese emphasis on tree tending has not been as extensive as the policy directives might suggest (Taylor, 1982, pp. 125-147). Nevertheless, China has integrated a variety of forestry methods during the last thirty years, ranging from planting beside homes to collective forest plots specifically designated for fuelwood production. A description of communal forestry in Shaanxi Province reveals that solutions had to be found to tree harvesting problems that arose in the later stages of the project (for details, see Taylor, 1982, pp. 134-136), once again stressing the need for organized tree care after planting.

The Korean, Gujarat (India), and China social forestry programs have involved planning at every stage from media campaigns and seedling distribution to harvesting and division of benefits. In Korea the village forestry associations are responsible for all aspects of tree production and they enjoy substantial support from the government. The village forestry associations clear the sites and grow seedlings in nurseries or purchase them from state or private nurseries. In addition, they plant, maintain, and harvest the trees on both private and public land. On private forest land the village forestry associations are legally entitled to 90 percent of the forest products, while the landowners, who are not involved in any of the plantation activities, are entitled to 10 percent.

In India the state forestry department is responsible for all forestry activities in the social forestry programs. The department has developed a forestry extension service which reaches down to the village level; this

extension program provides information and in most cases actually participates in planting, maintaining, and harvesting the trees on land provided by the villages. The villagers have the option of providing their own labor to maintain their woodlots, or they can relinquish that responsibility to the forestry department for a smaller share of the final harvest (World Bank, 1980, p. 12-13). All stages of the social forestry program in Gujarat are backed by the forestry extension service which was developed to implement social forestry programs. The Chinese, Korean and Indian experiences show that the most complete social forestry programs are carefully planned, with each stage supported by the forestry extension and with prior understanding of how the harvested trees will be distributed.

The lesson suggested by these few cases of organization of social forestry programs is that to be most successful the local production of wood products must not be a piecemeal activity dealing only with isolated or preliminary stages of the reforestation process. Media campaigns and the distribution of free seedlings without advice on planting, adequate species selection and maintenance procedures, along with equitable distribution of benefits, may turn out to be no more than gestures toward combating local destructive deforestation. This does not mean that seedling distribution programs by themselves are doomed to failure; where villagers are motivated to plant trees on their own land, as in the Gujarat program, they can be successful. But social forestry programs are much less likely to work without logistical and forestry extension support to identify likely planting areas and appropriate species and to assure timely delivery of seedlings. On the other hand, comprehensive social forestry programs are not guaranteed to succeed just because all aspects of tree growth have been planned for in the project--although the likelihood of success is indeed higher. Even in these comprehensive programs, local participation and proper administration are key determinants to the success of social forestry.

Administrative Options for Different Project Types

Social forestry requires a different kind of administration than large scale industrial and commercial forestry plantations. Large scale reforestation for industrial purposes or watershed protection is a capital-intensive operation on clearly defined properties in sparsely

populated regions. Most importantly, it requires very little contact with local residents.

In contrast, social forestry typically encompasses a series of small scale projects which are geographically dispersed and which require extensive forestry extension services along with substantial community support. This represents a substantial change--both for forestry officers and for villagers. For instance, as an enforcer of forestry laws, the forester has traditionally been viewed by most villagers as a person who should be avoided because he hands out fines. To compound these difficult adjustments, forestry departments in developing countries are notoriously understaffed and in many instances may not have the capacity or training to carry out social forestry programs. Also, the administrative requirements of a social forestry program vary with the type of project.

In this section we review the problems involved in the administration of the several different kinds of social forestry projects reviewed in this study: social forestry as a component of other development projects, direct forestry department planting without village cooperation, forestry department planting with village cooperation, and multi-purpose social forestry programs (see table 3). Some social forestry programs involve major funding efforts in countries that can handle the necessary administrative responsibilities. But in other countries, perhaps with a poor administrative capacity for forestry-related projects, social forestry has been attached to other major programs. Below we review some of the various options for administering social forestry projects.

Social Forestry As a Component of Other Projects. Many social forestry programs are set up as small components of existing large scale commercial forestry projects or other programs. The social forestry component is supposed to benefit from the overall administrative structure of the project; however, often the administration of small social forestry programs cannot easily fit into the same mold as large commercial forestry projects. While the addition of a nursery and seedling distribution component in the right circumstances can make a significant contribution, care must be taken that the social forestry component does not become merely a symbolic gesture toward meeting wood fuel requirements and controlling deforestation (Noronha, 1980, p. 34-35). Even when social forestry is only a component of a larger project, there must be sufficient

Table 3. Types of Social Forestry Administration and Activity for Villages Not Located in Forests

Type of Administration	Type of Activity
Social forestry as a component of other projects	1. Seedling distribution 2. Watershed protection 3. Protection of agricultural lands (soil protection) 4. Fuelwood forestry component of rural development project
Direct forestry department planting with no village cooperation	1. Watershed protection 2. Planting along roadsides, canal banks, and other locations 3. Urban or small town tree and pole plantations 4. Shelterbelts for wind control to prevent soil erosion
Direct planting by forestry department with village cooperation	1. Village woodlots 2. Planting on school grounds or in other public places 3. Fuelwood/forestry as a component of rural development projects
Multi-purpose projects	1. Seedling distribution 2. Village woodlots 3. Tree maintenance agreements 4. Change in local tree use tradition or laws 5. Forestry extension component 6. Development of forestry administration capacity 7. Planting along roadside canal-banks, etc. 8. Fuelwood marketing agreements 9. Villagers input into design of program

and genuine commitment of extension services, a prompt and timely delivery of key inputs, and follow-through including instruction for farmers or communities concerning the technical factors involved in planting, maintaining, and harvesting trees. For instance, in the Nepal Rural Development World Bank project, social forestry was successfully integrated with a project for erosion control and rural development, but this occurred only after a slow start-up period and after sufficient support services had been provided (Noronha, 1980, p. 35).

Direct Forestry Department Planting Without Village Cooperation. Planting along roadsides, canal banks and along farm borders can be an effective interim means of demonstrating the utility of social forestry to villagers. Many watershed protection schemes, which generally are not classified as social forestry, involve similar tree planting in marginal areas. The earliest social forestry projects in Gujarat were the direct planting of trees along roadsides by the forestry department (see World Bank, 1980; Jhalla, 1976). The purpose of the early direct roadside planting was to demonstrate the benefits of social forestry for rural communities. The administration of these projects is similar to the administration of large scale plantations, with the exception that planting sites are widely dispersed.

Public planting along roadsides and in other areas can have multiple goals--improving the environment and wood fuels supply and enhancing the capacity of the forestry department to administer tree planting in dispersed locations. By carrying out such projects the forestry department learns about appropriate planting techniques, potential pest control problems, and preliminary ways to elicit local support for social forestry. Roadside planting also can be an interim stage for training and developing a forestry extension staff and for other institution-building activities. The main drawback is that such social forestry schemes do not delegate forestry responsibilities to local communities; the transfer of knowledge, if it occurs, is by example rather than support from extension services.

Forestry Department Planning With Village Cooperation. Many private donor agencies concentrate social forestry efforts on particular villages, and programs may range from full scale community development to the concentrated planting of village woodlots. Usually the tree planting programs rely on inputs of labor and land from the village, while bringing

in tools and other equipment, seeds or seedlings, and managerial expertise from outside the village. Typically the forestry department manages such projects in cooperation with donor agencies. However, if the success of social forestry depends on outside inputs and if supporting governmental institutions are weak, then the temporary infusion of capital and manpower into a community may result in a project which cannot be institutionalized on a wide scale. In the Sahel, such programs have been described as "top heavy" by borrowing planting techniques directly from industrial plantation practices while treating villagers as little more than hired laborers (Winterbottom, 1980, p. 21). In many cases projects that concentrate on particular villages may not be replicable even a few miles away, because of the government's inability to provide extension services and the lack of local capital. Ideally, pilot projects should be replicable in communities that do not necessarily receive a direct infusion of capital from the donor agencies.

Multi-purpose Social Forestry Programs. Multilateral and bilateral donor agencies have been involved in large scale multi-purpose social forestry programs. For a variety of reasons these programs have been more successful than the others. Since social forestry is their primary focus, and the projects are not added on to other programs, in most cases the multi-purpose projects are more likely to address the crucial problems of local participation and institution-building. The particular form of their administration depends on the national and local political structures, which can be quite different from one country to another. In South Korea, multi-purpose social forestry is administered through the village forestry associations, and in India through the state forestry departments. In both projects, there is supervision of all stages of planting, from seedling distribution to tree tending. The anticipated benefits are evaluated before the project is started, and substantial institutional and political support provides a base for social forestry. In fact in both India and Korea, the projects were already in progress and already enjoyed substantial national support before they subsequently received substantial funding from the World Bank. It should be noted, however, that India and Korea have had extensive experience in institution building, so the results of these multidimensional social forestry programs, while exemplary, could be misleading when generalizing to other countries.

In summary, social forestry programs which have had a high rate of tree survival or wood production (a) have provided support at all stages, from seedling distribution to harvested trees, and (b) have developed the forestry extension service and infrastructure necessary to administer the projects. A project in Nepal was recently cut back from a goal of 15,000 hectares to 11,000 hectares because of a lack of infrastructure including access roads, nurseries, water supplies, and other factors involving labor shortages and land tenure problems (Montague Yudelman, private communication, 1980). While institution-building should not be considered as an end in itself, clearly promoting or publicizing seedling distribution and tree planting pilot projects which do not have the necessary administrative support or extension capacity should be avoided.

Effective administration of social forestry at each stage may be a necessary but not sufficient condition for successful social forestry. Other important factors also must be considered. Where the need for trees is considered pressing by local people, an effectively administered program, even if it stops at an early stage, might be quite successful. Conversely, even social forestry programs which have been carefully planned at every stage from nursery to harvest may fail when legal, economic, or cultural conditions are in conflict with the design of the program.

Comprehensive programs also may be inadequate to guarantee successful social forestry if planting or tending methods cannot be continued when subsidies are withdrawn. In the long run, the replication of tree planting by other communities or individuals not covered by the projects really is the essence of successful social forestry. The next sections examine some of the legal, economic, and social constraints that affect tree-planting on a nationwide or regional scale.

Land Legislation, Tree Tenure, and Other Constraints on Social Forestry

While in most developing countries the tenure rights to agricultural land are fairly well established, tree tenure rights and the control of marginal land are often subject to a myriad of confusing and sometimes conflicting claims. Conflict between government and villages may arise because local residents assume that their right to graze on marginal land is sacrosanct, while forestry department goals may be directed toward

limiting local grazing. Conflict between individuals may arise when persons who plant trees on their own disagree with their neighbors regarding who has the legal right to harvest the trees. Governments or forest departments also may have legal prohibitions on the cutting of particular tree species no matter who owns the trees or who has rights to the land on which the trees are located. Formal laws and informal tradition can vary dramatically depending on the sociocultural setting and the local history of land and forestry legislation. Therefore, the structure of land legislation and forestry laws, along with varying levels of commitment to enforce the laws, can have quite significant implications for the development of social forestry programs (see Thomson, 1981). In this section we review several types of land and tree tenure arrangements and their implications for social forestry programs.

In many parts of Africa, especially those countries or regions which are moving from slash and burn to sedentary agriculture, trees may be unowned or unregulated common property. Within this legal structure everyone has the right to (or is not forbidden to) harvest any tree and consequently no one will take the individual responsibility to plant trees. Such a situation is common in countries where forests presently are or recently have been in abundance, and the consequence is that there is widespread consumption of forest products including fuelwood without regard for continued production. If individuals do not utilize the resources available to them, either the forestry department or their neighbors may harvest the trees. For instance, Skutsch (1981) has observed in Tanzania that tree planting may be discouraged in villages with transient populations and weak inheritance rights. Individuals or families are not assured of the benefits, so they do not plant trees. While society would benefit from individual planting and conservation behavior, anyone that improved the conditions of the forest, woodlands, or commons would have no special claims to the trees saved by their individual action.

In contrast to unregulated common property, trees in government forest reserves are property of the state, and permission for cutting and harvesting is granted by the state. However, in typical cases the government regulations are ineffectively enforced, and there is widespread illegal cutting. Because of the lack of effective enforcement combined with essentially no informal social control to prevent poaching, the trees

in the forest reserves are prey to all those in need of fuelwood or other forest products. Those who live in the rural areas are typically all in the same situation; they are united against the few ineffective foresters who patrol the forest reserves (Thomson, 1981). Villagers break the formal laws to obtain much needed fuelwood and other forest products, and consequently no informal social pressure develops which would protect the trees from poachers.

Between the extremes of no regulation of tree harvesting and the formal prohibition of tree harvesting (often without enforcement), there are many possibilities for dealing with the formal legal arrangements and informal traditions which might affect social forestry programs. One set of legal conditions conducive to social forestry is that trees may be defined as the private property of a community, sub-community, or individual. Farmers who plant trees along the banks of their fields must be assured that they will have the right to harvest the trees. Establishing village woodlots without defining who has rights to the benefits from the trees may lead to conflicting claims by the government and the village. For village woodlots communities must have the legal right to utilize the commons or local waste land for establishing tree plantations. Thus, the rights of the village, the government, and the individuals in the village must be clearly demarcated. Any uncertainty surrounding village woodlot or private tree ownership increases the risks that villagers will not participate in the program. As reported for the Gujarat (India) project, the government may be perceived as introducing social forestry programs just to gain control over village common lands, or villagers may perceive the programs to be a private windfall for the local elites who participate heavily in the program. Also, villagers and owners of private plantations may come to an agreement whereby villagers may collect fuelwood by lopping branches in the timber plantation (Skutsch, 1981). Thus, a combination of formal laws with local social control and consensus is seen to be an essential prerequisite for the establishment of social forestry programs (Noronha, 1980, p. 31).

The programs of Korea and India provide two quite different solutions to the legal problems surrounding social forestry. The problem in Korea was that over 73 percent of forest reserves are privately owned. Thus, in 1973 the government of Korea passed a forestry development law to establish

a legal basis for the social forestry programs which were being introduced into the villages (Gregerson, 1979). The law empowers the village forestry associations with responsibilities to plant, maintain, and harvest trees in woodlots located in private forests. According to the 1973 law the owners of the forest reserves retain their legal right to the land and they are entitled to 10 percent of the fuelwood and forest products produced in the managed village woodlots.

By contrast in India only 10 percent of the land is classified as forest reserves and all of this land is owned by the government. The commons and village marginal land to be utilized for woodlots are controlled by the local village governments called panchayats. Many village panchayats have been suspicious of the social forestry programs because they require significant government intervention. Villagers fear the program may be a ploy by the government to assume control over local land. To allay these fears, the forestry department signs a detailed contract with the village panchayat formally defining the duties and rights of all parties engaged in the social forestry project (World Bank 1980, p. 12).

Similarly in China apparently there was a threat to an afforestation program because of premature harvesting of trees by individuals. The problem was solved by formally organizing fuelwood collection and designating specific fuelwood collection zones, which could be rotated when necessary (see Taylor, 1982, pp. 134-135).

In the Tanzania and Upper Volta social forestry programs, which have been much less successful than those in India and Korea, there has been very little clarification and redefinition of laws regarding tree and grazing tenure. These few case examples suggest that a precondition to serious social forestry is an appropriate legal and land tenure framework, formal and informal mechanisms to enforce rules and regulations, and an effective mechanism for settling conflicting claims to trees and the land.

Economic Factors in Social Forestry

Very little hard evidence has been collected or analyzed on the costs and benefits of individual social forestry projects, much less for social forestry as a whole. The costs of programs involve not only the financial

costs incurred from bringing resources from outside rural areas and in mobilizing local resources, but also the non-monetary costs of intensely utilizing existing institutions such as forestry departments. Perhaps one of the most important costs, and one of the most difficult to assess, is the time and labor spent by villagers in locally organizing the program and helping to plant, maintain, and harvest trees. In countries short of managerial talent, moreover, the opportunity cost of training staff to capably administer and monitor such projects may be quite high.

Benefits are also quite hard to calculate in a strictly monetary sense. The most obvious benefit from social forestry is wood products of all kinds, from fuelwood, to poles, to particular tree crops such as fruits or even gum arabic. In the context of an energy crisis, the value of fuelwood as a benefit is of particular importance. But fuelwood or substitutes for fuelwood including crop and animal waste are often outside the monetized economy, and therefore it is difficult to set a value on those products. Often, time spent in gathering fuelwood is used as a surrogate measure for the local value of fuelwood, but this is often not a satisfactory strategy since such estimates are difficult to make and are often imprecise. Other benefits are more indirect: growing trees for fuelwood may save crop residue and animal wastes for fertilizer to improve agriculture. Perhaps one of the most important benefits from fuelwood projects--protection of the environment--might not even accrue to the local village at all, but may benefit the larger region or even the country. If fuelwood plantations are able to prevent erosion of soil, to minimize loss of soil nutrients, and to stabilize local hydrology, then concerns of national importance like agriculture, hydroelectric power, and environmental quality would be benefitted. These latter benefits, however valuable, present impossible measurement problems.

The dynamic or long term nature of the deforestation problem is another economic consideration that deserves attention. One possible reason that some social forestry projects have not been that successful might be the unavailability of scarce resources such as management and capital. Undoubtedly, lack of infrastructure such as roads, support facilities, and even local credit outlets may contribute to the demise of promising projects. However, one must also consider the dynamic nature of the deforestation problem itself. Potentially at least, the steady decline

of forestry resources might have a stronger impact on future economies in developing countries. If forest resources are becoming scarcer in general, then wood fuels will soon become more expensive--in whatever measure of worth--and present social forestry projects would become even more valuable.

Therefore we first consider dynamic changes in benefits and then review the present evidence for wood scarcity. Following that, we briefly examine some of the cost and benefit "calculations" that have been conducted for various existing projects.

Dynamic Changes in Benefits: The Wood Scarcity Problem

In the most affected regions the deforestation problem should be reflected by rises in fuelwood and charcoal prices and by increases in the labor necessary for collecting fuelwood. However, the evidence of wood scarcity and rising real prices is rather sparse. Most analysts seem to agree that wood scarcity is a very location specific problem. The most recent figures from the FAO (1981) indicate rising current prices, but there is a wide standard deviation among countries and inflation adjusted prices are rising only moderately (see table 4 and figure 2). A sample of spot wholesale and retail prices of fuelwood and charcoal in selected developing countries shows that current prices have more than doubled over the 1970 to 1978 period, but aggregate real prices have risen only slightly. Increasing relative prices typically imply increasing scarcity; thus to the extent that the figures do indicate rising real prices, this evidence alone may make a case for overall increases in wood scarcity. However, since the sample size and variance both increase over the time period, it is impossible to know how widespread this trend is.

Aggregation also obscures the fact that regional transaction costs or market imperfections may sometimes cause the cost of fuelwood to rise disproportionately, imposing severe scarcity in very localized areas. For example, according to one source, the real price of fuelwood in the Philippines between 1970 and 1978 has risen from $32 to $46 per cubic meter (see table 4). In the city of Ouahigouya, Upper Volta, real prices of wood rose from $2.25 to $5.14 between 1970 and 1978. But the general severity of the problem is not known. Another possible result of deforestation is an increased amount of time spent in collecting fuelwood. In tables 5 and

Table 4. Real Fuelwood Prices in Selected Developing Countries (1975 dollars per cubic meter)*

	1970	1975	1978
Bangladesh[a]	50.22	43.60	46.07
Burma	6.46	5.62	12.83
Cameroon	N/A	16.32	17.80
India	11.00	15.08	N/A
Indonesia	N/A	12.48	15.93
Ivory Coast	N/A	N/A	26.10
Madagascar	N/A	15.37	N/A
Mexico[b]	15.35	14.00	15.18
Morocco	15.12	14.31	12.02
Pakistan[a]	20.62	16.55	22.40
Philippines	32.13	35.26	46.44
Senegal	N/A	32.66	27.91
Upper Volta Ouahigouya	2.25	4.67	5.14[c]

*Prices were converted to U.S. dollars at 1975 exchange rates and were deflated using consumer price indices in 1979 and 1980 editions of International Monetary Fund, International Financial Statistics Yearbook (Washington, D.C., IMF).

Note: N/A stands for price not available.

Source: Forest Products Prices, FAO Forestry Paper (FAO, 1981, Rome); Upper Volta prices from Robert Winterbottom, "Reforestation in the Sahel: Problems and Strategies," paper presented at the African Studies Association Annual Meeting, Philadelphia, October 18, 1980.

[a]Large devaluation between 1970 and 1975.

[b]Large devaluation between 1975 and 1980.

[c]1979 price.

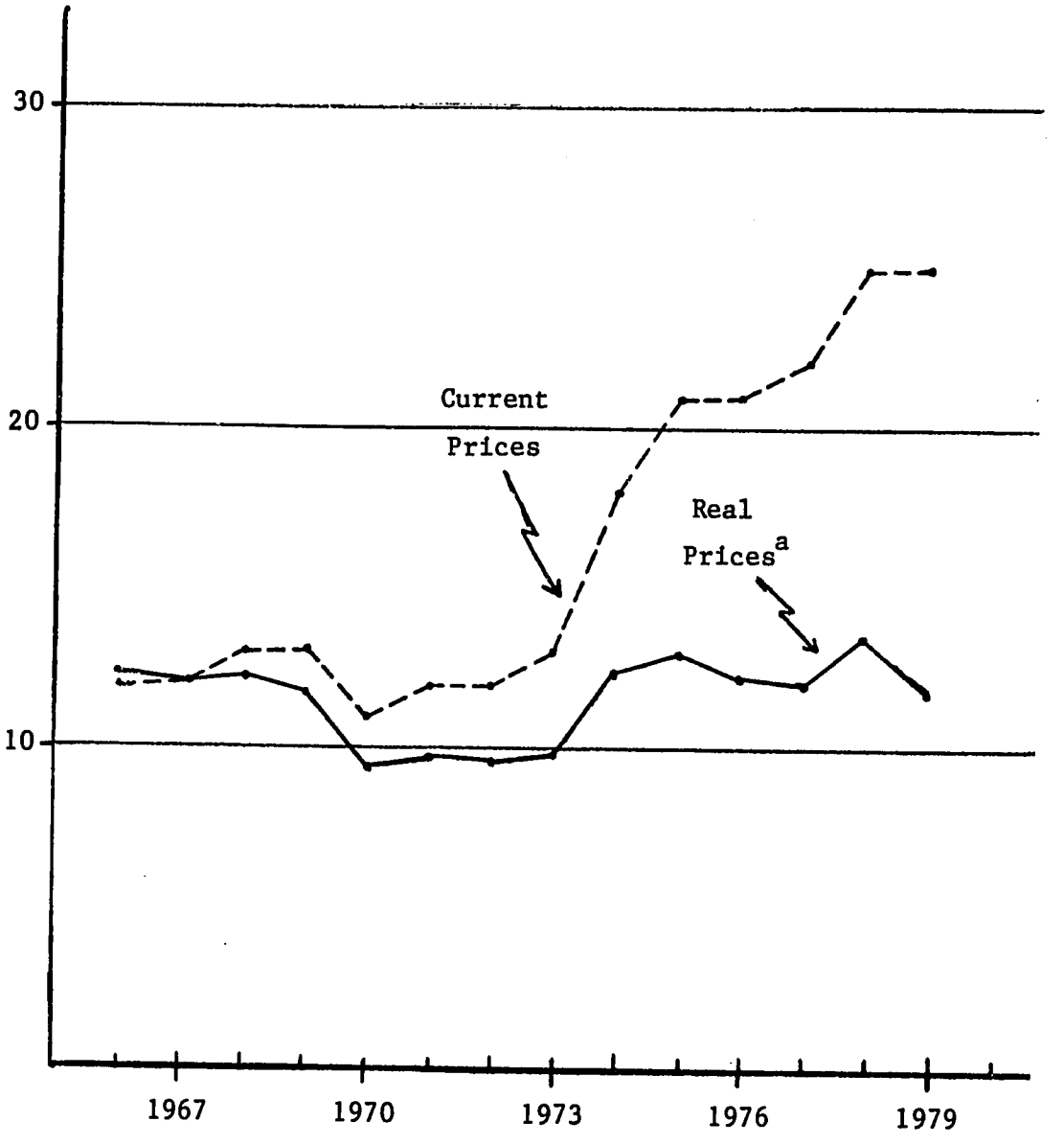


Figure 2. Mean yearly price for fuelwood in 19 countries--current and real prices
(dollars per cubic meter)

Source: Food and Agricultural Organization of the United Nations, Forest Product Prices 1961-80 (Rome, FAO, 1981).

[a]Real prices were calculated using the U.S. Consumer Price Index.

6 the distance walked to collect woodfuel ranges from insignificant to 10 kilometers, while the time spent gathering wood ranges from six person-hours to seven person-days per household per week. If this time could otherwise be spent producing food or in other productive economic activities, it would indicate a high opportunity cost associated with wood collection for rural households. Nevertheless, the data show no increasing trend in distance travelled or amount of time devoted to wood collection. Thus, there is not a clear case for wood scarcity based on an analysis of prices and cost of collection. On the other hand, the data also are not sufficient to reject the hypothesis that deforestation has led to wood scarcity. The most that can be said is that in many specific locations real or relative prices of wood are rising, and in a few cases, they are rising dramatically.

Review of Evidence of Costs and Benefits

Most social forestry projects attempt some accounting of expected indirect and direct benefits, measured against the costs, in justifying the decision to undertake a social forestry project in a particular place. In this context a close examination of the techniques used to identify and estimate indirect benefits is in order. The following section reviews a very few existing examples of economic analysis of various types of social forestry projects.

Social Forestry as a Component of a Larger Project. Often social forestry is subsumed in large forest plantation projects. In these cases, such as the Malawi Wood Energy Project and the Rwanda Integrated Forestry and Livestock Development Project (World Bank, 1980b; 1980c) the social forestry component is considered so small that no benefit-cost analysis is undertaken. The primary focus of the Malawi Wood Energy Project is the establishment of forest plantations for fuelwood and poles, but a small social forestry component calls for the establishment of nurseries for later distribution of seedlings to farmers. According to the project documents, no extension services will be provided, and the farmers are totally responsible for planting and maintaining their own woodlots. The possible benefits from woodlots are therefore not calculated, nor are they compared to the costs of establishing the nurseries. The Rwanda Integrated Forestry and Livestock Development Project consists of two large fuelwood

Table 5. Distance Walked for Firewood Collection or Traveled for Wood or Charcoal Transport (kilometers one way)

Country	Distance	Year	Source
	a. Rural Areas		
Fuelwood			
Botswana	7.5	1980	Shaikh
Cameroon (Yaounde)	2-6	1980	Roy
Kenya	1.6-7.0	1979	Openshaw, 1980
Malawi*	0-3.6	1980	Malawi
Sudan (Bara)	1-10	1977	Digernes, 1977
Tanzania	1-5	1980	Araya
Upper Volta (Boulenga)	5	1977	Ernst
Upper Volta (Koudougou)	5-10	1979	Winterbottom
Charcoal			
Kenya (Machakos)	3	1979	Openshaw, 1980
Sudan (Bara)	16-25	1977-78	Digernes, 1978
	b. Urban Areas		
Fuelwood			
Burundi (Bujumbura)	50-60	1979	Mbi, Burundi
Cameroon (Yaounde)	50-100	1979	Mbi, Cameroon
Zambia	70 or less	1978	Zambia
Charcoal			
Burundi	50-60	1979	Mbi, Burundi
Rwanda (Kigali)	80	1979	World Bank
Tanzania	140-160	1980	Mnzava
Thailand	500 or less	1978	Openshaw, 1978
Zambia (Lusaka)	80 or less	1979	Chidumayo

*For 90 percent of population. Remaining 10 percent collected fuelwood at distances greater than 3.6 kilometers.

Sources: Zerai Araya, "Village Forestry in Tanzania: Problem Context and Organizational Proposal for Sustained Development." A consultancy report submitted to the Forest Division Ministry of Natural Resources and Tourism (Dar es Salaam, Tanzania, January 1981).

Table 5 (Continued)

Ngulube Chidumayo, "Household Wood Fuel and Environment in Zambia," Environmental Report No. 1 (Lusaka, Zambia, Natural Resources Department, 1979), p. 9.

Turi Hammer Digernes, "Wood for Fuel-Energy Crisis Implying Desertification--The Case of Bara, The Sudan." Major thesis in Geography at the University of Bergen, Norway, 1977, p. 100.

_____, "Addendum to Thesis, Wood for Fuel-Energy Crisis Implying Desertification--The Case of Bara, The Sudan," Bergen, Norway, 1978, p. 7.

Elizabeth Ernst, "Fuel Consumption Among Rural Families in Upper Volta, West Africa" (Ouagadougou, Upper Volta, Peace Corps, 1977), pp. 1-2.

Malawi, Ministry of Agriculture, Energy Unit, Malawi Rural Energy Survey (Lilongwe, Malawi, 1981), p. 13.

Emmanuel Mbi, "Energy Services in Urbanization Projects: Energy Assistance, Burundi Urban Development Project, Annex E" (Washington, D.C., World Bank, January 30, 1980).

_____, "Energy Services in Urbanization Projects: Cameroon Urban Development Project, Yaounde: Urban Energy Report" (Washington, D.C., World Bank, November 1980).

E. M. Mnzava, Report on Village Afforestation: Lessons of Experience in Tanzania (Rome, UNFAO, 1980), p. 10.

Keith Openshaw, "Rural Energy Consumption with Particular Reference to the Machakos District of Kenya" (Morogoro, Tanzania, University of Dar es Salaam, 1980), p. 7.

_____, "Wood Fuel-A Time for Re-Assessment," Natural Resources Forum vol. 3, no. 1 (1978), pp. 35-51.

Dr. Sumita Roy, "Case Study on Fuel Wood Collection and Problems of Rural Women" in Collected Papers from a Seminar on the Role of Women in Community Forestry held December 4-9 at the Forest Research Institute in Dehra Dun, India.

Asif Shaikh with Patricia Carson, "The Economics of Village-Level Forestry: A Methodological Framework" prepared for Africa Bureau, U.S. Agency for International Development, Washington, D.C. (n.d.)

Robert Winterbottom, "Upper Volta Koudougou Agricultural Development Project," Appraisal Report for the Forestry Subprogram, August 1979, pp. 6-7.

The World Bank, "Rwanda Integrated Forestry and Livestock Development Project," Staff Appraisal Report, Eastern Africa Region, Central Agriculture Division (Washington, D.C., The World Bank, May 9, 1980), p. 10.

Zambia Forest Department, "Lusaka Fuelwood Project," Lusaka, Zambia, 1978.

Table 6. Labor Expended in Fuelwood Collection (Manhours Per Household Per Week)

	1975	1978	1979	1980	Source
India	--	--	--	14-56[a]	Roy
Kenya (Mbere)	--	6	--		Brokensha and Riley
Nepal	38-46	--	--	70[a]	Spears, Donovan
Tanzania Central (Dodoma)	38-46[a]	--	48-58	38-58	Spears, Openshaw & Moris, Mnzava
Kwemzitu	--	4-12	--	--	Fleuret and Fleuret
Upper Volta	--	--	--	12-18	Winterbottom

[a]based on assumption that persons work ten hours a day seven days a week

Sources: David Brokensha and Bernard Riley, "Forest, Foraging, Fences, and Fuel in a Marginal Area of Kenya." Paper presented for USAID Africa Bureau Firewood Workshop held in Washington, D.C., June 12-14, 1978, p. 9.

Deanna G. Donovan, "Forest Exploitation in Nepal," Institute of Current World Affairs, May 4, 1979. DGD-5.

Patrick and Anne Fleuret, "Fuelwood Use in a Peasant Community." A Tanzanian Case Study, n.d., p. 6.

E. M. Mnzava, Report on Village Afforestation: Lessons of Experience in Tanzania (Rome, UNFAO, 1980), p. 10.

Keith Openshaw and Jon Moris, "The Socio-Economics of Agroforestry" (Morogoro, Tanzania, University of Dar es Salaam July 1979), p. 3.

Dr. Sumita Roy, "Case Study on Fuel Wood Collection and Problems of Rural Women" in Collected Papers from a Seminar on the Role of Women in Community Forestry held December 4-9, 1980 at the Forest Research Institute in Dehra Dun, India.

John S. Spears, "Agriculture Strategy Paper Forestry Sub Sector" (Draft, Washington, D.C., The World Bank, February 6, 1981).

Robert T. Winterbottom, "Reforestation in the Sahel: Problems and Strategies," Paper prepared for presentation at the African Studies Association Annual Meeting held in Philadelphia, October 15-18, 1980, p. 3.

and pole plantations to be administered by the forestry department, and nurseries for seedling distribution to pilot rural woodlots. The nurseries are intended to compensate the villagers for converting land they currently rely on for fuelwood into plantations. No attempt is made to identify benefits and beneficiaries of the project.

Social Forestry as Community Woodlots. While field reports have indicated mixed success of community woodlots, there are almost no studies which report the impact of programs which rely on seedling distribution and individual planting. Speculation on the efficacy of individual tree planting versus community woodlots is a recurrent issue in the social forestry literature, but only one systematic benefit-cost analysis of the issue has been undertaken (Shaikh, 1980). The study is based on the assumption that community woodlots are established on productive agricultural land, and therefore the value of agricultural production foregone is subtracted from the value of the wood produced. In contrast, individual farmers in the study are assumed to plant trees along banks and on the edges of their fields, causing an actual increase in soil fertility over time and ever higher-valued agricultural yields. Not surprisingly, the analysis concludes that community woodlots have negative present values of net benefits and individual planting schemes provide positive returns. In fact it is not true that communal woodlots necessarily take valuable agricultural land out of production, nor do individual tree planting schemes necessarily increase land productivity. Consequently, the analysis fails to resolve the issue of whether communal or individual schemes are more economically viable.

Social Forestry on Marginal Lands. Economic analysis of two important projects in India and Korea reveals that social forestry on village commons and marginal lands can yield substantial returns for the village and the society. For example, the South Korean social forestry program successfully mobilized community support for planting and maintaining trees on mountain watersheds and in private forest reserves. The project's estimated rate of return is 17 percent, indicating that social forestry on marginal lands in Korea is an attractive investment from the point of view of society (Gregerson, 1979). However, no financial analysis was reported, so the financial return may be negative when all costs of seedlings, fertilizer, labor, supervision and harvesting are balanced against the

net present value of the wood harvest alone. By comparison, for the social forestry project in Gujarat, India, the financial rate of return is only 4 percent compared to the discount rate used for most project analyses there of 10 percent. Note that the Gujarat project includes the not inconsiderable cost of developing forestry extension services. Depending on contractual arrangements, half the project benefits go to the villagers for provision of land or labor and the government recovers only operating costs in the form of 50 percent of the revenues from its share of the sale of poles, fuelwood and other forest products. Thus, as long as social forestry project cost recovery is low, social forestry projects will not be self-replicating, and government support will be necessary.

Multiple Product Schemes and Species Selection. Another important issue in social forestry project analysis is that of multiple products. Since different tree species produce different amounts of timber, food, fodder, and forage, the choice of species for a social forestry project will affect its success. Villagers often have complained that forestry departments advocate exotic fast-growing species for wood production, while failing to recognize the importance of indigenous species which also provide fruits, medicines or other useful products. Tree species in a social forestry project should be chosen to meet local demand for all forest products, even those which are not marketed (Smale, 1980). The higher tree survival rate and multiple products from indigenous species may more than compensate for slower rates of wood production.

In the past, few project analyses have addressed the species choice issue directly. But recently in an economic analysis of the Madhya Pradesh social forestry project, Bromley (1981) found that a pure fuelwood plantation had an internal economic rate of return of 13 percent while the internal rate of return was 33 percent for a plantation with 20 percent fruit trees. Although all the social forestry options considered in his analysis had positive rates of return, the mixed plantations appear more profitable than those providing only fuelwood. A word of caution--these results depend on local prices or shadow prices imputed to non-marketed forest products, and therefore the results may vary from place to place.

Summary of Economic Issues

Any benefit-cost analysis of social forestry must address the difficulty of market failures in developing areas. The cost of developing social forestry extension services in most countries would likely outweigh the financial benefits from specific projects. Many of the benefits also are almost impossible to measure, especially the environmental benefits of avoiding future deforestation. Finally, the situation is a dynamic one: the total area of forest in the Third World is becoming smaller and there is every reason to suspect that the fuelwood and deforestation problems will become greater as time goes on. However, at present it is difficult to quantify this effect in any sensible way in order to evaluate the specific costs and benefits of particular social forestry projects. Intuitively, we only can conclude that there are large social benefits in successful social forestry projects that may well dwarf ordinary cost considerations.

The Human and Institutional Parameters Affecting Local Participation

Local participation is a key element in social forestry projects, and most forestry departments in developing countries are ill-equipped to promote community participation. In the past, forestry departments have been primarily concerned with protecting forest reserves from villagers rather than encouraging villagers to properly manage the trees and shrubs on their village commons and other land. As indicated previously, foresters have often been more like policeman than extension officers. However, much of the literature on social forestry has been too quick to blame the forester, when as this review indicates, the problems involved in encouraging local participation include the legal system, economics, project design and administration, and the extent of government support.

Existing research on diffusion of innovations provides a convenient framework for analyzing the role of local participation in the adoption of social forestry practices. Typically, the diffusion of an innovation involves a two-stage communication process. First, the information about the innovation is passed from change agents or mass media to community opinion leaders (the persons in the community most likely to be receptive to new ideas). Second, the information on new practices is diffused to the

general population through personal contact with the opinion leader. The individual adopters of innovation, whether they are opinion leaders or members of the general population, generally go through a four stage adoption process: awareness, evaluation, trial and adoption/discontinuance. While there are many variations on this theme and the time lags involved between introduction and diffusion can vary dramatically, social forestry programs can be examined as a specific type of innovation.

Awareness: Perception of the Need for Social Forestry

Villagers must perceive that social forestry is going to alleviate local problems and benefit their lives before they would consider participating in a program which would involve a substantial allocation of time, land, and resources. Unidimensional programs such as village woodlots for fuelwood production provide a considerably narrower basis for favorable local perception compared to multi-purpose programs which would include such features as erosion protection, provision of fodder during the early stages of the project, and the production of a variety of tree species. One important conclusion drawn from the projects in the Sahel is the need for considerable and real input from local communities in the project design stage (Hoskins, 1979, 1982). Preliminary evidence from Tanzania indicates that women may play quite an important role in determining whether trees are planted and maintained for fuelwood production (Skutsch, 1981). Social forestry projects designed in conjunction with women and community leaders are far more likely to reflect community needs and stimulate local interest and involvement than programs administered exclusively from the top down.

The extent of local deforestation and consequent shortages of woodfuels and building materials also may be a factor in determining the level of local participation in social forestry projects. In this regard social forestry must provide some evident relative advantage over past village conditions (see Rogers, 1961, p. 146). Villagers who perceive that deforestation is a significant problem would be more likely to become involved in social forestry programs than those who feel that deforestation is only a nuisance or no problem at all. Difficulties caused by local deforestation that adversely impact villages include increases in the price of wood fuels and building poles, local environmental problems, increases

of private plantations may come to an agreement whereby villagers may collect fuelwood by lopping branches in the timber plantation (Skutsch, 1981). Thus, a combination of formal laws with local social control and consensus is seen to be an essential prerequisite for the establishment of social forestry programs (Noronha, 1980, p. 31).

The programs of Korea and India provide two quite different solutions to the legal problems surrounding social forestry. The problem in Korea was that over 73 percent of forest reserves are privately owned. Thus, in 1973 the government of Korea passed a forestry development law to establish

in the amount of time required to collect wood fuels, and others. While projects should address the adverse impacts of deforestation, social forestry can provide additional benefits as well, including shade, fodder, a variety of food sources, and others. Once again women are the primary users of woodfuels and their perception of the relative advantage offered by social forestry might be a key to the success of the program (Hoskins, 1980). Recent findings from Tanzania indicate that the extent of deforestation and fuelwood scarcity evidently is a factor in villages which decided to start projects (Skutsch, 1981). Thus, social forestry must project an image of some future improvement in the rural quality of life or in village economic conditions through decreasing fuelwood prices or labor involved in collecting fuelwood. Otherwise villagers will not be inclined to expend time and energy on a project that they perceive will not significantly improve their lives.

As stressed above, social forestry projects must be compatible with past experiences and existing formal and informal laws in the community. The legal right to trees in both a formal and an informal sense must be clarified before the inception of any social forestry program. Thomson (1981, p. 121-123) reports the example of a peasant farmer in the Sahel who planted trees for a windbreak, only to find goats eating the leaves and people lopping off branches for fuelwood. The peasant had no basis in formal law or informal tradition upon which to protect his trees, so his attempts to construct a windbreak were totally frustrated. This case can be compared to one village in Tanzania where villagers jealously guard the trees that they plant on their farms (Skutsch 1981). There, if anyone wants fuelwood from these trees, they must pay the person who owns the land. Even within different communities in the same country there may be a wide variety of rules regarding the cutting down of trees, and social forestry programs would have to work within the existing framework of customs regarding tree use. Finally, educational programs and impersonal communications sources such as mass media campaigns can be utilized to increase awareness of the deforestation. If deforestation is perceived as a serious problem by the village, informal rules and customs regarding trees can be changed through education and awareness campaigns.

Evaluation: Local Opinion Leaders

Local opinion leaders are extremely important in the first stage of designing and implementing social forestry programs for rural communities. Opinion leaders are individuals who are influential in approving or disapproving new ideas in rural communities (Rogers, 1961, p. 209). Depending on the program, they may be local political leaders, educators, or important farmers. Forestry change agents should attempt to identify community opinion leaders who would lend support to social forestry programs.

In the Gujarat program, one of the characteristics of successful woodlots was the presence of dynamic leadership (Noronha, 1981, p. 8). An unexpected opinion leader in one village was a temple caretaker who established a plantation on the land surrounding his sixteenth century temple. Identifying opinion leaders early and concentrating extension efforts on those who favor social forestry projects establishes the first of the two stage communication links with the village. At this point the opinion leaders will evaluate the idea of social forestry and decide whether to condone social forestry and then start a pilot project.

Trial: The Demonstration Effect

At this stage the opinion leaders have evaluated the project and have agreed at least to provide land for a demonstration project. This is a critical stage, and it is essential that the necessary support services are readily available, including both physical and informational inputs. The demonstration of the viability of a social forestry pilot project is also the most important stage for personal contact between the forestry change agents and the opinion leaders. The forestry extension officers at this stage should concentrate their efforts on assuring that the pilot or demonstration plot is successful. Winterbottom (1979, p. 53) reports that in the Sahel one of the reasons for the low tree survival rate in village woodlots was the failure to deliver key inputs at the right time. Likewise in Tanzania, Skutsch (1981) found that villages close to seedling distribution centers were more likely to grow trees for fuelwood than villages distant from the centers. In Nepal the social forestry program was cut back because the poor infrastructure hindered efforts to provide

necessary inputs into the project (Yudelman, Montagne, 1980, personal communication).

During this phase opinion leaders are taking a risk that the new program is worth their time and effort, and if their judgement is accurate, then the adoption of social forestry by others in the community will follow. Poor advice on species selection or location of the woodlot, improper delivery of key inputs, and lack of follow-up advice regarding tending the trees in the demonstration plots would discourage not only the individual opinion leader, but all those who later might copy their behavior.

Social forestry pilot projects have a major disadvantage compared to other innovations. The lag between the time the trees are planted and harvested is quite substantial, so there are no immediate rewards for planting the trees. Thus, as in the Madhya Pradesh (India), social forestry projects plan to plant interim crops for fodder or other purposes during the time when the trees are small and not producing any wood fuels, timber, or fruit. The multidimensional social forestry projects typically have an advantage over other projects in that they yield benefits for the individuals or communities almost immediately, compared to the 5 to 10 year lags of other projects.

Adoption/Discontinuance: Local Determination of Success or Failure

The spread of the innovation to persons other than the opinion leaders is the second stage of the diffusion process. This second part of the two stage communication process should involve personal communication with the opinion leader or other adopters, a demonstrated relative advantage of the social forestry pilot project, and the institutional capacity to deliver inputs and information on a much broader scale. The long-term goal of social forestry is centered on changing local patterns of land management so the village commons, local marginal lands, and other underutilized land are much more productive than in the past. This goal can only be realized if the pilot programs demonstrate a relative economic or social advantage consistent with societal norms and are easily replicable in other villages. The development of a forestry extension service would facilitate the replicability of social forestry projects in the villages which do not

receive the subsidies involved in promoting and institutionalizing the pilot projects.

Thus, the often-reported "lack of local participation" is more often than not the discontinuance of social forestry innovations by individual villagers or rural communities. Viewed in this light, the reasons for lack of local participation can be understood from the very nature of the adoption process itself and from the complexity of social forestry programs. Villagers can discontinue participation in social forestry programs at any stage, from seedling distribution to the time of harvesting the trees. Programs can also be discontinued (or not started) at any stage in the adoption process, from the perception of the need for the program to the evaluation and adoption based on the success or failure of the pilot programs.

Conclusions and Policy Recommendations

This paper reviews some of the general principles that can be learned from existing social forestry projects. Some lessons for the organization and administration of future projects are intuitively reasonable, and apply to many economic development projects. Others are more specific to social forestry. Although social forestry has a fairly extensive history in some countries, and many new projects presently are being funded, documentation on their effectiveness is lamentably quite sparse. But on the basis of the few projects reviewed here, we can highlight some of the more important problem areas.

As with all economic interventions, and with economic development in general, it is safe to say that project success is likely only when several key preconditions are satisfied. From the economist's point of view, two basic preconditions are an adequate supply of capital coupled with local market circumstances that display no potentially crippling constraints--such as land tenure problems. However, markets have often been imperfect or lacking: local forestry products in the past have often been "free" public goods. This fact along with lack of technical information and low levels of labor and management skills, means that project success could not be assumed even under rather stringent conditions. Outside sources of capital are needed in conjunction with

administrative leadership and extension services from national agencies. But ultimately, even with outside aid, projects cannot proceed without mobilizing local resources, specifically, without active help and cooperation from the villagers. This means that villagers must be motivated through their own local knowledge of present forest resource crises, or that they must be made aware of national or regional problems by outside agencies. Thus, specialized national agencies, sometimes but not necessarily connected with forestry departments, must be formed to address the special needs of social forestry programs.

In addition to these general conditions, the foregoing examination of existing projects leads to a few more down-to-earth, practical hints for development. For example, simple packages of forestry techniques which can be easily disseminated to encourage local tree planting would be of immense utility in aiding social forestry extension services. Furthermore, certain social considerations, such as the special role of women in collecting fuelwood in many areas, should be given explicit recognition. Although it might seem on the surface that large-scale, industrial types of efforts could have great advantages, nevertheless it has been observed that massive planting of trees cannot be emphasized at the expense of more important maintenance, harvesting, and marketing extension services. Thus the scale of pilot projects should be kept at a reasonable level and projects should resist the temptation to plant trees too quickly while neglecting to build the necessary support to tend and maintain the trees.

Although one can talk about general and specific practical conditions for individual projects, the individual pilot project itself means little in the context of the pervasive poverty and extensive energy needs of the Third World. Therefore, pilot social forestry projects are ultimately of little use unless they lead to replication in adjoining areas. This goal of replication is unlikely to be met, unless there is effective communication and financing commitments along with national government participation--all carried forward through long-term planning. Forestry project benefits tend to be delayed in time and human resources tend to be difficult to get into motion; the long-term commitment both to individual pilot projects and to overall national afforestation programs is the major challenge to successful forestry project development.

Appendix 1.

SOCIAL FORESTRY PROGRAMS REVIEWED FOR THIS PAPER*

Country	Type of Program	Organization	Coverage	Source
China	Agricultural planning fully integrated with forestry. A wide range of forestry techniques from "taungya" to forestry farms.	Professional foresters and other specialists provide guidance and backup services to peasants. Mass participation by communes. Promotion of "forest consciousness and education."	In Northwest China 700,000 farmers established shelter belt 1,500 km long and 12 m wide. In Fu Koo county, 74 million trees (140 trees per person) were established between 1958 and 1975. In Chouchou county extensive forestry programs have been closely associated with doubling agricultural yields over 10 years.	U.N. FAO, p. 25
China	Community Forestry	Chinese political revolution; China's ability to mobilize huge numbers of people to accomplish tasks.	Increase of forest land from 5% in 1949 to 12.7% in 1978. Reidar Persson estimates 30-60 million ha of new forests. Chinese officials imply 72 million ha increased.	Eckholm, pp. 39-47; Taylor, 125-147
Egypt	Five year research project begun in 1975	Government; Ministry of Agriculture; technical assistance and specialists of the Horticultural Research Institute give advice.	Planted two million trees 15 years ago.	El-Wakeel, p. 164
Guatemala	Forest Cooperatives	Organization of forest cooperatives are mobilizing local people to make better use of forest resources; close involvement of the population in the planning	Some Indian communities (approx. 60 families - 600 people) have formed production cooperatives based on a forest resource of 10,000 ha each. Small sawmills have	U.N. FAO, p. 43

Country	Type of Program	Organization	Coverage	Source
		and execution of the program is maintained through regular meetings of a board of 11 community representatives.	been erected for the production of timber. Additional activities - construction of roads to improve access to markets and reforestation.	
India - Gujarat	Many-dimensional program 1) Establishment of plantations along roads and canal bank; 2) Forest dept. provides seedlings and advice free of charge to anyone; 3) Village plantation scheme; and 4) "Social security" forestry program.	1) Establishment of plantations along roads and canal banks. State owns strips of land and carries out planting on them. 2) Forest dept. provides seedlings and advice free of charge to anyone; 3) the forest dept. proposed to the elected councils governing each village (panchayats) that they set aside a minimum of 4 hectares for forestry plantations. The dept. provides seedlings and pays villagers to do the preparation and planting. The villages guarantee to protect the areas from grazing and unauthorized gathering.	In 1978 about 6,000 of the states' 17,000 kilometers of roads and canals were lined with new forests and each year trees are planted along another 1,500 kilometers. By 1978 nearly 3,000 of Gujarat's 18,000 villages established woodlots through the plantation program.	Eckholm, pp. 48-56

Indonesia	Plans to restore the damaged watershed in the Solo River System.	Planting trees on state-owned land and private land along riverbanks. Creation of temporary soil regeneration plantations in critically eroded areas. In the uplands forest systems are being introduced to protect the land from erosion while providing fodder for domestic animals. Pines are planted with eucalyptus to conserve soil. Elephant grass is grown under trees.		U.N. FAO, p. 29
Korea	Village Fuelwood Plantations	Village Forestry Association (VFA) is responsible for carrying out the forestry work. Gov't subsidizes the provision of seedlings, fertilizers and other materials. Main reasons for success of the scheme are the commitment of local communities to rural development and the government's actions to encourage and support the establishment of fuelwood plantations.	By 1975 the annual planting rate reached over 40,000 ha.	U.N. FAO, p. 27
Nigeria	Taungya Farming - started 1927	Efforts are being made to adapt the existing system so higher incomes can be provided to participating farmers to give them more stability. The construc-	1975/76 24,427 taungya farmers grew crops on nearly 20,000 ha of forest reserves. An estimated 1,221 workers employed by State Forest Departments cultivated an	U.N. FAO, p. 41

Country	Type of Program	Organization	Coverage	Source
		tion of several pulp mills offers prospects of a guaranteed market and should encourage farmers to value trees as part of their rotation.	additional 1,448 ha.	
Philippines	Small holder tree farming; combined agriculture and tree farming development plans; fast growing trees are planted and harvested by individual farmers to provide raw materials to pulp plants.	Organized in late 1960's by the Paper Industries Corporation of the Philippines (PICOP). Participants devote up to 80% of land to a fast growing tree species, the Albiza falcataria, PICOP provides seedlings (at cost), technical assistance for pulpwood production and agriculture on the remaining land, and an assured market for the pulpwood. Loans are available to farmers from the Development Bank of the Philippines.	Average area of smallholdings is 10 ha. By 1976 nearly 3,500 farmers had joined the scheme and planted an area of 12,726 ha.	U.N. FAO, p. 39
The Sahel (Chad, Senegal)	Local forestry development	Two recent FAO projects. N'Djamena in Chad - natural vegetation is being regenerated by fencing off areas and in Senegal, sand dunes in the Cap Vert region are being stabilized to protect the fertile interdune areas. Savannah areas used for rainfed agriculture and grazing are also being restored by planting acacias in denuded places.	During 2 years, the project completed 120 ha of dune stabilization, 30 km of windbreaks, and 100 ha of acacia enrichment.	U.N. FAO, p. 35

South Korea	Village forestry. Priority has been placed on meeting the needs of the rural population by enlisting their energies and unused lands. Forestry campaign has tried to mobilize villagers to plant public and private lands, form cooperatives to produce and market nonwood products and establish firewood lots to meet local needs.	1973 gov't devised a prominent new forestry policy and law. Program is implemented by a combination of private and governmental organizations. Gov't encouraged establishment of Village Forestry Association (VFA). Officials from gov't., federation, and village associations calculate wood requirements and identify suitable land. Most lands are private and owners are given option of reforesting themselves or turning over to VFA in return for 1/10 the proceeds.	More than 1/3 of the nat'l land area is stocked with trees less than 10 years old. End 1977 643,000 ha of village woodlots had been established.	Eckholm, pp. 39-47
Sudan	Tree fallow system and Gum Arabic. A settled system of agriculture was evolved which included the tree in a fallow period.	Local communities have shown self-reliance in organizing the industry and devising an agrisilvicultural system suited to the environment.	Typical unit 25 ha: one-quarter for food production; one-quarter has acacias from 0-4 yrs, and the remainder has productive trees from 5-12 yrs. Density of 600 trees/ha is desirable.	U.N. FAO, p. 37
Tanzania	Village Woodlots	Forest department raises tree seedlings in nurseries and district officers or extension agents ("Bwana Shamba") distribute them to villagers free of charge. The farmers plant and tend the seedlings.	A village of 500 families plants between 2-5 ha/year.	Mnzava, pp. 19, 35

Country	Type of Program	Organization	Coverage	Source
Tanzania	Local tree planting	Media campaign "Misitu ni Mali": radio announcements, posters, banners, advocating tree planting. Distribution of booklets describing problems caused by deforestation and tree planting methods.	Nurseries unable to meet increased demand for seedlings.	
Thailand	Forest Village Scheme - to encourage landless people to settle in communities which offer better standard of living and greater stability than nomadic life.	Officer of the Forest Industries Organization (FIO) supervises the program. Other gov't inputs--land, tools, social services and a cash bonus of up to $155 U.S. per yr. for good performance. Each family is allotted 1.6 ha/yr for clearing and taungya cultivation for 3 yrs. As an extension service, resettlement villages of 200-500 families are being established. Each family is provided with a lease on 2.4 ha for permanent farming and long-term loans to assist with house construction and initial farming investments.	By 1973 some 2,000 ha of taungya plantations were established per yr 1976 21 forest villages with 817 families and 4,325 people. Trees were planted on 10,600 ha.	U.N. FAO, p.33
Upper Volta	Yatenga-village woodlots	Yatenga Organization Rurale du Developpement (ORD) distributed seedlings. ORD extension agents and Peace Corps Volunteers helped establish plantations.	Yatenga-1975 the ORD was planting 50-60 ha of village woodlots annually.	Winterbottom, pp. 10-18

Upper Volta	Koudougou - Village woodlots	Koudougou Forest Service manages central nursery, distributes seedlings and provides technical support.		Winterbottom, pp. 10-18
Upper Volta	Dedougou - industrial plantations and village woodlots	Dedougou - French development assistance wanted to establish forestry center to help establish industrial plantations and village woodlots. They established 3 year funding program which the Netherlands took over in 1979.	Dedougou - planted 90 ha of industrial plantations and 60 ha of village plantations.	Winterbottom, pp. 10-18
Upper Volta	Bobo - Dioulasso & Hounde-village reforestation	Bobo-Dioulasso & Hounde ORD extension agents encouraged village groups to start small woodlots. ORD purchased and delivered seedlings.	Bobo-Dioulasso and Hounde 1978 13 ha planted. 1979 ORD began charging for seedlings and villages decided not to buy more seedlings to extend woodlots.	Winterbottom, pp. 10-18

*Not all social forestry projects are included. This list is from programs which have been described or reviewed in the literature on social forestry. For a complete list of forestry projects see USDA, 1980, pp. I1-I63.

Sources: Erik Eckholm, Planting for the Future: Forestry for Human Needs (Washington, D.C., Worldwatch Institute, 1979).

A. Talaat El-Wakeel, "Forest Resources for Energy in Egypt" in Stephen G. Boyce, ed., Biological and Sociological Basis for a Rational Use of Forest Resources for Energy and Organics. Proceedings of an Int'l Workshop sponsored by the Man and the Biosphere Committees of Canada, Mexico, and the United States held at Michigan State University, May 6-11, 1979.

E. M. Mnzava, Report on Village Afforestation: Lessons of Experience in Tanzania (Rome, FAO, 1980).

Robert P. Taylor, Rural Energy Development in China (Washington, D.C., Resources for the Future, 1981).

U.N. Food and Agriculture Organization, Forestry for Rural Communities (FAO Forestry Dept., n.d.).

Robert T. Winterbottom, "Reforestation in The Sahel: Problems and Strategies," Paper presented at the African Studies Association Annual meeting held in Philadelphia, Pa., October 15-18, 1980.

REFERENCES

Allen, Julia and Douglas Barnes. 1982. "Deforestation, Wood Energy and Development" Working Paper (Washington, D.C., Resources for the Future).

Bromley, Dan. 1981. "Madhya Pradesh Social Forestry Report: Economic Analysis." Design Team Report to U.S. Agency for International Development (New Delhi, U.S. AID).

Cecelski, Elizabeth, Joy Dunkerley, William Ramsay. 1979. Household Energy and the Poor in the Third World (Washington, D.C., Resources for the Future).

Daniel, J. C. and A. Kulasingan. 1974. "Problems Arising from Large-scale Forest Clearing for Agricultural Use: The Malaysian Experience," Malay For vol. 37, no. 3, pp. 152-160.

Eckholm, Eric. 1975. The Other Energy Crisis: Firewood. Worldwatch Paper #1 (Washington, D.C., Worldwatch Institute, 1975).

_____. 1976. Losing Ground: Environmental Stress and World Food Prospects. Worldwatch Institute with the support and cooperation of the United Nations Environment Program (New York, W.W. Norton and Co.).

Food and Agriculture Organization of the United Nations. 1978. China: Forestry Support for Agriculture (Rome, FAO).

_____. 1981. Forest Products Prices, FAO Forestry Paper (Rome, FAO).

Gregerson, Hans. 1979. "Village Fuelwood Plantations in Korea: Case Study No. 2." in UN Food and Agricultural Organization, Economic Analysis of Forestry Projects: Case Studies (Rome, FAO).

Hoskins, Marilyn. 1980. "Community Participation in African Fuelwood Production, Transformation, and Utilization," in David French and Patricia Larson, eds., Energy for Africa (Washington, D.C., U.S. AID, September).

_____. 1982. "Social Forestry in West Africa: Myths and Realities." Paper presented at American Academy for the Advancement of Science Annual Meeting, Washington, D.C., January 3-8.

Jhala, B. K. 1976. "Involvement of Villagers in Social Forestry Programs." Paper presented at the Workshop cum Seminar on Social Forestry, Gandhinager, India, February.

Mnzava, E. M. 1980. Village Afforestation: Lessons of Experience in Tanzania (Rome, FAO).

Noronha, Raymond. 1980. "Sociological Aspects of Forestry Project Design." Draft (Washington, D.C., World Bank, Agriculture and Rural Development Dept.).

_____. 1981. "Why Is It So Difficult To Grow Fuelwood?" Unasylva vol. 33, no. 131, pp. 4-13.

Osmania University and Resources for the Future. 1980. "Market for Fuelwood in Hyderabad," survey by Manzoor Alam and K.N. Gopi of Osmania University, Hyderabad, and Joy Dunkerley and William Ramsay of Resources for the Future. Report in preparation.

Rogers, Everett. 1962. Diffusion of Innovations (New York, MacMillan Company).

Romm, Jeff. 1979. "Toward Operational Models of Community Forestry." Draft (New Delhi, Ford Foundation).

Shaikh, Asif. 1980. "The Economics of Village-Level Forestry: A Methodological Framework" (Washington, D.C., AID, Africa Bureau).

Simon, Julian L. 1982, "Life on Earth is Getting Better, Not Worse" American Association for the Advancement of Science talk (Washington, D.C.) January 5.

Skutsch, Margaret. 1981. "Socio-Economic Impacts of Existing Wood Fuel Programs: Village Case Studies, Tanzania." Draft (Washington, D.C., Resources for the Future).

Smale, Melinda. 1981. "Community Forest Product Use in the Brakna Region, Mauritania." Mideo (Nouakchott, Mauritania).

Taylor, Robert. 1981. Rural Energy Development in China. (Washington, D.C., Resources for the Future).

Thomson, James. 1979. "Firewood Survey: Theory and Methodology" (Ouagadougou, Upper Volta, U.S. AID).

Thomson, James T. 1981. "Public Choice Analysis of Institutional Constraints on Firewood Production Strategies in the West African Sahel" in Clifford Russell and Norman Nicholson, eds., Public Choice and Rural Development (Washington, D.C., Resources for the Future).

United States Department of Agriculture Forest Service. 1980. Forestry Activities and Deforestation Problems in Developing Countries (Washington, D.C., USDA).

Winterbottom, Robert. 1979. "Upper Volta, Koudougou Agricultural Development Project." Appraisal Report. (Ouagadougou, Upper Volta, CILSS Ecology and Forest Team, August).

_____. 1980. "Reforestation in the Sahel: Problems and Strategies." Paper presented at the African Studies Association annual meeting, Philadelphia, October 15-18.

World Bank. 1978. "Forestry." Sector Policy Paper (Washington, D.C., World Bank).

_____. 1980a. "Forestry Project Case Studies, Gujarat Community Forestry Project" (Washington, D.C., World Bank).

_____. 1980b. "Malawi, Phase II of National Rural Development Program: Wood Energy Project." Staff Appraisal Report (Washington, D.C., World Bank).

_____. 1980c. "Rwanda, Integrated Forestry and Livestock Development Project." Staff Appraisal Report (Washington, D.C., World Bank).

_____. 1981a. "New Forestry Initiatives by the World Bank in the Development World." Paper presented to the National Capital Section of the Society of American Foresters (Washington, D.C., World Bank).

_____. 1981b. World Bank Annual Report: 1981 (Washington, D.C., World Bank).

RFF DISCUSSION PAPERS

D-1 VOTE TRADING: AN ATTEMPT AT CLARIFICATION, by Clifford S. Russell, December 1976.

D-2 WATER POLLUTION DISCHARGES: A COMPARISON OF RECENT NATIONAL ESTIMATES, by L. P. Gianessi and H. M. Peskin, February 1977.

D-3 MANAGEMENT OF ENVIRONMENTAL HEALTH IMPACTS OF DEVELOPMENT PROJECTS, by Blair T. Bower and Patricia L. Rosenfield, December 1978.

D-4 ENVIRONMENTAL MANAGEMENT AS A REGULATORY PROCESS, by A. Myrick Freeman, III., January 1977.

D-5 THE DISTRIBUTIONAL EFFECTS OF THE UNIFORM AIR POLLUTION POLICY IN THE UNITED STATES, by L. P. Gianessi, H. M. Peskin and E. Wolff, March 1977.

D-6 ECONOMIC ENERGY AND ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVE ENERGY REGIMES: AN APPLICATION OF THE RFF/SEAS MODELING SYSTEM, by R. Ridker, W. Watson, and A. Shapanka, April 1977.

D-7 AN ECONOMETRIC MODEL OF THE PETROLEUM INDUSTRY, by Patricia Rice and V. Kerry Smith, April 1977.

D-8 MODELS OF THE PRODUCTION TECHNOLOGY FOR ELECTRICITY SUPPLY: A SURVEY, by Thomas G. Cowing and V. Kerry Smith, April 1977.

D-9 THE CHARACTERISTICS OF EFFLUENT CHARGE SYSTEMS, by Clifford S. Russell, May 1977.

D-10 CONTROL COSTS AND DAMAGES OF ALTERNATIVE NATIONAL POLLUTION CONTROL POLICIES, by William D. Watson, Jr., May 1977.

D-11 MEASURING NATURAL RESOURCE SCARCITY: THEORY AND PRACTICE, by V. Kerry Smith, May 1977.

D-12 SUMMARY, CONCLUSIONS, AND POLICY IMPLICATIONS OF THE MONTANA COAL STUDY, by John V. Krutilla and Anthony C. Fisher with Richard E. Rice, August 1977.

D-13 THE AMES-ROSENBERG HYPOTHESIS AND THE ROLE OF NATURAL RESOURCES IN THE PRODUCTION TECHNOLOGY, by V. Kerry Smith, August 1977.

D-14 THE ROLE OF AIR AND WATER RESIDUALS IN STEAM ELECTRIC POWER GENERATION, by Tran Thi Ngoc Bich and V. Kerry Smith, August 1977.

D-15 THE IMPLICATIONS OF ENVIRONMENTAL REGULATION FOR OPTIMAL MAINTENANCE, SCRAPPAGE AND INVESTMENT, by Raymond J. Kopp and V. Kerry Smith, August 1977.

D-16 REGULATING ENERGY: INDICATIVE PLANNING OR CREEPING NATIONALIZATION?, by V. Kerry Smith, September 1977.

D-17 RESOURCE AND ENVIRONMENTAL CONSTRAINTS TO GROWTH, by V. Kerry Smith and John V. Krutilla, November 1977.

D-18 COSTS AND BENEFITS OF WATER POLLUTION CONTROL: THE HIGH COST OF INEFFICIENT POLICY, by William D. Watson, Jr., November 1977.

D-19 SOME EXTENSIONS OF A SIMPLE VALUE OF LIFE SAVING MODEL, by A. Myrick Freeman, III, October 1977.

D-20 FRONTIER PRODUCTION FUNCTION ESTIMATES AND THE TECHNOLOGY OF STEAM ELECTRIC GENERATING PLANTS: AN ECONOMETRIC ANALYSIS, by Raymond J. Kopp and V. Kerry Smith, January 1978.

D-21 UNCERTAINTY AND ALLOCATION DECISIONS INVOLVING UNIQUE ENVIRONMENTAL RESOURCES, by V. Kerry Smith, January 1978.

D-22 BACKGROUND PAPERS FROM WORKSHOP ON ALTERNATIVES FOR NONINDUSTRIAL PRIVATE FORESTS, by Marion Clawson, Robert S. Manthy, Philip M. Raup, and William R. Sizemore, January 1978.

D-23 CITIZEN LEGISLATURES: THE BARRIERS TO TURNING GOOD INTENTIONS INTO GOOD POLICY, by Helen Ingram and Nancy Laney, February 1978.

D-24 THE NUCLEAR DEBATE, by Robert C. Mitchell, February 1978.

D-25 CONTINUED CARE OF URANIUM MILL SITES: SOME ECONOMIC CONSIDERATIONS, by Winston Harrington, January 1978.

D-26 ECONOMIC AND ENVIRONMENTAL CONSEQUENCES OF A NUCLEAR POWER PLANT PHASEOUT, by William D. Watson, Jr., February 1978.

D-27 TOWARD A DEFINITION OF THE SPATIAL LIMITS OF TRAVEL COST RECREATIONAL DEMAND MODELS, by V. Kerry Smith and Raymond Kopp, April 1978.

D-28 PRICING OF OUTDOOR RECREATION, by Elizabeth A. Wilman, May 1978.

D-29 DISCRIMINATING BETWEEN ALTERNATIVE PROCESS ANALYSIS MODELS FOR ENVIRONMENTAL QUALITY MANAGEMENT: AN ECONOMETRIC ANALYSIS, by V. Kerry Smith and William J. Vaughan, May 1978.

D-30 THE EFFECTIVENESS OF THE NAVAJO SULFUR CHARGE IN CURBING SO_2 EMISSIONS AT THE FOUR CORNERS POWER PLANT, by Winston Harrington, May 1978.

D-31 LONG-RANGE TECHNOLOGICAL FORECASTS FOR USE IN STUDYING THE RESOURCE AND ENVIRONMENTAL CONSEQUENCES OF U.S. POPULATION AND ECONOMIC GROWTH: 1975-2025, by Adele Shapanka, May 1978.

D-32 THE UNITED STATES ENVIRONMENTAL MOVEMENT AND ITS POLITICAL CONTEXT: AN OVERVIEW, by Robert C. Mitchell and J. Clarence Davies, III, May 1978.

D-33 THE COSTS OF FEDERAL WATER POLLUTION CONTROL POLICY AND THEIR DISTRIBUTION, by L. P. Gianessi and H. M. Peskin, June 1978.

D-34 EVALUATING PERCEIVED TECHNICAL INEFFICIENCY WITH STOCHASTIC COST FRONTIERS: AN APPLICATION OF PSEUDO-DATA, by Raymond J. Kopp, V. Kerry Smith and William J. Vaughan, May 1978.

D-35 NATIONAL ENVIRONMENTAL LOBBIES AND THE LOGIC OF COLLECTIVE ACTION: TOWARD A THEORETICAL PARADIGM OF WHY PEOPLE CONTRIBUTE TO THE PRODUCTION OF COLLECTIVE GOODS, by Robert C. Mitchell, July 1978.

D-36 ENVIRONMENTAL PUBLIC OPINION: TRENDS AND TRADEOFFS 1969-1978, by Kathryn Utrup, July 1978.

D-37 HEDONIC PRICES, PROPERTY VALUES, AND MEASURING ENVIRONMENTAL BENEFITS: A SURVEY OF THE ISSUES, by A. Myrick Freeman, III, July 1978.

D-38 THE REVIVAL OF ENGINEERING APPROACHES TO PRODUCTION ANALYSIS: ESTIMATION WITH PSEUDO-DATA, by V. Kerry Smith and William J. Vaughan, July 1978.

D-39 ECONOMIC CONSIDERATIONS IN CONTROLLING MERCURY POLLUTION, by William D. Watson, Jr., July 1978.

D-40 HOUSEHOLD CLEANING COSTS AND AIR POLLUTION, by William D. Watson, Jr. and John Jaksch, August 1978.

D-41 THE MEASUREMENT OF TECHNICAL EFFICIENCY INDEXES: AN APPLICATION TO STEAM-ELECTRIC GENERATION, by Raymond J. Kopp, September 1978.

D-42 MANAGEMENT OF ARID LANDS: AN AGENDA FOR RESEARCH, by Helen Ingram, Rosemary Nichols, Anne Gault, and Patricia L. Rosenfield, October 1978.

D-43 CAPITAL-ENERGY COMPLEMENTARITY: FURTHER EVIDENCE, by Raymond J. Kopp and V. Kerry Smith, October 1978.

D-44 THE COLLECTION OF POLLUTION CONTROL EXPENDITURE DATA, by Henry M. Peskin, December 1978.

D-45 THE PERCEIVED ROLE OF MATERIALS IN NEOCLASSICAL MODELS OF THE PRODUCTION TECHNOLOGY, by Raymond J. Kopp and V. Kerry Smith, January 1979.

D-46 THE IMPLICATIONS OF MODEL COMPLEXITY FOR ENVIRONMENTAL MANAGEMENT, by V. Kerry Smith and William J. Vaughan, February 1979.

D-47 ON THE MEASUREMENT OF PRODUCTIVE EFFICIENCY: CONCEPTS AND SUGGESTIONS, by Raymond J. Kopp, March 1979.

D-48 APPLICATIONS OF PUBLIC CHOICE THEORY: AN INTRODUCTION, by Clifford S. Russell, April 1979.

D-49 PRODUCTIVITY MEASUREMENT AND ENVIRONMENTAL REGULATION: AN ENGINEERING-ECONOMETRIC ANALYSIS, by Raymond J. Kopp and V. Kerry Smith, April 1979.

D-50 SINGLE ISSUES: THEIR IMPACT ON POLITICS, by R. Kenneth Godwin and Helen Ingram, May 1979.

D-51 MULTIPLE USE FORESTRY AND THE ECONOMICS OF THE MULTIPRODUCT ENTERPRISE, by Michael D. Bowes and John V. Krutilla, May 1979.

D-52 ANALYSIS OF FUNDAMENTAL POLICY DIRECTIONS: NATIONAL FOREST MANAGEMENT AS AN ILLUSTRATIVE CASE, by John A. Haigh and John V. Krutilla, May 1979.

D-53 ENVIRONMENTAL IMPACTS AND ECONOMIC EVALUATION RESEARCH NEEDS FOR COASTAL AND MARINE RESOURCE MANAGEMENT, by Elizabeth A. Wilman and John V. Krutilla, June 1979.

D-54 THE EMPIRICAL RELEVANCE OF HOTELLING'S MODEL FOR EXHAUSTIBLE NATURAL RESOURCES, by V. Kerry Smith, October 1979.

D-55 ENDANGERED SPECIES PROTECTION AND WATER RESOURCE DEVELOPMENT, by Winston Harrington, November 1979.

D-56 SINCE SILENT SPRING: THE INSTITUTIONALIZATION OF COUNTER-EXPERTISE BY THE U.S. ENVIRONMENTAL LAW GROUPS, by Robert C. Mitchell, July 1979.

D-57 ENERGY, RESIDUALS AND INEFFICIENCY: AN ENGINEERING-ECONOMETRIC ANALYSIS OF ABATEMENT COSTS, by Raymond J. Kopp, August 1979.

D-58 THE PUBLIC RESPONSE TO THREE MILE ISLAND: A COMPILATION OF PUBLIC OPINION DATA ABOUT NUCLEAR ENERGY, by Robert C. Mitchell, September 1979.

D-59 LABOR AND THE ANTI-NUCLEAR MOVEMENT IN THE U.S., by Rebecca Logan and Dorothy Nelkin, October 1979.

D-60 PUBLIC OPINION ABOUT NUCLEAR POWER AND THE ACCIDENT AT THREE MILE ISLAND, by Robert C. Mitchell, August 1979.

D-61 THE POLLS AND NUCLEAR POWER: A CRITIQUE OF THE POST-THREE MILE ISLAND POLLS, by Robert C. Mitchell, November 1979.

D-62 MEASURING THE PROSPECTS FOR RESOURCE SUBSTITUTION UNDER INPUT AND TECHNOLOGY AGGREGATIONS, by Raymond J. Kopp, December 1979.

D-63 HOW "SOFT", "DEEP" OR "LEFT?" PRESENT CONSTITUENCIES IN THE ENVIRONMENTAL MOVEMENT FOR CERTAIN WORLD VIEWS, by Robert C. Mitchell, February 1980.

D-64 SUBSIDIES FOR DOMESTIC OIL SUBSTITUTES AND TAXES ON OIL IMPORTS: THE TWENTY TO THIRTY DOLLAR MISUNDERSTANDING, by Mark Sharefkin, May 1980.

D-65 ENVIRONMENTAL POLICY AND CONTROLLED TRADING OF POLLUTION PERMITS, by Clifford S. Russell, July 1980.

D-66 MODELING NON-NEUTRAL TECHNOLOGICAL CHANGE: AN EXPERIMENTAL ANALYSIS, by Raymond J. Kopp and V. Kerry Smith, September 1980.

D-67 CENTRAL ARIZONA PROJECT CASE STUDY, by Helen Ingram, William E. Martin, and Nancy K. Laney, September 1980.

D-68 ESTIMATING THE CHANGING PROBABILITY OF PARTICIPATION IN RECREATIONAL FISHING DUE TO CHANGING WATER QUALITY, by William J. Vaughan and Clifford S. Russell, October 1980.

D-69 REGULATORY RULEMAKING IN THEORY AND PRACTICE: THE CASE OF EPA'S EFFLUENT GUIDELINES, by Wesley A. Magat, Alan J. Krupnick, and Winston Harrington, October 1980.

D-70 THE PERFORMANCE OF NEOCLASSIC-ECONOMETRIC MODELS OF NATURAL RESOURCE SUBSTITUTION IN THE PRESENCE OF ENVIRONMENTAL CONSTRAINTS, by Raymond J. Kopp and V. Kerry Smith, October 1980.

D-71 TWO PAPERS ON NATIONAL ACCOUNTING AND THE ENVIRONMENT, by Henry M. Peskin, October 1980.

D-72 MEASURING THE BENEFITS OF CLEAN AIR, by Allen V. Kneese, March 1981.

ENERGY IN DEVELOPING COUNTRIES SERIES

D-73A INDUSTRIAL ENERGY DEMAND AND CONSERVATION IN DEVELOPING COUNTRIES, by John E. Jankowski, Jr., July 1981.

D-73B INTERFUEL SUBSTITUTION IN THE INDIAN ECONOMY, by Ashok V. Desai, July 1981.

D-73C FACTORS AFFECTING THE COMPOSITION OF ENERGY USE IN DEVELOPING COUNTRIES, by Joy Dunkerley and Gunnar Knapp, with Sandra Glatt, December 1981.

D-73D INDUSTRIAL ENERGY CONSUMPTION IN A DEVELOPING COUNTRY: THE ECUADORIAN CASE, by Eduardo Moran and Pierre Vernet, March 1982.

D-73E THE ROLE OF RURAL ELECTRIFICATION IN DEVELOPMENT, by Elizabeth Cecelski with Sandra Glatt, April 1982.

D-73F SOCIAL FORESTRY IN DEVELOPING NATIONS, by Douglas F. Barnes, Julia C. Allen, and William Ramsay, April 1982.

D-73G FUEL ALCOHOL: SOME ECONOMIC COMPLEXITIES IN BRAZIL AND IN THE UNITED STATES, by Shafiqul Islam and William Ramsay, April 1982.

D-73H THE FOREIGN TRADE DEFICIT AND THE FOOD CRISIS: ANTICIPATED RESULTS OF AN AGGRESSIVE PROGRAM OF ALCOHOL FUEL PRODUCTION IN COSTA RICA, by Rafael Celis U., Rosario Domingo B., Luis F. Herrera F., Mario Vedova W., and Juan M. Villasuso E., April 1982.

D-73I ENERGY CONSERVATION IN KENYA'S MODERN SECTOR: PROGRESS, POTENTIAL AND PROBLEMS, by Lee Schipper, Jack Hollander, Matthew Milukas, Joseph Alcomo, Stephen Meyers and Scott A. Noll, Joy Dunkerley, John E. Jankowski, May 1982.

D-74 ECONOMETRIC MODELING OF PRODUCTION ACTIVITY: THE CASE OF NONFUEL MINERAL DEMAND, by Raymond J. Kopp, June 1981.

D-75 THE DECOMPOSITION OF FRONTIER COST FUNCTION DEVIATIONS INTO MEASURES OF TECHNICAL AND ALLOCATIVE EFFICIENCY, by Raymond J. Kopp and W. Erwin Diewert, June 1981.

D-76 ESTIMATING ENVIRONMENTAL COMPLIANCE COSTS FOR INDUSTRY: ENGINEERING AND ECONOMIC APPROACHES, by Raymond J. Kopp and Paul R. Portney, July 1981.

D-77 VALUING A FISHING DAY, by William J. Vaughan and Clifford S. Russell, July 1981.

D-78 MEASURING AND PREDICTING WATER QUALITY IN RECREATION RELATED TERMS, by William J. Vaughan, Clifford S. Russell, L. A. Nielsen, and Leonard P. Gianessi, July 1981.

D-79 THE NATIONAL RECREATIONAL FISHING BENEFITS OF WATER POLLUTION CONTROL, by Clifford S. Russell and William J. Vaughan, July 1981.

D-80 THE DISTRIBUTION OF RECREATIONAL BENEFITS FROM IMPROVED WATER QUALITY: A MICRO SIMULATION, by Winston Harrington, November 1981.

D-81 APPLICATIONS OF THE RFF ENVIRONMENTAL DATA INVENTORY, by Leonard P. Gianessi and Henry M. Peskin, December 1981.

ENERGY AND NATIONAL SECURITY SERIES

D-82A SOCIAL COST OF IMPORTED OIL AND U.S. IMPORT POLICY, by Douglas R. Bohi and W. David Montgomery, December 1981.

D-82B TARIFFS AND THE ECONOMIC COSTS OF AN OIL DISRUPTION, by Douglas R. Bohi and W. David Montgomery, December 1981.

D-82C REVIEW AND ANALYSIS OF OIL IMPORT PREMIUM ESTIMATES, by Harry G. Broadman, December 1981.

D-82D THE IMPACT OF OIL MARKET DISRUPTIONS ON OTHER FUEL PRICES, by Thomas J. Lareau, February 1982.

D-83 MATERIALS REQUIREMENTS AND ECONOMIC GROWTH: A COMPARISON OF CONSUMPTION PATTERNS IN INDUSTRIALIZED COUNTRIES, by S. Victor Radcliffe, Leonard L. Fischman, and Radford Schantz, Jr., December 1981.

D-84 ISSUES IN URANIUM AVAILABILITY, by John J. Schanz, Jr., Samuel S. Adams, Richard L. Gordon, and Hans H. Landsberg, January 1982.

D-85 RATIONALITY AND IRRATIONALITY IN THE PUBLIC'S PERCEPTION OF NUCLEAR POWER, by Robert Cameron Mitchell, January, 1982.

D-86 ORDINAL AND DUMMY EXPLANATORY VARIABLES: AN ERRORS IN VARIABLES APPROACH, by Richard T. Carson, Jr., January 1982.

D-87 AN ECONOMIST'S REFLECTIONS ON MAN'S RELATION TO NATURE, by John V. Krutilla, January 1982.

D-88 SELECTED ISSUES IN PUBLIC LAND POLICY, by John V. Krutilla, January 1982.

D-89 FORMAL VS. DE FACTO SYSTEMS OF MULTIPLE USE PLANNING IN THE BUREAU OF LAND MANAGEMENT: INTEGRATING COMPREHENSIVE AND FOCUSED APPROACHES, by Christopher K. Leman, January 1982.

D-90 A DYNAMIC ANALYSIS OF CROPLAND EROSION CONTROL POLICY, by James S. Shortle and John A. Miranowski, February 1982.

D-91 IMPACT OF EROSION CONTROL POLICIES ON WILDLIFE HABITAT ON PRIVATE LANDS, by John A. Miranowski and Ruth Larson Bender, March 1982.

D-92 NATURAL GAS DEREGULATION: OVERVIEW OF POLICY ISSUES, by Milton Russell, April 1982.

D-93 A SURVEY OF AVAILABLE DATA AND METHODS FOR DEVELOPING ENVIRONMENTAL ASSET ACCOUNTS, by Edith Brashares, Winston Harrington, Joy Hecht, Alan Krupnick, Henry Peskin, and David Yardas, April 1982. (Available from The National Technical Information Service).