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ENERGY FOR AFRICA

Selected Readings

edited by

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INTRODUCTION

by David French

During 1979 and 1980, the African Bureau of the U.S. Agency for International Development worked to establish guidelines for its energy program. As part of this process, papers were commissioned on the following issues: the relationship of energy to African development, energy surveys, the economics of energy systems, technology transfer, community involvement in fuelwood activities, and the monitoring of energy projects. In order to reach a wider audience, these papers (somewhat condensed) are reproduced together in this volume.

In the opening paper, Martha Novick questions the common assumption that Africa's future will in most essentials be an extension of past development trends. The people holding this view concede that problems now exist with respect to oil and fuelwood, which together account for 90-100% of energy consumption in most African countries and which are rapidly becoming unavailable. Nonetheless -- or so goes the assumption -- new trees will be planted and renewable energy substituted for petroleum products. Given a necessary period of readjustment, modernization will proceed as before.

Novick, on the other hand, raises the possibility that scarce, expensive energy may be a permanent condition in Africa. In this view, deforestation cannot readily be reversed, and renewables will provide energy only at much higher cost than prevailed in the cheap-oil era before 1973. If this proves correct, it is imperative that we begin to consider the question of what African development may be like in a period of scarce and expensive energy.

Novick reviews Africa's energy crisis specifically in terms of balance-of-payments effects, transportation problems, fuelwood availability, and agricultural output. In most of these areas, current prescriptions for growth have been modelled on the development experience of Western nations. Under new energy conditions in Africa, these approaches are likely to prove unsustainable. For various reasons, however, fundamental adjustments in national development strategies cannot take place overnight. As Novick implies, the fact that such adjustments will have to be slow and incremental is all the more reason that they be carefully thought through and begun at once.

One area where action is essential is the provision of fuelwood, which provides 60-90% of all energy used in most African countries. In his paper on fuelwood surveys, James Thomson

concentrates on the way that fuelwood decisions are made and enforced by individuals and groups. When the basis for local decision-making is understood, aid donors and government officials can design better fuelwood projects.

Thomson notes that an African family has little incentive to protect or replace trees on the common land where it typically finds its wood or which it clears to grow crops. This made little difference when forests grew as fast as people could cut them down. Now that wood is scarce, however, the family's need for wood or cleared land increasingly conflicts with society's need to preserve its trees.

The answer lies either in "privatizing" land and trees or in strengthening the ability of local groups to manage common resources. Each of these solutions poses problems. By gathering the kinds of information which Thomson specifies, officials can gauge the approach most likely to succeed in each of the areas surveyed.

Thomas Graham looks more broadly at the ways in which surveys can help governments know what to do in the face of changing energy conditions. For Graham, surveys are means of identifying new technologies of potential value, especially to the poor. If a government moves systematically to support such technologies, it will automatically be carrying out a correct energy policy. Survey, policy, and action at the local level are thus indissolubly linked.

To do this work, according to Graham, surveyors should start by asking people what their problems are. After preliminary consideration of local economic and social conditions, proposed solutions can be discussed with the people being surveyed. Data are then collected to allow analysis of the economic, social and technical feasibility of systems under review. Systems which appear feasible on all three grounds can then be installed and tested.

Key to this process are what Graham calls the "analytical filters" through which data are passed to judge a proposed system's feasibility. The economic "filter," for example, is benefit-cost analysis, adjusted to reflect the economic outlook of the system's potential buyers. Comparable filters exist for social and technical analysis. Any energy survey must <u>start</u> with agreement on what these filters will be; only then can we know which data should be collected to help us predict the appropriateness of new systems in the area surveyed.

Asif Shaikh looks in detail at the economics of energy systems. In part, he relies on the usual rates of return:

financial (as seen by the individual buyer) and economic (from the standpoint of society as a whole). Before finally choosing among competing systems, however, decision-makers may also wish to know which would yield the greatest total benefits from a given outlay of government funds. To help with this judgment, Shaikh introduces the idea of a "dissemination cost ratio," which compares (a) the incremental budgetary cost of introducing one unit of a given system and (b) the net present value of that unit to society.

According to Shaikh, the application of these measures in practice requires close cooperation among economists, technologists, and sociologists. This is especially true with respect to:

- Incentive to Buy: Villagers may choose to buy (or not buy) new systems for reasons that have little to do with economics. A new mud stove, for example, may save precious wood and yet be rejected if mud items are traditionally identified with extreme poverty. To take account of such factors, the economist must carry out a wide-ranging "demand analysis" of the proposed system, including social as well as economic aspects of demand.

- Scarce Resources: A lack of available cash may prevent people from buying an otherwise attractive system. This will be especially true where the technology generates no income to defray initial expenses. To predict such a system's appeal requires an understanding of available resources and credit mechanisms in areas where the system might be sold.

- Ease of Dissemination: Some technologies will spread rapidly once their usefulness becomes clear. These may be made by industry, by local artisans, or by the final users themselves. Other devices will have little appeal to industry or artisans and will be too complex for users to construct and maintain without outside assistance. (Shaikh fears that mud stoves might fall into this category in much of Africa.) In this latter case, governments could be faced with high and persistent dissemination costs. To predict the outcome will require detailed knowledge of the economy and culture where the technology is to be tried.

To expand economic analysis in these ways makes it almost impossible to find a single number (rate of return, present value) which will tell whether a technology should be supported. Instead, Shaikh suggests, such analysis can best serve as feedback in a continuing process of adapting and redesigning technologies to meet local conditions. For example, mud stoves may have a high paper rate of return but offer little "incentive to buy" and pose great dissemination problems. To meet their basic objective of conserving scarce wood, governments might therefore wish to think instead about metal cooking stoves

or solar ovens for baking bread. Considerable time and money may be saved by going through this analytical process both before prototypes are constructed and while they are being tested in the field.

If sound technologies are identified in these ways, Africans are likely to adopt them. As Cecil Cook points out, Africans throughout history have accepted appropriate new tools, crops, weapons, clothing, patterns of government and commerce. If our technological ideas are rejected, it is not through any African unwillingness to innovate.

Drawing on case studies of technology adoption in many parts of Africa, Cook argues that change is most likely to occur where the "spontaneity/coercion ratio" is high. That is, villagers should feel that a new technology coincides with their self-interest and that the process of its adoption is under their control. They should not feel that the technology is being forced into their lives by powerful outsiders.

According to Cook, this means that "The best development strategy is the one that develops the least: the smaller the outside intervention, whether by a host country government or donors, the better." If energy programs are to succeed, villagers and outsiders must learn to understand each other well enough that any exchange will draw on the resources and meet the objectives of both.

Marilyn Hoskins examines this process in terms of the role of local groups in dealing with fuelwood problems. Such a community-based perspective is essential in Africa, according to Hoskins, since "it is increasingly apparent that the top-down approach is not working." Instead, "efforts to solve local fuel needs in ways that protect or re-constitute a healthy environment require support from local people." Such support must be genuine, and it must be present at every stage from project design to the ultimate distribution of benefits.

This implies close cooperation among donors, national forest services, and villagers. According to Hoskins, however, such cooperation is extremely hard to achieve, in part because of the very different perspectives from which the major actors view the problem. Donors, for example, often worry about integrated resource planning and interagency cooperation, issues to which forest services may attach much less importance. For their part, forest services think of how to create new institutions and projects which will work over the long term -- in the face of donor insistence that results be visible in two or three years. Villagers, on the other hand, wonder why greater attention isn't given to the local issues they think are most urgent (e.g., water, health, food, or jobs). When forestry activities are agreed upon, villagers may find both foreign donors and their own

governments somewhat unpredictable when it comes to promised assistance and the distribution of project benefits.

To ease some of these misunderstandings, Hoskins proposes that fuelwood activities start with a "project management agreement," to be prepared jointly by villagers, donors, and forest services (or other government agencies). Such an agreement would:

- establish long-range and short-range goals,
- select a site for the project,
- outline start-up and maintenance plans,
- specify the distribution of project benefits, and
- create procedures for monitoring and evaluation.

To negotiate such an agreement in advance would help ensure that all parties were in accord on the project's basic nature and the means of its implementation. As equal participants, villagers would have much more influence than is common in the shaping of rural development projects. According to Hoskins, it is only by involving villagers in this way that we can expect to succeed with large-scale fuelwood programs in Africa.

Once energy projects are underway -- in support of woodlots or of "harder" technologies -- it is extremely important to keep track of the results. To ensure that systems being tested are in fact appropriate, George Burrill proposes that five questions be asked about them:

"1) How well does a given device perform technically within the physical conditions of the village where it is being tested?...

"2) What costs are associated with the installation and operation of the technology, and how do these costs compare to the benefits received...?

"3) How does the technology interact with the local culture and with the social organization of the village and family?...

"4) How appropriate is the technology for the village institutions or individuals who could own, operate, and maintain it?...

"5) What can be learned about transferring or adapting the technology to the village?..."

In seeking answers to these questions, Burrill suggests, we should think of pilot energy projects as "learning laboratories." This implies a serious commitment to gather and evaluate information throughout a project's lifetime. The process is a dynamic one, since managers will adjust the project as they go along in response to information collected.

In order for results to be significant, the "learning lab" approach implies full participation on the part of donors, host governments, contractors -- and the villagers who are to use the new technologies. According to Burrill, lack of such participation will jeopardize both the project's success and our ability to know whether it has succeeded or not. As a framework for organizing the common effort required, Burrill endorses the "project management agreement" outlined by Marilyn Hoskins.

The Africa Bureau of the Agency for International Development does not necessarily endorse all the above ideas. Nonetheless, the general line of argument of these papers is very close to the energy policies which the Bureau has evolved. We are grateful to the authors for their contribution to the way we view African energy issues; we hope that other readers will find this work as useful as we have.

ENERGY SCARCITIES AND AFRICAN DEVELOPMENT

by
Martha Novick

INTRODUCTION

As the century draws to a close, the sub-Saharan countries of Africa will be confronted with the challenge of promoting economic development in the context of increasingly scarce and costly energy resources. If oil price increases in 1979 were indicative of likely future trends, the developing countries of Africa will direct an increasing percentage of valuable foreign exchange to pay for oil imports. As for renewable sources of energy, conditions of fuelwood scarcity in Africa are already well-documented, and solutions which propose to rely on the new renewable energy technologies may require high initial investments of capital which village and town-dwellers can little afford.

A number of studies have cautiously ventured to discuss the future effects of high energy costs and conditions of scarcity on the development of African LDCs. By and large, analysts have approached the problem with the assumption that traditional patterns of development will continue unaltered, with some adaptation as required by exigencies of supply or pressures on foreign exchange reserves. The traditional pattern of development encompasses those activities contributing to the sustained growth of GDP: productive industry and commercialized export agriculture, practiced in the manner prescribed by former colonial metropoles and developed-country donor agencies. From this perspective, concern for the future of development as conditioned by the global energy situation focuses on the need to assure and finance reliable supplies of petroleum-based fuels and fertilizers.

This paper will argue that a broader framework of analysis is crucial to an accurate understanding of the energy dilemma facing Africa in the next thirty years. There are a number of questions which need to be addressed, if only at the general and highly speculative level, in order to recognize the issues that will be the most salient in the African context:

- What types of changes will be imposed on official development plans as a result of increasing cost and scarcity of energy resources? If existing development plans are cut back substantially as

oil price increases require more foreign exchange,
- what portions of development plans will be trimmed first?
- will internal political and economic realities in African countries allow policy-makers to curtail development plans and simultaneously retain the goals of income distribution and rural development?

- What might be the future alternative paths for development in an era of scarce and expensive energy resources? What kinds of structural changes in development might be envisioned for Africa?
  - Will individual countries be able to mitigate the effects of political, economic, institutional and resource constraints in order to initiate a comprehensive re-evaluation of development plans?
  - How will energy conservation and adaptive innovation be built into future planning without effacing the importance of economic, social, cultural and political factors in the decision-making process?
  - What will alternative development paths suggest for the role of international donors in the next twenty to fifty years?
  - What will be the predominant sources of structural innovation in the pace and scope of development efforts? Who will write and execute the blueprints for new patterns of growth?

- How will we need to alter our present views of development to accommodate the need for more creative and "imagination-intensive" approaches to development issues?

These questions have been approached only tentatively in the development literature. Some of the issues have been articulated; a few brave souls have called for the examination of potential alternative paths, but the challenge has not been taken up with any great urgency or enthusiasm. Persons consulted in the preparation of this paper were interested and concerned, but many had not been able to devote serious time or thought to the questions.

Experienced development practitioners will smile at the utopian quality of the approach outlined above. Indeed, the conditions under which development administration and implementation take place in Africa present formidable institutional and structural barriers to successful planning for resource management. To plan for integrated intersectoral study of energy flows and to incorporate such information into national

development plans seems possible in the abstract; but in the field, a whole array of administrative, information, human and material constraints prevail. And, too, the style and quality of policy-making appropriate to the task by Western standards may not be suited to African needs and priorities. (Rothchild & Curry, 1978: 18-23) As most African countries cannot afford to allocate sufficient resources to achieve a high level of policy-making performance, their efforts at plan implementation seem likely to entail an inappropriate use of scarce resources and hence, remain comparatively costly. (U.S. citizens should note in this context their own government's inability to produce an effective and coherent energy policy.) For the developing countries anxious for a solution to the energy dilemma, programs designed on the outside, by the standards of the developed countries, will often have too high a price tag, even if they can be implemented with satisfactory results.

Demand management and energy conservation are frequently held out as important partial solutions for the developing countries in their struggle with energy crisis conditions. Will conservation and demand management be sufficient or even marginally effective in reducing the growth in energy expenditures and consumption (all types), or are basic changes in the structure and direction of development actually necessary in order to alter patterns of energy consumption in a more lasting way? The answer to this question is crucial for the planning and investment programs of African governments and international donor organizations in the next twenty to thirty years.

This paper will briefly survey the above issues for the following sectors in the African context:

I. The Increasing Price of Oil -- Effects on Economic Growth and Adjustment Processes

II. Transport, Spatial Planning, Decentralization: The Intersectoral Linkages

III. Fuelwood: The Rural Impact of Scarcity

IV. Agricultural Productivity: Energy Constraints and the Goal of Food Self-Sufficiency

* * * * *

Attempts to conduct research on energy issues in the African context are hampered by the lack of even the most basic data concerning energy needs, uses and resources. Countries at relatively low levels of industrialization, with large populations engaged in subsistence agriculture, are not studied as much as the rapidly-industrialized, upper-income developing countries. In fact, they are often lumped together with all other LDC's in general discussions of their energy problems, discussions which emphasize commercial energy use and supply problems. In the studies which do attempt to deal with the lower-income oil-importing LDC's, the results are often disaggregated only by levels of per capita income without providing breakdowns according to regional, geographical, or resource-endowment criteria.

Even for sectors which make greater use of commercial fuels, varying methods for energy accounting, difficulties of data collection in developing countries and controversy over efficiencies, conversion coefficients and the nature of intersectoral linkages have made for confusion and sharp disagreement. There has been a strong tendency to rely on methodology and tools of analysis that were devised to measure energy consumption and end uses in the developed countries. This may not be the most useful approach to the study of energy consumption patterns of less-developed countries.

Another data problem is that the bulk of research in the field of energy and development has been performed in or about Asian countries; the results are not automatically transferable to the African context.

The bias toward commercial energy in the literature is not entirely appropriate for an intelligent appraisal of energy and development linkages in Africa. In the rural areas, where the majority of African populations live, the most alarming scarcity problem concerns renewable energy -- specifically, firewood. However, it is still important to investigate the efficiency and the future demand patterns of petroleum-consuming sectors in African countries, although most do not import large quantities of commercial fuel.

Lack of hard data and sound methodology is not the only reason for the dearth of writings on the development implications of energy scarcity. Understandably, there has been a reluctance to overemphasize the "energy element" in theorizing about development strategies, because it might imply that the energy "crisis" should take primacy over other resource constraints. It is important to reiterate that the energy sector alone is not all-determining of the directions in which development will turn. Other considerations -- economic, cultural, and political -- will intervene and overshadow energy as a predominant concern. However, the structure of

African economies dictates the importance of determining the costs and uses of energy over the long run. Energy should not be viewed as a separate variable in development but rather, as an integral element of every sector that contributes to economic growth or expansion as well as to the provision of people's daily needs. Although this essay is intended to examine the role of the energy situation in determining the future shape of development for Africa, it does not embrace an "energy theory of value" in which energy is claimed as the only variable which could justify profound structural changes in an economy.

A more integrated approach to energy issues, rather than the current emphasis on specialized, sector-by-sector studies of energy consumption and demand, would provide much useful information on the role of energy in development. The attempt to look at the total energy system of an economy from rural subsistence farming to modern urban and industrial use would entail close examination of the linkages between various sectors and between rural and urban ways of life and work. An integrated approach to research and analysis would help to narrow the rural/urban schism in the view of decision-makers and perhaps suggest areas in which demand can be reshaped with the goal of saving energy.

This essay does not presume to suggest the perfect solutions or answers to the many difficult questions posed above and in the body of the paper. Rather, it is an attempt to traverse some of the significant sub-issues within the larger questions, to examine the potential for alternative paths for development, and to suggest new ways of looking at what is essentially an old problem in the history of development: What can be done in the face of scarcity of natural resources?

I. THE INCREASING PRICE OF OIL -- EFFECTS ON ECONOMIC GROWTH AND ADJUSTMENT PROCESSES

Whole economies of several third world nations are about to be put out of business. The very security of nations, to say nothing about the welfare of millions of third world people will be at stake. OPEC nations appear to be oblivious to the harm they are causing.

The Nairobi Times, June, 1979

The 16 percent to 24 percent increase announced last month is expected to add $2 billion to the trade deficits of African nations . . . the higher costs leave the developing countries with politically difficult options. They can scale down development plans. They can force citizens to make painful sacrifices in consumption through higher prices or rationing. Or some, the wealthiest, can go deeper into debt by borrowing from commercial and multinational banks.

The New York Times, 3 July 1979

Recent increases in the price of petroleum products have had detrimental effects on the balance-of-payments positions of many sub-Saharan African countries. Direct and indirect effects of the oil price increases will have to be absorbed by (often) already-shaky economies. Direct costs include the higher oil import bills to be paid by these countries and the resulting increases in their trade deficits. Indirect costs, far more difficult to measure or predict, include the results of higher inflation and lower growth rates generated by the impact of higher oil prices in the productive, industrial sectors of the developed nations.

Opinions as to the magnitude of the adjustment problem vary. Rigorous inquiry into the implications of the adjustment process for Africa and the other developing regions has been noticeably lacking. How is it possible to assess the many effects of oil price increases on development? Any such preliminary analysis must break down the problem into a number of sub-issues. This brief overview serves merely to highlight the areas of greatest concern.

Balance-of-Payments Problems: Origins, Effects, Potential Solutions?

Although it is extremely difficult to disaggregate petroleum imports from the other factors active in a country's balance-of-payments dilemma, it is clear that, for many sub-Saharan African countries, oil imports have exacerbated if not precipitated crises. All but the strongest exporters have experienced growing deficits as a result of the price increases and some, including Madagascar, Tanzania, Mozambique, Kenya, Central African Republic, Zambia, Ghana and Sudan have had acute difficulties with payments. (Quarterly Economic Reviews, 1980) In Sudan, the finance minister, in a January 1980 report to parliament, cited bad planning and lack of productivity in the past for the current crisis; but he then stated that the balance-of-payments was being

adversely affected by imports of oil and petroleum products. The minister had calculated the cost of oil imports for 1979/80 at $306 million, at a price of $24 per barrel. This was based on a price for Saudi crude that has since been raised to $26 per barrel, but even the earlier cost figure was 50 percent more than Sudan expected to earn from exports of its cotton.

What effect does a balance-of-payments (current account) deficit have on the economies of these countries? The nature and intensity of any effects will vary according to the size and structure of the economy in question:

> "The degree of impact varies with the share of petroleum in the overall import bill, the prospects for exports of goods and services, the cushion of already-accumulated foreign exchange reserves, the prospects for capital inflow, particularly of a long-term character, into these countries, and measures to restrain the demand for imported fuel, either through conservation or through substitution, wherever possible by indigenous energy supplies." (United Nations, 1979)

Many of the sub-Saharan African countries fall into the category of oil importing LDC's which are "most seriously affected" by the oil price increases. They are unable to sustain their essential level of imports (petroleum products and the other inputs needed for development) on the basis of their expected export revenues. Sizable current account deficits force these countries to depress the level of their imports for development and many have seen a deterioration in their overall terms of trade as the prices of the goods they import rise steadily with oil-based inflation while the prices received for export may fluctuate, decrease or stagnate at unpredictable levels.

Increased costs for oil imports, combined with mounting debt service payments, will leave many of these countries less and less able to finance needed investment to stimulate economic growth or to provide for even the minimum basic human needs of a large segment of their populations. World Bank estimates indicate that LDC growth rates in the aggregate fell by more than 60 percent (from 7.6 percent to 3.0 percent) between 1973 and 1975, after the first round of OPEC price increases. (Palmedo, 1978) This may be seen as a direct result of the increased energy financing burden, but also, in part, as a result of lowered growth rates in the developed countries, which are markets for their exports during the recession which followed the OPEC embargo.

The extent of the debt burden as well as the formidable problem of repayment and rescheduling, has become a source of serious concern to international bankers. (New York Times, 1979) Some argue that if the international finance system survived the imbalances of the 1974-75 adjustment period, the current situation does not present a major danger. But for the African countries which have added considerably to their debt burden in the past two years and have little possibility of building up foreign exchange reserves against future payments crises, the situation appears bleak. Of those countries able to draw on bank loans, many have reached the upper limits of financing and refinancing -- in Africa, Zaire is the most frequently cited example, with debt service in 1977 adding up to 42 percent of the value of its exports. (Palmedo, 1978)

Many other African countries are in a particularly unenviable position in the face of petroleum-related payments deficits. It is far more difficult for them to obtain the critical loans from private banks to ease them over the period of crisis. Although it is true that assistance flows from OPEC, the developed economies and even from centrally-planned economies have cushioned the balance-of-payments impact of increased oil-import bills, the lower income countries have had to depend almost entirely on the largesse of these sources. For example, in late 1979, France provided financing to the Central African Republic in order to help the new regime pay for imports of oil, flown in from Kinshasa. (Quarterly Economic Reviews, 1980)

The exact dimensions of this lessened ability to invest in development have not been investigated with any attention to detail -- perhaps the history of the new oil prices is too brief for accurate analysis to be possible. Yet it seems clear that the oil price trend will have important ramifications for development planning, sector by sector and overall, and for growth.

In the short run, the lower-income developing countries of Africa can do little to alter their situation with regard to imported energy. These countries are expected to continue to be dependent on petroleum imports in the near future; their long-term prospects for relief of balance-of-payments pressures can really only emerge with a re-examination of their long-term energy policies. The possibilities of economizing on oil consumption without affecting growth or living standards are comparatively narrow, since the bulk of petroleum consumption is concentrated in such crucial areas as electric power-generation (where other sources of electric power are lacking),

truck and rail transportation, lighting and cooking in the urban areas, water pumping (where powered by diesel oil) for irrigation, and essential industrial activities. The lack of any significant margin to reduce essential energy consumption implies that reductions in oil imports may have serious consequences for levels of production, employment, transportation and consumption in the poorer developing countries of Africa. (United Nations, 1979)

Too often, analysis of this issue stops with this short-term realization to proclaim the situation hopeless and predict that the only solution to the African energy problem is more aid, more loans and better attempts to conserve. But it seems clear that the medium- and long-term effects of continuing with this strategy will be seen in slowed growth and limited resources for development. With less foreign exchange to spend on development investment, and demand for oil increasing even at slowed rates of growth, more and more financial resources are diverted to payments for oil and less are apportioned to development programs aimed at providing the basic needs for survival to the rural and urban poor. How can African countries revise development planning in order to counteract some of the expected future effects of this alarming cycle?

Alan Strout has suggested three broad categories or problem areas which are useful when trying to identify the major issue areas:

1) What kind of energy supply and delivery systems are feasible and economic for widely dispersed populations such as usually characterize rural areas?

2) What are the trade-offs among energy, capital equipment, production time, and product characteristics in the production of bulk materials? Is it a technological necessity that future production of many of these materials will be as energy-intensive as appears to be the case today in the United States? What alternative productive processes and systems might be considered which would be more appropriate under today's relative price structure? How important appear to be the technical, industrial, and other linkages which have led countries to believe that domestic production of most of these commodities is an essential step in their own industrialization?

> 3) What are the amounts consumed and the functions performed by energy in cities? This is where most of the material-using and related productive activities of economies take place, and there is strong evidence that the urbanization process itself has been causally linked with industrial growth. As with bulk materials production, we would like to know the ranges for substitution among capital, energy, and time, and whether patterns that evolved in the low-cost energy past will continue to make economic sense in a higher-cost energy future. (Strout, 1976: 148-49)

In other words, African countries will have to find new answers to the question: "What is the true opportunity cost/shadow price of foreign exchange spent on imported petroleum?" The answers will probably vary as the price of oil increases.

In the long run, an alternative view of the relationship between energy consumption and the process of development will probably emerge. But the distance in time and imagination between today's energy dilemma and a changed vision of energy supply, needs and productive processes is very great. Policy-makers move incrementally in the planning process and it is difficult for them to conceive of a way to change the pattern of energy consumption in their countries, partially because it seems impossible to achieve development goals at lower levels of energy consumption. In the short to intermediate run, two more time-honored and reliable strategies will, in all likelihood, be most effective and pragmatic: supply-oriented and demand management policies.

Supply-Oriented Strategies and Demand Management Policies

By expanding the rate of growth of their domestic energy supplies, African countries lessen their dependence on international petroleum markets, but this strategy depends on two important resources: natural deposits of renewable and non-renewable energy, and collateral resources to develop them. With the World Bank and private petroleum companies taking a renewed interest in African oil deposits which were previously (at lower prices) written off as marginal, a number of African countries face the prospect of becoming self-sufficient in petroleum, if not modest exporters, by the mid- to late-1980s. This list includes Chad, Cameroon, Congo, Ivory Coast, Ghana, Senegal, Sudan, Mali, and Madagascar.

However, there are constraints to the full development of African discoveries. In some countries, political uncertainty and generally risky investment climates may impede drilling; in others, the lack of infrastructure sufficient to handle discoveries could cause oil companies to postpone investments. These arguments would also apply to investment in the coal-mining sector.

Supply-oriented policies would optimally also involve a concerted effort to increase efficiency in the economy. Governments and private enterprise would learn how to make local resources more productive, and how to adapt industrial technology so that it may be employed more efficiently in productive processes. Supply management will become increasingly important for African countries with petroleum or coal resources.

Careful management will also encompass policy initiatives in the area of renewable energy resources. Individual countries need to develop better data on energy needs, resources and uses, particularly for non-commercial energy sources such as wood and crop residues. Attempts to increase production, improve recovery and processing so as to facilitate transport to nearby towns and villages, and to improve the efficiency of rural stoves, all fall under the general category of supply management, and will become increasingly important in sub-Saharan Africa.

Demand management attempts to curtail the rate of growth of aggregate demand for energy, partially by shaping the patterns of demand by altering the structures of industrial production and individual consumption. This is complicated by the historical trend that increases in income, shifts in consumer tastes toward energy-intensive items, changes in producer technologies that favor energy-intensive inputs, and changes in the patterns of relative prices (so as to price energy low relative to non-energy items) all act to increase the aggregate demand for energy.

African governments may tread the risky path of limiting the rate of growth in demand for energy, but not so thoroughly that it will either impair the rate of overall economic growth and development below that dictated by the availability of other resources, or limit the rate of increase below what is vital to meet basic human needs. This requires a delicate balance of policies from price and taxing initiatives to longer-range planning considerations.

Unfortunately, low-income countries have the least to gain from even the most effective demand management scheme since they require a basic minimum level of energy inputs. Even with a workable scheme for demand management, these countries are likely to experience energy gaps which will become more and more serious to the longer-run; imports of oil will have to be increased in order to meet shortages. As their capacity to import without aid for financing is quite limited, future growth using imported energy supplies could be severely constrained. In these countries, demand and supply management have only a limited range in which to solve the energy and development dilemma.

For African countries without indigenous oil or coal resources, alternative strategies for development could hold out a means of reducing the outflow of precious resources to pay for imported energy. It is hoped that future research and exploration in the area of energy and development will bring forth new and workable solutions for lower-income developing countries. Until then, demand and supply management will have to be practiced as carefully and assiduously as is possible given political and institutional constraints. (Michalopoulos, 1979)

II. TRANSPORT, SPATIAL PLANNING, DECENTRALIZATION: THE INTERSECTORAL LINKAGES

The transport sector is integrally connected with all significant economic development in a country. Transportation potentially binds the economy of a country together into a single market which is crucial to the achievement of economies of scale in industrial production. It also transforms urban regions into single functional units by enabling persons to commute to workplaces that may be widely separated from residential areas. In Africa, where transportation infrastructure is underdeveloped and even lacking in some regions, its future patterns and mix of modes will be influential in generating employment, distributing essential goods and services, facilitating communications, and linking together distant regions of the countries. In addition, transportation will ultimately be an important factor in unifying African countries socially and politically.[1]

The transport sector is the second largest consumer of energy (after industry) in the economies of the developing countries: the energy intensity of transportation in developed and developing countries alike is higher than that of industry; and the developing countries show a higher energy intensity in the transport sector than their industrialized counterparts.

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[1]This essay draws heavily from an important paper by Thomas Vietorisz, Perspectives of Transportation and Liquid Fuels in the Less Developed Countries, first draft of a consulting report prepared for the Brookhaven National Laboratory, 10

World Bank studies reveal that the average share of transportation in economic output is significantly higher for the developing countries than it is for the industrial market economies. (Blitzer, 1979: 13-14) Although these aggregate figures are not broken down specifically for Africa, where industry with its related transportation needs is less developed than in Asia or Latin America, the energy intensity of the favored transportation modes in Africa suggests that the energy demands of the sector are considerable, and increasing steadily. In the Sahelian countries, it has been estimated that 30 to 50 percent of all oil imports are consumed by the transportation sector. Estimates of the transportation share in consumption of commercial energy for the lowest income-developing countries (aggregate) reach as high as 70 percent and a good number of African countries are ranked in this category. (Palmedo, 1978)

As the price of petroleum increases, the cost of operating and maintaining the existing transportation systems in Africa is escalating, with imported fossil fuels taking up a larger and larger portion of foreign exchange. Subsidized prices for gasoline and diesel fuel in many countries also places severe pressure on the country's financial resources. Moreover, given the energy intensity of construction and increasing energy costs, the cost of expanding the existing transportation networks will increase steadily over time.

One planner has theorized that, in the long-run, countries may be forced into painful and destabilizing structural adjustments of transport systems designed and conceived in a period of readily available and low-cost oil supplies. (Vietorisz, 1978) In the short- to medium-run, rapid increases in transport costs suggest the need for a re-examination of planning and budgetary assumptions which affect the magnitude and type of infrastructure investments for African countries in the 1980's and beyond.

It seems inevitable that African countries will be faced with a series of complex planning decisions in the next twenty to thirty years. The remainder of this essay will discuss the transportation situation for Africa in general terms and then move on to suggest the potential for planning based on a recognition of the linkages which exist between transportation, spatial planning and urban design. Because of the paucity of data from Africa, it is not possible to present specific country examples, but perhaps this abstract discussion may suggest the need for a framework for an integrated planning effort oriented toward a constructive exploitation of intersectoral linkages.

Potential energy savings in the transport sector may be best realised through policies which take account of the interdependence of several sectors. There are powerful institutional, political and economic barriers in the way of establishing an actual planning group to carry out the studies, analysis and implementation of solutions in the context of such an integrated framework. Yet in the spirit of investigating alternative development paths, the exercise has its (albeit intangible) benefits, if only to suggest the need for further research and conceptual work.

The Shape of Future Change: The U.S. Model, or Structural Shifts in Demand?

For better or worse, the growth of transport in the United States has served as a model for that of the less developed countries. In this century, transport in the United States has grown highly dependent on liquid fuels. Some analysts question whether the developing countries, particularly in Africa, must follow the patterns of transport energy and liquid fuel usage set by the United States and other developed countries. (Vietorisz, 1978) Other experts assert that there is little scope for effective response to the oil price increases within the transport sector. They argue that one can only hope to improve the fuel efficiency of petroleum-based transportation; the difficulty of finding oil substitutes is too great to surmount. (Palmedo, 1978) A related argument contends that developing countries still use relatively little of the world's liquid fuel energy in transport and that conservation would deprive them of important opportunities for growth, particularly in the urban areas. Alternatives to a highway and road network are characterized as inflexible, unable to accommodate the expected future changes in population, employment and residential patterns. The less energy-intensive modes of transport, such as rail, are criticized as having too high an initial capital cost of conversion.

In the case of transportation, what was practical and efficient in the era of cheap and readily available petroleum may not be the optimal pattern of consuming this precious resource in the decades to come. But policy-makers at the individual country level tend to shrink back from the prospect of sweeping changes in the transportation systems of their cities and regional centers. The constraints of capital and planning capacity inevitably loom large for African governments; the World Bank chooses major infrastructural transport projects very selectively, hence capital is not always readily available. The issue need not be seen

as an implicit trade-off between the future costs of continuing to develop an energy-intensive system and the capital costs in the near- to medium-term of investing in new transport systems (which would entail structural changes in demand for transport). Between the two extremes, there are policy options which could ease the growth in demand for petroleum without major sacrifices in "normal" growth in demand for transportation and could be implemented incrementally, at lower capital costs than the more all-encompassing structural reforms.

In making transportation policy, African countries should take into account their resource and capital endowments, estimated future demand for transportation services, and the opportunity cost of the foreign exchange that pays for imported oil. Using this information, individual countries could determine the approximate point in time in which the current system would become too expensive as a consumer of imported oil; policy-makers could then focus on potential changes to be implemented before that time arrives. Even tentative estimates of this nature would be invaluable to decision-makers responsible for determining the patterns of investment and structural change within the sector. (Vietorisz and Meier, 1978)

Present Trends in the Transport Sector -- The Sahelian Case

The CILSS* has called for a policy for transport which would use imported energy sparingly, and even a cursory review of the existing transport networks reveals the reason: a profile of high energy-intensity. According to the CILSS/Club du Sahel study:

-- Road transport is dominant, even for long-distance haulage of heavy products.

-- River transport is practically nonexistent.

-- Railroad transport is limited.

-- The construction costs of rail transport are high in comparison with road transport, and roads compete for the same routes even where a railroad already exists (i.e., between ports and capitals).

-- Few new railroad projects are underway, whereas the number of road projects is increasing. (CILSS/Club du Sahel, 1979: 81-82)

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*Comite Permanent Inter-Etats De Lutte Contre La Secheresse Dans Le Sahel.

Road transport will remain necessary for reaching all the regions of a country, particularly the more remote localities. On the heavily travelled major routes, such as those which carry the heavy goods, countries do have a choice between road and rail systems. These countries need to assign priority and resources to either railroads or highway networks. If first priority goes to rails, the country may conceivably discourage the growth of long-distance highway transport by tax and tariff disincentives. For land-locked countries, where it is especially crucial to determine a means of access to seaports, transport costs can be almost double those of coastal countries.

For the Sahel, the CILSS has a long-term recommendation for ". . . a system whose main arteries are rivers and railroads with roads used as radial channels to distribute traffic and fill in infrastructural gaps. . . ." (CILSS/Club du Sahel, 1979: 82) The rationale for this recommendation is that rail transport is one-half to one-third as expensive as highway transport for heavy products, and river transport may be even cheaper. Trains would consume less than one-third as much energy as trucks per ton-km, and river transport on barges uses still less. The initial investment is higher for rail than for a road network system, yet the difference in investment costs is narrowed if one takes into account the requirements of road networks for substantial additional investment (stocks of trucks and parts, garages and repair shops, road maintenance facilities, etc.) which are generally included when costing railroad investment projects. Railroads also tend to have a longer technical lifespan than road systems used by heavy trucks.

If a country or region plans to invest in either a rail or road system, it should be prepared to ensure adequate traffic to draw the greatest benefits from the inherent economic advantages of each. In the Sahel, the policy decisions taken in the next five to ten years regarding the development of important transport routes will largely determine the condition of the Sahelian transport system at the end of the century and beyond. They will also have a substantial impact on the extent of individual countries' energy consumption.

Alternative Paths for Transport -- Toward a Framework for Research and Policy

For proponents of alternative transportation patterns, it is tempting to view Africa as the great tabula rasa for untried new transport systems, as most of the countries have relatively little transportation infrastructure already in place. John Herbert has observed:

> ". . . the developing world's cities still have opportunities to achieve resource-efficient and varied transportation services, which most developed cities have long since lost or can recover now only at enormous expenses. Levels of automobile ownership are low, and street systems often serve the residential, commercial, and other spaces of the city rather than dominate them. There is no need to repeat the mistakes of the developed world." (Herbert, 1979: 139-40)

Although the constraints of financing, planning, management and design are formidable, there is scope for innovation and the implementation of energy-saving systems. However, it is difficult for developing countries to make decisions concerning an appropriate scale for change in the transport sector of a developing country, because the magnitude and life of the investments are so large. The large-scale projects, such as the building of a railroad line or the revamping of an urban transport network, require large investments of time, planning expertise, foreign exchange, and management skill, and may even require substantial operating subsidies into the forseeable future.

In many countries, resource constraints and the dicta of neo-classical economics have jointly resulted in a paucity of investments in the transport sector. Often the expected rate of return on railroad investment is insufficient to justify the expenditures of scarce capital resources. Many of the expatriate advisors who counsel developing countries believe that the optimal allocation of scarce economic resources requires that the cost of large, indivisible fixed items be recovered in the form of lump-sum taxes that are independent of rate of usage, rather than from direct user charges (otherwise the fixed investment remains under-utilized).

However, in the case of transport projects, there is the additional consideration that transport investments, by binding a region or country together and allowing the expansion of markets, division of labor, and capturing of economies of scale, confer enormous benefits on many other economic activities that are not properly expressed by the functioning of the private returns of transport enterprises. As Thomas Vietorisz points out:

> "Theoretical considerations suggest that there will be an underinvestment in transport activities unless society subsidizes transport enterprises to an extent commensurate with the external benefits that transport activities confer in a widely diffused manner on society as a whole." (Vietorisz, 1978: 21)

subsidies on this scale may be difficult for developing countries to undertake and projects may never be undertaken if the rate of return is judged to be too low.

In the context of existing economic constraints, it may be defeating, psychologically and economically, to approach the notion of change in the transport sector from the angle of the largest, capital-intensive projects. A more incremental and less costly beginning is not only more comfortable but more readily translatable into policy. Vietorisz has devised an effective framework for thinking about the problem; he cites three program alternatives:

-- Increasing the efficiency of energy and liquid fuel usage within a given transport mode. This may involve conservation of standard fuel, or substitution of a non-standard fuel for the fuel now used. When such substitution involves a substantial change in the design and operating characteristics of a given mode, it will be treated as a:

-- Change of transport mode: substitution of a mode that uses less energy, particularly in liquid fuel form. No change of the structure of transport demand is, however, assumed under this program alternative. If a change of mode is impossible without a simultaneous substantial change in the structure of transport demand, the program alternative will be treated under the next heading. For example, a substitution of the bicycle mode for much of inner-city automobile traffic involves enough of a qualitative change in demand to warrant treatment as a structural transformation.

-- A change in the structure of transport demand. This program alternative embraces fundamental changes in such aspects of economic development as urban-rural migration, income distribution, urban and suburban design, the location of workplaces in relation to housing, and other factors that determine the demand for transport of passengers and freight, both qualitatively and quantitatively. (Vietorisz, 1978: 23-24)

For the formulation of an alternative path for transport, program alternatives two and three are the most significant; but some of the first steps toward this goal will take place within the purview of the first alternative in many developing countries.

Vietorisz recommends four major possibilities under his second alternative, involving changes in modes of transport; 1) basic changes in the automotive transport mode; 2) water transport options; 3) rail options to limit highway transport; and 4) options to replace urban car and bus use. For example, he suggests that the use of electric city vehicles -- taxis, jitneys, buses, commercial and delivery vans, public service vehicles -- shows considerable promise for energy savings.

It would seem that all these suggestions could find potential application in African countries in the intermediate-run. However, it will not be easy to initiate these changes given prevailing institutional constraints (planning and policy-making capacity may be limited) and the need to avoid adverse effects on redistribution of income. Many African cities will need to be concerned with designing projects to provide transportation services for the urban poor directly, in order to provide access to jobs, to facilitate the distribution of essential commodities used by the poor, to facilitate access to essential urban services, etc. These varying and even conflicting goals will not be achieved in perfect congruence, and the system with the most potential for efficient use of liquid fuels may not necessarily be optimal from the point of view of redistribution. Resolution of contradictions and priority-setting with regard to varying objectives will be among the most perplexing tasks of African policy-makers.

Structural Change in Demand and Energy Economies -- Intersectoral Linkages

The third program alternative, calling for structural changes in the demand for transportation, poses the largest challenge, as the scope of the changes described is difficult to envision. Vietorisz suggests that urban redesign and redevelopment could significantly affect the average commuting distance to work with the predominant goal of increasing energy and liquid fuel efficiency. He implies that these results may only be achieved in an environment in which planners have a certain degree of leeway in moving industries, planning for decentralization and clustering of workplaces and residences (with distinct centers or "nuclei"), and applying the principles of urban design for a more efficient design of outlying urban areas (shantytowns). Vietorisz' vision of the energy-efficient city after urban redesign includes a transportation system combining pedestrian, bicycle and light-rail modes, with commerce and shopping planned in close relation to residential areas, and with related energy economies to be realized in construction, heating, cooling and other aspects of urban design.

This ambitiously-conceived plan relies heavily on the ability of planners to exploit the appropriate intersectoral linkages, particularly between transport and industry/commerce.

While the response times to changes in urban design might at first appear so slow that structural changes would be relevant only to the far distant future, experiences in Mexico City suggests otherwise. Vietorisz asserts that:

> "Policy measures that change the structure of new additions to urban areas today will have a significant impact in the near future. Within five years, they will affect a quarter of the urban population; within ten years, almost one half, assuming an urban growth rate of 6 percent per year -- a realistic figure for many Third World countries." (Vietorisz, 1978: 45-47)

Vietorisz may well be overly optimistic as to the potential for rapid developments in effecting changes in the structure of transport demand itself, changes that originate in transformations, planned or unplanned, of the economy as a whole or of its major urban and industrial sectors. Yet in self-contained urban areas, as his paper convincingly argues, there is scope for the reorganization of patterns of commuting, industrial location and, hence, liquid fuel consumption.

The concept of intersectoral linkages has also been suggested as a guiding principle for large-scale plans to tie together rural and urban regions by means of integrated spatial planning on a country-wide scale. The literature on this issue tends to be somewhat futuristic and jargon-laden, but the overall concept could be integrally related to the possibilities for alternative transport paths discussed above. In praise of integrated spatial development, two planners have stated:

> "A national economy requires the organization of space, the concentration of development activities in urban centers of the different sized spatial units, a system of infrastructure within and between spaces, and the integration of agricultural and industrial development. Each level of urban center would contain the activities appropriate to its size. This would overcome the current gross imbalances between investment in the large cities and the rest of the country." (Rodinelli & Ruddle, 1978: 22)

Development theorists and aid officials have recognized in the past few years that spatial planning could have a crucial role in increasing food production, relieving energy scarcities, and promoting employment and social welfare in developing countries.

Transportation networks are among the most important linkages for integrating spatial systems. They reduce travel time, lower shipping costs, widen marketing, commuting, and migration opportunities, allow greater access to nonagricultural employment, improve communications, and extend areas of service delivery. In some cases, already-existing settlement patterns may form a workable backdrop against which the advantages of new forms of transport may be effectively imposed. In Africa, for example, market and district towns are important centers which serve as intermediaries between the village/rural sector and the larger urban areas. Studies of tropical Africa indicate that, where they exist, province towns and intermediate cities attract migrants who either move to them instead of going to the capital city or use them as temporary way stations before moving on to the metropolis. Planners have noted that market towns and small cities are the most critical settlements in what they call a well-articulated spatial system for linking rural and urban functions. For many reasons, it would seem that there is great potential in Africa to enhance and support the role of market towns by means of improving the transport links as well as other local services.

On the other hand, one may wonder whether decentralization schemes would prove efficient in terms of energy consumption in the longer run, or whether the large amounts of resources required to build up regional towns would not include increasing amounts of energy of all types. There is as yet no satisfying answer to this question. Decentralized centers could become virtually energy self-sufficient with appropriate investment in renewable energy technology, and with an energy-efficient transport network linking them with other regions; but the energy bill for the inevitable transport and construction costs during implementation could be formidable.

A successful effort in the direction of integrated spatial planning and decentralization would involve not only country-specific but region-specific research and planning studies within countries. A formidable obstacle to this kind of research effort is the lack of information in many rural areas as to local conditions, which makes evaluation of investment decisions difficult, increasing uncertainty and risk of failure. In Africa, the lack of organizations that collect, aggregate and analyze data on regional social, economic, technological, and resource-consumption trends will hamper efforts by policymakers to act to meet regional development needs.

Although the energy-related considerations will not be the major and compelling motivation for African governments to move ahead with studies relating to decentralization and integrated spatial planning, there may be greater potential for energy efficiency, particularly in terms of new transport investments, than policy-makers initially suspect. Because the transport sector consumes a large proportion of the liquid fuel imported by African countries, it will be essential in the next decades for each country to increase its awareness of the energy cost of new transport investments. Whether these decisions are made in the context of urban, regional or country-wide policy, opportunities for altering the structure of demand such that petroleum use is diminished must not be overlooked. With increased attention to energy-efficient urban design, innovative spatial planning, and community and government commitment to policies of resource-conservation, increases in the consumption of liquid fuels could potentially be kept at manageable levels, at great savings in foreign exchange.

The goal of development has always been to arrive at a social and economic situation at least comparable with what exists in the most advanced countries today. Policy alternatives aimed at achieving structural change in the demand for transportaion, where the nature of proposed changes runs the deepest against the traditional, conventional grain of assumptions about development, will produce the most dissonances. The broad categories Vietorisz suggests (e.g., rural and handicraft stabilization and decentralization of workplaces and residences) are not only suggestive of an anti-spontaneous movement toward new objectives, but may involve development planning and implementation of the most instrumental and insensitive sort.

To take one example, Vietorisz notes that:

> "Urban design representing an integration of pedestrian, bicycle, and light rail traffic is a post-industrial conception contrary to the structure of achievement motivations in developing areas where bicycle riding is a symbol of lower-class status, and motor vehicles, especially luxury automobiles, embody the idea of personal success and social progress." (Vietorisz, 1976: 68)

An African government attempting to curtail the use of automobiles in order to promote the use of bicycles and jitneys

might not maintain power long; in some countries, serious riots have been touched off over incremental increases in the price of gasoline.

With policies of this type there is some potential for reliance on coercive measures to achieve the goal of energy efficiency. However optimal the result desired, this may have serious and detrimental social and political ramifications that cannot be overlooked. Development theorists might well ask themselves whether instrumental or potentially repressive development policies are a desirable corollary to objectives designed to achieve energy-efficiency and lessen dependence on expensive imported oil.

III. FUELWOOD SCARCITY: THE RURAL IMPACT

The writings of Erik Eckholm and others have served to alert the development community to the nature and dimensions of the fuelwood crisis in Africa and other parts of the developing world. (Eckholm, 1975, 1979; French, 1978; Spears, 1978) The situation is critical when we consider that for most African countries, fuelwood provides the main share of total energy consumed: in Tanzania, for example, fuelwood supplies 96 percent of total energy and in Nigeria, 90.6 percent. (Earl, 1975: 10) The challenge of devising solutions to stem the trend toward rapid deforestation has been treated thoroughly in the literature. Because the issues of technology fix, AID interventions, and reforestation programs have been discussed elsewhere, this essay will focus on the related but broader development issues raised by the fuelwood crisis:

- What does the chronic firewood shortage imply for future rural development? This encompasses the following sub-topics:

  -- Potential for disruption of the social fabric in villages with changing patterns of:

    - access to wood
    - harvesting wood
    - division of labor for collection
    - storage
    - distribution
    - consumption: heating, cooking, local industry

  -- Impact of gradual transition to a view of wood as a market commodity;

-- Effects on nutrition;

-- Possibilities and effects of substitution;

-- Cyclical pattern of deforestation: degradation of the environment, lowering of agricultural yields, deforestation.

- If we assume that village dwellers will be forced to make a series of adjustments in their daily routines, what forms will those adjustments take? Can we make predictions about the shape of responses to scarcity? What will be the impact of these adjustments and responses on the pace and pattern of rural development? What types of indigenous innovations might arise spontaneously as adaptive responses to conditions of shortage?

To discuss the firewood problem predominantly in rural terms does not deny that African urban dwellers who use firewood for cooking and space heating have also suffered under the prevailing conditions of scarcity and higher prices for wood. While there is growing urban use of fuelwood, this urban demand is not the only contribution to deforestation and its attendant problems. Urban dwellers experience far greater potential for substitution of other fuels for firewood, albeit at higher prices.

Firewood: Patterns of Collection, Substitution and Purchasing

At the village level, various adaptive behaviors may be exhibited in reaction to fuelwood scarcity. Not all of these will be harmful; some may merely represent incremental changes in customary practice.

Under conditions of firewood scarcity, most villagers spend many additional hours collecting their fuelwood in order to keep pace with daily consumption. The gathering of fuelwood is usually the task of women and children; the more time they spend in search of wood, the less is available for the performance of other essential tasks. In areas where wood is not sold or bartered as a market good, villagers turn to substitutes as wood supplies dwindle. As fossil fuels are either too expensive or unavailable because of transport difficulties, people turn to locally available fuels such as dried dung or crop residues like millet stalks. Elsewhere the scarcity has forced Africans to spend limited household cash reserves on fuelwood or locally available substitutes. These range from charcoal to the burnable residues of local industry (furniture, sisal) which may be sold in the form of wood chips, shavings or woody fibers. In the urban areas which have had a tradition of commercial firewood, prices are escalating; it has been estimated that in parts of West Africa urban families spend one fourth of their income on wood or charcoal for cooking. (Eckholm, 1979: 28-29)

In towns of intermediate size, people will often shift to other fuels as the price of firewood goes up, but only if they can afford or obtain the substitutes. Turi Digernes found in Bara, Sudan that cooking patterns had undergone changes over the past ten years owing to the doubling in the price of wood and the clearance of the town perimeter. Whereas women all collected their own wood ten years ago, the distance to wooded areas has increased so much as to make individual collection impractical. Most women have made the adjustment to dealing with the professional wood sellers (some have been unwilling to pay for this formerly free good), but the increasing difficulty and expense of obtaining wood (and charcoal) in Bara have encouraged a shift toward the use of kerosene for families at a higher level of income. However, supply is uncertain and the price has increased rapidly. Turi Digernes noted that many families consume less kerosene now than ten years ago because the black market price has become impossibly high; they claim their standard of living has deteriorated as a result. (Digernes, 1977)

Brokensha reports that Kenyans in the Mbere Division have been forced to modify their former wood-burning habits and that wood use changes depending on availability of supply and patterns of land adjudication. Firewood first appeared for sale at markets in 1976; previously firewood was gathered as a free good, although persons with higher incomes could make financial arrangements to be supplied. Local views had changed, too; while the sale of firewood for income had previously been considered a sign of poverty, trees are now seen as an acceptable source of cash revenue. (Fleuret)

Increasing shortages of firewood and a reluctance to spend scarce household cash to purchase it could result in a return to the barter system. Conceivably, food or labor could be exchanged for fuelwood; in Tanzania, the exchange of wood and wheat has been observed. (Brokensha & Riley, 1978) However, when villagers are eventually forced to treat wood as a market commodity, serious adjustment problems can be foreseen. In many African cultures, women earn separate cash from their own income-generating enterprises. Would their income be spent on fuelwood, or would their husbands be responsible for purchasing it? What would the decision imply for the division of labor concerning firewood; would total responsibility for providing cooking fuel shift from

the women to the men? Changes in time-honored patterns of fuelwood collection could be potentially disruptive to the social fabric of village cultures, with ripple effects throughout the village economic and energy systems.

David Hughart has observed that the poorest (landless migrants, others) of the poor in rural areas will be the hardest hit by energy scarcity. The poor are denied access to community woodlots, to dung collection, and to agricultural inputs. They tend to adjust by using less energy or by spending more time developing energy sources or by reducing other necessary expenditures. Attempts to institute communal woodlots, collect animal or plant residues for energy processing, or contain indiscriminate fuelwood gathering may be blunted by the inability of the poorest villagers to take the same perspective as others concerning resource conservation for the future. (Hughart, 1979)

Effects on Nutrition and Health

Changes in cooking patterns, conditioned by fuelwood scarcity, will have important ramifications for nutritional levels and hence, maintenance of health and strength. There is already evidence in West African villages of a trend to reduce the number of daily cooked meals from two to one. Another fuel-saving response involves cooking food for less than the traditional length of time; this is damaging nutritionally as many grains need longer cooking times in order to break down nutrient substances. In parts of West Africa, observers have noted a tendency to cook meat less thoroughly, increasing the likelihood of parasitic disease. It is possible that African villagers will alter agricultural practices to grow more crops that do not require as much or any cooking, such as fresh vegetables. In one area, African women claim that beer produced from grain is more nutritious than the grain itself and they feed their husbands the beer because it fills them up faster. (Hoskins)

In addition, the fuelwood crisis poses a threat to the supply of one of the most important sources of protein in the African diet: dried fish. The fish is sold by petty traders, who trek it hundreds of miles inland from the villages where it is caught and processed for sale. (Graham and Gordon, 1979) Fish processing in Senegalese villages can involve wood-smoking as well as salting and sun-drying. As wood becomes more scarce and expensive in these villages, dried fish could be less available in other parts of Africa; this could create conditions of protein deficiency miles away from the specific fishing centers.

Solar dryers for fish have been suggested as an appropriate technology for fish processing. The use of solar dryers would cut out excessive wood consumption and dry the fish more thoroughly, forestalling further waste or illness resulting from spoilage. However, the local people must be able to afford this new technology. There is also concern that women would be eliminated from an income-generating activity in which they now have a substantial role.

Finally, it is possible that demand for the dried fish could be altered: prices could change if villagers perceived differences in the taste of fish processed with the new alternative technology. The smoke from wood-drying gives the fish a distinctive flavor, in addition to keeping bugs away and solar dryers would mitigate these effects. In some cases where new fish ponds were installed as a development initiative, villagers dried the fish for local consumption even though they could have eaten it fresh; hence established tastes may be significant barriers to innovation.

Rural Industry and Traditional Manufacturing

Solar driers may also provide a solution for the tobacco industry in areas such as the Tanzanian region of Tabora, where farmers consume large amounts of firewood to dry and cure the tobacco leaves. Although the Tanzanians have attempted to substitute indigenous coal for wood in some instances, they are also making efforts to alter their techniques in order to conserve firewood in the curing process. In Malawi, tobacco curing is estimated to require about 17 percent of national energy consumption. Demand for fuelwood in concentrated processing uses may even outstrip household demand in certain regions. (Arnold, 1979)

As population growth puts increased pressure on the land in rural areas, the generation of off-farm local employment opportunities will become crucial. World Bank projects and other donor efforts to encourage off-farm employment may result in the proliferation of more rural industries which will put pressure on existing supplies of fuelwood. Traditional manufacturing industries such as blacksmithing, charcoal-making, pottery-making or textile manufacture require large quantities of fuelwood. Not enough is known about each activity: who engages in it, how and where it is done, and how much fuelwood is used. For example, the amount of wood required to produce charcoal will vary according to local practice; research will have to be conducted at the village or regionally-specific level to determine the actual potential for conservation and the most suitable means of achieving savings. Traditional kilns or retorts for charcoal are inefficient users of firewood but

they require no capital outlay as they are constructed from local materials. The advanced kilns are more efficient, but they require significant cash outlay and must be transported to the site of use. The use of the newer systems, if they could be made affordable, would raise the efficiency of wood use in the charcoal industry, which is important because it supplies fuel for urban and rural households.

Environment, Agriculture and Deforestation -- The Vicious Cycle

The depletion of fuelwood reserves has causes other than the ubiquitous demand for cooking fuel; the spread of agriculture is in fact the major cause of deforestation. As population pressure increases, larger areas of forest will be cleared to create land for cultivation or grazing. Continuous fuelwood collection and the harvesting of commercial timber add to the pace of uncontrolled deforestation. The results, particularly in densely settled areas, include soil erosion, flash flooding, drying up of perennial streams and desertification. As soil fertility is lost, cultivation may decline or be discontinued.

The problem is compounded by another factor. As villagers substitute animal dung and crop residues for scarce firewood, they are decreasing the fertility of their land. (Spears, 1978: 4) Because commercial fertilizers are unavailable or too expensive for rural use, the diversion of dung and crop residues for fuel use contributes to declining agricultural productivity. Yields are low per hectare, which creates additional pressure to bring more land under cultivation for subsistence crops. This involves felling more trees and the cycle is indefinitely perpetuated. As Erik Eckholm has noted, the cycle of environmental degradation and deforestation is not simply a firewood problem:

> "Usually, uncontrolled deforestation is a symptom of a society's inability to get a grip on other fundamental development problems: agricultural stagnation, grossly unequal land tenure, rising unemployment, rapid population growth, and the incapacity to regulate private enterprise to protect the public interest." (Eckholm, 1979: 16)

* * * * *

The continuing fuelwood crisis suggests that rural people will be influenced by circumstances to make a gradual series of accommodations in the way they harvest, allocate, store and consume fuelwood resources. We can expect to see changes in

the ways cooking and heating are organized, in the roles and responsibilities of various household members, and in techniques of fuelwood uses. As traditional sources of fuel become more expensive and more difficult to obtain, villagers will be more willing to change their customary ways. This trend will probably encompass acceptance of small-scale renewable energy technologies if they can be introduced with sensitivity to cultural factors.

In order to make more rational assertions about future patterns of accommodation, we need to know more about the adjustments that village dwellers are making under conditions of scarcity. It would be of special interest to know of spontaneous innovations in the efficiency of drying, storage, and consumption of firewood in all its uses. Since patterns of fuel use, substitution and even scarcity vary from village to village, more information is needed before generalizations about future wood use and the ensuing development implications may be made with any assurance.

IV. AGRICULTURAL PRODUCTIVITY: ENERGY CONSTRAINTS AND THE GOAL OF FOOD SELF-SUFFICIENCY

Introduction

At present, the agricultural sector in most African countries is not a large user of fuel energy. Overall, only a small percentage of African farmers use chemical fertilizers and mechanized plowing or irrigation, and most of their produce (often specialty and vegetable crops, if not export crops) is intended for sale in the cities, not for consumption in the villages. Further, only ten to fifteen percent of all crops move in the commercial markets; if expanded to include village-to-village marketing, this figure is twenty percent. (Johnson) However, African agriculture is a large indirect consumer of precious fuelwood reserves and substantial increases in the use of petroleum-based fuel energy are planned in a number of countries.

Cursory analysis of the difficulties plaguing the subsistence agriculture of Africa suggests why African governments have intiated modernized agriculture programs. Other reasons include the high cost of imported rice and wheat subsidies and political factors favoring the goal of food self-sufficiency.

Programs to increase the use of energy-intensive inputs in large-scale commercial agriculture promise higher yields, but at the cost of building energy inefficiency into the agricultural

systems of countries unable to shoulder the financial burden of importing the petroleum-intensive inputs. (See Stryer, 1978) In the African context, how can the goals of increased food production be reconciled with the need to conserve fossil fuels? It is important to consider the realities, the trade-offs and the possible alternatives confronting policy and decision-makers in energy and agricultural planning. (See Frederick, 1976)

Any discussion of agricultural productivity in Africa is complicated by the differentiation within the sector and the large variation between techniques of production used in the "sub-sectors." For the purposes of this discussion, I will make the distinction between subsistence farming, small farms producing some cash crops, and large-scale commercial agriculture (plantation or large-farm).

Increasing Food Production: Dilemmas of Scale and Cost

Many rural areas of Africa are caught in a vicious cycle of population growth, ecological deterioration, increasingly extensive agriculture and continued deforestation. How will it be possible to increase food production in Africa, in the face of declining conditions in the rural subsistence sector? The solutions that are often suggested require efficient government planning, organization and implementation. Given the limited effectiveness of government extension services up to now and the paucity of transport infrastructure as well as the pressing need to keep the large cities supplied with food at the lowest possible price, it is unreasonable to assume that large-scale development programs will penetrate to most portions of the African hinterlands.

The acceleration of agricultural development and the introduction of advanced agricultural systems will involve the concomitant use of fuel energy inputs which have been primarily responsible for the large increases in the productivity of labor and land which are associated with such systems. The introduction of fuel energy inputs takes many forms:

> ". . . mechanization replaces muscular energy inputs in land preparation, planting, irrigation, cultivation, and harvesting; fertilizers help crops convert solar energy into food energy; pesticides reduce crop losses to insects and weeds; and other fuel energy forms are used in the processing and distribution of food." (Frederick, 1976: 93)

Advanced systems tend to be conceived and executed on a grand scale. In most areas of Africa, land is not the primary constraint to these activities. Could less energy-intensive methods work in such cases? Many analysts think not. Even where land resources are still relatively ample, low-energy agricultural systems can rarely be expanded without resulting in declining yields to land or labor. Generally, the most accessible and fertile lands are already being cultivated. The choice of options then becomes a matter of scale: will the African government in question opt for large-scale investments with high-energy requirements to open up the virgin lands, or will it choose to intensify the level of on-farm investments to counter the decline in land and labor yields in a situation of poorer natural growing conditions? For many areas, additional though related investments would also be necessary; and these might rely on technological advances like improved management of tropical soils or eradication of the tsetse fly.

The Sahel and Green Revolution Agriculture: Benefits, Costs, Trade-offs

One analyst has offered the following summary of the problem facing African development planners in the area of agriculture:

> ". . . the technologies associated with high labor and land yields have required large increases in fuel energy inputs. This has been true regardless of whether the development has occurred in countries with high or low land:labor ratios or in developed or developing countries. Moreover, the fuel energy used in these high yielding agricultural systems has generally come from fossil energy sources which would have to be imported by most developing nations. These characteristics of advanced agricultural technologies are hardly surprising since the technologies were developed under conditions of inexpensive and seemingly abundant energy supplies. However, in view of the dramatic increases in fossil fuel costs and the uncertainties regarding future energy costs and availabilities, the high fuel requirements of these technologies could pose serious obstacles to accelerating agricultural development in the developing areas." (Frederick, 1976: 101-102)

Despite this gloomy outlook with regard to energy costs, Sahelian countries, the Ivory Coast and others have declared their food self-sufficiency programs as central development priorities. Internal political and economic motivations have

dictated this policy choice and an obvious trade-off is involved: the continuous progress of the food self-sufficiency programs will act to intensify dependence on imported fuels, although it will lessen dependence on imports of rice and wheat. (CILSS/Club du Sahel, 1979) Extended dependence on foreign energy imports has apparently been considered as an inevitable associated cost of agricultural development in this region; as a Club du Sahel/CILSS study states:

> "The orders of magnitude involved, say 500,000 tons to 1,000,000 tons of oil a year are only a small percentage of the Sahel countries' total energy consumption in the year 2000.
>
> This use of oil is an obvious priority for the Sahel countries to achieve food self-sufficiency. It is therefore out of the question to subject it to an arbitrary limit." (CILSS/Club du Sahel, 1979: 73)

The Sahel food self-sufficiency programs are designed to require the following energy-intensive inputs:

- -- irrigation
- -- mechanized plowing
- -- petrochemical fertilizers and pesticides
- -- transport of agricultural inputs (improved seeds, fertilizer, motor fuels)
- -- transportation for extension services
- -- fuel for fishing boats (where part of program, i.e., Senegal)

As these Green Revolution techniques are adopted in Sahelian agricultural development plans, many of these inputs will be imported at high and increasing cost from the developed world, although it should be noted that the modern sector of countries like Senegal and the Ivory Coast is increasingly able to produce fertilizer and other needed inputs. Because countries have opted firmly for food self-sufficiency without careful attention to the energy implications of their plans, they could encounter some difficulty in financing the imports necessary for implementation. Potential impediments to the smooth progress of these projects include the rising cost and periodic world-wide shortages of fertilizers and the future uncertainty of oil supplies, not to mention rapidly escalating petroleum prices.

Moreover, adoption of the new technologies forces farmers to rely primarily on outside sources of supply for improved seed varieties, fertilizer, pesticides, fuel and credit, as well as markets for their products. Inevitably, the degree of risk that farmers come to associate with this process is an important influence on the rate of innovation. Many of the necessary inputs are complementary; fertilizer, pesticide, irrigation, and good seeds must be used together, as Green Revolution techniques are based on the use of seed varieties which respond well only to favorable growing conditions. Therefore, it is scarcely worthwhile to supply farmers with irrigation unless the seed and fertilizer are available to take full advantage of the water. By the same token, if water supply is uncertain because of the lack of a system of irrigation or difficulties with fuel supply (for pumping), the use of fertilizers and improved seeds becomes a riskier and less attractive investment. As Kenneth D. Frederick has observed:

> "Both the price and the reliability of access to inputs are important factors in a farmer's willingness to become dependent on purchased inputs. Farmers don't care whether these inputs are imported or are produced domestically as long as the supply is reliable and the price reasonable. However, a nation's willingness and ability to provide its farmers with reliable, low-cost inputs is likely to decline if foreign sources are involved. . . . [The] availability and cost of the fuel-intensive inputs are commonly determined by foreign suppliers and a country's foreign exchange reserves. The sharp increases in international energy prices and the global fertilizer and pesticide shortages of recent years illustrate the risks of being dependent on foreign fertilizer, pesticide and energy sources." (Frederick, 1976: 104)

A situation of increasingly scarce and expensive energy also raises the issue of the cost of food self-sufficiency programs to the individual government in question. In most programs, the government is involved in subsidizing some or all of the new techniques to a certain extent. Subsidies to encourage farmers to use the imported fertilizers and mechanized inputs put a strain on the government budget. Middle- and high-level distillates are already heavily subsidized in all African countries. In many countries, government extension services have very little mobility in the form of transport for field staff; rising fuel costs will inevitably cut the effectiveness of extension efforts presently in place. In the event of sudden and/or drastic oil price increases, the governments are forced further into debt as

they cannot pass on the costs to producers or consumers; to raise food and fuel prices in most capitals is politically disastrous and overall food production will not increase or even continue at consistent levels without some degree of government subsidy. Irrigated rice schemes, planned in several Sahelian countries, appear to be highly dependent on subsidy:

> "Except for the Office du Niger, where most investment is considered as sunk, the costs of irrigated production appear to be very high. This is especially true of some of the large-scale, mechanized schemes along the Senegal River. Furthermore, there is a close relationship between the costs and the amount of subsidy furnished by government. Thus not only do those schemes decrease economic growth and efficiency directly, but they also are an important drain on public revenues which could be used to finance development elsewhere. Because of their need for substantial subsidies and the limited resources available to the Sahelian governments . . . it is unlikely that these schemes will be able to contribute much to the achievement of self-sufficiency." (Stryker, 1978: 43)

This is not to imply that food self-sufficiency programs are inherently wrong-minded as development initiatives for Africa. However, the decision to undertake such a program is generally made in the absence of any extended analysis of energy costs, a good indication that energy constraints are not considered sufficient deterrents to the plan. Few analysts would advocate that energy costs and availability should be the predominant factors in the food self-sufficiency decision. But in an essay concerned with the interconnections between energy use and development, it is important to understand what is implied when a country deliberately undertakes large-scale programs which utilize a highly energy-intensive set of inputs.

Alternative Techniques of Production: Costs, Research and Development

How will it be possible for countries committed to the goal of food self-sufficiency to enjoy the potential benefits accruing from Green Revolution agricultural techniques in the long-term without locking themselves into an energy-intensive agricultural path that could have detrimental ramifications for other development objectives? Potentially, there are two options:

-- to adopt a resource-conserving approach to the practice of Green Revolution agriculture, or

-- to investigate the development of alternative agricultural technologies which do not rely solely on energy-intensive inputs.

The realization of the first option is made more difficult in many cases because the Sahelian countries often lack detailed, long-term national energy policies. Therefore, the energy needs of the food self-sufficiency programs have not been carefully analyzed from the perspective of potential conservation or program re-design. There is scope for more efficient use of chemical fertilizers, and rising energy costs will discourage the somewhat indiscriminate mechanization which has occurred in some cases. (Abercrombie, 1978: 14) An overall attempt to conserve fuel energy in agricultural development planning would involve an input-by-input examination of the energy-intensive technologies in order to determine areas of potential substitution or adjustment. Experiments with gravity, wind, and photovoltaic irrigation pumps have been undertaken in several areas in Africa; so far, results are expensive and not encouraging. (CILSS/Club du Sahel, 1979: 73-76)

It has been suggested that schemes to accelerate agricultural development could do well to concentrate on developing food and cash crop production on small, rainfed farms by introducing improved seeds, fertilizer, animal-drawn equipment and other inputs. (Stryker, 1978: 45) This general approach might be complementary with the goal of reducing energy intensity in agriculture, although it would be necessary to introduce at least one fuel energy-consuming input (fertilizer). This tactic would save energy in comparison to a highly mechanized technique of production, but the yields would almost certainly be less spectacular, varying according to natural rainfall.

The limitations of a resource-conserving approach suggest the second and complementary option: the challenge of developing alternative technologies to enhance agricultural productivity. Technologies requiring less fuel per unit of output and alternative energy sources for farmers could be instrumental in easing the food and energy problem of African countries in the next fifteen to thirty years.

Research has focused recently on the need for more efficient conversion of solar energy to plant matter. Plants are inefficient converters of solar energy into food energy. Even at highest rates of efficiency, crops which produce record yields now photosynthesize at only half their potential rate. Research is presently underway to improve upon this performance. Scientists have expressed optimism that this research will produce significant results and one expert suggests that there are three possible routes to success:

-- to select genetic varieties with greater photosynthetic efficiencies;

-- to modify plant architecture for better light reception;

-- to apply chemicals to suppress glycolate biosynthesis and inhibit photorespiration. (Frederick, 1976: 216)

Clearly the first two choices would act to increase food yields in proportion to fuel energy inputs.

Research is also in progress to increase the capacity for biological nitrogen fixation in certain plants, such as legumes. It is even possible that nitrogen fixation ability might be transferable genetically to grain crops that do not now possess this characteristic.

* * * * * *

It is inevitable that a certain percentage of African countries will choose to take the Green Revolution path to increase the productivity of agriculture as rapidly as possible. It is to be hoped, however, that such energy-intensive techniques will not be adopted indiscriminately or without careful energy assessment, in light of the rising cost and increasing uncertainty of supply of petroleum resources. For the long run, African governments may find that it pays to evaluate food self-sufficiency programs very carefully with an eye to conserving fossil fuels and, wherever possible, reducing the level of structural dependence on non-renewable, imported energy. Sahelian governments have made it clear that they will prefer in the future to rely on irrigated perimeters, nitrogen fertilizers and mechanized inputs to achieve the goal of self-sufficiency in rice. With careful attention to technology choice, alternative paths, and economies of implementation, they may not have to exchange dependence on food imports for a system that relies on fuels and products whose price and availability will be determined in the volatile climate of international petroleum markets.

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FIREWOOD SURVEY:

THEORY AND METHODOLOGY

by James T. Thomson

INTRODUCTION

This document presents a framework for a survey of firewood problems in Africa. Using survey data, host countries and A.I.D. Missions should be able to more effectively identify and design appropriate projects to either increase firewood supplies or reduce firewood demand.

The document contains two parts. The first, an overview of firewood problems in Africa, lays a theoretical basis for the second part, a recommended survey package consisting of four questionnaires and two inventory instruments for use in host countries.

The overview presents an analysis of African firewood problems, focusing especially on institutional constraints and problems which may discourage production of adequate firewood supplies. It addresses as well two approaches to reducing fuelwood demand: switching to alternative fuels and improving combustion efficiencies in charcoal-making and cooking.

The survey package contains two groups of instruments which are designed to reveal official and individual producers' and consumers' perceptions of firewood situations - do problems exist? where? why? how serious are they? - and the feasibility of various solutions. Group I focuses on rural aspects of firewood problems and includes interviews of forestry officials, rural producer-consumers of wood, and charcoal makers. Group 2, which focuses on urban firewood problems, consists of an urban consumer questionnaire and an alternative fuels price form.

I. OVERVIEW OF FIREWOOD PROBLEMS

Demand for firewood has outstripped supply in much of contemporary Africa. Arid and urban areas now face the worst pinch, but population growth will soon create scarcities in many regions where supplies remain temporarily adequate. Since firewood will almost certainly continue to be the staple cooking and heating fuel of most African families, sustained severe shortages will sharply reduce many Africans' living standards.

The Problem: What Strategies for Firewood Production?

The pertinent problem, thus, becomes identification in particular settings of best strategies for preventing serious firewood shortages. Solutions fall into two classes, depending on the relationship between fuelwood supply and demand. Where supply exceeds demand and the resource is held in common, resource management is not yet indicated. Costs will be held to a minimum by merely allowing individuals to serve themselves at will.

Once demand exceeds supply, management becomes indispensable. Sustained yield management of fuelwood resources can be achieved in three ways: grow more, use less by making wood fires more efficient, or use less by shifting to other fuels. Which will work depends on technical, economic, financial, political and legal factors shaping contexts within which solutions might be implemented. The firewood survey proposed in this paper will assist in identifying individual's perceptions of both natural resource supply situations and relevant social and institutional factors. This will help in understanding why people act as they do, including obstacles they see to changing current firewood production and use patterns.

The present analysis therefore highlights technical, legal, political and economic impediments to reforestation and then suggests several strategies to reduce or overcome them. Drawbacks as well as advantages of individualist, collective and mixed approaches to woodstock management are considered. In a concluding section, firewood conservation possibilities are discussed in terms of both more efficient cooking and charcoaling processes and the substitution of alternative fuels for firewood.

Six Potential Constraints to African Firewood Production

Assume an African state wants to promote local participation in firewood production. Assume home and market demand suffice, all else equal, to encourage peasant production. Certain constraints may nevertheless hamper sustained yield management of the local woodstock. Major problems include:

1. Availability of seeds and/or seedlings, whether nursery stock or natural regeneration, of appropriate species. In land-scarce and food-short areas, "appropriateness" will reflect

species' compatibility with crops, effects on soil fertility and valuable by-products.

2. Land tenure, tree tenure and associated residential patterns which may:

   a. blunt farmers' interest in wood production if they don't own land they farm, and

   b. affect ease of protecting trees and thus choices between woodlot and on-field production schemes.

3. Feasibility of protecting trees from foraging livestock.

4. Feasibility of protecting trees from unauthorized cutting by humans.

5. Enforceability of property rights in land, which affects risk and advisability of growing such a slow-maturing crop as trees, and in trees, i.e., damage remedies when protection fails.

6. Collective action capabilities at the local level, given distribution of political (rule-making) authority there and in overriding regimes.

Each of these issues may affect African peasant's calculations of the desirability of agro-sylvo-pastoralism. The following illustration highlights some of these constraints.

Hedging the Law: A Case Study of Wood Production Problems *

Abdu Issa runs a peasant farm on ten arid acres of West African Sahel. One recent dry season, he decided to start a fuelwood plantation/windbreak through the middle of his sandy field; by planting the break counter to prevailing east-west winds he planned to reduce wind erosion on part of his land. As his field lies close to his home, Abdu also felt the hedge would simplify life for his wife, who gathers all firewood.

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* This is a partially fictionalized account which illustrates some of the constraints to fuelwood production in a Sahelien context.

FACTORS INFLUENCING FIREWOOD PRODUCTION

DEMAND

Consumptive Uses Rural and Urban, Market and Auto-Consumption

- firewood
- construction
- implements
- cordage
- fencing
- browse
- etc.

Non-Consumptive Uses, Rural

- nutrient pumps
- anti-erosion windbreaks
- protection of soil against hydraulic erosion
- live fencing
- shade
- valuable by-products (nuts, medicines, etc.)

INDEPENDENT VARIABLES

PERCEPTION OF FIREWOOD SCARCITY

Firewood becomes more costly in money or collecting time

POPULAR INTEREST REDUCING DEMAND AND INCREASING SUPPLY IN WOOD-SCARCE REGIONS

Collective Action Possibilities
- Locus of decision-making authority?
- Local rule-making, enforcement possibilities?
- Local taxation powers?
- Outside funding sources?
- Information costs about wood use?
- Relations with over-riding regimes?

Enforcing Land Tenure Rights
- Value of land
- Costs of legal action

Enforcing Tree Tenure Rights
- Informal policing possibilities
- Value of trees
- Costs of legal action
- Benefits of legal action
  - restitution of wood value?
  - punitive damages?

Appropriate Species
- Natural regeneration or planting feasible
- Land available or tree varieties not crop competitive
- Nutrient pump action?
- Growth characteristics?
- Wood characteristics?
- Valuable by-products?

Land Tenure
- Security for investments in producing trees?

Tree Tenure
- Who controls slow-maturing tree crop?
- Investment worthwhile?

Residential Patterns
- Close-settled versus dispersed - surveillance possibilities vary

First Protection Problem: Livestock
- Trees' self-defense mechanisms
- Grazing pressure
- Herding rules
- Damage remedies
- Proection possibilities: enclosure, guarding

Second Protection Problem: Humans
- Trees as private property
- Trees as common property
  - unregulated?
  - formally regulated, effectively unregulated?
  - formally, effectively regulated?

FEASIBLE COLLECTIVE AND INDIVIDUAL OR FAMILY WOOD PRODUCTION STRATEGIES

DEPENDENT VARIABLE

SUPPLY

MORE WOOD PRODUCTION

REDUCED DEMAND

Improved Combustion Efficiency
- Cooking
- Charcoaling

Substituting Alternative Fuels
- Cheaper?
- More convenient?

Abdu put in Commiphora africana, a small tree often used for live fencing because it can be started in the dry season from cuttings off existing stock. Trimmed hedges become dense and grow up without shading out adjoining crops. Modest nutrient requirements further reduce competition with crops. Trimmed branches burn nicely and, though slow growing, the wood is hard enough for saddle making. Finally, C. africana is not on the protected species list in Abdu's country. He could cut it without fear of being fined by a forester, as he might be were he to plant Acacia albida or any of fourteen other species on the list. Nor would he need permission, available for a fee (or a small bribe), each time he wanted to trim it. 1/

Unfortunately, other villagers at first took too little, then too much interest in the hedge. Livestock roam freely here after the harvest. Once fields were bare goats browsed the C. africana leaves and tender twigs in the daily struggle to fill their stomachs, thereby stunting the little trees. Many villagers saw animals chewing on the hedge, but no one shooed them away: after all, local rules allow animals to rove freely during the dry season.

Local interest picked up, however, when the hedge put out larger branches. Village women, too busy to comb surrounding fields for fuel, lopped off many for firewood. They all knew Abdu had planted the hedge but rationalized their actions by saying they were local residents at liberty to cut any unprotected species. These species are by national law unregulated common property unless title has been established to specific trees (planting formally vests title in the planter, by forestry code provision, but this rule is not universally respected in rural areas). Those who did not cut Abdu's hedge never told his trimmer's names for fear of being labeled troublemakers.

Abdu's wife complained; he finally got angry, caught a woman "trimming" his hedge and called a case against her before the canton chief. Since he lived in the same town, time and court costs were minimal. Had Abdu lived ten miles from the canton seat in a village with no local moot, such court action would have been much more expensive in time and money.

1/ The forestry code in this country in fact vests ownership of planted trees in those who plant them. But peasants are often reluctant, for a variety of reasons, to formally establish title. Many forestry guards see there an illegal opportunity to increase fines or bribe income ... and take it if they can.

In court, Abdu presented his complaint. In reply, the woman's husband publicly ridiculed him for being so petty as to haul an honest housewife to court over something so minor as a stick of wood. Moreover, he asserted, there really was no law preventing local people from trimming unprotected trees.

The canton chief, as judge, tried to decide after hearing the parties. The case perplexed him: what did Abdu expect? The woman had certainly taken the wood, but it was worth almost nothing. Did he want two cents' worth of compensation? Embarassed, Abdu said he didn't care at all about that piece of wood, but he did want an end to unauthorized trimming of his hedge. He asked for a two-dollar fine. The chief declined. He had no legal authority to impose such a fine. Nor could he legislate new rules, even were they to apply solely within his canton. Only his administrative superiors at the national level could make such decisions; at most he could only conciliate the parties.

True, he might have let Abdu pronounce a Quranic oath to prohibit further hedge trimming without permission. But penalties violators would face (leprosy, or poverty) were too draconian for the value involved. Moreover, he knew his superiors would rebuke him if he consented to the oath. It really offered no solution to Abdu's problem.

The chief's admonitions finally convinced the husband that his wife should give Abdu fifty cents in damages. She did; after all the fuss, Abdu had to accept. For his troubles, he made himself a laughing stock of village gossips. Damages did not even cover court costs, to say nothing of his loss of face. Worse still, the amount would not deter future trimmers, the more so because everyone knew Abdu could not afford, in personal terms, to call another such case. Nor were others likely to, after this debacle.

Later, somebody cut two good trees out of the windbreak. Abdu ignored the incident, though he could have used the wood; and the hole channelled strong air currents through the trees, severely eroding topsoil on both sides of the opening. He lost both ways.

Fuelwood windbreaks have not become popular items in Abdu's village. Implications of this example for firewood production using other unprotected species are only too clear. To raise protected species for fuelwood would require the regional forester's written consent - difficult to obtain, if only in waiting time. Otherwise, a standard permit would be needed to authorize cutting or even trimming above the three-meter level.

This account suggests some of the social, legal, political and technical constraints which may affect firewood policy and production schemes. Systematic examination of these and other obstacles to sustained yield management is now in order.

Constraints on Firewood Production: Details

1. Appropriate Tree Seeds or Seedlings

To pervert a proverb, great oaks from little acorns grow ... only. Seeds, seedlings or saplings, from natural regeneration, direct seeding or transplanted private or government nursery stock constitute the starting point of reforestation. They must be adapted to the job at hand, i.e., reproduction must be technically and economically feasible, survival rates adequate in rainfed (r irrigated) plantings, and wood must be adequate as fuel. All else equal, faster-growing species will be preferred. But other things are not equal. In addition to firewood, some species produce good construction materials, as well as valuable by-products such as foods, medicines, gum, tannin and fibers.

Non-consumptive uses served by various species also vary markedly, and these may sharply influence a farmer's decision to grow one rather than another, or to grow trees at all. In land-rich areas, crop-competitive characteristics - space, light, nutrients and water requirements - may be immaterial. But in infertile, land-scarce areas villagers will be extremely sensitive to these aspects: fuelwood for cooking is a basic necessity only if there is food to cook. Thus, there are undeniable advantages to species which fertilize crops through nitrogen fixation, reduce wind or water erosion, or act as nutrient pumps in bringing soil chemicals leached below the reach of crop roots to the surface again as leaf mulch or manure. [Poulsen, 1979a:4] These on-site uses and growth characteristics will influence farmers' decisions to plant fuelwood or stick exclusively to crops.

If disseminated to farmers, improved varieties could tip the balance in favor of more wood production. Greater cash income from tree by-products and replacement of market by homegrown items might well compensate for less cropland. Yet, much remains to be done in appropriate species research, development and dissemination.

2. Land Tenure, Tree Tenure and Residential Patterns

Land Tenure

Land tenure can be succinctly defined as "those legal and

contractual or customary arrangements whereby people in farming gain access to productive opportunities on the land" [Dorner, 1972:17]. Land tenure systems allocate productive opportunities. Those who firmly control land they farm can plan with security. But the tenant who expects his landlord to evict or shift him to another plot after several years to prevent him establishing title by prescription cannot plan improvements with the same security. He may be perfectly aware that terracing, live fencing or windbreaks eventually improve land productivity, and yet certain he will gain nothing thereby. Thus, he may rationally opt for short-term investments in greater fertility. Manure or chemical fertilizer promise return to investment at the next harvest, assuming he gets a reasonable share of the crop produced. Although such attempts to maintain soil fertility are probably inadequate in the long run given undiminished wind or sheet erosion, the farmer who expects to move on will find them preferable to longer-term, more fundamental improvements.

This logic applies with equal force to wood production schemes, since trees take at least four or five years to reach useable size. The potential fuelwood farmer whose view of the longer-term is cluttered with land tenure-related risk factors cannot be faulted for hesitating to grow trees.

Tree Tenure

African tree tenure terms often add another risk which inhibits investments in firewood production. Land ownership and tree ownership don't automatically go together. In pre-colonial times, he who planted a tree usually owned it. If he also owned the land under the tree, either might be sold without parting with the other. Trees growing wild in the bush, by contrast, often counted as "free goods" (or "bads", since they had to be cleared before cultivation).

Probable Indifference to Woodstock Management When Supply Exceeds Demand. It seems probable that few rural Africans were initially disturbed by deforestation. Accustomed for centuries to slash and burn agriculture, they judged woodstock levels by availability of free bush land.[2/] So long as forested lands remained for colonization, a frontier mentality prevailed. When farmland and surrounding bush failed,

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2/ Political boundaries drawn along ethnic or state lines clearly put some "available" lands off limits to aliens of the political communities involved. Such politically-imposed land shortages induced active conservation practices in many areas [Ware, 1977:174-75].

migration/colonization commonly offered the easiest way out. Under such circumstances, it made little sense to actively manage renewable resources. Positive conservation measures to permit continuous use - windbreaks, sheet erosion control terraces and dikes, etc. - demand sustained effort. They require more labor input than clearing forested, fertile lands which can be fallowed when worn out while the farmer opens new fields elsewhere. Given sufficient land, passive conservation-fallowing fields well before they were totally exhausted - served quite well to restore soil fertility and trees to the landscape. Africans knew this.

Colonial Forestry Measures. The colonial conquest brought a European-style forestry service to most African areas by the 1930's. Modifications in tree tenure followed. Colonial officials, fearing deforestation, imposed forestry codes. They generally tried to freeze demand rather than promoting sustained yield management. Particularly in the French colonies, codes restricted use of valuable species by establishing a protected species list and creating extensive forest reserves, without regard to customary African land and tree tenure rights [Raeder-Roitzsch, 1974]. Upholding these regulations against popular resistance required suppresive police action, a hallmark of Sahelien forestry ever since. With foresters spending the lion's share of their time chasing illegal cutters, opportunities for a cooperative approach to forestry were few indeed.

Much Wood Remains Unregulated Common Property. In many Sahelien states today deadwood and unprotected live species remain effectively unregulated common property. In supply-tight situations of the sort increasingly common in Africa, this arrangement, often underwritten through local-level misinterpretation of national forestry codes or regulations, discourages wood production. Where wood is available for the taking wood ownership is established by appropriation, not by investment in planting, nuture and protection. Despite urgent need for reforestation, working rules of tree tenure in such cases render the activity virtually pointless from the perspective of individual conservers.

Significantly, people increasingly consider deadwood private property in the evolving common law of many African locales (e.g., Zinder Deparment, Niger and Yatenga Department, Upper Volta). This development reflects peasant dissatisfaction with forestry code rules as locally interpreted. Research to determine villagers' perceptions of this situation should be a priority item in programs focusing on incentives and deterrents to increasing firewood supplies.

Critical Issue: Changing Attitudes about Conservation? Do shrinking firewood supplies make conservationists of peasants? If so, policy implications are far-reaching. Popular readiness to innovate, to experiment and to do added work necessary to use new techniques successfully may sharply reduce efforts needed to "sensitize" people. Peasants who want to reforest because they foresee shortages should make a willing audience for forestry extension workers. Conversely, premature efforts to make active conservationists of villagers not yet convinced by personal observation of a resource crunch, may merely waste everyone's time and money. Scattered fragmentary evidence suggests this is the case [Thomson, 1979a; Thomson 1980b], but more research on the question is indispensable.

Note, however, that pro-conservation attitudes by no means lead automatically to conservation activity. Intervening variables discussed in this paper shape farmer's final estimates of feasibility of sustained yield management, whatever their desire for this.

Residential Patterns: Close-Settled versus Dispersed

Some African peasants live in villages at the center of the community's fields. Others live in dispersed family units, each on its own field. If, as seems likely, trees have to be protected from livestock pressure and illegal trimming, dispersed settlement cuts surveillance costs for scatter-sited trees (windbreaks, live hedges, trees interplanted with crops). Close-settled communities, with many more eyes and ears, can better patrol village woodlots located close to population centers. But such sites are often hard to come by: agricultural competition is great for the rich fields, constantly fertilized by compound sweepings, manure and nightsoil, which lie in the first circle of land around villages [Raynaut, 1978].

Assume only protected seedlings survive. Then raising them in sites beyond range of costless surveillance by villagers going about their everyday tasks implies either hiring a guard, enduring unauthorized depredations, or giving up. Because most locations in dispersed-settlement communities can always be seen by someone, such localities may enjoy a tactical advantage in wood production over close-settled villages.

3. The First Protection Problem: Trees versus Livestock?

Many knowledgeable observers maintain that African arid area reforestation is feasible only if trees receive adequate protection from browsing livestock, particularly goats. Others argue the contrary [Poulsen, 1979c: 6-8]. The issue is, thus, problematic; research should seek data to help decide when, where, and if various species must be fenced to prosper. Given

cross-African variations in grazing pressure and tree species' self-defense mechanisms (thornless, thorn types, etc.), few sweeping generalizations about fencing are likely to be valid.

Major Interdependencies in Traditional Sylvo-Agro Pastoral Systems

Symbiotic relationships between highly productive herding, farming and tree-growing activities unquestionably exist [See Funel, 1979; Thomson, 1976]. To maintain this system of mixed farming under a tree canopy at peak productivity, interrelationships must be managed in mutually-reinforcing ways. When antagonistic competition replaces harmonious complementarity, the ensuing negative dynamic degrades the productive capacity of the system to the point of sterility. Desertification may well result.

Controlling Grazing Pressure

If livestock can destroy natural regeneration of trees, reforestation depends on control being exerted over livestock movements. In most Sahelien African countries, animals forage during the rainy season only under guard. After the harvest, however, they often roam at will. This cuts feeding costs; investments in herding, enclosures or fodder stocking are avoided.

Treating dry-season fields as a common property encourages overstocking. Each additional animal means more profit for the owner. But when pasture carrying capacity is exceeded, each additional animal marginally reduces food supply for every other animal. Hunger drives them all from the lush to the rough grasses and eventually to saplings, curtailing natural regeneration of the woodstock. This is the classic tragedy of the commons, in which a once valuable renewable natural resource is reduced to dust or hardpan laterite by uncontrolled overgrazing.

Two kinds of solutions to overgrazing exist; making pastures private property to encourage each owner to take account of the full costs of overstocking his own land; or political controls, to keep grazing pressure at or under carrying capacity. Both involve problems.

Controlling Livestock Movements

Short of these solutions, fuelwood resources can be protected from livestock by regulating livestock movements through herding, enclosure or stabling and tethering, or by somehow protecting trees, whatever happens to pastures.

Herding requires pasturage, herders and returns to herders' investments. Full-time transhumant herders, e.g., Fulbe and Twareg, are harder to control in terms of protecting the woodstock from abusive cutting of woody browse than are sedentary herders who have a greater incentive to respect local regulations concerning exploitation of tree forage. For herders, keeping hungry animals from gardens and woodlots is easier than protecting scattered natural regeneration. Local goats often are not herded, however, since their limited value does not justify the labor input.

Fencing is always difficult because it is expensive. Traditional fencing materials - thorns, mats and live hedges - may be in short supply, either because they are protected by forestry code provisions [Thomson, 1977: 64-65] or because population pressure has largely eliminated free bush lands. Enclosing larger areas reduces per unit cost, as some ethnic groups who maintain consolidated forms of land tenure have found [Souleymane, 1979]. Typically, however, this cannot be achieved when fields are small and scattered.

Stabling requires substantial labor inputs to collect fodder. Generally this is feasible only during the growing season, when grasses and foliage are plentiful near at hand. Tethering on pastures is again only feasible when forage is plentiful, i.e., when trees need no particular protection from livestock.

Where lack of appropriate sites precludes informal policing (see above, p. 55) seedling survival may depend upon active guarding. Local funds (rates or voluntary contributions), money from overriding governments or international aid donors may permit hiring guards. Or, assuming adequate political organization, guard duty might be shared on a rotating basis within the village.

Woodlots can be fenced given sufficient traditional materials or units large enough to reduce wire fencing costs to acceptable levels. Reusing materials on other sites once trees have outgrown stock pressure will further reduce costs.

Scatter-site, in-field wood production may also be possible using browse resistant species or fenced saplings, <u>if</u> tree growers are committed to protecting them and <u>if</u> they have legal access to enough thorns from mature trees.

4. <u>The Second Protection Problem: Trees versus People</u>

Doubts may exist about when, where and to what extent foraging animals threaten wood production. But people unquestionably destroy innumerable trees looking for fuelwood

and other forest products. Whether the woodstock will be run down or not depends on institutional incentives to balance supply and demand.

Trees as Private Property: Protecting and Producing to Guarantee Supply

Where trees are private property, tree owners either protect them or bear losses occasioned by theft. Two consequences flow from private ownership of trees. Firts, a "do to others as you would have them do to you" ethic is implicit, i.e., don't steal wood if you don't want yours stolen. Second, tree owners and their dependents function as an informal local police force. Community members thus help enforce tree tenure rules instead of leaving the entire job to foresters. Treating trees as private property also motivates individuals to produce them for their own use. Where all trees are privately owned, he who doesn't provide for his future wood needs by growing now will later pay the going price for lumber and firewood. Forestry service heads in Niger, Upper Volta and Mali are all interested in exploring individual investment in tree production along with collective approaches to reforestation.

Unregulated Common Property Trees: Consumption Without Production

Where trees are common property, wood will be harvested on a first come, first served basis. This reduces incentives to produce, since the tree planter has no guarantee he will reap the benefit of his investment. In this case, demand can exceed supply without automatically pressuring individuals to act in their enlightened self-interest by investing now in supplies to meet future needs and thus avoid total deforestation and environmental degradation.

Environmental Destruction through Peasant Stupidity or Inappropriate Rules? People often admonish African peasants to become aware of environmental degradation. Yet, it is highly unlikely that peasants fail to see ecological breakdowns occurring around them. They may be aware, concerned and yet simultaneously immobilized by inappropriate rules.

What motivates an individual to insure regeneration of an unregulated common property woodstock threatened by excessive demand? Very little, in fact. The peasant who values trees on his field as windbreaks, forage sources, soil fertility regenerators and the like will at most try to get his firewood elsewhere. If free bush exists nearby, he will use that. But once bush goes, desire for trees on his own field goads him to harvest those on his neighbor's fields to meet his own construction and firewood needs [Thomson, 1979b]. Given excessive demand, the unregulated

common property system leads to a "cut anywhere but home" ethic of forest exploitation. Instead of encouraging each landowner to invest in future supply, this ethic leads peasants to cut their losses by not investing in regeneration of common property woodstock which somebody else will most likely consume. Instead, people spend more time, energy and money meeting daily needs from the dwindling supply. To overcome the dissociation between investment in supply and reward inherent in all common property systems, special management capabilities must be developed. Some political community must control use and promote supply. Conceptually this is always possible; practically it is often difficult and costly ... often, but not always.

Spontaneous Conversion of Common Woodstock to Private Property

Assume the woodstock is formally unregulated; any tree is legally fair game for anybody. Given resource scarcity, will conversion of trees to private property replace the first come, first served rule? Economic theory argues the commons will be parcelled into private units when it is both technically feasible to enforce property rights and economically advantageous to do so. Field data from a rural region of Upper Volta not patrolled by the Forestry Service support the prediction. In addition, formerly common property crop residues (peanut vines, millet stalks, etc.) are now treated as private property in parts of Niger and Upper Volta where destruction of bush has made livestock forage a scarce commodity. This change encourages more individual investment in wood supply; other alternatives also exist.

Common Property Woodstock: Formally Regulated, Effectively Unregulated

Assume a woodstock is formally but not effectively regulated because of inadequate enforcement. Even though firewood demand exceeds supply, incentives still discourage a move to better wood supply management through informal conversion of trees to private property. Everybody is in the same boat: all have to cut protected species illegally to satisfy urgent needs for wood. It is, therefore, difficult for anyone to protect his "own" trees by preventing others' cutting on his own land. 3/ Worse, nobody can morally afford to assist foresters in protecting

3/ Given a formal permit system, an individual could in principle acquire one and then legally cut trees on his own land. But since foresters are thin on the ground (a) it is expensive in time and energy to find them, at which point one must pay for the permit, and (b) since they are thin on the ground, it is often possible to get away with illegal cutting. When this becomes everybody's least-cost solution, unregulated deforestation proceeds apace.

trees except where such "collaboration" is the only way to avoid unjust punishment for others' illegal cutting on one's own land. This leaves the forestry service with total responsibility for defending the woodstock.

Reducing Disincentives to Invest in Supply of Common Property Woodstock

Disincentives to producing common property trees can be reduced by subdividing common property trees into exclusive units allocated to specific user communities. Formalizing local control should encourage village investment in policing and increasing the woodstock by explicitly allocating management responsibility to village residents. This strategy seems especially attractive where some fields are already treeless; reducing potential hardship some would suffer through privatization of trees currently maldistributed on village lands should ease transition to sustained yield management.

Village governments or quarter committees could regulate access. Local management units would be empowered to exclude non-residents.[4/] By reducing information costs and facilitating consensus required to maintain a local regulation system such units might well cut policing and investment costs involved in building collective supply.

Equitable Management Requires Accurate Information. Adequate collective management decisions depend on accurate knowledge about who's doing what with the woodstock. Wood must presumably be distributed under some locally acceptable formula which would equitably apportion supply and hardships associated with short supply. Details of distribution formulae appear an intimately local matter, defined by each village's consensus about what is right and proper. Two general conditions hold, however.

4/ Where scattered quarter or village land holdings interpenetrate each other, interesting boundary problems can be expected. If they are sufficiently intractable and collective management is considered a must, special woodstock management districts not necessarily contiguous with existing villages or quarter boundaries might offer a solution. Each district would regulate wood on a group of contiguous fields no matter where field owners resided or were registered for census and tax purposes. The approach is not without problems; however, they will not be explored here.

First, such formulae must be enforceable to be effective. If those who run short are permitted to raid the collective woodstock, the now inappropriate first come, first served rule will replace group management.

Second, a formula will only work it it is seen by villagers to achieve equity. Arrangements that don't, will be violated by aggrieved peasants pressed for fuel. Considerable room for local experiment exists here, but the smaller the user group and the greater their daily interaction the lower will be information costs [Olson, 1965]. It may only be possible to control use of guarded woodlots; monitoring wood gathering from on-field trees not in woodlots may be simply too expensive. If so, privatization of trees not in woodlots may be the only workable way to manage them for sustained yield.

Achieving Consensus. Consensus on distribution formulae and investment in new wood supplies will be easier where the quarter or village is accustomed to taking collective decisions, if the same process and persons can handle woodstock management. Otherwise, organizational difficulties must be surmounted before local collective management will be feasible. This issue is discussed in greater detail below.

New Supply Increments. Local collective management for sustained yield assumes sustained investments in new supply. Planting trees and protecting natural regeneration require labor, perhaps money.5/ Management units thus require authority to impose user charges, labor service or taxes on group members. In many parts of Africa, such authority does not now exist, at least for purposes of collectively producing trees.

User Fees. User fees might provide a way to sensitize users to the social impact of their individual demands on the woodstock. They could promote conservation by adding a price to the time and energy invested in harvesting fuelwood. They could also generate funds to pay for more supply in the form of woodlots or by protecting natural regeneration (fences, guards' or herders' salaries). Again, adequate information and effective enforcement would condition feasibility.

5/ Acquiring access to woodlot sites poses fascinating problems. Location of sites, terms of cession (sale? loan? rent? conditions of reversion to owner?), possible effects on distribution of product must all be examined ... but not here. Local political authority seems indispensable. Overriding regimes should offer a dispute resolution process only to settle intractable local deadlocks about woodstock problems.

5. Enforcement of Property Rights in Land and Trees

This section treats the critical problem of rule enforcement. It builds on earlier discussion of protection problems, particularly arguments about informal policing mechanisms and local collective action organization.

Enforcement: The Indispensable Minimum

Laws are man-made artifacts designed to organize human conduct for certain ends. Laws, however, are not self-enforcing. Formal laws only become effective when individuals and officials uphold them in cases of dispute or violation. Absent enforcement, laws remain mere formal orderings, paper rules, without the capacity to shape realities of human conduct. Effective laws, by restricting choices open to individuals, raise odds that desired actions will occur.

Collectivizing management of a common property woodstock when demand exceeds supply illustrates the process. Individual users' choices about where to harvest are reduced by the management unit, and investments in supply promoted. If rules are effective sustained yield results instead of resource degradation.

Whether officials command the necessary power to enforce rules is problematic. Assuming they do, whether they will use this power to uphold formal laws depends (1) on whether their decisions are subject to review by superior officials (and if so, how those officials exercise their powers); and (2) if their decisions are not subject to review, whether they consider a particular law should be upheld in light of their own analysis of the situation. Where an official has the last word, or determining power, the danger always exists that this capacity to enforce laws may be abused to promote the official's interests at the expense of at least some members of the going concern.

Information about working rules, and the enforcement process that underlies them, is thus indispensable to accurate understanding of why people act as they do.

Legal Costs. Legal costs include time and energy necessary to litigate, official and personal costs of coming into court, lawyers' fees and illegal payments to court personnel.

All else equal, the lower are legal costs, the more vigorous one can expect litigants to be in protesting rule violations and perceived unjust rulings. Officials' exercise of power will thus face greater scrutiny, diminishing the potential for abuses.

Village moots to resolve disputes and maintain local rules probably offer the most efficient, low-cost solution to enforcement problems. Village moots by no means guarantee a just legal process. Yet appeals to overriding regimes are usually possible. This provides a partial check on local court-holders and makes rule manipulation less attractive in their eyes if superiors consistently correct abuses. Although necessary as a control measure, however, appeals can threaten integrity of the local legal process if sued too frequently. They may then make village-level rule enforcement impossible [Thomson, 1976].

Enforcement of Property Rights in Trees

Where excessive demand threatens the woodstock, are trees valued enough by somebody so rules promoting sustained yield management can be upheld by enforcement when necessary? What are the costs, and therefore the likelihood, of enforcement?

Land disputes usually don't face this cost deterrent to effective litigation because land is so obviously important as a factor of production most peasants will jump to defend it, whatever the price of litigation. Trees are another matter. Where supply exceeds demand peasants will not likely complain about cutting. Even when the balance changes, it may be some time before people perceive the loss of a tree as one they suffer. Sooner or later, however, lack of wood will bring the questions of tree tenure and enforcement processes become pertinent. Who owns what? What kinds of policing deter violators? When formal rights are violated, what kinds of recourse are available at what costs?

Policing: A First Order Solution. Policing is an indispensable start towards management. It demonstrates somebody's concern with trees directly and puts potential violators of notice they are illegally infringing collective or individual interest in the woodstock.

State control and policing of the woodstock to the exclusion of all local involvement in management is a major weakness of many contemporary Sahelien reforestation schemes. It dissociates policing and harvesting interests: foresters police alone and everybody else harvests on the sly. Moreover, the financing now available to most African forestry agencies is insufficient to permit the massive staff increases necessary for effective control. Thus, exclusive state policing will not encourage sustained yield woodstock management.

Local policing, where trees are collectively owned by local units or held by individuals, appears to offer a useful alternative. However, unless enforcement is effective there will be a return to the working rule governing unregulated common property woodstock use: "Cut anywhere but home."

Local Enforcement: Calculations. Insistence on enforcement of tree tenure rules will be heightened if clear remedies exist when illegal cutting occurs. If user fees are in force, reimbursement should be provided in kind or cash for wood taken. Tree tenure rule violators, having paid the appropriate fee for wood taken, should also compensate owners for the loss of non-consumptive uses they suffer when live trees are felled. As an added deterrent, punitive damanges might also be imposed.

Combined sanctions must be adequate to deter but not so draconian as to hinder application. Only the local sense of equity can set appropriate standards. Local autonomy in this respect is a necessary element in effective local management, as is authority to modify penalty structures in light of changing definitions of equity.

Judicial Costs. As with land tenure enforcement, judicial costs to the litigant will affect his willingness to prosecute violators of tree tenure rules. Unless these costs are minimal, wood owners aren't likely to bother litigating.

Collective ownership, because it spreads any loss sustained over all group members, probably means the management unit will have to designate an enforcer to represent the community in proceedings against violators. The representative should be compensated for shouldering this responsibility.

6. Issues of Collective Action

Governments or external donors often assume villages will handle the local organizational and managerial aspects of fire[illegible] projects, not recognizing that many villages cannot handle these matters. In many areas, traditions have eroded and informal collective action capability has greatly weakened or expired, or there is no legal authority for making local decisions. Unwillingness to grapple with the implications of this local disorganization and consequent dependence on outside decision makers and decision-making processes simply means programs are highly likely to fail.

Erosion of traditional forms (and their replacement by informal modern alternatives in some instances, e.g. religious communities and voluntary organizations) is extremely variable across, but also within, ethnic groups. Organizational capacity is a village-specific, even a village group-specific phenomenon. (See Thomson, 1980c: 14-16) Projects should be

designed to take account of this local complexity, by drawing on villages' organizational strengths where possible and respecting others' limits by not arbitrarily imposing collective forms on those which now lack such capacity. Designs should build in local options to choose reforestation strategies from a range of possibilities. For certain kinds of reforestation programs, it will be necessary in some locales to invest time and energy reconstituting or creating local autonomous capability.

Collective Action Costs

Two kinds of costs associated with collective action can be identified: (1) costs of taking collective decisions, e.g. time and effort required to establish a management structure and to obtain authorization from higher government levels; and (2) costs flowing from decisions taken, e.g. land loss sustained by villagers whose fields may be expropriated for community woodlots or user fees which people may be required to pay. (See Ostrom, 1968) These costs vary with degrees of effective local autonomy and organization in any particular community; however, the higher the costs, the less likely that collective action will be taken.

Where local structures can achieve consensus and uphold decisions with or without official authorization to enforce rules, time and effort required to establish a woodstock management structure may be relatively low. But in consequence, some people may bear substantial costs. They may lose land, or have to buy wood, or invest in new supplies when they would prefer to do other things with their time or money.

On the other hand, where local government is weak, consensus may be extremely difficult to achieve and decisions impossible to impose. In consequence, people may escape immediate costs associated with decisions they don't like. It is probable, however, that failure to manage woodstock for sustained yield will lead ultimately to desertification in much of Africa, costs of which are probably incalculable.

If to manage their woodstock, local communities require authorization from higher government levels, e.g., district, county, state or national jurisdictions, in general one can expect costs of getting authorization will rise as the authorizing level becomes more remote. Since officials only have as much time as anyone else, they typically cannot deal with all problems presented, but only with those they consider most important. A village petitioning for permission to manage its own woodstock (in the absence of special enabling legislation) is likely to face great difficulty acquiring the requisite authority. Thus, one can expect villages to be uninterested in formulating and presenting such petitions.

The problem will be dealt with, if at all, in a top-down manner by officials who view it as serious enough to merit their attention.

Alternative Fuel Sources

Preceding sections have explored ways to produce more firewood. Reducing effective demand for wood offers another means to sustained yield management of African woodstocks. Two obvious strategies exist: shift to alternative fuels; improve cooking and charcoaling combustion efficiencies.

Alternative Fuels: Possibilities and Problems

Contemporary discussions of African firewood issues commonly list five possible alternative fuels to firewood: (1) charcoal, (2) manure and crop residues, (3) fossil fuels - butane gas and kerosene, (4) solar energy and (5) electricity.

Charcoal. Recent studies show charcoal gaining importance as a cooking fuel, especially when wood source areas lie a certain distance from consumption centers. [French, 1978:27-28]. Lower transportation costs of charcoal compared to firewood compensate for higher preparation costs. Impact of charcoal use on wood supply remains unclear because researchers disagree about heat energy lost during charcoaling and cooking. Estimates range from 7.5 percent to 84 percent. Even if losses are as low as 10 percent, increased charcoal use will translate into significantly higher demand for wood. The rural and urban consumer surveys recommended in this paper assess use and market data for charcoal.

Manure and Crop Residues. Both often become fuel in many parts of contemporary Africa. It is highly questionable whether they should since, as potential fodder and fertilizer, they are much needed for animal and soil fertility maintenance. Stricter privatization of both may evolve, pricing them out of the fuel market. Surveys should determine working rules governing access to and use of both manure and crop residues.

Fossil Fuels: Butane and Kerosene. Until the recent petroleum price hikes fossil fuels offered an attractive alternative to wood among relatively affluent urban Africans who lacked time to cook because of employment obligations. The trend has now reversed in some areas [S.A.E.D., 1977].

In many African states any massive shift from domestic wood to imported fossil fuels would seriously threaten an already shaky balance of payments position. Credit ratings and availability of development loans would be adversely affected.

African states having domestic petroleum reserves could market butane or kerosene at domestically subsidized prices without directly risking balance of payments difficulties; but they would forego valuable foreign exchange domestic petroleum products would otherwise command if sold abroad at world market prices. Against this background, only serious fuelwood crises would justify classifying domestic urban demand for subsidized fossil cooking fuels as an indispensable need.

Rural dwellers will not shift to fossil fuels unless there is a severe wood shortage and both fuel and cooking apparatus are highly subsidized. New modes of food preparation, perhaps new foods, and changes in rural domestic life rhythms implied by substitution of hot, quick-cooking fossil fuels for low heat, slow-cooking firewood could also generate resistance to changes.

Solar Energy. Solar energy has yet to prove itself as a viable fuel for cooking anywhere in Africa. Social feasibility depends on cooking patterns. If cooking takes place early or late in the day, solar energy fails because the sun will not generate adequate heat. Unless timing can be modified and accompanying dislocations in other domestic patterns accommodated, solar successes will be few.

Even if timing poses no problem, expense and efficiency of solar stoves often hinder adoption. Design problems also dampen local enthusiasm for solar stoves: intense heat prevents use of traditional utensils to properly stir cooking foods.

Electricity. Electric stoves are expensive but technically feasible; however, generating current by burning fossil fuels again raises balance of payments problems if fuels must be purchased at world market prices. Distribution grids outside densely populated urban areas will probably be prohibitively expensive as well. Where cheap hydroelectric power becomes available, as it increasingly will in certain African urban areas, electricity could feasibly substitute for firewood.

Cost Comparisons

In each survey country, general cost data will be gathered for firewood and for each alternative energy source. Converted to standard energy units, cost comparisons will provide a partial basis for policy planning.

Where people harvest their own fuel sources (firewood, crop residues, animal droppings), surveys will record time devoted to fuel collection. Respondent's attitudes about this activity will also be checked to assess willingness to switch to other fuels and motivation to engage in greater fuelwood production.

Improving Combustion Efficiencies

Surveys should identify (1) range of cooking stove types traditionally employed in the country, (2) rough efficiencies of each, (3) range of charcoaling processes; and, if possible, (4) rough efficiencies of each. Such data may be readily available in some survey countries. VITA may have relevant information on these matters, as will the CILSS Forestry and Ecology Section for the West African Sahelien zone.

Cooking Stoves

Where no data exists, surveys will identify range and distribution of stove types and approximate amount of fuelwood required to do a week's cooking for the respondent's family. Once prevalent stove types have been identified, a combustion expert should establish reliable efficiency data through laboratory and field tests. Special funding for such tests must be allocated in any survey country lacking appropriate and reliable information.

Charcoaling Processes

The charcoal maker's survey will be used wherever charcoaling is a specialized occupation. Survey teams will record the range of charcoaling processes and approximate efficiency of each. This will be impossible in some areas without special field equipment and budget supplements because charcoaling amounts to nothing more than firing and then smothering standing or fallen dead trees. Without prior sectioning wood cannot be weighed before firing to establish process efficiencies. It may be simpler to arrange tests with charcoal makers near an adequate scale and other equipment, rather than running field tests.

CONCLUSIONS

In addition to considering firewood conservation through improved combustion techniques or substitution of alternative fuels for firewood, this analysis of African firewood production problems has addressed technical and institutional issues which may impede woodstock management once dwindling wood supplies convince local residents that active conservation measures are reasonable. Clear possibilities exist in Africa for greater tree production and sustained yield woodstock management, but realizing these will depend on awareness of and ability to overcome the problems discussed.

Technical advances - more appropriate species, production techniques, etc. - remain critical; peasants already hard-

pressed to survive will shun species and projects they know to be unproductive or threatening to short-term crop production.

The kind of woodstock management strategy appropriate for any particular user community depends on land and tree tenure rules, political organization capabilities, the judicial process and woodstock protection possibilities. Some villages or village quarters can master both individual and collective approaches to wood production. They may prefer one, or the other, or a mix. Others, lacking appropriate local institutions, are restricted to individual enterprises. Probabilities that either will succeed can be greatly heightened by legal changes, particularly in some African national forestry codes. Reforms should give villagers greater incentives to participate in woodstock management by authorizing local communities to make and enforce management rules necessary and relevant in light of local conditions. Reforestation project designs should also address these critical issues as the most efficient way of promoting effective reforestation and environmental management in African states.

II. SURVEYS AND IMPLEMENTATION*

The Survey Package

The recommended survey contains two groups of instruments. GROUP ONE, which focuses primarily on rural aspects of firewood problems, contains:

1. Forestry Official Questionnaire
2. Rural Producer-Consumer Questionnaire
3. Charcoal Makers' Questionnaire
4. Village Background Data Form

GROUP TWO, focusing on urban aspects of firewood problems, comprises:

1. Urban Consumer Questionnaire
2. Alternative Fuels Price Form

In general these questionnaires will seek the following kinds of information:

Forestry Official Questionnaire

This survey will gather data from officials about wood reserves by region, including estimates of deforestation rates,

* The actual questionnaires and detailed guidelines on survey implementation were included in the original paper and may be requested from the Energy Adviser, AFR/DR/SDP, Agency for International Development, Washington, D.C. 20523

firewood consumption per capita, firewood availability by region, and all fuelwood management projects planned or operational. Copies of formal rules governing wood production and use (forestry codes and other regulations) will be collected. National and regional foresters' willingness to adopt collective, individual or family, and mixed strategies of woodstock management will be assessed. Information about technically desirable reforestation sites (appropriate soil quality, rainfall and temperature) will be obtained from forestry officials if possible; otherwise, other government agencies and research institutes will be approached for this information. It will subsequently be used to map appropriate reforestation areas.

Rural Producer-Consumer Survey

This multi-purpose survey instrument will collect data in rural settings about villagers' perceptions of:

1. desirability of local fuelwood management projects;
2. availability of species villagers consider appropriate;
3. land tenure, tree tenure and local residence patterns;
4. need to protect fuelwood trees from animals;
5. need to protect fuelwood trees from other humans;
6. possibilities and problems of enforcing land and tree tenure rights;
7. village collective action possibilities;
8. fuels currently used, how acquired, availability and cost (in money or labor);
9. fuel use trends and explanations for these;
10. stove types and approximate combustion efficiencies; and
11. cooking patterns (meal preparation times and cooking periods during the daily cycle).

Data produced by this survey will allow policy makers to generalize about perceptions and characteristics of firewood problems within surveyed villages. The data would not permit rigorous generalization from surveyed villages to surrounding communities even though the latter may share many common problems.

From this range of cases, however, certain guidelines for effective fuelwood management projects can be extracted. Assuming planners and administrators pay careful attention to local details in subsequent projects or - better by far - create implementation systems supple enough to permit villagers to tailor solutions to their particular problems, these guidelines will greatly facilitate later project identification and planning.

Surveyed villages will produce data most useful for future planning if they accurately represent conditions typical of particular areas. Two of the ten villages should be located in surplus firewood areas as identified by forestry officials. Assuming such villages are representative, data from them should reveal the effect of perceived surplus firewood supplies on peasant willingness to participate in firewood management projects. The remaining eight villages jointly should meet the following criteria:

1. location in deficit firewood areas as identified by forestry officials;

2. location in areas of actual or potential local-level fuelwood management programs;

3. representative of as many ethnic groups, major land tenure and residence patterns as possible; and

4. otherwise representative of their immediate areas.

If possible, among the ten communities investigators should identify two village pairs similar in all respects (environmental setting, politico-legal, cultural relations) except fuelwood availability. Comparison of data from such paired surplus-deficit firewood communities would critically test the hypothesis that villagers become interested in wood-stock management projects when they perceive firewood scarcities.

Charcoal Makers' Questionnaire

This quota survey of five charcoalers per survey village will be administered by the rural producer-consumer survey team. It will inventory types and approximate combustion efficiencies of charcoaling methods currently employed in each survey site.

Village Background Data Form

This form is designed to collect general information, such as village population, size and location of households, the organization of local legal and administrative systems, crops grown and livestock raised. Working with local political and administrative officials, each enumerator will complete the form for his/her survey site.

Urban Consumer Survey

This survey will gather data in two cities about urban dwellers' perceptions of:

1. fuels currently used, how acquired, availability, and cost (in money or labor);

2. fuel use trends, and explanations of these trends;

3. stove types and approximate combustion efficiencies;

4. cooking patterns (meal preparation times and cooking periods during the daily cycle).

A stratified random sample will reflect three major urban socio-economic divisions:

- elite residential quarters populated by affluent nationals and expatriates;

- popular quarters comprising houses, frequently numbered, situated on numbered lots (city hall should have lot and house numbering data); and

- shantytowns created with no official regulation.

Data produced by this survey will permit analysis of firewood demand in the two survey cities and projection of probable fuel use patterns. Petroleum price escalations during recent years have changed urbanites' perceptions of probable future costs of fossil fuels (butane and kerosene). If demand remains unchanged, this is a significant development; if it has shifted back towards firewood, increasing pressure on fuelwood supplies can be predicted. Such data will be useful in deciding about the desirability, size and location of fuelwood production plantations and will inform policy makers about the advisability of efforts to promote fuelwood management in areas further removed from urban centers.

Alternative Fuels Price Form

The team will collect data from major suppliers in both urban areas on the evolution of butane, kerosene, electricity, charcoal and firewood prices over the preceding five years. These data will facilitate construction of reliable cost comparisons between firewood, charcoal and alternative fuels.

Survey Schedule and Budget

The Firewood Survey will take eight months to complete, one month for preliminary contacts between the project coordinator, host country officials and other interested parties, and seven months for survey adaptation, administration, data tabulation, and analysis. The estimated cost per country is $89,000, including $67,000 for the ten-village rural survey and $22,000 for the two-city urban survey.

SURVEY RESULTS

Surveys will produce data about rural and urban demand for firewood in the context of competing fuels, feasibility of different firewood production strategies (individual or collective; plantation, woodlot, windbreak, etc.), impact of firewood scarcity on willingness to conserve, already initiated conservation strategies, and stove and charcoal combustion efficiencies. This information can be used in firewood policy planning and project design. It will help determine appropriate areas for firewood production projects, organizational format for projects, material inputs needed, where forestry extension work is desirable, what species are appropriate, and the possibilities for fuelwood conservation.

Meetings to Disseminate Survey Results and Plan Firewood Projects

The Project Coordinator, in consultation with USAID Mission and supervising host country personnel, will schedule a series of seminars and conferences with interested parties during the last two weeks of the survey. Seminars should be geared to examination of data and their policy implications, and to preliminary negotiations on firewood projects appropriate and feasible in light of survey data.

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CRITICAL ISSUES FOR DESIGNING ENERGY SURVEYS IN AFRICA

by Thomas Graham

INTRODUCTION

This paper discusses a number of issues important to energy program officers involved in the design and implementation of energy surveys, as well as impressions gained through survey work in Swaziland and Cameroon.

A survey consists of information gathered and analyzed in the field concerning the demand for and supply of energy sources and conversion technologies. There are several ways in which such information can be acquired: direct interviews with residents, experts, officials, artisans, etc; group discussions; observations of peoples' behavior and taking scientific measurements. * The need for such information in Africa is greatest in the rural sector, where most of Africa's poor people live and work. We have a comparatively firmer grasp of energy realities in the modern commercial sector, where the bulk of fossil fuels are used.

Surveys are important in assisting host government and foreign donor energy planners in the formulation of comprehensive energy policies and in identifying field projects. Similar information may be gathered in the course of implementing energy projects; but this is considered part of the monitoring and evaluation process, a topic covered separately in the accompanying essay by George Burrill.

I . Issues

Priority issues which should be kept in mind during the design process are as follows:**

- Energy assessments should fully reflect the needs, wants and preferred solutions expressed directly by people being surveyed.

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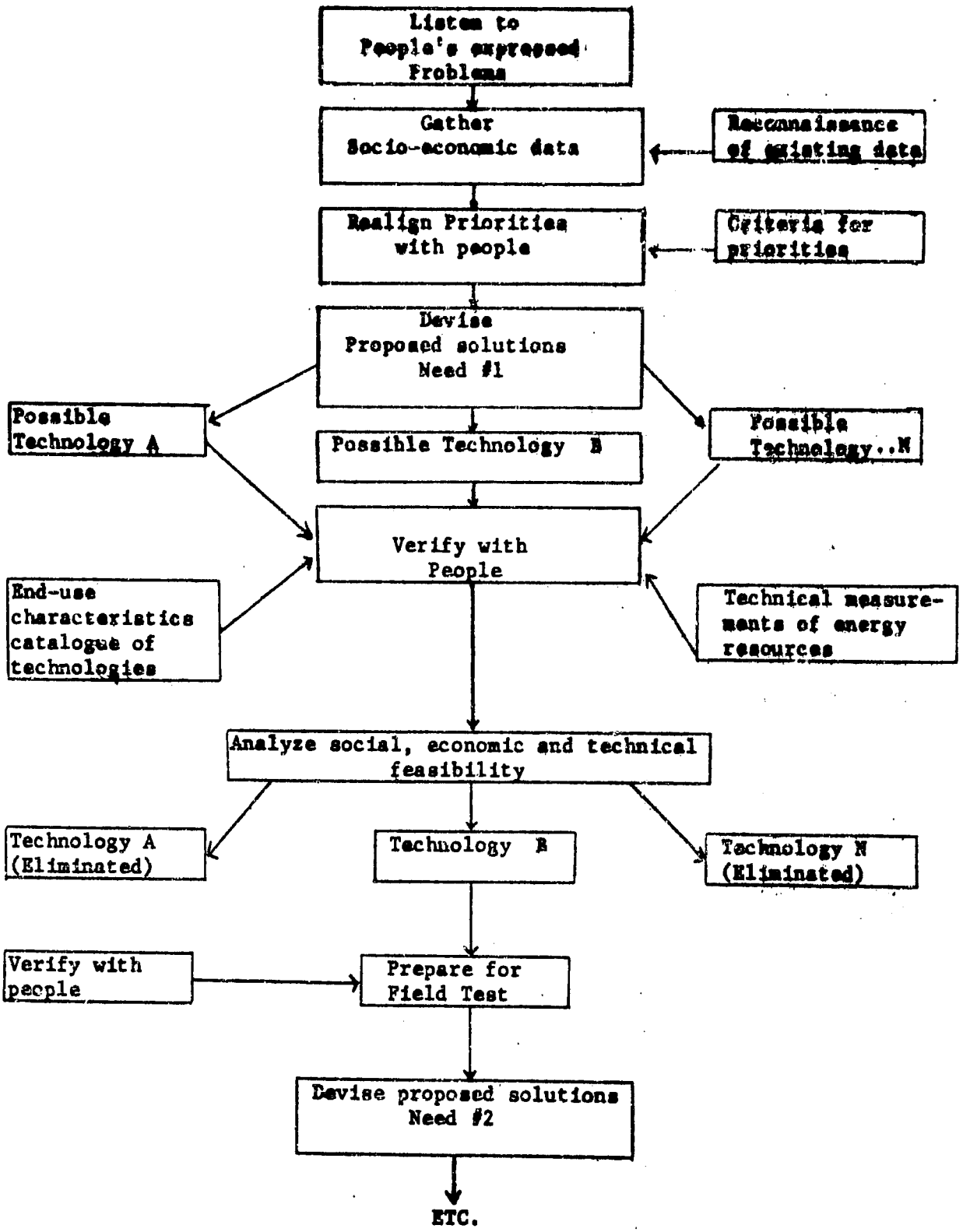
* For a detailed review of survey design issues, including objectives, data base, ways to collect and analyze data applicable to Africa, etc. see Donovan, Hamester and Hattien, Inc., (Graham, Delasanta, Reliquet) Africa Energy Survey Methodology. Wash., D.C., A.I.D. Africa Bureau, June 1979, 2 volumes.

** The diagram on the following page outlines the steps recommended for the design of energy surveys and will be referred to throughout the paper.

PERFORMING ENERGY SURVEYS



- **Avoid collecting a surplus of data.**
- **Technical data should be collected after, not before, initial socio-economic data.**
- Subject energy conversion devices to formal feasibility tests prior to building and installing them for demonstration.
- Stagger a series of technology-specific surveys with field tests.

1. It is essential that surveys reflect needs, wants and preferred solutions, as expressed directly by people being interviewed or observed.

What villagers and poor townspeople tell us is critical in finding out which technologies are most relevant to their local needs and financial capabilities. In designing renewable energy surveys, the following suggestions are offered to insure maximum contributions from local people:

- Listen to minority as well as to majority opinions;
- Concentrate on the proper way of talking with people to obtain important information from them;
- Respect the positive reasons people tell us why they act as they do in dealing with fuel shortages.
- Try to involve the same respondents throughout the entire survey process: needs identification, data collection, feasibility and analysis.

The first suggestion is based on assessment methodology itself. Normally one attempts to interview people so that conclusions on their attitudes and behavior reflect those of a larger population and area. Statistical procedures accentuate the importance of finding the average, in order to make generalizable recommendations. However, in specific cases, we can learn a great deal from those individuals who do not reflect average opinion. They might be people who are trying out new ideas in a village. For example, a survey might identify a local entrepreneur who has found an easy way to manufacture and distribute charcoal. There might be people who have found ways to conserve their efforts in collecting fuelwood. A number of women may be sharing the same efficient grain grinder. Of course, if such initiatives are to be emulated, we must be sure that the people carrying them out are viewed positively by other members of the community.

Another way to involve local inhabitants in the energy survey is to focus on the best style of communication with them. In the preliminary stage of survey design, local respondents should be asked who should ask them questions. Who would have their confidence -- a local influential person? a university student who comes from the local area? a government extension agent? a social scientist? Normally, selection of interrogators is made by outsiders for professional and logistical reasons. But these reasons are secondary to the urgent priority of eliciting candid and accurate responses from people. It would be preferable to avoid using expatriates in face-to-face contact with respondents. Ideally, the survey should be carried out by a local institution experienced in dealing with rural development problems. Such an institution can then recruit and train those interrogators preferred by local people.

Communication will also be enhanced by determining the best setting in which to ask questions. In some cases, group discussions are more effective than interviews between two single people; in other cases, individual interviews will be best. Normally, single interviews using precoded questionnaires are easier to standardize, process and analyze. Group discussions, if they are open-ended, are particularly difficult to analyze for common findings. Observation, not questioning, by an effective outsider may result in portraying well what people do but not so well in finding out what they think. It may be useful to try out the same questions initially using all approaches to find out the one best. However, an easier way might be simply to choose the interrogator so carefully that he or she could work out with the respondent(s) the best setting for questioning.

Rural energy surveys should determine the positive reasons why people take certain actions in dealing with an energy shortage? For example, it would be very useful for an energy survey to tell us why people want to continue to cut down trees: they perceive wood as a free good; an alternative fuel is too expensive; they do not see the need to buy stoves; they like socializing with one another around wood fires; etc. All this does not exclude the possibility that people may suggest an explicit solution, e.g., organize a nearby woodlot.

Finally, people will be more involved in energy surveys if they participate in several aspects of the process:

- They could comment on what surveyors conclude about their behavior.
- They could react to what outside analysts determine through feasibility tests to be economically and socially acceptable technologies.

- The same people could be the users of those technologies under field test.

- They could advise evaluators how their devices are working.

In order to use the same people for a prolonged time, some sacrifice of methodological rigor or logistical convenience might be necessary. To be representative, for example, a survey might have to be conducted in remote areas. The people responsible for testing new systems, on the other hand, may wish field trials to be carried out near the major cities where they live. To avoid starting over with new people at each stage of the process, it may be necessary to find a compromise between these conflicting objectives.

2. Avoid collecting surplus data.

The role of energy in development is such a comprehensive subject that a preliminary assessment can be a complex undertaking. However, planners have scarce resources and need to apply survey findings efficiently. There are several ways to avoid having to collect and analyze extraneous data:

- Focus on objectives.

  Careful choice of specific policy and research objectives will narrow the information base required. The level of precision and detail judged necessary will also limit the data base. For example, planning growth in the total national energy sector, investigating specific energy development schemes, and quantifying rural energy needs will require different amounts of data.

- Do secondary research first.

  Planners can undertake a reconnaissance of previous surveys and field studies to find out fuel-specific data, end-use characteristics of energy-conversion devices, and related socio-economic information.

- Consider ways in which the data are to be analyzed.

  If we know how we are eventually going to analyze the data, then the questionnaire can be designed to collect the specific data needed for analysis. For example, if benefit-cost analysis is to be used to judge economic feasibility of new systems in the areas surveyed, what data are needed to perform such analysis?

- **Listen to people.**

  Once a particular need has been expressed by people, only relevant data need to be collected. As an illustration, if the overriding need of a particular area is for cooking fuels, it is unlikely that some form of wind conversion power would be relevant, although the same area may have high and regular wind velocities. Hence, wind data need not be collected. Of course, if the survey area is large, other needs may be identified where wind measurements have a place; but to find the total raw energy potential for specific villages before identifying needs may be an expensive proposition.

3. Technical data should be collected after, not before, initial socio-economic data.

As we said earlier, assessments should start by ascertaining what local people need, want and prefer to do about their energy-related problems. The next step would be to collect data that would provide more information on what can be done about these problems. Among questions to be addressed might be the following:

- What kinds of energy is being exploited and used (fossil fuels, biomass, human animal and mechanical conversions)?
- How are people coping with shortages of fuel?
- How do use patterns change because of these shortages, and how are they affected by links to the cash market economy?
- What are the degrees of complementarity and substitutability among alternative fuel uses?
- What are the perceived, nominal, and real costs of such fuels to the individual, the market, and the society at large?

The intention here is to arrive at hypothetical solutions to meet the expressed needs of the villagers; these potential solutions can then be discussed with the villagers.

At this point it would be wise to initiate technical measurements to determine engineering feasibilities. As mentioned earlier, such physical measurements need to be selective since only those data which are relevant to people's

expressed needs should be collected in the local area. Where appropriate, such physical data might include:

- Water stream flows and head (e.g., for micro-hydro technologies);
- Solar energy intensities;
- Wind velocities, variability and direction;
- Energy efficiencies of particular devices; and
- Spoilage factors of foods.

Such information applicable to specific sites could well supplement those objective data already (and ideally) gathered in some form of handbook of end-use conversion devices. Both sets of data could then be used by the survey enumerator when technological options are discussed with local people.

4. Undertake formal feasibility studies of technologies identified in the survey before the devices are built and installed for testing and demonstration.

Let us suppose that a preliminary energy assessment has just been completed for a particular region of the country, with a focus on local systems for food production, distribution and marketing. A reconnaissance of existing data and consultation with people resulted in gathering data on four options where fuels might be used more efficiently, or where new sources of fuel could be applied. Three of the four general options are removed as being found not reflecting people's wants, needs or preferred ways of dealing with the problem. The remaining option, say, food preservation, could be facilitated with five candidate technologies worthy of further investigation.

Do we conclude the energy survey at this point, publish the results and recommend that field practitioners go ahead and build and install the five specific devices for field testing? No, the survey needs one additional step: subject all five devices to objective feasibility tests. We shall refer to these tests as the "analytical filters" through which survey data are passed. The first filter is a qualitative checklist -- a socio-cultural feasibility analysis. The second filter is benefit-cost analysis which is used to predict financial benefits to the investor-user and economic benefits to society at large. A third filter, engineering feasibility, is more commonly understood and accepted and will not be discussed here.

The socio-cultural "filter" will look at the proposed technology in terms of:

- The existing technological and environmental system (subsistence technology, shelter and crafts, the cycle of the economic year and transportation).
- The economic system (allocation of productive resources, organization of work, distribution and patterns of consumption and distribution of income).
- The social system (kinship organization, associations, and system of stratification).
- Political organization (authority, law).
- Belief system (religion, observances, religious hierarchy and power).
- Languages. [Donovan, Hamester and Rattien, 1979]

Such a socio-cultural catalogue should answer these critical questions:

- What are the incentives for taking the risk for acceptance and use?
- Who would benefit and how?
- Who would control the time saved by use of the device, and what alternatively would be done with such time?
- Who pays, owns, controls, and inherits the device? (Tinker)

The second "analytical filter" - benefit-cost analysis- should be based on the following kinds of financial and economic data, reflecting both private and national benefits:

- Value of output from the technology;
- Alternative employment opportunities foregone;
- Costs of site preparation and installation;
- Direct operating costs in labor hours and in cash;
- Extension costs borne by outside agents for introduction and maintenance of the system;

- Local rates for borrowing money; and,
- Characteristic local investments. (French, 1979)

The objective here is to answer the following questions:

- Does the proposed system have a positive rate of return from the national ("economic") point of view?
- If so, does the system also promise positive returns from the ("financial") point of view of the person who is expected to buy it?
- If economic returns are positive and financial returns negative, can a case be made for public subsidies to make the system more attractive to investors?

For field project designers and managers, there are very real advantages to carrying out feasibility tests before and as well as during field testing. Most obviously, it may be possible to save money by screening out at least a few technologies. It is probably cheaper to engage the very short-term services of a local sociologist and economist to provide the analyses than to pay for building, installing, and demonstrating what could have been earlier predicted to be an unwarranted, risky and unacceptable device.

Another reality of pilot field tests is a bit more subtle. We need to encourage unsupervised daily use of the product rather than oversell initial acquisition. Pilot projects tend to be resource-intensive: funding is often lavish; the best equipment is allocated at a high priority; the best staff usually gets assigned; subsidies to lessen the user's risk tend to be excessive. All these factors tend to emphasize the acquisition of a device to such a degree that actual use patterns get disguised. Pre-test feasibility analyses help to further the objective of permanent adoption of a new technique because what is being promoted has already passed a proxy test for acceptance.

In order to use such analytical filters in the field during the course of a survey, certain problems need to be considered:

First, one might ask how benefit-cost measures can be accurately applied before the device is actually installed and used? In particular, we refer to two items: costs of site preparation and installation and direct operating costs in labor hours and in cash. To meet this problem, economists have devised a technique called "sensitivity analysis".

Simply put, such analysis looks at the possible range within which costs (or benefits) might fall, in order to predict whether the system would be feasible, under any realistic set of assumptions.

Second, benefit-cost analysis can be a costly and overly-rigorous feasibility test. In some cases, what is obviously cheap and yields easy-to-perceive benefits may not require pre-pilot test analyses. But if the private investor has a lot of money at stake and the resultant change is going to be profound, project designers can save a lot of trouble by hiring an economist as early as possible.

5. Stagger a series of technology-specific surveys with field tests.

Normally, an entire preliminary survey is completed before field tests commence. All data on needs, characteristics and solutions are gathered, processed, analyzed, and then findings are published. There are problems with such a process. Full preliminary surveys take months -- in some cases, years -- to get published. Meanwhile, local and official enthusiasm for renewable energy projects slacken; funding priorities change; resources get allocated elsewhere.

How can we get to field testing activities faster, without compromising the integrity of preliminary survey findings? It is proposed there be a series of technology-specific surveys staggered with field tests. On the next page is a graphic explanation contrasting the above approaches.

For example, the following needs might be identified in a preliminary survey in the order of villagers' priorities: something to provide clean water; easier cooking; better food preservation. Data would then be gathered immediately on water supplies and use. Various technological systems would be identified to pump clean water close to home. The systems would be screened for economic and technical feasibility and then field tested. During these field tests, data would be collected and systems could be identified and screened for second identified need-easier cooking. While demonstrations related to cooking (stoves? woodlots?) are taking place, preliminary surveys start on food preservation, and so forth.

The entire process can then stop when the added cost matches the added benefit gained from further investigations and field tests. Otherwise, if one were to start additional survey and field installation with the first four needs expressed by villagers, there may be no money left to survey and field test a fifth (and possibly critical) need identified later.

Suggested Sequence for Tests to Follow Surveys

(Not this:)

Survey identifying all needs, all characteristics and all proposed technologies.

Field testing for all candidate technologies for all needs passing preliminary tests.

(But this:)

Survey identifying all needs, but characteristics and relevant candidate technologies for first need only.

Field test first set of candidate technologies for first need passing preliminary feasibility tests.

Survey identifying characteristics and relevant candidate technologies for second need.

Field test second ...

Survey ... Third need

TIME

In some cases, it might be possible to demonstrate an energy device even without a fully detailed preliminary survey. The need and acceptability may be evident from a reconnaissance of previous surveys taken, and from discussion with influential people and local groups. When such an immediate demonstration takes place, more time and effort could be reserved to uncover additional needs and ways of dealing with problems. With this staggered approach, a momentum for official acceptance of additional surveys could be built up when local people see evidence of at least one test activity going on.

II . Experience in Africa: Swaziland and Cameroon

Descriptions of field experiences in two African countries are offered to illustrate the points made above.

Swaziland

In practice, project designers may find that fine points of survey methodology are less important than the question of whether a survey is possible at all. In Swaziland, one clear reaction people expressed was their exhaustion with surveys -- in this case, the usual household interview process using precoded questionnaires. Field practitioners, government officials and university researchers informed the author that no one in the countryside knew what many of the past surveys had concluded about people's behavior and attitudes. Survey findings could have been discussed at regular meetings of the local elite and other rural dwellers, but this was not done. Surveyors considered dissemination of findings to be the Government's job; extension agents thought this was work for the surveyors.

Another frustration expressed was that no one could see much connection between surveys and subsequent action programs. Key people interviewed did not know how their responses would later be used in the design of specific project proposals.

Previous survey approaches met with difficulties. One-on-one interviews were found not to be an effective medium for expression. Designers had to worry about how much would have to be paid to those being singly interviewed, especially where lengthy questionnaires were used. Such interviews took up to three hours to administer. Some respondents would either courteously race through the answers to get through, or tell the interrogator what they thought he or she wanted to hear. In some cases, respondents would interrupt the questioning to go onto other activities and never return.

In addition, there is the problem of non-response with one-to-one interviews. In one survey, 40 percent of the women

questioned would not discuss proposed solutions to their problems. As one investigator concluded:

> "... this survey has revealed that a topic such as this one - PROBLEMS AT HOME - would have been best investigated through group discussions rather than the questionnaire technique we used. This offered very little or no freedom of expression; and as a result, most women preferred to give this negative answer..." (Nxumalo)

Another question to resolve in Swaziland was the use of university students for administering surveys. They had been used in a few surveys, but there were limits on the use of their time; they could only be used full-time during college vacations. This factor alone heavily influenced the statistical design of one key homestead survey. The vacation month of June was approaching and there was not sufficient time to design a larger, more "scientific" sample. The choice of sample areas was also influenced by the fact that students undertook interviews in areas near where they were living, some of which had characteristics that varied greatly from the rest of the country. Survey findings based on averages had to be constantly adjusted.

Another impression gained was the difficulty of creating a representative sample for collecting data. Swazi rural household characteristics are quite diverse. A very large sample size of thousands of households would have to be covered, in order to include all significant variations. Such an effort would heavily tax existing managerial, logistical and financial resources. Hence, one must accept the reality that very, very few surveys can represent a "perfect" sample of the population.

The trip to Swaziland did illustrate ways in which energy assessments can be abbreviated in particular cases. After interviewing many informed people and reviewing all pulbished surveys and secondary sources, one need was identified as a clear priority for rural homesteaders -- clean water. It was, therefore, recommended that a renewable energy device be demonstrated in an existing project to deliver clean water to homestead taps. It was proposed to substitute a micro-hydro pumping system for a proposed diesel ground-water pump. In terms of surveys, preliminary efforts could be limited to the taking of objective measurements. Rural c[illegible]ity participation in the maintenance of the proposed sy[illegible] would have to be assessed. In addition, one would have [illegible]sure that local homesteaders accepted use of this new source of electricity for pumping water, rather than for some other preferred purpose not foreseen by the project authorities. In light of current attitudes in Swaziland on energy surveys and one the use of formal analytical tools to screen devices under test, such an initial demonstration of a micro-hydro turbine might create a more favorable atmosphere to legitimize other survey activities.

Cameroon

In April 1980, one of the Government's scientific and technical research institutes initiated a survey of rural and urban energy demand and supply in the Northern Province. At the time this paper is being revised, the survey is only about one-third completed; yet, some preliminary observations can already be made:

- At least in its first stages, the survey succeeded in marrying two seemingly disparate objectives. The objective of A.I.D. - the donor agency - is to use the survey results to determine possible energy projects. The government organization has agreed to this approach, because its objective - to identify field-oriented scientific and technical research topics - requires similar kinds of data. Nonetheless, if an "action" project is to follow, determining what action agency would implement the project should be done as early in the process as possible.

- There has been an impressive sensitivity to social science concerns on the part of the geologist, chemist and physicist who are running the survey in Cameroon. However, if analytical work using social and economic filters is ultimately to be carried out, trained social scientists will soon have to be found to do this work.

- A very important trade-off took place in the selection of interviewers. Originally, university students were considered likely candidates. However, given the difficult problems of access to villages and households in the Northern Province, the scientific authorities finally decided to use local people with less than a high school education. Some sacrifice to scientific rigor and interviewer "efficiency" might already be resulting. Nevertheless, the decision to place emphasis on rapport with interviewers by selection of people closer to field realities is worthy of consideration.

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A FRAMEWORK FOR EVALUATING THE ECONOMICS OF RENEWABLE ENERGY TECHNOLOGIES

by Asif Shaikh *

A. AN APPROACH TO ECONOMIC EVALUATION

1. Introduction

The objective of this paper is to develop a simple and usable framework for the economic evaluation of renewable energy technologies (RETs) in developing nations. Until recently, limited attention has been paid to the need to evaluate the economics of technologies being offered to "beneficiaries" in the Third World. Even once the need is recognized, however, an appropriate definition of the criteria by which the economic soundness of RETs should be judged can be quite elusive.

Many of the new technologies entering rural areas of LDCs are being consciously introduced as part of donor programs. Donors may be domestic or foreign; public, semi-public or private. An important implication of donor-funded technology is that it sharply alters the financial constraints within which technology diffusion would otherwise occur (or fail to occur). A common characteristic of this altered financial picture is the absence of any economic criterion for determining when a technology should not be introduced. Because the funds and the needs being satisfied by those funds emanate from different sources, they respond to different imperatives. It is not structurally necessary to verify the existence of a need before spending funds on it. Therefore, the first and most fundamental issue for economic evaluation is to determine the perspectives from which feasibility should be analyzed.

A second, related issue is one of scope. The term "technology" is too easily interpreted as implying some kind of "device" or gadget which exists independently of a social environment. In fact, new technology historically has been a major vehicle for social change -- desirable or undesirable. In recognition of this basic fact, multi-disciplinary teams (technologists, sociologists, economists, etc.) routinely

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* I am especially indebted to David French for his very valuable comments and encouragement. Samuel Hale, Philip Palmedo and Patricia Larson also provided useful comments on earlier drafts of this paper.

perform joint analyses of potential projects; yet there is little interaction between the disciplines. The task for economic evaluation here is to create a framework which is open to and makes productive use of the non-economic factors which are key ingredients in economic decision-making.

A third issue, and one that underlies the entire framework for economic evaluation, is that of incentive: what is the incentive to possess a technology, to promote it, and to transmit it? These may or may not be material incentives, but they must identifiably exist in order for there to be a reasonable expectation that a technology will be acquired, promoted or transmitted. Moreover, to be adequately considered, the issue of incentives must be addressed not only for the pilot stage of a project, but also- and most importantly- for an eventual implementation phase.

2. The Economic Cost/Benefit Framework

Three economic judgements are necessary in order to determine that a proposed Renewable Energy Technology (RET) is an economically sound undertaking:

- it should be financially attractive for the purchaser or investor;
- it should be in the economic interest of society as a whole; *
- its dissemination should be an efficient use of limited project (development) resources.

The last point requires further explanation. The fundamental tenet of economic thinking is that resources are scarce. Choosing to make a given use of them necessarily implies the willingness to forego some other use of the same resources. The value of the opportunities foregone must be weighed in the decision to commit resources to a given technology. In economists' terminology, we must look not only at the net benefits to the investor and to society, but at the opportunity cost as well.

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* In practice, "society as a whole" is usually defined as the "nation". However, there is no reason in principle why it could not refer to village, a region or any other social grouping, as long as costs and benefits were realized at that level.

Clearly the question of opportunity costs can be posed at several levels. Alternative RETs which serve the same need can be judged against each other; comparisons of effectiveness can be made between RETs which serve different purposes (wood-burning stoves vs. windmills for water pumping); or, indeed, expenditures on RETs can be evaluated against expenditures on some entirely separate activity, such as education or health services. Economic evaluation of technologies cannot make such choices, which depend, instead, on policy objectives and national priorities. However, economic analysis can contribute a more limited judgement as to how effectively a given technology project is likely to achieve its own objectives. This in turn provides a basis for comparing the efficiency of one or more potential investments.

The tools applied to carry out the three levels of cost/benefit analysis (investor, social, project) should be flexible enough to capture their diversity as well as to integrate as much useful information -- quantifiable and non-quantifiable -- as possible. The most commonly used technique -- investment analysis to calculate some rate of return* -- should be used with great caution in judging the feasibility of alternative technologies in the context of rural socio-economic development. Calculations of NPV and IRR** are fairly unambiguous when it can be presupposed that an expenditure is viewed as an investment and that the principal motivation is financial gain. In this context, costs and benefits can be converted into common units of measure and the balancing of these units accurately depicts incentive to invest.

However, decisions to acquire RETs should be viewed not only as investment decisions, but as consumption decisions as well. This is true for a number of reasons, including the scale of the investment, personal ownership, use in domestic activities and so on. The likelihood that an affluent urbanite will want to buy a given make of automobile cannot be accurately predicted by long-term savings in bus fares. In the same way, the economic viability of mud stoves must factor in such economic considerations as "consumer preference". This is a well-developed concept which forms the basis of much of micro-economic theory. That it has not been used more frequently in this kind of analysis is probably because it is not quantifiable. In practice, there is no way to measure consumer

* The term is used broadly here to include such techniques as Net Present Value (NPV) and Internal Rate of Return (IRR).

** Net Present Value (NPV) and Internal Rate of Return (IRR).

preferences, but this does not prevent them from being an important part of the decision-making process. We must, therefore, incorporate an element of what economic theory calls "demand analysis", even at the cost of losing some of the comforting precision of purely quantitative manipulations.

In order to address these and other problems, the methodology proposed here makes full use of the techniques of investment analysis, but at the same time incorporates them into a broader framework which takes account of as much relevant information as possible. This information is integrated into a systematic -- though less formal -- economic analysis, the objectives of which are:

- At the level of investor/consumer analysis, to depict more accurately the actual decision-making process of inventors.
- At the level of social cost/benefit analysis, to deal more effectively with non-quantifiable benefits.
- At the level of dissemination efficiency analysis, to establish criteria which contribute to the more efficient use of scarce development resources.

The inevitable result of greater analytical breadth is that the results are necessarily crude in some respects. Because the information being considered cannot all be converted into common units of measure, the end-product of the economic evaluation is a range of information rather than a single rate of return. However, the very lack of analytical elegance is the prime advantage of this framework when it is judged in terms of the objectives it is designed to serve: to use all relevant information; to organize it in such a manner as to facilitate an explicit judgement on economic feasibility; to maximize feedback concerning adaptations needed to make a technology work in a given environment.

3. Characteristics, Feedback and Technology Adaptation

In order for technology development and adaptation to be related to local needs and conditions, technologies should be evaluated in terms of their component characteristics, rather than as unchangeable wholes. The concept of viewing a particular good as a set of characteristics is not new to

economic literature. It has seldom been applied to economic evaluation of goods or technology, however, although it has potential advantages in the context of village-level development technology. Instead of a single rate of return that says a technology is viable or not viable, we can have information on which of a technology's specific aspects make economic sense.

Let us return to the example of the mud stove, and consider its feasibility in Botswana, where an AID team recently evaluated RETs using the methodology developed in this paper. Mud stoves are financially attractive for most Botswana households in that the value of time and wood saved far outweigh purchase costs (approximately $10). This tells us that a technology which cuts wood use in half and which costs about $10 is a sound financial undertaking for a Botswana family.

However, mud stoves have several drawbacks in the Botswana setting. First, mud is considered socially unattractive. It is associated with poverty, and many people are reluctant to spend cash (even if they have it) on mud. Second, mud stoves require protection from the rain, yet most cooking is traditionally done in the open air. Third, evening gatherings around open fires are a social activity, yet mud stoves fully enclose the flames. Finally, only a part of the year is spent in the village, with the remainder spent living on agricultural lands or at cattle posts. Since mud stoves are not portable, they would be idle for several months a year.

A number of possible conclusions could be drawn from the above information. If the stoves were analyzed on investment grounds alone (as is most often the case), they would likely be judged economic. If the economic evaluation also encompassed demand*, one might conclude that mud stoves are not economically viable. On the other hand, an economic judgement that evaluated specific characteristics might reach a conclusion which is very different from the above two, both in its content and in its form: that it is economically desirable to provide villagers with a new cooking device which costs about $10 or less, reduces wood needs by one half, is not made of mud, is portable, and provides some lighting. The implication of this economic conclusion is that the technology proposed to satisfy village needs can be adapted to be more appropriate to its setting. Several points should be made in this regard:

* Or, alternatively, if the investment analysis were combined with a sociological analysis.

- Technology diffusion is a <u>process</u>, not an event.

- The proper role of evaluation is to provide <u>feedback</u> into that process by generating feasibility information that can guide adaptation.

- This feedback on technology characteristics is not simply a one-time, <u>ex ante</u> judgement; rather, its importance is amplified <u>after</u> a pilot technology is tested because of the much larger amount of information available at that time.

- As part of the on-going process of adaptation, what began as an economic question about the feasibility of a specific technology now returns to the technical arena: is it possible to adapt to the needs revealed by the analysis? In the Botswana mud stove case, new technical ideas have been generated which show promise of satisfying the major desired characteristics.

4. <u>Levels of Cost/Benefit Analysis</u>

The three levels of feasibility analysis, and their most important subcomponents, are as follow:

- the private investor/consumer perspective
  - financial analysis
  - demand analysis
- the society's economic perspective
- the dissemination efficiency perspective.

The level of analysis which is the most important in evaluating a particular technology will depend, to a large extent, on who the actual purchaser (investor) is, and on the nature of that purchaser's motivation. Some technologies may be acquired by individual households as a "consumer durable"* (mud stoves). Others may be purchased by households or entrepreneurs for income generation (solar mud ovens). Still others may be purchased by central, district or local government in order to create a new social service (solar electrified rural clinics) or as a more economical means of providing existing services (windmills instead of diesel to pump village water supplies). Numerous examples could be

* A consumer good which does not directly [illegible] but which yields a flow of services ([illegible] be income-saving) over a long period.

cited. The central point is that purchaser motivation has a great deal to do with what levels of analysis will be stressed, discounted or ignored altogether in the actual decision-making process. The following ordering principles are suggested:

- If a technology is significantly unattractive from the purchaser's standpoint, it should be considered impractical, short of some overriding social concern coupled with an explicit readiness to impose the technology, directly or indirectly.*

- A technology to be acquired privately should be analyzed at both the private and social levels.

- Within the private level perspective, either investment or demand analysis, or both, can be used. Some technologies are clearly acquired more for investment than for consumption purposes, and vice versa. However, it would be rare to have a village level, small-scale, private technology choice be either purely an investment or purely a consumption decision.

- A technology acquired by a government need not be analyzed from the private investor's standpoint. This does not mean that a government may not be interested by some of the same factors as private investors, such as, for example, cash-flow analysis. Such factors can, however, be addressed within the framework of the social level analysis.

- All technologies should be evaluated from the dissemination efficiency perspective.

a. Investor/Consumer Perspective

Adoption of a given RET technology requires that those who would pay for it be willing to commit a portion of their resources for the purpose. The likelihood that they will do so is a basic criterion of a technology's "economic feasibility." Two major issues are involved:

* In the case of water pumping with diesel, for [illegible] direct imposition of alternate fuels could [illegible] of a ban on diesel use for water pumping [illegible] can also be indirectly imposed by creating a [illegible] the incentive structure, such as through [illegible] ure.

- Is the expenditure economically advantageous to the purchaser?

- What are the principal factors (of which economic advantage is only one) which enter into the potential buyer's "demand function?" Put simply, on what basis will the buyer decide?

The latter evaluation is not only a means of judging if a project technology responds to peoples' needs in the first place; it also serves to break out the specific characteristics which are more or less desirable to purchasers. This, in turn, is an important guide to what cosmetic or design adaptations are needed in a given setting. There are four steps to the economic evaluation at this level:

(1) Financial analysis, which relies on the traditional financial tools: projections of revenue, costs, project life, and discount rates. Where appropriate, labor saved can be quantified using an estimate of opportunity cost as perceived by the individual. *

(2) Sensitivity analyses, which determine how sensitive the results of the financial analysis are to key assumptions. For example, an expenditure which saves villagers two hours a day in wood gathering time may be judged very profitable if the time saved is valued highly, or quite unprofitable if it is not.

(3) Scarce resource analysis, which examines the likelihood that specific resource limitations may prevent the adoption of a technology, regardless of its overall attractiveness. For example, are villagers likely to have enough discretionary cash for the purchase? If not, is credit available? At what terms? Does the investment yield net benefits in cash (which is scarce), rather than just in time or resources (which may be more abundant)?

(4) Demand analysis, which does no more than identify and categorize the principal factors which appear to influence the non-financial elements of the desire to make a given expenditure. It draws heavily on the sociological understanding on which the project is based. Attempts to artificially quantify demand factors are counterproductive here, since they reduce rather than enhance the informational content of the output.

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* See Annex I of Lesotho RET Project Paper: "[illegible] Renewable Energy Systems for Lesotho." (U.S. A.I.D.[illegible]

The outputs of this level of analysis can then be summarized and presented as follows (using the example of mud stoves in Botswana):

ECONOMIC EVALUATION

INVESTOR/CONSUMER PERSPECTIVE

Technology	Financial Analysis	Sensitivity Analysis	Scarce Resource Analysis	Demand Analysis
Mud Stoves	Highly attractive financial return if labor time valued at 15¢ per hr.	Very sensitive to how time is valued	° Cash cost/ benefit analysis highly negative ° Cash often unavailable for this purpose	° Limited perception of benefits ° Mud socially unattractive ° Stoves not portable

The analysis of specific technology characteristics is not formalized at any particular step in this approach. Rather, it underlies the entire analytical framework, and may also arise in the sensitivity, scarce resource and demand analyses.

b. Society's Economic Perspective

The steps in the economic evaluation at the social level are as follows:

(1) Economic analysis, using the same techniques as the financial analysis at the investor level, but with several input substitutions:

-- Labor time is valued at shadow wages, which equal the social opportunity cost of time.

-- Shadow discount rates are used to reflect social, rather than individual, preferences as to future growth vs. immediate benefits.

— The analysis incorporates social costs, which take account of cost or benefits which may accrue to society, but which are not realized by the individual investor. These include such things as environmental benefits, costs of extension and so forth. A method of addressing non-quantifiable benefits — developed in the Lesotho RET project paper* — is extremely useful here. It consists of including a non-quantifiable cost or benefit in the financial analysis, but entering "X" for its value. The system can then be solved for the value of "X" which makes the investment economically worthwhile. From here we can make a crude judgement as to whether the non-quantifiable benefits (costs) in question can reasonably be expected to be in the range of "X".**

(2) Sensitivity analysis, which, as in the investor level analysis above, determines how stable the economic results are in response to changes in key assumptions.

(3) Scarce resource analysis, which, at the social level, becomes a measure of how practical a technology is within the specific constraints of LDC rural areas. For example, windmills require trained mechanics for maintenance and repair. Are those human resources available? At what cost? Similarly, biogas systems require almost constant supervision and "tinkering" to function satisfactorily. Even if the technical skills were available, the principal capability required is good management***, which is one of the most precious and scarce development resources.

(4) Evaluation of national policy objectives, which may affect a technology's economic value to society.

Outputs of the social/economic analysis can be summarized and presented as follows (using the example of windmills for water pumping in Botswana):

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* Annex I of Lesotho Renewable Energy Technology Project Paper: "The Economics of Renewable Energy Systems for Lesotho." (USAID, 8/79)

** Clearly, only one non-quantifiable item can be addressed at a time, or the system cannot be solved for "X". Where there is more than one non-quantifiable item to be considered, "X" may be interpreted as the sum of benefits from all such items.

*** The term is not used in a corporate sense here; it [illegible] a capacity for close supervision and [illegible] timely intervention (maintenance, repair).

ECONOMIC EVALUATION

SOCIETY'S ECONOMIC PERSPECTIVE

Technology	Economic Analysis	Sensitivity Analysis	Scarce Resource Analysis	Policy Objectives Analysis
Wind-powered water pumping systems	Attractive rate of return relative to diesel systems	° not economic for deep wells ° not economic for over 6000-8000 liters per day	Relies heavily on already taxed maintenance capabilities	Major contributions to national economic independence

c. Dissemination Efficiency

From the standpoint of a project's effectiveness in achieving its objectives (such as, for example, reaching the rural poor), it is not sufficient that a given technology be cost effective from the investor and social perspectives. It should also be a more efficient vehicle for achieving project goals than alternatives which are equally feasible at social/investor levels. Even where no clear-cut alternative technology exists, project design requires some judgement of whether it makes economic sense to spend program funds to introduce and disseminate a technology.

Many development projects tend to judge investments in isolation, rather than in terms of the possible alternatives. That is, if a project is judged economically sound*, it is worth doing. This tendency is especially pronounced in projects funded by foreign donor agencies, where the very availability of donor funds cannot be separated from the existence of the specific projects being evaluated. Yet the urgent need of economic development is to use scarce resources efficiently, not just adequately.

It is obvious that the actual judgements as to whether a given expenditure on technology projects is preferable to some other [illegible] lie largely beyond the jurisdiction of the NET economic evaluation. For example, the decision that an incremental dollar spent on [illegible] for villages is more useful than one spent on new [illegible]

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* By whatever criterion is being used, such as, for [illegible] minimum rate of return.

made at some other policy level. Nevertheless, the choice of how best to achieve the objectives of pumping water (through wind-powered pumps, diesel engines, or solar photovoltaic systems) may be an economic one. Economic analysis can contribute to the more efficient use of scarce resources by devising means to compare the efficiency of alternative technology expenditures.

To some extent, the economic/financial analyses carried out from the investor and the social perspectives create the framework for the comparative evaluation of technologies. But project effectiveness can depend on other factors which go beyond the scope of those analyses and which it is useful to consider separately. The most important of these is an area that is largely ignored in the economic analysis of public sector projects: the process by which technology is disseminated. Whatever the other criteria of economic benefit deriving from a technology, the underlying premise must be that it reaches its potential beneficiaries. Yet this is precisely where many LDC technology programs fail. The rural landscape of the Third World is littered with "pilot" schemes that have never left the ground.

The commercial analog to "dissemination" is "sales". It would be absurd for an entrepreneur to introduce a new good without some indication that it will sell. Similarly, it makes little sense to introduce a technology intended to improve living conditions for a population without some indication that it is capable of reaching a significant portion of that population.

There are several dissemination mechanisms through which this can occur. These include, among others:

- extension/training
- informal social process
- commercialization
- direct government implementation

Generally, two or more mechanisms operate at once. There is often a time pattern to how different mechanisms come into play, with training/extension ideally giving way over time to dissemination processes generated within the socio-economic system.

For purposes of judging project effectiveness, two aspects of dissemination are of particular interest:

- What is the likelihood that a technology will spread and actually reach those it is intended to help?
- What are the costs of dissemination, both absolute and in comparison to the alternatives?

Each dissemination mechanism brought into play introduces a new set of actors and incentives, and thereby influences both of the above questions. Neither question can be answered with precision, particularly when looking over a medium- to long-run time frame. Moreover, useful information can be derived from analyzing the characteristics of the technology in question and of the economic environment of rural areas. A threefold approach is proposed:

1. Dissemination Cost Ratio

A measure of the cost of dissemination can be defined by the following ratio:*

$$\frac{\text{incremental budgetary cost of transferring a technology to one new user}}{\text{incremental benefit to society of transferring a technology to one new user}}$$

In practice, the denominator can be measured by the Net Present Value of the technology when evaluated from the social perspective. While this is a crude measure, it does address the key criterion for a pilot implementation project: is it economically practical to spread the technology to a much larger audience should the pilot succeed? Moreover, when this ratio is used to compare technologies, it becomes a more refined measure of the relative merits of two or more program alternatives.

2. Changes in Dissemination Costs Over Time

Changes in the dissemination cost ratio should be examined over time. That is, some technologies may have dissemination costs per unit which are high at the outset, but which decrease after an introductory period. This may occur because of demonstration effects, greater public familiarity, field-proven effectiveness or, simply, because new dissemination mechanisms have come into play. An appropriate time frame within which to project these changes would be in the order of 15 to 20 years.

3. Overall Dissemination Effort

The above indicators of dissemination costs should not be [illegible] mechanically. Together, they only provide inputs into a [illegible] how likely it is that a technology will actually [illegible] meaningful impact on some target population. For [illegible] dissemination cost ratio is fairly high and [illegible] reaching fifty percent of rural households [illegible] a major national commitment of resources. [illegible] should be estimated and explicitly accepted as [illegible]

* There could be more [illegible] devised because it is [illegible] both [illegible] equally [illegible]

and likely before project resources are committed to the initial effort. It should be emphasized that the dissemination cost ratio alone merely indicates whether spreading a technology generates net benefits (i.e., that dissemination costs are less than benefits). Only by combining this information with that on changes in dissemination costs over time and evaluating overall dissemination effort to reach a target population can a judgement be made as to whether a given technology merits priority consideration. This latter judgement, in turn, depends on the social opportunity cost of the budgetary and other resources required.

The outputs of this level of analysis can be summarized and presented as follows:

Technology	Dissemination Cost Ratio	Changes in Dissemination Costs Over Time	Overall Dissemination Effort
Thatch insulation	Favorable, but high	Good prospects for commercialization	Acceptable Limited mainly to introductory phase

5. Conclusion

The main focus of this methodology is to capture and effectively use a wider range of information on economic costs, benefits and motivation than is encompassed by the conventional tools of financial analysis. It is based on the premise that mere numerical analysis often hides more useful information than it reveals. The analysis draws on sociological information because social process is an important component of economic decision-making.

Finally, the output of this approach to economic feasibility evaluation should not be a simple positive or negative judgement. It should instead be feedback as to a technology's feasibility, including information on specific characteristics or constraints which influence that feasibility. A technology is not simply a fixed entity, but rather a bundle of characteristics, many of which can and must be adapted in response to feedback on local needs, particularly in the context of appropriate technologies for rural needs.

B. EVALUATION OF RENEWABLE ENERGY TECHNOLOGIES IN RURAL [illegible]

This portion of the paper uses the approach [illegible] to evaluate three specific Renewable Energy [illegible]

are responsive to three types of purchaser motivations: and stoves for domestic cooking, which are consumer durables; and ovens for baking bread, which are analyzed here as an income-producing private investment; wind-powered water pumping systems, which are evaluated as a public sector service to provide village water supply. All three of the technologies have been examined in terms of their feasibility in rural Botswana. This not only permits the analysis to draw on information from a recent AID-sponsored mission to Botswana; it also underscores a central theme of this approach: that "generic" assessments which are divorced from the specific socio-economic and institutional environment in which the technology is to operate are of extremely limited value.

Energy Use in Rural Botswana

The principal forms of energy consumed in rural areas of Botswana are wood, human and animal power and diesel oil. The first three fuel types satisfy the majority of domestic and agricultural energy needs, while diesel is used extensively for water pumping, as well as for electricity generation for rural institutions.

Virtually all poor rural households depend on firewood for cooking and space heating, as do a significant number of the urban poor. The amount of time required to collect sufficient wood for household needs has been rising sharply in most areas. The problem is particularly acute around the larger villages, and in the arid regions of West and Central Botswana. It is not uncommon for villagers (usually children or women) to spend three hours per day collecting wood. In some villages, such as Molepolole, estimates range to four hours, or about 7.5 kilometers of travelling in search of wood each day. A recent study estimates this figure could reach 10.5 kilometers in 20 years if no remedial action is taken. This situation has several economic and environmental implications:

— As wood collection time increases, it threatens to impinge on productivity in other useful economic pursuits.

— Wood needs now exceed the environment's natural regeneration capacity, leading to significant deforestation around population centers.

— More and more, families are forced to purchase firewood commercially (by the bicycle load or the cart load), thereby losing a degree of economic self-sufficiency, becoming cash-dependent in a cash-poor subsistence economy, and facing a growing financial squeeze as commercial prices reflect the increasing inaccessibility of firewood. A donkey cart load (enough for about 5-6 weeks for an average household of eight) now costs P[illegible] [illegible]

* P = Pula = $1.27

and P20 in Old Naledi (a poor section of the capital city Gaborone).

Human and animal power are the principal forms of energy used in agriculture and in a number of domestic activities. Of the applications of human power, one of the most onerous as well as the most time-consuming on a year-round basis is debulling and pounding sorghum, a task performed exclusively by women. Other demands on the time of rural women have increased steadily as they have taken on the productive activities of the male population which has emigrated to work in the mines of South Africa.* Another important use of human energy in Botswana is in water extraction from wells. As most of the country is characterized by low rainfall and extremely few surface water sources, groundwater provides the only reliable source of drinking water for both human and animal consumption. In certain regions of the country (especially in the slightly more fertile eastern corridor), groundwater is sufficiently close to the surface to be directly extracted or pumped by hand. Where water depth is too great for hand pumping (as in Western Botswana, where water depth is 100-400 meters), mechanical pumping is relied upon.

Diesel fuel is used in rural areas to pump water from boreholes at cattle posts, to pump village domestic water supplies, and to generate electricity for rural institutions. There are several thousand boreholes for watering cattle in Botswana, and an extremely large proportion of these are equipped with diesel engines to pump water. Increasingly, villages are being equipped, through government/donor programs, with diesel-pumped boreholes to serve community water needs. Yet all of the diesel used in Botswana is imported, and is supplied from South Africa. By increasing reliance on diesel for the provision of drinking water, Botswana has greatly increased its vulnerability to disruptions of supply from South Africa and to the effects of rising world fuel costs.

1. Mud Stoves for Domestic Cooking

The stove analyzed here is well-known in the rural technology field. It is made of mud and straw, fully encloses the flame and channels heat directly to one or more "burners" (which are actually just open holes atop the stove). The outside of the stove is normally glazed, and a chimney may or may not be used.

a. Investor/Consumer Perspective

(i) Investment Analysis

We make the following assumptions:

- On the average, one member of [illegible] spends 2.5 hours per day, five [illegible] collecting firewood.

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* Twenty-five percent of the rural male [illegible] Africa, according to recent [illegible].

- The cost of materials for building the stove is P7*.

- The average life of a properly maintained stove is five years.

- Average maintenance time is 3 hours per month.

- The labor time (including learning) to build a stove is 16 hours.

- The rate at which the average villager discounts future vs. current income is 30%. This high figure reflects the extremely limited surplus, if any, over current subsistence needs.

- Labor in wood collection is valued at 12 thebe/hour. Labor in stove building is valued at 20t/hour. The distinction is made for two reasons: a percentage of child labor is used in collection; also, whereas wood collection is an established activity already budgeted for, building labor would eat into other productive activities (raising the marginal opportunity cost of labor).

Earthen stoves appear to be an extremely attractive investment from this perspective. (See table next page)

(ii) Sensitivity Analysis

The key sensitivity factor is how time is valued. There is considerable evidence that the economic opportunity cost of wood gathering time is low, up to some threshold level, particularly when children perform the task. While the results are sensitive to changes in how time is costed, even drastic reductions in this figure yield positive results: a 50% reduction in the value of wood gathering labor still yields an NPV of P36.04.

(iii) Scarce Resource Analysis

A principal scarce resource for rural poor is cash. Earthen stoves generate no cash income. There are few, if any, sources of credit at this scale, and there would be no way of repaying credit in cash should it be available. The cash limitation appears to be an obstacle for many villagers interviewed particularly when coupled with the other factors discussed below.

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* P stands for "Pula", the currency unit in Botswana
t denotes "thebe", the component of a Pula
1P = 100t
1P = $1.27 (approximately)

INDIVIDUAL INVESTMENT ANALYSIS:

Mud Stoves

	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue					
labor saved in wood collection	39	39	39	39	39
Costs					
Construction materials	7	-	-	-	-
labor in training and construction	1.92	-	-	-	-
labor in maintenance	9.6	7.2	7.2	7.2	7.2
Net Benefits	20.48	31.8	31.8	31.8	31.8
Discounting Factor	1.00	.769	.592	.455	.350
Discounted Benefits	20.48	24.46	18.82	14.47	11.13

NET PRESENT VALUE: P89.36

(iv) Demand Analysis

- Many villagers do not appear to perceive the wood-saving benefits of earthen stoves.

- Mud is not considered socially attractive; moreover, mud stoves go counter to established patterns as they must be constructed indoors and cannot be transported to lands or cattleposts.

- Mud stoves fully enclose the flames and thereby inhibit the lighting and social benefits of open fires.

b. Social Perspective

(i) Economic Analysis

From the social perspective, the following assumptions are made:

- The major, though unquantifiable, benefit is reduced environmental degradation.

- The economic opportunity cost of wood-gathering time is very low.

- The social discount rate is 12%.

Even if the social opportunity cost of wood-gathering were valued at zero* (an extreme assumption), the technology would be economically attractive from the social perspective if the environmental benefits were valued at P8.27 per year per family. This seems well within the range of social benefits derived from reduced environmental degradation.

(ii) Sensitivity Analysis

No major sensitivity factors were considered.

(iii) Scarce Resource Analysis

No resource constraints at the social level.

(iv) National Policy Objectives

National policy objectives served are:

- reduced deforestation, and
- reduced movement towards imported kerosene as a substitute for firewood.

* This implies that, from a social perspective, it is [illegible] time now spent in gathering wood would not otherwise be used for any economically productive activity.

c. Dissemination Efficiency Perspective

(i) Dissemination Costs

Any earthen technology requires instruction by a trained specialist, as well as close monitoring in construction and maintenance. It requires significant labor input by the purchaser as well. Close follow-up by the extension specialist is especially important in the first several weeks to prevent cracking and other potential problems that can severely reduce efficiency. The basic introduction/dissemination mechanism is through village-level extension. The incremental costs (exclusive of the fixed costs of an extension network and of support infrastructure) are extremely high relative to purchase price. However, the dissemination cost ratio is clearly favorable.

Incremental Labor Costs for Extension: (12 hours at 50t/hour)	P6.00
Net Present Value of Stove to Society:	P41.00
Dissemination Cost Ratio :	0.15

The incremental extension cost used here does not include any of the fixed costs of maintaining an extension network. If these were included, the dissemination cost ratio would be higher.

(ii) Changes in Dissemination Mechanisms Over Time

- Earthen stoves cannot be transported. Therefore, they cannot be bought and sold as exchange goods.
- Any affordable price to the rural poor is too low to warrant an individual's constructing them as a commercial service, particularly given their labor intensity.
- For these same reasons, to the extent that they could spread through some "informal social process," dissemination is likely to be extremely slow. It seems entirely likely, in fact, that some alternative technology would supplant them before they had any significant impact (in the absence of extension).
- The costs of actively spreading earthen technology, therefore, would remain high even after a successful pilot stage.

(iii) Overall Dissemination Effort

Let us consider the implications of this ratio. If the pilot stages of a RET project show mud stoves to be worth diffusing more widely, it would require a major national effort to disseminate them. The total population of Botswana is about 700,000, or approximately 100,000 to 150,000 households. If we assume there to be 75,000 target households in the country, nearly one million hours of incremental extension time would be required to reach and train people; several times that would be used in channeling the efforts of existing extension structures; and a major coordinating effort would be needed. In addition, at least another one-and-a-half million person hours would be expended by villages in order to learn to use and maintain mud stoves.

This is not to suggest that this large labor input is either good or bad, but rather that it is unlikely governments will devote this much effort to wood stove dissemination and that this may not be an efficient use of scarce manpower and money. It would seem worth asking, for example, if the limited availability of skilled trainers, of managerial talent and of individuals' capacity to absorb training would not be better spent on acquisition of some other, more versatile skill. While the dissemination cost ratio cannot answer this question, it does provide a point of reference for comparing alternatives.*

2. Earthen Solar/Wood Ovens

The unit being analyzed here consists of a mud structure with a baking chamber and a wood-burning chamber. The baking chamber has metal racks and an angled glass panel that admits sunlight. The oven uses a combination of solar heat and heat from the wood fire. Compared with units which rely on solar energy only, this unit has greater baking capacity per day (shorter baking time), can work on wood alone on cloudy days, leaves capital cost virtually unchanged, and adds P1 per day in recurrent costs (for wood). The basic motivation in adopting this technology is income generation.

a. Investor/Consumer Perspective

(i) Investment Analysis

We make the following assumptions, based on available information:

- The cost of building the oven in P15.
- Labor time in learning and building is 16 [illegible]

* For a summary evaluation of mud stoves, see [illegible]

MUD STOVES FOR DOMESTIC COOKING

Economic Evaluation Summary

Investor/Consumer Perspective

Investment Analysis	Sensitivity Analysis	Scarce Resource Analysis	Demand Analysis
Highly attractive financial return	- sensitive to time valuation - positive return under most assumptions	strongly negative cash cost/benefit	- limited consumer perception of benefit - socially unattractive - not portable

Social Perspective

Investment Analysis	Sensitivity Analysis	Scarce Resource Analysis	National Policy Objectives
attractive return	--	--	strongly serves national objectives.

Dissemination Efficiency Perspective

Dissemination Costs	Dissemination Mechanisms/Costs Over Time	Overall Dissemination Effort
Extremely high	Likely to remain costly in long run	Major national commitment required to reach target population

- The average life of a properly maintained stove is five years.
- Average maintenance time is three hours per month.
- Labor is valued at 40 thebe/hour.
- Using the oven, an entrepreneur can bake 30 loaves of bread per day, and demand is sufficient to absorb this quantity.
- The cost of ingredients is 16t per loaf.
- The sales price is 32t per loaf.
- The daily labor required to bake 30 loaves is 8 hours; the business operates six days per week, fifty weeks per year.
- The discount rate is 30%.
- Wood needs are P1 per day.

Clearly, earthen ovens are an extremely attractive investment for a village level entrepreneur. (See table next page.)

(ii) Sensitivity Analysis

The key potential sensitivity factor is baking capacity. A decrease in output from 30 loaves to 25 loaves per day would make the investment uneconomic. However, the high figure is thought to be very conservative for the combination solar/wood oven.

(iii) Scarce Resource Analysis

Cash scarcity is not likely to constrain investment in the solar oven, as it generates sizable cash returns. All of the revenues are generated in cash, whereas a sizable portion of the costs (operating labor) does not require a direct cash outlay. Therefore, the cash benefits are even more attractive than the overall return.

(iv) Demand Analysis

Unlike earthen consumption technologies, solar/wood ovens do not appear to be judged on social attractiveness, rather on profitability. In Botswana, of all [illegible] village technologies, earthen ovens have [illegible] interest, mostly from village women. Rural [illegible]

INDIVIDUAL INVESTMENT ANALYSIS: [illegible]

	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue	2880	2880	2880	2880	2880
Costs					
Construction of oven	15.0		-	-	-
Labor in building and training	6.4	-	-	-	-
Labor in maintenance	18.4	14.4	14.4	14.4	14.4
Operation labor	960	960	960	960	960
Ingredients and materials	1440	1440	1440	1440	1440
Wood	300	300	300	300	300
Net Benefits (Costs)	140.2	165.6	165.6	165.6	165.6
Discounting Factor	1	.769	.592	.455	[illegible]
Discounted Net Benefits	140.2	127.3	98.0	75.4	[illegible]

interviewed have received several inquiries on how to acquire them. Women using ovens extended to them by a research/technology center in Kanye have been in successful commercial operation for two years.

b. Social Perspective

(i) Economic Analysis

From the social perspective, the following new assumption is introduced: the social opportunity cost of labor (shadow wage) is 20t per hour. This reduces labor cost in training, building, and most significantly, in operation. The social economic return is, therefore, significantly higher than the individual financial return, and yields an NPV of P2041.2.

(ii) Scarce Resource Analysis

The most important scarce resource upon which solar/wood ovens draw is wood. Use of the ovens increases rural consumption of wood. However, several factors distinguish wood use for these ovens from wood consumption for domestic cooking:

- Wood-burning in the oven is quite efficient relative to an open flame.
- Because wood-burning serves only to complement solar heat, consumption is quite low relative to cooking output.
- Even if solar/wood ovens were widely diffused, they would reach a very small number of targeted entrepreneurs, not a large population of rural households.

(iii) National Policy Objectives

National policy objectives served are:

- increased energy in rural areas;
- incentives to rural entrepreneurial efforts;
- increased self-sufficiency in villages, to which bread is now brought from urban centers or from South Africa.

c. **Dissemination Efficiency Perspective**

(i) Dissemination Cost Ratio

As with mud stoves, the basic dissemination mechanism for these ovens, at least at the outset, is through village-level extension and training. Considerable labor is required in construction and maintenance, particularly in the early stages of use. The incremental extension costs can be assumed equal to those for mud stoves, yielding a much lower dissemination cost ratio due to the higher net present value.

Incremental Labor Costs for Extension: (12 hours at 50/t hour)	P6.00
Net Present Value:	P2041
Dissemination Cost Ratio:	0.003

(ii) Changes in Dissemination Mechanisms Over Time

Although solar/wood ovens cannot be transported, they generate enough cash revenue for purchasers to warrant paying for training which might otherwise have been provided by village extension. Such payments could take several potential forms:

- Someone in the village who has been trained (by extension services) can train purchasers of ovens for a suitable fee.
- Purchasers could simply hire someone to construct and maintain an oven.
- Potential investors could pay their transport and a fee to attend training sessions offered at some centralized location.*

Village surveys and interviews with Village and District officials reveal considerable interest on the part of several village women to raise the cash (through informal cooperative financing which is repaid from the investment's proceeds) to undertake the necessary training.

(iii) Overall Dissemination Effort

It should be underscored that the objective of introducing solar/wood ovens is not to reach all rural households, but rather to place these ovens with a small target

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* In Botswana, one location offering just such facilities is the Rural Industries Innovation Center at Kanye.

group in each village. Although this group may number less than a thousand nationwide, many times that number would receive indirect benefits (fresh bread, employment, etc.). A number of levels of incentives are likely to come into play in the production and dissemination processes. The target group has sufficient incentives to bear the costs of technology acquisition. The organized dissemination effort is therefore likely to focus more on making information available to interested entrepreneurs.*

3. Wind-Powered Systems for Pumping Village Water Supplies

The system described here is a windmill and water pump which uses wind power to raise water from a depth of approximately 100 meters. The system examined is capable of supplying the domestic needs of approximately 500 people plus a very limited number of livestock. It is worth noting that similar systems could be used for pumping water at private cattleposts, but that the economic evaluation for such an end-use would be extremely different than for village water supplies being financed through the public sector.

a. Investor/Consumer Perspective

No analysis is required from this perspective, as windmills would be provided as a social service to villages by some level of government. Therefore, the social level analysis incorporates all necessary economic assumptions.

b. Social Perspective

(i) Economic Analysis

From an economic/financial viewpoint, this system makes sense if it competes favorably with the best available alternative, which in this case is a diesel-powered pump. At present, the Government of Botswana is in the process of a major national program to provide piped water supplies to all villages in the country by 1985-86. The vast majority of these systems will rely on diesel pumps to raise water from underground sources. The following table presents cost assumptions for diesel and wind-powered systems.

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* For a summary evaluation of solar/wood ovens, see chart on next page.

EARTHEN SOLAR/WOOD OVENS

Economic Evaluation Summary

Investor/Consumer Perspective

Investment Analysis	Sensitivity Analysis	Scarce Resource Analysis	Demand Analysis
very profitable	remains profitable under most reasonable assumptions	highly favorable cash cost/benefit	-good demand appears to exist -use of "mud" socially unattractive, but financial return is primary motivation

Social Perspective

Investment Analysis	Sensitivity Analysis	Scarce Resource Analysis	National Policy Objectives
very attractive	--	increases use of wood	-increases energy options of rural areas without fossil fuels -enhances economic self-sufficiency of villages

Dissemination Efficiency Perspective

Dissemination Costs	Dissemination Mechanisms/Costs Over Time	Overall Dissemination Effort
very favorable	Likely to diminish through commercialization	minimal budgetary drain

ECONOMIC ASSUMPTIONS

Annual Revenues and Costs (in Pula)

	(1) Diesel	(2) Wind	(3) Net Change [(2)-(1)]
Revenue	X	X	0
Capital Cost	3500	10,000*	6500
Operating Labor	548	548	0
Maintenance	525	400	-125
Fuel Costs	1000	0	-1000

Other assumptions

- The system serves the water needs of 500 people and 50 head of cattle.
- Borehole depth is 100 meters.
- Equipment life for both systems is assumed to be ten years.
- The diesel system is assumed to operate six hours per day.
- The discount rate is assumed to be 12 percent.
- Water needs are 5000-6000 litres per day.
- The shadow wage is P1.50 per day.
- Operating labor requirements are for 365 days per year.
- Diesel fuel costs escalate at 5 percent (real) per year.

As the objective of this analysis is to [illegible] feasibility of using windmills instead of diesel [illegible] investment analysis is performed on the basis of [illegible] costs and benefits of making that substitution. [illegible]

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* Including storage capacity

both systems are designed to satisfy the same water supply needs. Therefore, although the value of these needs is unquantifiable as indicated by the "X" in columns (1) and (2) of the row labelled "revenue", the incremental benefit of using wind rather than diesel is zero (as indicated in column (3) of the same row). Similarly, the extra capital cost of a wind system is P6500, but the incremental annual fuel cost is -P1000, because wind systems do not have the recurrent fuel costs of a diesel system.

This incremental approach permits a comparative evaluation of both systems within one investment analysis: incremental revenues are entered as zero, because the windmill provides no greater or lesser water supplies than the diesel alternative; incremental costs are entered as positive for items where wind system costs are greater than diesel system costs; they are entered as negative for cost items where wind systems are the cheaper alternative. When this system is solved for Net Present Value, a positive NPV implies that the small wind-powered system is more economic than the available diesel alternative; a negative NPV implies the opposite.

As shown in the table on the following page, wind is an attractive alternative to diesel from the social economic standpoint. As indicated, the Incremental NPV is P1902. In fact, this figure underestimates the financial advantage of windmills, as the useful life of such a system is likely to be longer than the 10 years assumed here.

(ii) Sensitivity Analysis

One sensitivity factor is fuel cost. However, since the only direction in which this is likely to move is up, the relative advantage of windmills would only increase.

The economic feasibility of wind-powered systems is also very sensitive to borehole depth and to daily water volume required. For wells much deeper than the 100 meters assumed here, wind systems are, at present, technically inadequate. If much more than 6000-8000 liters per day of water are needed, two windmills and two boreholes become necessary, more than doubling capital costs and making windpower uncompetitive with diesel pumps.

(iii) Scarce Resource Analysis

The introduction of windmills would require training of maintenance personnel at the district level who are now equipped to maintain diesel engines. This would further burden

Social Economic Analysis: Wind-Powered Village Water Supply [illegible]

(Incremental Values of Wind over Diesel Systems)

	YEAR 1	2	3	4	5	6	7	8	9	10
Incremental Revenues	0	0	0	0	0	0	0	0	[illegible]	[illegible]
Incremental Costs										
Capital	6500	--	--	--	--	--	--	--	--	--
Maintenance	-125	-125	-125	-125	-125	-125	-125	-125	-125	[illegible]
Fuel Costs	-1000	-1050	-1103	-1158	-1216	-1276	-1340	-1407	-1478	[illegible]
Net Incremental Revenue (Incremental Revenue minus Incremental Costs)	-5375	1175	1228	1283	1341	1401	1465	1532	1603	1676
Discounting Factor	1	.893	.797	.712	.636	.567	.507	.452	.404	.361
Discounted Net Incremental Revenue (ONE PERCENT VALUE: P1902)	-5375	1050	979	913	853	794	743	692	648	[illegible]

already taxed water system maintenance units. However, this is only a short to medium-term bottleneck.

(iv) National Policy Objectives

Substitution of any renewable energy source for diesel strongly supports the national objective of reducing dependence on imported fossil fuels, all of which now come through South Africa.

c. Dissemination Efficiency Perspective

(i) Dissemination Cost Ratio

The dissemination of windmills for village water pumping will occur more through an administrative mechanism than through extension, markets or an informal social process. The incremental costs of placing each windmill occur mainly in the form of training of village water pumpers/technicians and of district level village water supply maintenance mechanics:

-- 2 weeks (12 days) training for one village pumper, @P6 per day (including P3 per day salary):P72

-- 3 weeks (18 days) training for two maintenance mechanics, @P8 per day each (including P4 per day each of salary):P288

Incremental dissemination costs are, therefore, in the order of P360, and would yield a dissemination cost ratio of 360/1902, or approximately 0.19.

However, if a wind system is to be placed in a village which has no mechanical pumping of water at present, the incremental dissemination costs should be calculated net of what it would have cost to put a diesel unit in place.* In such a circumstance, the "net incremental dissemination costs" become negligible, and their ratio to NPV is highly favorable.

(ii) Changes in Dissemination Costs Over Time

This ratio can be expected to fall even further as more than one windmill is placed in each district and the cost of training two mechanics can be spread over an increasing number of units.

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* This is because the dissemination cost ratio [illegible] here is the NPV of a wind system over and [illegible] fits of a diesel system (see Section [illegible]).

(iii) **Overall Dissemination Effort**

There are several hundred target villages, encompassing the entire rural population. The full cost of bringing pumped water supply to these villages is a major national effort. However, it is one the Government of Botswana has accepted and is already undertaking. The extra resources required to direct that effort toward wind vs. diesel powered systems is quite small.*

For a summary evaluation of wind-powered pumping systems, see chart next page.

WIND-POWERED SYSTEMS FOR PUMPING VILLAGE WATER SUPPLIES
ECONOMIC EVALUATION SUMMARY

Investor/Consumer Perspective

Not applicable

Social Perspective

Investment Analysis	Sensitivity Analysis	Scarce Resource Analysis	National Policy Objectives
attractive returns relative to diesel pumps	° rapidly rising fuel costs can sharply enhance attractiveness ° not economic for deep wells ° not economic for over 8000 liters per day	draws heavily on already taxed maintenance capability	reduced dependence on imported diesel

Dissemination Efficiency Perspective

Dissemination Costs	Dissemination Mechanisms Over Time	Overall Dissemination Effort
Extremely low	Likely to decrease over time	Minor extra effort, given existing programs

SOCIO-TECHNOLOGICAL CHANGE - A MODEL OF LOW FRICTION TECHNOLOGY ADOPTION IN AFRICA

by Cecil Cook

"Development to Europeans is the placing of square beds in round houses." Paraphrased from a Tswana chief; "Inaction is better than ignorant action," Meher Baba in Listen Humanity.

INTRODUCTION

The paper which follows is inspired by the hypothesis that most of the real and enduring socio-cultural changes going on in the world are not planned, guided or subsidized by any supervisory body or "agent of change." I would even go so far as to argue that often direct effort to help a people develop in a particular direction creates its own resistance in proportion to the push by an outside party. Imagine a Japanese management expert from Sony going to Harvard University to help improve inter-disciplinary communication between the departments by recommending the high-yield collective decision-making methods proven in his country. To lecture is one thing; to fund and to push a Japanese style of operation is quite another.

Most fiascos in the overseas development field are iatrogenic. This means they are caused by development professionals and organizations, both foreign and LDC, through the launching of projects with unintended destructive impacts on client communities. For example, the present frantic U.S. concern over the fossil energy shortage which is menacing the U.S.'s highly mechanized economy and way of life leads directly to the isolation of energy sources and technologies as a high priority in LDC's. This donor country fixation upon energy shortages creates an isolated focus around which a whole mini-generation of development programs are designed. It is a poor way to approach client communities or LDC governments because energy is an abstraction and energy technologies are meaningful only as means, never as ends in themselves.

A minimum goal of all development programs should be that the resulting state of affairs in a community undergoing a directed change process not be retrogressive; the quality of individual and community life should not be reduced by local or world standards. Unfortunately, there is ample evidence that development programs often result in more costs than benefits over both the short and the long run.

The purpose of this paper is to examine some of the literature on the change process in Africa, before, during and after the colonial period, to determine whether there is a factual basis for supposing that specific items of technology and technique, or whole socio-cultural patterns, have been adopted by African communities largely or entirely on their own initiative across major cultural and societal frontiers. A second purpose is to isolate some of the mechanisms, carriers and contexts wherein such spontaneous adoption occurs, which might provide some guidance for AID in assisting developing countries meet their energy needs. Before turning to the substance of the paper, some biased language, which has become prominent in the development dialogue, must be cleared up.

The concept of technology transfer expresses a narrow, Western materialistic focus upon development as a capital accumulation process and our experience of technology as a weapon that conveys power on the battleground of the market place. Technology does not transfer from one society to another and then bring about major institutional adjustments in the superstructure as a consequence; rather, a society under external and internal pressures begins to reorganize itself and in the process makes use of new technology available to it from the outside world. In place of technology transfer, which assumes comparable donor and donee technology-using organizations, it makes more sense to speak of the "evolution" of a community's receptivity to or willingness to explore the use of a given technology or technique. Next the technology must find a social organization home for itself, someone or some group to give it legitimacy and to own it. The technology does not transfer until a societal interest and organizational capacity exists to make use of it. The "transfer" is the effect, the last step in a complex but sometimes lightning-fast process of societal adaptation.

A related biased concept is that of technologies as ends. Using energy programs as an example, there is no clear acknowledgement by donors that energy technologies aimed at villagers must assume the role of dependent variables in a more comprehensive community and economic development package to which there is indigenous commitment by a significant segment of the target population.

Another misconception may be the enthusiasm over Schumacher's thesis that intermediate technology is beautiful because it is small. Intermediate technology-oriented

development programs can result in a disastrous decentralisation of the same kind of technology-centered failures which have plagued large-scale undertakings. It is not the scale of the technology so much as the extent to which existing socio-cultural patterns are dynamically incorporated into a change program that will determine the quality of any community economic development process (Basil Davidson, 1974).

Resistance to beneficial changes is also a biased concept. The bulk of the applied anthropology done by Foster, Erasmus, Barnett and others in the U.S. and Britain in the 50's and 60's discusses the causes of resistance to fundamental changes in agriculture, health, politics, housing and settlement, etc., as proposed by outside authorities who are looking after the "best" interests of a colonial or client people. For example, stock reduction programs to improve herd quality and reduce over-grazing among pastoral people the world over have been met with unremitting resistance. The dominant thrust of applied anthropology from this period is how to rationalize the necessary changes in the indigenous scheme of things so that the subject people either actively seek or at least acquiesce to the required changes in their lives and livelihoods. The whole operation is manipulative and has little to do with indigenous priorities. An alternative approach would be to advocate other courses of action by removing, where possible, external constraints on the target people's aspirations in some other prestigious activity.

The next section is a synthesis of empirical findings from African development studies and ethnographic studies into an abstract model of the spontaneous change process.

I. SOCIO-TECHNOLOGICAL CHANGE

A. An Abstract Model of Spontaneous Change*

Misconceptions about the Static Nature of Pre-colonial African Societies

It is common for Americans to assume unconsciously that pre-colonial African tribal societies were largely static communities, endlessly repeating themselves. This notion is refuted by Robert Levine:

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* The author's theories on spontaneous change are based on a number of contrasting models of how societies [illegible] tically change and the role of different [illegible] and mechanisms in initiating and steering the [illegible] culturation, revitalisation, applied [illegible] cultural materialism, etc.) which were [illegible] in the original paper.

> Rather than thinking of Africans as tradition-directed people perpetuating an ancient and stagnant culture, we might more accurately regard them as pragmatic frontiersmen with a persistent history of migration, settlement and resettlement on new lands, and responding to the challenge of inter-tribal wars and the slave trade. In this historical perspective, Africans were experienced in adapting to and taking advantage of change, instability and movement, so that they were more prepared to adopt new paths of advancement offered by European institutions than were the populations of some of the more stable non-Western countries." (Robert Levine, 1966)

The most superficial reading of the history of pre-colonial Africa reveals ample evidence of African receptivity to new influences and opportunities: the trans-Saharan cultural and trade interchanges from the time of Christ onward; the Moslem impact on the Sudan and resultant horse and camel based empires; the extensive trade in goods and slaves between Europeans and African states on the Guinea Coast and in the Congo from the 15th century onward; and the rapid movement of many formerly isolated tribes from subsistence agriculture to successful involvement as entrepreneurs in national economies in the span of one generation.

Most sensitive observers of the contemporary African scene would probably agree that the problem of most African national societies is not too little change, but too much change, albeit the wrong kind of change.

The Quality of the Change Process

Development planners tend to be concerned with easily quantifiable results of projects -- higher productivity, more housing units, increased employment -- rather than with improvements in the quality of life -- security, anxiety levels, sense of fulfillment. The model of spontaneous change under development in this paper treats the existential experience of participating in a change sequence as more important than the long- or short-term goal itself.

In other words, unless the process of change is constructive and personally rewarding in itself, or at least more positive than negative, the whole process is aborted.

The degree of integrity and institutional balance maintained during the change process is also a useful tool for gauging the buildup of contradictions leading to non-negotiable conflicts between competing factions or classes within the change community.

Finally, an even process of systematic change along a broad front is preferred to a patchwork of uneven change with vast alterations in one sphere, the economic sector, and no corresponding meaningful changes in other functionally related areas of family and community life. (Cook) An operational way of measuring the coherence of the societal transformations as they are taking place is needed.

The Abstract Model: Spontaneous vs. Coerced Change

The record of the changes which various tribal and state societies in Africa have undergone over the last 500 years suggests that by far the dominant adaptations and innovative departures from pre-colonial patterns are spontaneous and willed by the actors rather than coerced and/or directed by outside change agents. It is possible to argue that changes in socio-economic practices imposed by outside authorities are largely destructive or inconsequential in nature. They do not lay the foundation for a new mode of production or a major shift in social and political organization.

For example, the Ashanti in the forest region of southern Ghana are reported to have taken up the growing of cocoa on their own at first slowly and then in a great rush after the turn of the century in response to demand and good prices (the seeds first came from Surinam via the Portuguese). (Allan, 1965, pp. 224-32, 346-359; Hill, 1963; Lloyd, 1967, pp. 95-101.) This pattern of rapid response to cash crop demands by small-scale African farmers operating entirely within their own framework of land, tools and labor skills has been repeated for peanuts (Senegal), coffee (Ivory Coast), palm oil (Nigeria, Congo), cotton (Uganda), and so forth across the face of the continent.

> "Although they have accounted for the bulk of the increase in farm output in tropical Africa during the past half century, there is not a great deal to be said concerning spontaneous changes in traditional agriculture. (My emphasis.) Their [illegible]

> common denominator is that they all represent a response to disequilibriating factors that have led to modifications of the traditional agricultural system. The most important of these factors appear to have been knowledge of a new crop, population growth and increased food requirements, access to a market -- domestic or export -- as a result of improved transportation, and reduction of the male labor force in agriculture in certain areas, owing to the absence of adult males employed as migratory workers in mines, on European farms, or in industry." (Johnson, 1968, pp. 164)

The hypothesis of this paper is that the greater the degree of spontaneous involvement in a change process the greater the likelihood of a successful response to new and "disequilibriating" opportunities through the adoption of innovative behaviors and tools. This is termed the spontaneity/coercion ratio. These new behaviors are legitimized in traditional terms because they are initiated and controlled by the indigenous actor and community. The outcome is a maximum adaptation to an inter-cultural situation with minimum change in the prior socio-cultural system. An example of this maximum output/minimum input relationship is the small holder investment in Nigeria schemes where small amounts of assistance in the form of seeds, marketing and extension services are made available to the small farmer on his own land. The small farms were ten times more productive than plantations, six times more productive than settlement schemes and four times more productive than other small holder improvement projects in terms of the ratio of government input to improved agricultural output. (Fogg, 1971, p. 580) It follows from the spontaneity hypothesis that the greater the degree of intrusive intervention into a community, the greater the socio-cultural resistance (friction) and the less the resultant behavior change per unit of time, money, and manpower invested in the development effort.

It must be emphasized that the model of spontaneous change presented in this paper is an "ideal type" formulation in the Weberian tradition. Its usefulness comes as a pure and simple conceptualization within which more specific explanatory hypotheses and action proposals can be thought through and tested against reality. The model assumes the existence of a well-advanced inter-cultural situation with the presence of intrusive demonstration of an alien way of life and livelihood.

B. Postulated Mechanisms by which Spontaneous Change Occurs

Complementarity

The logic of the spontaneous change model is not one of extremes in tension nor an intensification of contradictions beyond the breaking point. The prime dynamic postulated is a selective process by which the potentially conflicting cultural systems seek and find those areas of mutually beneficial interchange. That is, inter-societal communication is possible only where there is a common ground and a shared language or a translator function of some sort.

Heavy and Light Central and Peripheral Culture

Cultures have been losely spoken of as possessing their own genius or esprit. Herskovits in his book Cultural Relativity states that African people have different cultural focii, such as the inordinate interest in cattle shown by pastoralist tribes. These foundational principles, which inform societies with distinctive patterns, are called here heavy culture (central, deep, etc.).

Light culture (peripheral, superficial, etc.), on the other hand, is more easily changed. It has been observed the world over, during the 500 years of European colonial expansion, that tools and weapons which are obviously technically superior to their indigenous counterparts are highly desired; trade in such items between tribesmen and Europeans constituted the first constructive interchange between hostile parties. Steel axes, hoes, knives, new food crops, guns and gunpowder, beads and other means of personal decoration, etc. are absorbed quickly and easily into the surface cultural layer because of their obvious utilitarian value.

Material Culture Substitutions

The speed of the diffusion of corn, peanuts and manioc, introduced by the Portuguese on the west coast of Africa, throughout much of sub-Saharan Africa, is proof of how permeable this utilitarian sphere tends to be. The only constraint on the incorporation of these items is adequate initial exposure and a means of obtaining them, such as warfare, theft, work service, or trade (McMaster, Coursey, and Miracle in Knoczacki, ed., 1977). The relatively slower rate of spread for ox-drawn plowing would seem to be due to a variety of factors: joining the right cash crops, the right kind of land, oxen and plows and a division of labor by sex which encourages the man to do agricultural work (Okai, 1975). Incorporating the ox-drawn plow [illegible]

requires a change in the traditional male role which only becomes worthwhile when the right combination of factors makes such a conjugation profitable, i.e., the benefits outweight the costs within the culture of the innovating actor.

Enclave/Exclave Interactions and Balance of Trade

Many anthropologists have established that the prevailing attitude of tribal peoples toward active economic engagement with the European-dominated or influenced exclave economy and society -- a willingness to migrate and to experiment with new crops and forms of enterprise -- is largely the result of the internal socio-economic state of the enclave community. (Schapera, 1934; Douglas, 1965; Watson, 1958) If there is acute land shortage (Arusha), territorial intrusion and occupation (Kipsigis), a condition of intense competition between the young men and a gerontocracy (Lele), a major collapse of the traditional economy (the riderpest which killed most of the Bantu peoples' cattle in South Africa), then there is rapid, spontaneous exploration of the options for change available within the exclave to improve the balance of trade with the outside world by expanding the carrying capacities of their territorial base through innovation (Harris, 1970). If, on the other hand, there is a continuing positive balance of trade as with the Masai, Pakot and other conservative Nilotic pastoralists, who want less of the modern world's material goods than the colonial and national governments want from them, there is very little alteration of the enclave community's chosen patterns.

The advent of generalized peace over large multi-tribal areas has caused enclaves to expand the scene of their economic activities tremendously. The movement of the Ibo peoples, formerly locked into small local communities in southeastern Nigeria, into positions of responsibility throughout modern Nigeria is well documented. Eventually they threatened the numerically more powerful Hausa and Yoruba peoples who retaliated initiating a sequence of mounting ethnic violence leading into the Biafran war. Generalized conditions of peace render enclave boundaries more permeable and have everywhere set the stage for a lessening of the hold of tribal obligations, since all actors now have the option of crossing into the exclave world and pursuing their immediate, personal interests in this [illegible].

The outcome of these internal pressures [illegible] enclave community can be used as a technique [illegible] mining those enclaves that are likely to be [illegible]

tive to direct and indirect change programs of a given type. The state of the enclave can also be measured in terms of the "balance of trade" between the traditional land-based economy, controlled by the enclave, and the exclave.

Counter-Assimilation

This mechanism may seem hopelessly backward-looking since so much has happened during the recent colonial past to firmly install islands of Western industrial production and commerce in Africa. Nevertheless, a case can be made that Western-style economics and organization systems have been successfully implanted into African societies and function effectively outside of direct Euro-American management only because these new modes of organization and know-how have been successfully integrated into the pre-existing African root cultures. Simply put, the underlying nexus, the deep forms, the attitudes and aspirations of the native actors are profoundly Africa; the "superficial and utilitarian" Western techniques and institutions (the surface culture) have been subtly reworked to express the persistent indigenous world view and attitudes (George Kimble, 1960).

There are numerous examples in the literature of change in African societies which document the staying power of indigenous social organization in slightly altered forms in new socio-economic contexts. (Lloyd, 1966; Ames, 1955; Hapgood, 1965; etc.) Good examples are the role of voluntary associations in urban settings throughout West Africa, the role of chiefs in Botswana as pivotal managers of the exchanges between exclave and enclave, and the role of the Swazi king in selectively reshaping an externally-imposed parliamentary system to emphasize the traditional reliance on dialogue and consultation until consensus is achieved. We have every reason to expect profound African reformulations of the transplanted Euro-American economic institutions during the closing years of this century.

Change by Capture; Apprenticeship; Transcultural Carriers and Receivers

Skirmishing between neighboring tribes and states with the taking of captives, who typically became dependent members of the slave-taker's extended family, no doubt resulted in the transmission of knowledge of new crops, weapons, animals and other useful items across significant geographical distances. Where regular trade existed between tribal entities, the movement of utilitarian innovations from society to society is not at all problematical. Trade between semi-

hostile neighbors has elements of reciprocal "capture"; the traders are taking control of goods which they desire.

Shaka, the Zulu leader who created a major conquest state in the eastern part of what is now South Africa, had several European advisors who were captured, who lived with the Zulu and mastered their language, and who then served as interpreters and lieutenants, assisting Shaka in his various campaigns. This inter-cultural situation enabled Shaka to innovate a number of lethal weapons and military tactics which gave him and his standing armies such an advantage over neighboring tribes that it required less than fifteen years to establish Zulu dominance. Shaka was himself a cultural hybrid who had a fair amount of exposure to English and Boer settlements as a youth.

The technology-by-capture mechanism touches on one of the most essential ingredients of the spontaneous adoption process -- the availability of a comparatively neutral place, organization or cultural intermediary which allows enclave members to master a given innovation, to serve an apprenticeship in a low pressure situation, and to evaluate its pros and cons in their own terms. The author has seen a whole village of Brazilian Indians become literate in their own language in less than one year while only the juveniles were taught to read and write by missionaries. The village was an information-sharing unit, and as the youth played games, making words in the firelight at night, their parents also became literate. Missionaries throughout the world have been "captured" experts, responsible for the lion's share of the technological changes introduced into tribal communities along the frontiers of Europe's colonial expansion.

Another mechanism of inter-cultural mediation goes on, not by osmosis or at a distance, but through intermediaries serving as carriers and receivers of innovations. The intermediaries from both sides of the frontier do this by meeting each other halfway, by creating a bridge across which meaningful change occurs. The carriers of different cultures, once they have engaged in a non-violent relationship, are driven by the ambiguity of their situation, the unknown nature of the cultural other, to seek by experimentation a way to penetrate each other's worlds. This is done by discovering one or more workable crossover points where each party is getting something it wants.

II. CASE STUDIES AND EXAMPLES OF SPONTANEOUS CHANGE

Eight instances of "spontaneous" change are discussed in this section. Some of the changes occur with little outside influence, while others are more directed. Some are successes and some are failures. They all contain important lessons for development planners.

A. The Kipsigis -- Change with Alacrity (Manners, 1965)

The Kipsigis of Kenya were primarily herders with small household gardens of millet and vegetables. In 1906 European settlers arrived in the Kericho district and took over estates averaging 5,000 acres each, including land where Kipsigis were living. The majority of the Kipsigis chose to remain as legal squatters in exchange for paid labor, since money was now being required to pay a hut tax. It was only a matter of five or six years before increasing numbers of Kipsigis began to cultivate corn -- the dual purpose cash and subsistence crop brought by the Europeans. Itinerant Asian traders, who began to settle in the area, and the larger number of Africans who were working full-time on the European estates provided an expanding market for the corn.

Prior to World War I all Kipsigis maize production was done by hoe cultivation and yielded only a small surplus. The first plow was bought by a Kipsigi in 1929 and by 1930 there were 200 plows in use in the Belgut location alone. By 1938 there were seventy-three Kipsigi-owned water mills for grinding maize into flour. The sale of corn expanded greatly during this period.

A young, mission-trained Kipsigi started out with five acres and eventually amassed and enclosed between 250 and 300 acres. He built two water wheels for grinding his corn, one near his farm and the other near a major road. He charged an in-kind fee for grinding the corn of local Kipsigis. He bought wagons to transport his grain to trading centers and built his own feeder road. Later he purchased a truck, a passenger car and now he has built a brick house on the site of his hut. He used his capital to go into merchandizing by opening two shops run by employees. As described by Manners:

> "He is one of several outstanding Kipsigi leaders in the Reserve whose activities not only reflect the growing importance of money but who have served, by their example, to accelerate the tempo of [illegible]

to increase cash mindedness, and to speed the drive for acquisition of western commodities among their tribesmen." (p. 233)

The Kipsigis pushed aggressively ahead by establishing hundreds of small shops, planting small tea and coffee plantations up to one acre, the maximum allowed by the colonial government. They struggled with the government for permission to import high-yield European milk cows, so as to claim for themselves a larger share of the internal Kipsigis market for raw milk. The many small Kipsigi-owned shops came into being without any government or centralized credit assistance. The Asian traders already operating in Kipsigis-land extended credit in the form of merchandize to their clients (pp. 244-245).

Manners predicted that as the per capita land base continued to drop, the Kipsigis would be forced to seek more intensive cash crops and other forms of wage labor. He concluded: "It seems clear that the incentives to increasing participation in the cash economy -- of which the emerging markets were one aspect -- came from the Kipsigis themselves." (p. 245)

Comment: The Kipsigis are an example of rapid, self-propelled exploitation of the opportunities for self and ethnic development opened up by the colonial occupation of their home land. Initially there was a quickening of an indigenous agricultural pattern. Before the external demand and alien technologies could be joined into a functioning complex, the Kipsigis needed an opportunity to apprentice themselves to cultural aliens. The mission stations and wage employment for the settlers gave the Kipsigis a common ground where they learned about and then mastered the innovations in a neutral sphere. An important pre-condition for the adoption of the ox plow and the water wheel was the existence of a prior and stable demand for corn as a cash crop.

From the Kipsigis known to the author, it would seem that an essential ingredient in their cultural makeup is an almost cocky self-assurance that they are conquering the foreign "savages" and their infernal machines and thus demonstrating both by expanding Kipsigis civilization into the world society.

B. <u>The Botswana Chiefs as Innovators</u> (Schapera, 1970)

I. Schapera, the indefatigable and matter-of-fact ethnographer of the Botswana for the last 50 years, has produced a valuable study of the role of chiefs as mediators, filters, and initiators of cultural interchanges between their peoples and Europeans.

For example, the Kgatla tribe, under the initiative of Chief Isang, during a period of acute drought, convinced the tribal council to pay for a number of tube wells in 1926-27 by means of a special levy. The care of the wells was entrusted to a small committee chosen from men with cattle posts nearby. A watering fee paid for upkeep. Later Kgatla "syndicates" paid for their own boreholes and gained exclusive water rights. By 1940 all tribal capitals had boreholes which were treated as tribal property, paid for and kept up by funds from the tribal treasury (page 100).

Some chiefs were, according to Schapera, "conscious social planners seeking progressive futures":

> (Bathan II about his father Seepapitso)". . . he felt that any change coming to his people must not alter their personality, their spirit, their character as Tswana . . . He was a magnificant link between the government and the tribe." (page 251)

> (a written address by Isang to a teacher's conference) "Material advancement: I introduced better bulls and seeds, also double furrow steel ploughs, encouraged the building of better houses and helped the people find the water for their cattle <u>without government aid</u> (my emphasis); found markets for their grain, produce and cattle and controlled the sale of kaffir corn to prevent famine; made laws to prevent wasting of money on unnecessary European clothes. . . ." (page 258)

Schapera also discusses the role of returned migrant laborers, colonial administrators, missionaries and traders respectively as contributing to the introduction of changes of various kinds in Botswana life. He concludes that the chiefs as a group played the most strategic, responsive and legislative role in determining the nature of the interactions between their people and the imported European system:

> "What I have been trying to demonstrate is the the spread of European innovations among the Botswana was not a one-sided process controlled entirely by Europeans. It was to some extent also controlled by the chiefs. They readily accepted for their people many innovations of European origin. But they also rejected or restricted some that were attempted, and persuaded Europeans to modify or themselves modified some of those they accepted. Thus, although they were not the prime authors of these particular innovations they can at least be said to have originated them locally by deciding which to establish and in what forms." (page 250)

The intermediary role of the Botswana chiefs and the European intermediaries -- missionaries, traders, administrators, settlers -- provides a clear-cut example of what Arensberg calls the principle of reciprocal accomodation (Arensberg, 1978), whereby a give-and-take interaction occurs between donor and donee. In this process, a given innovation is reformulated so that it complements existing socio-cultural capital and advances the collective purposes of indigenous communities. When the interaction between enclave and exclave is mediated in an orderly way between legitimate leaders as is the case in Botswana, there is seemingly a more consultative process of rationally searching for the most constructive interchanges.

C. Luhya and Taita (Kenya) -- Examples of Spontaneous Innovation

(The following information on spontaneous acceptance of innovations was obtained from Fred Mugivanie, a Luhya, and Mary Ann Godia, from the Taita who live along the coast.)

Among the Taita of the Taveta District, a mountainous coastal region, a number of innovations have gained widespread acceptance as a direct result of population expansion beyond the carrying capacity of traditionally exploited resources. The widespread conversion to "white iron sheets" for roofing in place of grass thatch has been forced by the virtual disappearance of thatching grass as more and more land is cultivated. According to Mary Ann Godia, "There simply is no land left where the thatching grass can grow . . . so people have used asbestos cement roofing but that is even more expensive. People who cannot afford the iron sheets cut open paraffin tins and other metal containers,

flatten them out, and use these to cover their roof tops. Poor families are firing their own clay shingles on site. Since there is also a growing shortage of firewood, this type of roofing is becoming prohibitively expensive." These changes have been a natural response to the growing shortage of thatching grass, according to the informant; it has not been due to an effort to be modern or to imitate city dwellers.

The bulk of the housing in the Taveta District is what Kenyans call semi-permanent housing, meaning that it has a cement floor, long-lasting wall construction, and a durable non-thatch roof covering. The walls are made of either fired clay bricks or cement and sand blocks or sun-hardened adobe, all fabricated on site. The informant emphasized that building a semi-permanent house was a costly and time-consuming process involving the labor of all members of a household. Cement is preferred as the bonding agent over firing since firewood has become so scarce. Again change is induced by increasing scarcities of a formerly free and plentiful natural resource.

The shortage of firewood has also caused most households to shift over to kerosene or charcoal-burning stoves. Both of these are manufactured elsewhere and purchased locally. The fuel is also imported. A new kind of mud stove, which holds up to three pots and has a controlled, fuel-conserving combustion chamber, has begun to gain acceptance among the Taita women. The informant did not know the origin of this stove.

Two other changes were readily accepted by the Taita. Higher yielding, drought-resistant hybrid corn has been rapidly adopted "because it yields so much more corn per acre." Artificial insemination of cattle has also been widely accepted among the Taita because the cross between high milk-yielding Euro-American breeds and local African cattle produces a hybrid offspring that gives more milk on the same feed while retaining the disease resistance of the African stock.

Among the Luhya, living inland in Western Kenya in a region of foothills, there has been a gradual conversion to metal roofing and semi-permanent housing. Because the Luhya population is not yet as dense nor the grass and firewood as scarce as that of the Taita, the changeover has not been as rapid.

An innovation that has been widely adopted by the Luhya is the water-driven grist mill, which is built, maintained and owned by entrepreneurs. The informant

did not know where the water mills came from, however, he stated that they are very common in Western Kenya where the conditions are right and the technology is completely controlled by the Kenyans.

Comment: The spontaneous change processes reported for the Luhya and Taita represent a deliberate change in approach to meeting a basic need where these needs are not being met adequately by either traditional or "modern" sector resources and technologies. The innovative responses are of several different types: (a) the combination of new and old elements in such a way that a constraint is overcome (soil cement construction, roofing tile, metal roofing); (b) exploiting an under-utilized resource controlled by the local community (high milk-producing cattle, labor and land-intensive specialty crops) in a new way; (c) adopting a technology that does more with less (the fuel-efficient mud stove, the water-driven grain mill). These socio-technological changes are rapidly incorporated because (1) they improve the balance of trade with the outside world, and/or (2) enhance the productivity of labor, land and other resources within the local economy. Put simply, there is greatest receptivity to those socio-technological changes which respond directly to the most pressing economic and resource constraints threatening the immediate well-being of a community in both absolute and relative terms. The greater the degree of local control over all the essential ingredients making up a complete socio-technological change package, the more spontaneous will be the change process in a given community and from one community to another.

The first step in the socio-technological change process is the identification of those particular resource and economic constraints which people feel threaten them with retrogression. The next step is the search for those socio-technological change packages that uniquely respond to each predicament and place the initiative back into the hands of the indigenous actors. The most easily-managed changes are those where the actor already controls most or all of the necessary ingredients; all that must be done is to learn how to make a new combination by learning a new technique or mastering a simple technology. The Luhya and Taita examples clearly show this self-help dynamic.

D. Women in Development/Village Technology Unit (Swaziland)

The experience of Village Technology Unit (VTU) in Ntonjeni Valley in Northern Swaziland provides a good opportunity to find out what sorts of appropriate technologies small Swazi farmers are drawn to and why. The Women in Development project is funded by the United Nations; it is nominally under the administration of the Ministry of Agriculture. The director, Linda Vilakati, is an extremely competent Swazi woman who received her college education in the U.S.; she is a person of unusual capacity and forcefulness. The primary objective of the WID program is to assist rural women in finding ways to increase their productivity and income and to improve the health and happiness of their families. A small builidng serves as meeting house, workshop and office space. It was built within easy walking distance of several thousand persons and just down the road from the Ntonjeni high school. The women are attracted to the center for classes on sewing, nutrition, kitchen gardens, handicrafts, etc.

About two years ago two Swazi "artisans" who had been working as extension agents for the Ministry of Agriculture were sent for two weeks to the UNICEF-run Village Technology Center near Nairobi. Upon returning they constructed a number of basic technologies within an enclosed compound to demonstrate what they had learned to the Swazis of the valley. The technologies demonstrated were Cinva Ram earth blocks, an evaporative cooler, solar water heater (thermosyphon), solar cooker, a simple stove built with precast concrete slabs, solar food dryers (a portable wooden one and one constructed of mud), eggshell concrete water or storage vessels (up to three feet in diameter), a hand-operated peanut huller, a wash basin on a stand with a drain pipe, and a hydraulic-ran pump. After a solar workshop by C. Cook and M. Lillywhite, they added a solar water distiller, a direct gain bread box-type solar water heater, a cold frame or grow hole, and a thermosyphon solar water heater of improved design.

Only those people sufficiently curious to come to the demonstration center have had a chance to start using some of these devices. Thus, the first generation of innovators is a highly select group. One visitor, a peanut farmer who last year planted less than one acre, immediately asked the artisans to make him a hand-operated peanut huller. According to the director, this farmer has increased his peanut acreage to three or four acres because he now has a simple and inexpensive way to shell large quantities of peanuts.

The women frequenting the center were most strongly drawn to the cement vessels which are made by filling a plastic bag with sawdust and troweling a rich cement mixture over the expanded bag. The initial purpose of the vessels was for storing water, but the women of Ntonjeni were more interested in them for grain storage (reformulation by users). In contrast to the appropriate technology philosophy of teaching farmers to build technologies for themselves, the women asked the artisans to make the vessels for them to buy. They reasoned that "you know how to make them better than we do. We will plant more corn and sell it. Then we will buy the storage vessels from you."

The second most popular technology is the solar vegetable dryer constructed of mud, polyethylene liner and plastic film for glazing. (The Swazis dry corn in corn cribs and traditionally they dried other vegetable products for storage.) The covered solar dryer opens up the possibility of dehydrating fruits. It improves sanitation and accelerates the drying process. The WID program has discovered that guava, which grows wild, can be easily dried and stored for months in a sack in the rafters of Swazi houses. Several women have built their own dryers. The Ministry of Agriculture has used the artisans to train about 100 women extension workers in how to build the mud dryers. The cost is less than $2.00 when polyethylene plastic is used inside and as the transparent glazing. According to the WID, several of these food dryers have been constructed elsewhere in Swaziland as an outgrowth of this training.

There has been interest in the improved two-handled digging shovel (Intermediate Technology Development Group design) and the cement slab cook stove which has a metal plate with several removable round grates so pots can fit down inside the fire box. The women liked the fact that a chimney carries the smoke outside the house even more than they liked the savings in fuel wood.

Comment: The work of the WID/VTU in Swaziland shows the effect of several important variables postulated in the spontaneous socio-technological change model. The approach to the people is initially non-directive and therefore non-coercive. It is exploratory, seeking to introduce as many people as possible to a broad range of technological options in a fashion that allows the potential users to assess personally each option's relevance and practicality.*

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* It is the author's personal opinion that a superior way to demonstrate these technologies would be to build a fully functional, live-in Swazi homestead where these devices are incorporated to their best advantage, as opposed to the present museum-like display. A model Swazi homestead would give Swazi families an idea of what a rural pattern of life might embody in the [illegible] an alternative to the urban model of [illegible]

In addition, the people demonstrating the technologies are relatively high-status members of their own society.

Another important dimension of the WID approach is that it depends upon the self-selection of persons who are highly motivated to try a given innovation, rather than attempting to motivate a whole group of people to collectively try out something new. The VTU provides a de facto neutral place where the technology can be demonstrated and those persons who are interested enough can apprentice themselves without any risk of failure or social censure. The gradual expansion of new technologies into the surrounding community allows time for the users to reformulate the innovation -- to substitute low cost materials, to figure out the best means for obtaining "exotic" materials, to work out the economics of financing the initial cost, and to realistically measure the payback or other benefits. There is a natural sequencing taking place at Ntonjeni which is allowing the WID staff to experimentally piece together whole socio-technological change packages comprising a product and a process which integrate the right hardware, financing, payback/payoff, social organizational fit, and cultural symbolism and values.

One final lesson to be learned from this example is that unless the technology solves a serious difficulty faced by rural people or drastically increases income and/or the quality of life, the willingness to adopt it is low.

E. Rural Industries Innovation Center (Kanye, Botswana)

(Observations made during the summer of 1978.)

One of the more interesting development organizations in Botswana is the Rural Industries Innovation Center, which is centered in Kanye, a traditional town of some 25,000 to 35,000 inhabitants in the southern part of Botswana.

The ten-year old RIIC is funded by the Fredrick Ebert Foundation which receives most of its funds from the West German government. Although it is still heavily subsidized, it is committed to covering as much of its operational costs ($300,000-400,000/year) as possible by means of income-producing small industries, run by the RIIC directly or by local craftsmen-entrepreneurs who rent facilities and equipment.

The RIIC is run by a community board which includes local representatives of both the traditional and "modern" governments and representatives of such other constituencies as

merchants, farmers, and craftsmen. The top management is imported from Europe and North America, giving the RIIC the strengths and weaknesses of many expatriate-dominated development organizations.

The Center is divided about evenly between applied research concerning basic technologies and the launching of income-generating activities. The physical plant is impressive. It contains complete wood and metal-working shops which are run by RIIC's own power plant. Various RIIC staff have fabricated a number of the standard appropriate technologies from around the world: a batch biogas plant providing gas to the kitchen of a demonstration house, an underground (Chinese) continuous feed biogas system, wind pumps and electricity generators, a range of solar water heaters, energy-efficient wood-burning cook stoves constructed of mud, improved traditional housing built of materials taken from the site, solar cookers and ovens, etc.

Richard Caruthers, a Canadian engineer, has put together an extension program to direct the resources of RIIC toward meeting the highest priority needs of nearby Botswana villages He and his partner, a Botswana woman, have chosen a policy of first developing relationships with the leaders in ten to twelve villages outside of Kanye. Next, they conduct lengthy interviews with individuals and at meetings called by the village leadership to discuss village problems and explore alternative solutions. Finally, they participate in and help precipitate a consensus about what activity would motivate some or all of the villagers to participate.

In one of the villages visited by the author, it had required twelve separate visits lasting many hours to decide that the highest priority was the need for a year-round communal well and a pump.* Caruthers anticipated another series of meetings would be held before the work force was organized and the well dug. His plan was to teach several men how to build the hand-operated pump and gravity-feed water filter system. The system would belong to the village and the knowledge to maintain and repair it would be established in the village under the control of the senior men. Thus, the RIIC is attempting to gradually stimulate the village to function as a self-help unit around the community's need for water.

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* The owners of the one existing well serve themselves and their friends first; a certain amount of friction results from their assertion of private control over what others believe should be a public resource.

Comment: The RIIC rural development strategy has several problems. First, it is incredibly slow and costly in terms of time and money. One solution would be to have someone live in the village for a period of time instead of making trips back and forth.

Second, in the interest of not overly influencing the villagers toward particular technological options, the RIIC outreach methodology does not expose them to the full range of relevant technological choices. As a consequence, the villagers are discussing their needs without knowing what solutions are available at various levels of human and capital investment.

Finally, the RIIC extension strategy, although sensitive to the importance of village culture, lacks some essential dynamic ingredients.

The villagers in the area appear to be fragmented and unmotivated. As is the case with other colonized villagers, the typical attitude is to allow European patterns and Westernized elite in charge of urban and national institutions to dominate and define the interface between the village and the metropolis, in terms favorable to the metropolis. The villagers are reactive; they tend to passively conserve village ways and wait for outsiders to implement changes. The RIIC strategy does little to change this pattern. It fails to encourage the rethinking of ends and means by villagers. The RIIC is correct that real interests must be identified and technology found to address these needs; however, it is equally essential to encourage a preceding village animation process that comes before and after the technology transfer, to encourage the community to break out of its passive response to urban patterns.* Some unit of societal action -- malcontent individuals, progressive factions, age groups, village leaders -- must be identified as the lead

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* Rural animation is a technique developed by L'institut de Recherche et Application des Methodes de Development (IRAM), a small international organization, which was used in Senegal. It consists of bringing high-status young men from a group of villages to a training center for a three-week program. They study the relationship between their village, the nation and the government, followed by discussions of the economic problems of their area and what can be done about them. The men then go back and share their experiences with their village and decide on a project for the village. They return to the center for a few days to learn techniques necessary for implementing the project.

Animation programs had many more failures than [illegible] Traders and marabouts (Moslem priests) [illegible] over government-initiated cooperatives [illegible] It was found that rural animation [illegible] where European influences are [illegible] of culture and community [illegible]

constituency, which will give innovation a serious try in the community. A technique must be found which successfully challenges a rural community to creatively assert its deep cultural patterns, in contrast to superficial ethnic styles, as a basis for expanding its sphere of activities into the so-called modern sector.

For lack of an established term, what is called for is "progressive nativism" in place of the old idea of development as a socio-cultural game of catch up with rapidly antiquating Western economic institutions. Here we get into an examination of the "privilege of backwardness." Certain competitive advantages in principle exist that favor village-centered expressions of the desire for "progress." The advent of an existential villager, who has the requisite skills to make it as an urban dweller but chooses to live in the village because the quality of life is higher there, makes it possible to talk about development as the progressive transformation of the rural community, in pursuit of its own values and interests. The refusal to convert to pre-packaged urban life styles constitutes a transvaluation process which Paulo Freire calls conscientizacao (see Pedagogy of the Oppressed). It depends upon a profoundly independent affirmation of the values and goods of rural/village existence, perhaps even an inner spiritual assurance of its power -- cosmic and socio-cultural -- relative to other world views and life patterns.

F. Tinkabi Tractor Works

The Tinkabi tractor was the brain child of Allen Catterich, an agricultural engineer who taught throughout the 1960's at the Swaziland College of Agriculture near Malkerns. While on the faculty, Catterich undertook an extensive research program to identify the major constraints on Swazi agricultural productivity. This research objectively documented that Swazi farmers, who depended upon oxen power for plowing, had to waste the first six weeks of the rainy season before they plowed and planted. This was because the oxen are so weakened by poor forage by the end of the dry season that they develop only one-third of their normal draft power. In addition, the soils of Swaziland have a high clay content which becomes densely compacted during the dry season. Thus, Swazi farmers wait for the rains to soften the soil and the new grass to strengthen their oxen before plowing. Catterich and his colleagues demonstrated that if the land is plowed and waiting at the onset of the rains and planted at the right moment, then yields increased from 200 percent to 300 percent without any other input. (The average yield per acre for corn in Swaziland is extremely low, typically under 10 bushels, so it is not hard to imagine the yield rising to 30 bushels per acre.)

A design team drew up criteria for the Tinkabi tractor: it must cost about as much as a team of six oxen (around $1,600 with equipment), be manufactured in Swaziland, be easy to repair, serve as a prime mover for water pumps, hammer mills, generators, etc., and in general constitute the central piece of a whole low-cost farming system. The King of Swaziland, Subhusa II, saw a full-scale model of the Tinkabi during independence day celebrations and was very much taken with the idea. The government's main development arm immediately followed up the King's show of interest with a series of grants to the Tinkabi Tractor Works Corporation for refining the prototype and developing the industrial capacity to produce the Tinkabi in Swaziland.

By 1978 the Tinkabi had been in production for several years. Only about 100 units are sold annually in Swaziland. More units are sold abroad, but transportation costs are high. The basic tractor, plow, disc and two-row planter system was sold for about $2,200 in 1978. A great variety of attachments are manufactured at the factory. The motors, transmission, and metal are all imported from the Republic of South Africa. Most of the work is done by Swazis at the main plant just outside of Manzini, although the direction and management of the operation remains firmly in the hands of Catterich, an Englishman.

The main Swazi market for the Tinkabi is rural entrepreneurs who use the tractor to plow other small farmers' fields, to grind corn, and to perform other tasks for cash. The purchase of a mechanical ox, which must be fed with money, is used by some "progressive" Swazi farmers to escape from onerous obligations to kinship and tradition -- the obligation to help neighbors with plowing free of charge using a team of oxen. Using a privately-owned Tinkabi they can charge for the same service.

The tractor is not selling nearly as rapidly as was expected. According to Catterich, the Tinkabi could be the centerpiece of a small farm system. However, it has been restricted by several factors. Foreign agricultural assistance programs push more expensive, high-powered tractors, which are perceived to have a higher status. Another obstacle to the use of the Tinkabi by small farmers is that the average size of Swazi farms and their annual cash income are too small to afford the Tinkabi. It is cheaper for a person with under five acres to pay someone to plow his land. Further, [illegible]

the Tinkabi is slower than imported tractors, it is not as attractive to co-ops or rural entrepreneurs who pay for their tractors largely by plowing as many fields as possible.

Comment: The development of the Tinkabi is a classical example of the value of establishing criteria for new technologies, based upon a careful analysis of what the constraints really are in a given society and region of the world. Unfortunately, the focus of the Tinkabi project was upon the tractor as a source of traction power and as a prime mover for a total small farm system. The question of what socio-economic group would purchase, control and maintain the tractor was not as clearly thought out. The result has been an inability to successfully graft the technology into the rural community because no leading socio-economic group or role -- traditional or new -- has been firmly connected with as the carrier of this ingenious traction technology. This failure points out the critical need for objectivity testing and then preparing the socio-economic side of the development package.

CONCLUSIONS: A SIMPLE METHODOLOGY FOR "DOING IT RIGHT"

Two kinds of conclusions will be presented: (A) some general rules of thumb on how to organize and design spontaneous socio-technological change programs; and (B) check-list for judging the spontaneity rating of any proposed development program.

A. Rules of Thumb for the Design and Implementation of Spontaneous Development Programs

Rule Number 1: Development must be viewed as the search for those relatively few areas of inter-societal connection where positive interation can occur.

For genuine cross-cultural cooperation to occur, there must be an honest pursuit of mutually beneficial objectives. The socio-cultural context of the indigenous actor is the bedrock upon which an existential development process must be based. The pre-existing social and cultural "capital" must be used to the greatest extent possible. Thus, development becomes a way to "Africanize" the change process itself, rather than a manipulative exercise whereby African villagers are urbanized and westernized by development professionals.

Rule Number 2: The best development strategy is one that develops the least; the smaller the outside intervention, whether by a host country government or donors, the better.

For example, missionaries, who labored to improve their material surroundings and productivity under conditions similar to those in villages, were often unintentional sources of technological innovation.

By keeping inputs small, donors allow local actors to exercise their own initiative to continue the socio-technological change process launched by a development enterprise, without depending on highly unreliable outside sources of investment and technical assistance.

Rule Number 3: It is critical that a way be found to accurately assess villagers' highest priority needs and wants.

In development planning, the interests of host governments, donor agency, and target community overlap in relatively few areas. The subset of shared interests, where these three parties agree, defines the arena in which fruitful planning for village-centered, socio-technological development can be explored. Some method for giving legitimacy and power to the villagers' views is required.

One solution is to ensure that there are representatives of the host government, the donor agency and the target community serving with relatively equal status on the development planning teams at all stages of a socio-technological change program. Typically, foreign development planners are not sufficiently familiar with the country to plan a socially sound project. What is called for are cross-cultural mediators and translators, and the generation of a shared frame of reference whereby all major parties to the change process can communicate directly with each other. The development process thus becomes an exercise in collective bargaining and consultative solutions where new areas of agreement are mapped out.

Rule Number 4: The most essential rule, dominating the other three rules of thumb, is that for a spontaneous change process to be launched a threshold must be crossed whereby a particular socio-technological change package comes together with sufficient power to excite the self and collective interests of villagers.

This threshold can only be crossed when the socio-technological changes become instantly traditionalized, because they expand and strengthen the culture and community of the innovating actors from the insider's point of view. The spontaneous nature of actor-initiated and actor-carried changes is the opposite of coercive and manipulative change processes conducted for the presumed good of the indigenous actor by outsiders. The experience of being forced or pushed or bought by change programs administered from an outsider's point of view generates a natural response of both resistance and opportunism. The thesis upon which this study is based holds that a change program that depends upon a high degree of outside intervention for its completion results in more losses than gains from the perspective of the target community. Thus, the determinant of coerced versus spontaneous change is whether the local culture and social organization is being developed in its own terms or whether the development is defined in the terms of the host government and the donor government. Given the centralizing nature of most large-scale organizations, it is predictable that villages as centers of organization, control and initiative will be diminished. As a result, rural communities will be weakened and urban communities, already bloated by default, will continue to monopolize the economic development process.

This paper demonstrates the inadequacy of AID's approach to social soundness analysis, which is done after a program has already been put together. Such analysis tries to factor the perspective of the indigenous actor back into the equation at the last minute. In contrast, the challenge of development is to inject the African's point of view into the first formulation of a development program's ends and means. This objective requires a bottom-up methodology that uses multi-cultural project design and implementation teams. A major factor in the failure of U.S.-funded development ventures is an over-reliance upon American expertise and a de facto mono-culture approach to defining problems and prescribing solutions. Indigenous input is solicited secondarily on the question of how to get the job done. The sequence needs to be reversed. Much more time needs to be spent in diagnosing problems and prescribing solutions from the indigenous actors' point of view. In fact, the first year or two of a program could well be devoted to this phase of development assistance. No major American corporation would think of launching a new product without having spent as much time on "market studies."

If more time and manpower is spent penetrating the world of the target community by using multi-cultural teams, the amount of intervention required to gain a measurable unit of constructive change will no doubt be greatly reduced, i.e. the resistance will be less. Further, the problem of replication and dissemination will be largely resolved by the spontaneous nature of the changes initiated, once the socio-technological package is right. The initial innovators will carry it throughout the society because of its utility and compatibility with local socio-cultural patterns.

B. Spontaneity Checklist: How to Design Development Programs for Maximum Self-Help Input

The objective of development is not change or convincing people they need to become different than they are. Rather, it is finding ways to realistically enable people to become more of what they want to become. This study has attempted to construct an ideal type of a spontaneous, inwardly managed change process in contrast to a coercive, outwardly managed change process which depends upon large injections of outside resources and expertise. A set of minimal preconditions have been assembled which can be used to score past, present and future development programs to get a very crude measure of its spontaneity quotient. These preconditions have not been weighed or rank-ordered. They are a scrambled checklist of the prerequisites for gaining a spontaneity effect, identified by the author in the course of doing the research for this paper. The value of this checklist of prerequisites has not been demonstrated independently of the research reported in this paper. It is offered as a heuristic device:

1. There is a neutral, low-risk space where a socio-technological package (STP) can be demonstrated under real conditions of use, including opportunities for apprenticeship to master the STP.

2. The STP experts can be "captured" by the local folk; there is an opportunity for insiders and outsiders to develop a lasting social relationship based upon mutual respect (not authority or power).

3. The STP is part of a wider community revitalization process.

4. There is a method for identifying the innovative community group and/or individuals who will be the initial carriers of an innovation.

5. The STP has been designed for a well-established lead constituency in the local community that will "own" it and maintain it.

6. The STP grows in response to objectively-determined, high-priority needs of indigenous actors; it results in a sure-fire improvement of income, standard of living, production, or money/labor savings in the self-defined area of greatest need.

7. The STP results in an improved balance of trade between the rural community and the urban center; it builds greater economic autonomy.

8. The design and implementation teams are microcosms of the major parties interacting in the development process.

9. The STP makes extensive use of the existing socio-cultural system and minimizes the introduction of outside experts and new organizational arrangements.

10. The STP enhances and expresses in a fundamental fashion the values and desires of the "target" community. These values are clearly known by both "insiders" and "outsiders." The STP has both the short- and long-term effect of increasing the cooperation and interdependence of the face-to-face community carrying the innovation rather than causing greater conflict, competition and factionalization.

11. The STP has been custom-designed for the people and the micro-region. The technology works. There is training and technical assistance and the provision of adequate access to all the other essential ingredients -- land, energy, financing, market and demand for the product. The access to these essential ingredients can be controlled by the actors. The STP is sufficiently simple that indigenous actors, once they have mastered it, can teach it to others.

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COMMUNITY PARTICIPATION IN AFRICAN FUELWOOD PRODUCTION, TRANSFORMATION, AND UTILIZATION

by Marilyn Hoskins

INTRODUCTION

All over the world governments are showing an interest in developing a new approach to forestry. They are indicating an alarm over environmental degradation including the decreasing carrying capacity of land to feed growing populations, and also over the depletion of forestry products, by-products, and tertiary products. This concern is augmented by the rising costs of energy that focus new interest on the dwindling supply of firewood.

The urgency to improve forestry production comes at a time when many donors, from small private voluntary organizations to multi-national organizations, are re-assessing their approaches to development, and deciding that development is not something one does to someone, but something people do themselves. They are concluding that a developmental role is a supportive role; it is that which facilitates local people solving their problems in a way to gain control over their own futures.

FORESTRY FOR LOCAL COMMUNITY DEVELOPMENT

The "new approach" to forestry, then, focuses on ways to help local people identify and supply their local firewood and other forestry needs from the "bottom up" rather than from the "top down." It is an attempt to bring local residents into management decisions on integrated land and resource use, and to develop an "appropriate forestry" approach which FAO describes as follows:

> ...Rather than setting national goals, the priority is to enhance the lives of specific local communities.
>
> Forestry for local community development must reflect the needs, problems and aspirations of local people as seen through their eyes. To be truly appropriate the strategy will vary according to community [illegible] In underlining social, rather than strictly [illegible] needs, community forestry calls fo[illegible] attitudes. In particular, the di[illegible]

> and forestry which seems so clear as between industrial forestry and intensive agriculture must be abandoned. (FAO, 1978 pp8-9).
>
> Bringing forestry to the aid of rural communities is not so much a technical problem as a psychological, institutional, and political one. (FAO, 1978 p22).

This approach also includes transformation and utilization of forestry and related products as part of forestry for local community development projects.

Interest in developing this new type of programming has been widespread. FAO has held several "expert consultations" where there was broad North-South participation discussing potential for this approach. From these discussions FAO published "Forestry for Local Community Development" and other papers elaborating problems and methodology. The Eighth World Forestry Congress held in Jakarta, Indonesia in October, 1978 received papers from numerous countries for the new discussion topic area, "Forestry for Rural Communities." Within six months after the World Bank published a forestry policy paper describing its change of focus from industry-oriented to people- and environment-oriented programs, requests for technical and financial assistance came in from about forty different countries (Spears, 1978). A number of countries in Africa have sent representatives to workshops and conferences to consider ways of solving local forestry problems and to share experiences with representatives from other countries. This new approach has frequently been called Forestry for Local Community Development or FLCD to emphasize the need to incorporate community development techniques with forestry and related technology.

TOP-DOWN FORESTRY

Why is there such interest in using this new approach based on community participation to supply African fuelwood needs? Because it is increasingly apparent that the top-down approach is not working. That is not to say there is no further need for industrial plantations, for example, supplying urban centers with fuel. It is to say, however, that efforts to solve local fuel needs in ways that protect or re-constitute a healthy environment require support from local people.

Examples of failures of top-down forestry projects are everywhere. It is not difficult to pay workers to plant trees, but to keep them alive in Africa takes a positive commitment. It takes energy and effort to weed around saplings when it is

120 degrees Fahrenheit in the shade. It takes diligent supervision of animals to protect young trees. It also takes self-discipline to protect locally planted saplings if the only other available forage and fuel is much farther away. The total community must be involved for as one report stated, "why should a farmer invest time in caring for a tree he knows a neighbor's goat will surely eat?"

A major problem which illustrates the need for local support is the control of bush or forest fires. During a visit lasting only one week into the Casamance area of Senegal in early 1979, an FLCD team from FAO observed fires in four different national reserves. In only one case were neighboring people helping control the fire and they were paid workers from an endangered forestry nursery fighting the fire under the direction of their forestry supervisors. One of the fires had obviously spread from a certain village. Even a local law requiring villagers to help fight a fire spreading from their village, did not induce them to help.

All four fires took place in a region which had been the recipient of an intensive Canadian program on community involvement in fighting fires. Many residents had seen films, school children had heard lectures and drawn posters, and a number of villages had been given back-tanks for fighting fires. However, as anyone who has fought a bush fire can testify, fire-fighting is a hot, dirty, uncomfortable business. Successful control of fires can be obtained only when the residents see they have something personal at stake, and these fires were in what residents considered "foresters' lands." (Hoskins, 1979).

If various African nations are to solve their energy problems, then it is not going to be from top-down projects. Local energy problems cannot be isolated from localized basic needs and priorities and will require local input in the planning and broad local support. Fuelwood production, transformation, and efficient utilization approached from the bottom-up or FLCD philosophy raises many new issues. This paper explores some of these issues.

I . PRODUCTION

Simply deciding to include local participation in producing fuelwood does not solve the problem as it requires a new approach and new methodology. Unfortunately there is a lack of experience in FLCD, not only by host country foresters, but also on the part of many expatriate forestry advisors as well. Generally, this has not been recognized. [illegible] than Swiss, Austrian, and some Scandinavian [illegible] of local woodlands, there is little European or [illegible]

experience with locally planned, implemented, and managed forests. This is perhaps why the Swedes and Swiss are in the forefront of many FLCD efforts.

A demanding and rigorous education in forestry has given many upper-level European and African foresters a sense of elitism. This training stresses rule enforcement and includes military training but seldom includes courses in sociology, community development, or extension methods. Rural Africans may have more contact with foresters than with most other government officials but these foresters are usually in uniform, often armed, and frequently feared.

It is not suprising, then, that early attempts at community forestry have suffered from a lack of clarity regarding the philosophy of FLCD, a lack of effective techniques for carrying it out, and a difficulty in communication creating frustrations for the various actors involved. The donors, the host country services and technicians, and the local participants all see local fuelwood problems and attempts to solve them from different perspective The following is an examination of some problems in implementing FLCD programs from these three perspectives. It is important to look at these in turn and then draw out basic issues to see how they can be dealt with in an effective and rewarding manner.

DONORS

When donors and other planning agencies discuss the urgency of African firewood production and their difficulties in attempting to establish FLCD, their attention usually focuses on the following four issues: community participation integrated resource planning, interagency cooperation, and commitment on the part of local forestry technicians to the FLCD approach. (See: CILSS, Winterbottom).

Community Participation

Donors have been frustrated by the lack of community participation in forestry projects. They are just beginning to determine the many different reasons for this. The World Bank describes an early attempt to integrate forestry into a government planned "people-centered" program. It was a project designed to include village woodlots in a government-implemented rural development scheme in Maridi, Niger:

> (The) project, which included the establishment of 900 hectares of village woodlots, failed because, as fast as the trees were planted, the people either pulled them out or allowed uncontrolled grazing to take place. The main reason for this was because they themselves had not been involved in formulating the project and because they perceived the village woodlot area as a traditional grazing ground, access to which was now precluded because of the project. (Spears, 1978 p.4).

In Senegal, foresters directed local residents to plant and maintain trees at the edge of a forest reserve. Residents were given the seedlings, forestry lands were made available for planting, and residents were told they would benefit from use of the matured trees. Foresters described the residents as uncooperative and recalcitrant when it became apparent that they were purposely destroying the trees. But one resident clarified the reason for the villager's actions when he remarked (out of hearing of the foresters) that he no longer had the problem of leaving his fields to tend the trees as no one could expect him to come this distance to care for dead trees. (Hoskins, 1979).

Several West African woodlot projects have failed even after they were planned with local village men who willingly planted the trees. These failed because they were located in regions where women traditionally do all crop maintenance tasks. Since women were not involved in the project the trees died from lack of care.

Each of the examples above were planned to "benefit participants." One was implemented by government services, one by village chiefs, one by foresters, and one organized by a local group but requiring input from another. If participants feel their land, their labor, or their time is being improperly used, and if they do not recognize the "benefits" as being important to them, experience shows woodlot projects requiring continuing vigilance and care will probably fail.

Integrated Resource Planning

In Africa, where there is a great deal of ecological contrast from area to area, integrated resource planning is particularly important. This relates to all aspects of [illegible] including regional, national, and local transportation [illegible] as fiscal policy and land and water use.

The FAO team in Senegal (early 1979) found that even in that one country shortages of fuelwood were not only regional but almost village-specific. This type of uneven distribution requires careful evaluation of transportation systems and fiscal policy. One project manager in an area with a plentiful wood supply discussed the fact it was easier to export charcoal by boat to France than to send it by truck to regions in the same country which are in urgent need of fuel. (Hoskins, 1979). CILSS* experts point out that in the Ivory Coast 500,000 hectares of forests are cut for planting each year for an estimated yield six times the amount of wood used yearly by the total population of the Sahel. One planned dam project in Selegue, Mali alone will flood enough forest lands to have provided Bamako's fuel needs for six years. Salvaging this wood and delivering it to areas in need of fuel would take regional cooperation and coordination and might require an upgrading of transportation systems. In some countries the lack of coordination of price controls, taxes, and subsidies combine to encourage environmentally disastrous practices such as exporting wood and charcoal while importing other fuel and denuding the countryside. (KiZerbo, 1979; Brokensha, 1978).

Donors insist that governments must be aware of the environmental ramifications of their decisions. For example, in Morocco terraced hillsides developed over many years were destroyed almost overnight when the government quit controlling tree-cutting. In Matameye, Niger, a formerly protected regenerated area was declassified with no management plan; the result was a quick reversion to its former unusable state.

At the local level, integrated resource management decisions also need to be made, especially, where a long-term commitment of land is needed. Communities should consider their current and future needs for food, for fuel, for animal feed, for income, and for other purposes and, giving consideration to their land and water resources, make wise decisions as to where their forestry projects should be located.

Several African governments have taken steps to give local residents more responsible roles in local land management. For instance, the government of Senegal is in the process of implementing a new land reform bill giving land ownership to the national government and control of land use and tax money with which to develop projects to local communities. Foresters and other technicians as well as national and local leaders speak optimistically about future community participation they feel will be stimulated by the new legal strategies.

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* Comité Permanent Inter-Etats De Lutte Contre La [illegible] Dans Le Sahel.

They report that other African governments have shown interest in observing the results of this approach, which appears to be more compatible with many African traditions than Western models.

CILSS has stressed the need for more emphasis on integrated planning at all levels and UNICEF and the World Bank have made provisions for supporting local efforts in integrated resource planning. (See Diallo, 1979). In particular, they suggest that more African countries could allow residents to participate in selecting management options for park and reserve lands to facilitate the most advantageous use of limited land.

Interagency Cooperation

Donors have pointed out a related problem, that of lack of cooperation between various agencies. As long as the forestry programs were based on commercial production there was little need for forestry services to seek ways to work closely with other services. This cooperation, which is essential for FLCD, will be difficult to develop given the current systems in many countries. In Upper Volta, the regional development organizations work independently of the ministries where forestry is represented. In the 1979 CILSS meeting in Niger, participants commented that it was the first time the chiefs of the forestry and of the livestock services had met together to talk about common problems. Agriculture and extension schools seldom teach forestry, and forestry schools include little if any agriculture and extension. One extension official watching a forest fire in Senegal remarked calmly that forest fires were not a problem of the people, only of God and the forest service. The World Bank and FAO have stressed interagency cooperation as being one of the most urgent problems constraining FLCD success.

Forester Commitment to FLCD

The very fact that foresters carry guns demonstrates to donors and participants that the current emphasis of forestry services is not community development. In Burundi, in Mauritania, and elsewhere where there is tremendous land pressure and need for fuelwood, there remain protected stands of [illegible] trees which could be productively managed for the benefit of local residents. Foresters in Burundi discuss with [illegible] concern over protecting seedlings in government [illegible] from theft by local farmers rather than seeing this [illegible] for trees as a potential for an extension program. [illegible]

Some donors also complain that expatriate and host country forestry officials are thinking in terms of expensive, high-technology support which donors believe is inappropriate to FLCD. For example, the cost of barbed wire fencing was not such an important issue when forestry was focused on limited numbers of large-scale plantations. However, the cost of surrounding individual and small groups of trees with barbed wire under the FLCD approach is staggering. It is apparent that if projects rely on barbed wire they will always be limited to the "model project" approach, as donors will never be able to cover all of Africa with enough barbed wire.

Foresters have also been accused of not seeing the potential role of the villagers in the new forestry. Foresters in Senegal say repeatedly that women cannot be involved in forestry projects as they do not and cannot plant trees, when Senegalese women have traditionally raised crops as well as planted trees in the courtyards of these foresters' own homes. Several evaluations of FLCD programs in Upper Volta indicate forestry technicians did not inform or educate villagers about the projects or follow-up with technical support or information after the seedlings were delivered. This may be because foresters do not yet view trees as a long-term crop or as an extension of the simple courtyard plantings to be used by local people to answer basic human needs. The forestry services and technicians, on the other hand, faced with these criticisms, have a different view of problems in implementing FLCD.

FORESTRY SERVICES AND TECHNICIANS

The frustrations of host country forestry officials and technicians in implementing FLCD projects often fall into four main areas: funding from donors and government budgets, donor expectations, land-use issues, and community participation.

Funding

Foresters are quick to point out that while donors and others speak theoretically of FLCD, foresters expected to implement new programs are often handicapped by lack of funds, transportation, materials, and appropriately trained personnel. Forestry services are generally given much smaller budgets than agricultural services and may be severely handicapped in implementing projects with these and other services. Seedlings [illegible] when the local forestry service has to share a [illegible] services, has no gasoline, or has to service a [illegible] the short planting season. The Forestry Service [illegible] personnel to educate villagers or materials [illegible] programs.

Finally, both top level forestry service officials and local foresters bemoan the fact that the European-based forestry educational system and working structure does not allow merit rewards for lower level agents who work well in FLCD programs. Due to the permanent streaming into A, B, C, or D level forestry training and salary schedules it is difficult to reward para-foresters or those who have adequate technical training for village forestry or take specialized workshops but have not attended more advanced educational facilities. Top level forestry officials in several African countries would like an examination of the total forestry educational system with the possibility of basic reform. (Hoskins, 1978, 1979).

Donor Expectations

Foresters point out that most donor budgets are based on two-year projects while community development forestry projects must be long term. Donors who require results within the two-year period defeat the possibility of slowly building a lasting village level capability in forestry. Although the FAO has shown interest in the long-term approach it has little funding for implementing projects; the World Bank can offer only soft loans but no grants to support its interest in building infrastructure and local capability. CILSS country officials comment that they have program proposals for FLCD-type projects which no donor has offered to fund.

Foresters also complain about donor requests for extensive research to prove there is a forestry need, to measure the extent of the need, or to calculate the speed of desertification instead of starting to deal with obvious and urgent problems. (Ulinski, 1978).

Land Use Issues

Foresters, like donors, feel the need for national and local resource management decisions supported by national governments and local residents. They feel paralized by lack of lands dedicated to forestry projects. In Senegal, when foresters tried to plan projects in the national forests, they found residents unwilling to travel the required long distance from their fields though there was no closer land available. Foresters feel caught between donor requirements, and local residents' needs. As one report commented, there really is no humane way for a local forester to protect a sapling when it is the only available fuel for the evening meal.

Community Participation

Foresters also believe that getting local participation in forestry projects is a problem. A Tanzanian forester found that after twelve years of community approach to forestry, villagers are "still unable to understand tree planting" or "to make management decisions." (Muzava, 1977). In many projects foresters get local cooperation in planting trees but say villagers may believe that further tree care is "up to God." (Winterbottom, 1979). Villagers, however, often see their problems with FLCD differently.

VILLAGERS

Villagers complaining of problems with forestry projects focus on the following four issues: timely and adequate project support from forestry or extension services, limited local and personal resources for fulfilling all basic needs requirements, confidence in the potential success of tree planting programs, and assurance of gaining benefits from participation.

Seldom are villagers asked to describe forestry projects from their point of view. This was done, however, in one FLCD project carried out in ten villages of Upper Volta.

Interviews with residents showed they were quite aware of forestry issues. They described the loss of local vegetation and were concerned about growing shortages of fuelwood, building poles, and trees which gave food for man and animal. They believed that trees increased the rain, protected the soil, and gave needed shade and were therefore necessary for a good environment.

The tree planting project in their village failed for other reasons. The project started with government officials telling certain village chiefs that their villages had been selected for woodlot projects. The chiefs were asked to select the land, organize the villagers, and manage the tree planting. The trees came late, many were small, some were dead, and others died when there was little rain after the late planting. Neither were they the species villagers wanted. Villagers were promised food, materials, insecticide, and extra seedlings for personal use. Most of this did not come. Few of the trees originally planted lived. The villagers were disheartened.

In discussing basic needs in the community, people mentioned that there were things more urgently needed by them than forestry products. They stated that unless they

could have water, health care, education for their children, jobs for their young adults, and enough food and income to keep their families together, it did not matter if they planted trees for the future.

Some villagers wanted to start nurseries so they could have fresh plants in time, and select species that interested them. Several residents suggested that given their bad luck perhaps they should leave it to "the good Lord." One suggestion was that since tree planting was new to them, small experimental plots and subsequent study of the results would be appropriate before investing large amounts of time and land.

When asked who would benefit from trees that lived, residents gave various answers: the government, the forestry service, the village chief, or the foreign project designer; others were unsure or unwilling to hazard a guess. Few thought they would receive any wood after harvest. (CESAO). These answers were similar to those given to the FAO team in Senegal. (Hoskins, 1979).

These woodlots are not far enough along to examine actual benefit distribution; but some that are support participant belief that they may never receive promised benefits from projects. For instance, a ten-year old stand of trees in the Maggia Valley of Niger is ready to harvest. The forestry service is harvesting the trees from these first woodlots to sell the poles to earn enough money to start woodlots in other areas. They are only giving the branches to residents for fuelwood. The local people feel cheated as they only get the refuse when they had been promised it all. (Weber, 1979).

Problems of forestry product ownership have been the most difficult for local residents. The Hausa have even invented a term for "being taken by" development projects. To discuss community project lands they say, "land that has become dawan goma (i.e., governmentalized)". This carries the connotation that its use is now lost to local residents - they have been had.

SUCCESSFUL PROJECTS

Each group of actors in FLCD, donors, foresters, and village level participants, express frustrations over [illegible] to the success of woodlot projects which they consider [illegible] their control. However, despite all these problems [illegible] projects that are reported to be going well. [illegible]

size and approach, although the two most prevalent types are the integrated and the special project design. In the integrated approach, the designer starts with a community and develops various projects in response to basic needs identified by the community, including those related to forestry. The second approach is to make available one or several forestry project packages, such as support for woodlot development, and then mold these to fit the circumstances in responsive communities. While the integrated approach is much more desirable because it allows project designers to determine village priorities, the project package approach is used more often because donors and host country governments are generally organized by sector.

Integrated Approach

An example of what appears to be a successful integrated community development project is at Labgar, Senegal. This is a mixed community, largely Peul, semi-sedentary pastoralists. In this community the pastoralists have participated on a voluntary basis to plan and carry out a forestry component of an integrated community development program. This example has the following elements:

1. Several government services and an outside funding organization cooperating in an integrated community development approach.

2. A Senegalese project director experienced in extension and government administrator who lives in the region.

3. A thorough sociological study of potential development of the region.

4. Self-selection of the village by positive response from residents of the area, many of whom live scattered around Labgar.

5. A woman extension agent and later a forester residing in the community.

6. Open dialogue between the director, the agent, the forester, and the villagers.

7. Development priorities chosen by area residents. Residents offered to provide labor and the donor organization and the government helped provide material and personnel. The first priorities addressed related to water, health and education.

8. Identification by the villagers of problems that still existed for them, and made them dissatisfied with their current life-style as compared to life before the drought.

9. Selection of a project with the help of field trips to see possibilities of tree planting and with the assurance they would own the trees and could not be punished by the forestry service for accidental animal damage to the trees. They selected the species from information provided by the forester and from past experience. They selected species to provide fodder, shade, income, building poles, and firewood for future needs of this growing community.

10. Time and labor scheduling with the forester. Villagers prepared soil ahead and at the appointed time, the first rain, herders came from many miles around. Men planted the trees while women carried water. They planted the area and chose to increase the area planted the following year.

This project had elements in which local community residents defined their own goals and priorities and the extension agent and forester acted as facilitators. The woman extension agent took the interests of the women as well as men into account and both participated in the project design and expect benefits. There was follow-through and flexibility especially with the facilitators living in the community. Many neighboring villages have requested similar projects.

Project Package Approach

A second type of project, also in Senegal, is much more common. A parastatal group (SODEVA) designed to increase peanut production, discovered that the carrying capacity of the soil was decreasing and that planting trees was necessary for soil fertility and for local fuel use. SODEVA officials decided to support individually owned backyard nurseries to provide needed seedlings. A female extension agent and a male forester contacted various groups, including women's groups in several villages, informing them of the possibility of operating nurseries and presenting the technical and labor requirements and potential risks and benefits. Women in Ngodiba, Senegal chose to [illegible] this as a project, planting small nurseries and selling the seedlings locally. Women found it profitable and plan to continue in the following years. Both individual [illegible] woodlots have been started in the region and been [illegible]

men participate.

The key to this type of project is an appropriate technical package being presented with appropriate extension methods. This project also has the advantage of a female extension agent interested in both men's and women's roles, of a forester giving technical support, and of the necessary material support.

Both model projects were based on the participants selecting the program, setting up the work plan, retaining the benefits, and on continuing support or follow-through. These elements can be part of any project by building them into the original design in the form of a project management plan or agreement. (Descriptions taken from Hoskins, 1979).

II . TRANSFORMATION

After wood is produced, the next step is to transform it from a tree to usable fuel through more efficient harvesting, charcoal making, transportation, drying and storage. This must be done with as little waste as possible. Not much attention has been paid to examining this step, yet fuelwood production is only as effective as the amount of fuel that arrives at the hearth and the amount of food it cooks. Several of the transformation issues relate to community participation and to protection of community interests.

HARVESTING

Traditionally, most fuelwood harvesting is collected for the family by women breaking dead branches from trees. Men help in some areas where larger logs are used for fires and wood must be brought from greater distances. When dead wood is no longer available, trees may be killed by girdling, by chemicals, or by fire made selectively by piling branches around the base of a tree or less selectively by burning larger forested areas. As pressures increase, women substitute millet stalks, peanut hulls, dung or other agricultural products which have important alternative uses, or they may even use saplings or fresh branches from fruit or nut-bearing trees. (See Ernst, 1978; Brokensha, 1978)

Donors have suggested that commercial harvesting should be encouraged to salvage trees from projected dam sites or other land clearing. This principle could be extended to salvage wood from less inhabited areas where dead trees from the drought are still visable in large quantities. Reports from Nigeria, Sudan, Kenya, and Upper Volta discuss various commercial enterprises which collect and transport wood. These efforts vary from [illegible] the Voltaic example of women collecting wood and selling it [illegible]

truckers, to the Sudanese example of armed landless gangs stealing trees and leaving large regions denuded. (Morgan, 1978; Digernes, 1977) Some of these examples illustrate the need for care in introducing more powerful tools for harvesting or organizing cooperative or other commercial ventures to protect fuel supplies for people living in areas to be salvaged.

Waste in current harvesting practices due to lack of effective tools, commercial organization, marketing supports, and transportation is clearly a field which deserves more thought.

CHARCOAL

Charcoal making is a subject over which there is much emotional controversy. Opponents say it is very wasteful to turn wood into charcoal, proponents say charcoal is used more efficiently than wood since it is used in stoves. Moderates point out that there is an energy cost in transportation and that, depending upon the area, there is a breaking point of about 75 miles from the source where transportation energy costs of the heavy and bulky wood balance the energy loss in making charcoal. A number of reports have stressed that in areas where charcoal is made improved techniques in charcoal production can reduce waste by more complete use of trees, including odd-shaped pieces of wood and sawdust, by more efficient techniques of charring the wood, and by lessening the number of accidents caused by kiln cave-ins and explosions. (See Brokensha, 1978; CILSS, 1979)

If making charcoal more productively is to be an FLCD project, it has to follow the rules for community development by starting with local participation from the beginning. In many parts of Africa, charcoal is made only by a specific caste working within long standing organizational structures. These structures must be understood thoroughly before changes can be productively introduced. In addition, in many areas where charcoal is made, the need to conserve wood is not recognized by charcoal makers and conservation techniques may appear to them to be simply restrictions on their economic freedom unless improved marketing or other incentives also can be introduced.

In one African country a charcoal project which was designed to change local behavior has aroused a great deal of antagonism and has failed to gain local support. It was designed as a two-step experimental program. The first step was to develop a less wasteful charcoal technology. The second step was to form cooperatives of charcoal makers eliminating middlemen and making sure the cooperatives would employ economically wise techniques. The project designer began his program with the support of the forestry service by:

- issuing licenses to limit the number of charcoal middlemen who hire charcoal makers and who control the transport and sale of charcoal;

- limiting the number of charcoal makers who can work under each middleman;

- restricting the area in which wood can be collected.

This cut down on the wood being used to make charcoal, but it also threw several hundred local people out of work. The project director then re-hired a few of the charcoal makers to help experiment with old and new techniques of charcoal making. The charcoal produced in these experiments is sold on the market at a subsidized price and thereby undersells the traditional vendors.

During the experiments, a technician designed a kiln which is not as expensive as many kilns, and which accomodates various sized pieces of wood and makes charcoal more efficiently. The project director has written an evaluation which reports the technical stage of the project has been successfully completed and they will now start the second stage, that of disseminating the technology.

Clearly, before the project goals were designed there was no thorough study of social realities: the positive as well as negative role of the middlemen, their relationship with charcoal makers, the traditional organization of charcoal makers themselves, or the perceived need for a new technology. Charcoal makers had felt no pressure of a limited wood supply until new prohibitions were introduced in connection with the project. Even if the new kiln design is cheaper than many others, the traditional way of making charcoal under a mound of clay involves no investment. Local residents discussing this project report that many middlemen and charcoal makers who were put out of work by the project's licensing procedure are very angry at the project and several have started forest fires in the protected areas. Even those who have licenses are angered at having to compete against project-subsidized charcoal. Although the technical aspects of the project may have been successful, the community participation and the use of the new technology aspects of the project was not well designed in terms of social reality and its success seems doubtful.

TRANSPORTATION

Transportation is part of total resource planning at the regional and national levels, discussed elsewhere. At the local level, one type of project is to introduce carts for village women to use in collecting wood. This can be done as part of an effort to lighten the work load of women so they may have more time to participate in such projects as woodlots or nurseries. It may also relieve pressure on closer overused lands, on land where there is an attempt at management or protection, or on fuels such as live branches, saplings or dung, which are less suitable but are available nearby.

In some areas in Upper Volta where carts have been given to women partially for fuel collecting purposes, women who have not traditionally used carts have lost control of them to their husbands. Where the husbands have used the carts to collect wood, the purpose has not been defeated; but where the men use the carts for other purposes leaving women to find fuel as before, it has. Therefore, it is essential to know the local wood-collecting patterns and potentials before introducing carts.

DRYING AND STORING

Another issue to be more thoroughly examined is wood drying and the protection of wood and charcoal from water in the rainy season. Wet wood is reported to be up to 20 percent less energy efficient than dry wood. Residents in many areas remark they know wet wood is not good to burn and only use it when they have no choice. Charcoal, which attracts moisture even more than wood, is also less efficient when wet.

Solar driers and enclosed storage areas have been suggested. However, in many areas where villagers lack sufficient grain storage and have no solar driers for drying grain or other foods, drying and storing wood and charcoal may receive a lower priority. The gravity of this problem varies in differing regions according to humidity and availability of suitable wood.

The encouragement of new harvesting techniques or organizing wood collecting businesses, making charcoal, transportation of wood and charcoal, and any projects relating to storage would all be very area specific but fall within a national energy plan.

III. UTILIZATION

Planting trees is important for future [illegible] the introduction of fuel-saving stoves [illegible] impact on available fuel. In the past, [illegible]

little donor interest in wood stove improvement in Africa, perhaps due to the lack of glamor of a mud stove compared to more technologically advanced innovations. Stoves that have been tried have had negligible success. (AID, 1978)

OUTSIDE-IN APPROACH

Some stove projects in African countries have been hailed as great successes but have had little long-lasting impact. (Draper, 1977) This is because the outside-in approach is not working. For example, in Ghana a model of a "smokeless stove", recommended by the Canadian Hunger Foundation and Brace Research Institute and presented in an FAO manual, was introduced by the Department of Social Welfare and Community Development in the late 1960's. The stoves "had been adapted for African cooking" and were made of locally available scrap metal and hard-baked clay tile, brick, or masonry. Stoves were built in women's training centers and in the homes of women involved in women's groups and women were told they would save 50 percent of the fuel. By the mid-1970's, it became apparent that women were no longer using many of the stoves. Women complained the stoves required larger pieces of wood than those found locally, the stove surface was too high for stirring the large pots for their traditional dish, and the holes in the stove were too small for large pots and too large for small pots. When the women did not tightly cover the unused holes in the multi-holed stove surface, or when the pot did not fit the hole, there was smoke in the room, the pots became dirty, and the stoves used more, not less, wood. The researcher evaluating this project remarked that dialogue with the women on the stove design prior to construction might have prevented many of these problems. (Martin, 1977) This was evidently not done although the Canadian Hunger Foundation stresses the need for local participation in its handbook. (Canadian Hunger Foundation, 1976)

FLCD APPROACH

In order to apply the FLCD approach to the introduction of stoves, it is important to isolate some of the problems which have handicapped the adoption of fuel saving stoves. Many reports simply say that new technology must be taught, that extension services have been ineffective in selling the new ideas, and that traditions die hard. But all these arguments may have focused on the second stage, the dissemination, before the experimental process has been completed. [illegible] projects appear to be weak in four fundamental [illegible] original stove designing process: failure [illegible] and their roles in developing stove design [illegible] criteria for introduction, failure to [illegible]

social reality and the trade-offs and risks presented by each change, and failure to establish effective criteria for evaluating "success".

Actors and Roles in Stove Design

If stoves were being designed for researchers in laboratories then there would already be many stoves which successfully fulfill all artistic and technical requirements. However, the scientists sometimes forget that the person with greatest expertise and who ultimately approves or disapproves the design is the woman who cooks every day. Other individuals who will evaluate and participate in the successful adoption of a stove design are the women leaders, the extension agents, co-op members and sometimes local officials. Local artisans may also be involved. These groups should join the scientists as part of the research team testing and modifying stove designs. If a stove design requires metal work, masonry or changes in sizes or shapes of utensils it may be up to the local craftsmen to help design these changes within local capabilities and be ready to make repairs and alterations.

Stove Designs and Trade-Offs

When stoves which fit laboratory or "Western" standards of improvement are brought to Africa, they frequently lack the bare minimum of usefulness in the African setting. Before a design leaves the laboratory it should be tested for its basic utility for specific areas. If it cannot hold the heavy pots, cook hard grains into mush for lengthy cooking periods, or perform the basic requirements for a certain locality, it should not even be introduced. Although this sounds like a self-evident requirement, it is frequently not done. Solar cooker specialists have been even less socially aware than wood stove technicians in their requests for women to stand over pots stirring their slow cooking foods on stoves which are uncomfortably hot to even approach in the African sun. They frequently suggest that women can easily cook in the daytime instead of the evening without noticing that during the day the women are working the fields and need that time to grow the grain to fill the pot. However, wood energy specialists, too, would save a great deal of grief if they looked at the purposes for which the three-stone stove is used. If they had tried cooking in tall kettles, constantly stirring mush for ten people with a large wooden paddle, they would not suggest waist-high wood stoves (unless they also added step-stools), flat-bottomed pans (which burn around the edges) and lids (for foods requiring constant stirring). One report chided a woman for using [illegible] in a wrong and wasteful manner because she left the [illegible]

for heat in the room while she cooked on the top. Since the need in that community was for heat as well as cooking, then the stove was not being wrongly used, it was simply the wrong stove.

The realities of the physical elements, the type of wood (size, shape), the size of the pot or pots (not just how many people are in the family because the situation may require extra for unexpected guests or leftovers for breakfast), the stove or stoves used now, the food to be cooked, the process used, the place and time cooking is done, etc., are all elements of the situation which should be known at least at a general level. A 1979 CILSS report gives a useful outline of physical elements involved in cooking in the Sahel. (Lepeleire, 1979) Each time a physical element is changed, one or more social elements may be affected. For example, in the illustration of the stove evaluation in Ghana, the stove required larger pieces of wood. However, the woman who collected the wood was not willing to walk the extra distance for this type of wood when there were adequate pieces of wood for a traditional fire nearby. When introducing a potential stove design the scientists should explore with other actors in the experimental group, all the elements that can change and the resulting trade-offs and risks. Questions such as who benefits, how, who pays, who maintains, and who introduces, should be considered.*

Criteria for Success of Experiment

In FLCD terms, success relates to local people solving their problems in a way that makes them more in control of their environment; it has nothing to do with BTUs produced in a laboratory. The test for a cookstove is not made until it is established in a community cooking one or more types of locally consumed foods. If it solves a felt need in a way that is economically and socially affordable, it will be adopted and its use will expand.

Throughout a large part of Africa, one sees stoves used for charcoal. How is it that charcoal stoves have caught on where wood ones have not? One might guess that since charcoal is more expensive the women using it could afford a stove, or would want to make it go farther by using a stove. However, when cooking large pots of traditional slow-cooking foods, the same women who use charcoal stoves for smaller more [illegible]

* An excellent description of some of the social [illegible] for stoves and the attitudes women in the [illegible] the advantages and disadvantages of the [illegible] stone stove is given in a 1979 CILSS [illegible] woman sociologist who discussed [illegible] and Nigerian women. (Kilerba, 1979) [illegible] basic information which can help [illegible] in changes in stove design.

cooked dishes will often still turn to the three-stone fires. The charcoal stove fulfills some but not all needs.

The same can be said for the bottled gas stove subsidized in Senegal by the government to relieve pressure on wood in the urban areas. This has not been successful, and officials frequently say women are too fixed in their ways to try new technology. One conversation with the wife of a forester, however, brought out the fact that the stove, similar to an apartment gas stove in Europe or the United States, was useful for coffee, water or even rice. However, it would not work for the large pots of millet mush cooked locally, mainly because the four small burners did not hold the huge kettles well and heated the mush in the center of the pan too hot and heated the rest of the large quantity too slowly. This woman suggested a large burner in the center of the stove which could be used for middle-sized kettles. For the largest-sized kettle used for celebrations, all five burners could be lit. She felt that if the stove were not so high, this new burner design would be accepted by women.

Although the three-stone stove is used as a symbol of a united family, this emotional factor has not stopped women from using alternative fireplaces for specific purposes such as brewing beer, roasting meat, drying salt, or frying cakes. The also alter the three-stone fireplace by putting rocks or earth between two of the stones when there is wind, etc. Women are willing to experiment with new stoves. If a stove really saves up to half the daily fuel or more and does not require undesirable trade-offs, what woman would choose the extra hours of hauling wood? Recently, some scientists and experimentors are beginning to doubt the wastefulness of the three-stone stove. Yet other reports suggest that fuel usage could be cut to .3 M^3 or even .2 M^3 if a certain stove is adopted. Until this is well established in the field, it would be dangerous and misleading to present it as a proven fact.

An experiment is successful when it solves local needs, and at this point women will want to use it. Now it is ready for the demonstration and dissemination stage. However, the experimental process should still continue as an impetus for further improvement and for flexibility in introducing the new stove in differing environments. If, however, a stove design is found to be competely unsuitable, the experiment is still successful as an experiment if the reasons are documented and if the design is not forced on the unwilling women.

IV. ISSUES AND RECOMMENDATIONS

A recent CILSS report stressed that the basic goal of CILSS countries to become self-sufficient in food production is meaningless without sufficient fuelwood. A woman in the peanut area of Senegal echoed the same sentiments somewhat more dramatically when she said, "One can starve with a full grainery if one has no fuel." Since the top-down approach to forestry has not succeeded in supplying the fuel needs of the cities and rural areas of Africa, it is time to make a serious effort to identify issues and make recommendations for techniques to overcome some of the problems FLCD has faced up to now. The main problem is how to insure local participation from the beginning to the end of the project, and how to provide appropriate technical and managerial support to assure programs will be successful and will benefit those who participate.

PRODUCTION

Including local people in the design, the implementation, and the benefit-sharing aspects of fuelwood production projects raises a number of issues which were not considered important in industrial forestry. It calls for reorienting goals and expectations, and re-designing training, technical packages, and managerial supports, as well as a new type of commitment on the part of donors, technical support agents, and local residents. Currently, there is a great deal of frustration within each group, with each stating that success or failure of projects is out of its control.

There is a need to underscore what this new approach offers to each of these three participating groups and what they must contribute in return. There is also a need to examine ways in which these rewards and responsibilities can be made clear from the beginning of the project.

Community Level

The basis of FLCD is community participation. If residents do not participate in designing the project, it risks being inappropriate for addressing local needs. If they do not participate in implementation, the trees probably will not survive. If they do not participate in receiving benefits, the project is meaningless.

If residents participate in an FLCD program, they have the right to help design a program which complements their other essential activities. After learning about required inputs, risks and potential benefits, they may select the best options and expect appropriate technical and managerial support. They have the right to receive benefits they value in return for their work. Programs must also be tailored to the appropriate people depending on local interests, property ownership, land availability, social structure, and work patterns.

The subject of benefits and incentives is probably the most difficult to address but it is the heart of motivating participation. While wood is available as a "free good" it will be difficult if not impossible to interest villagers in projects which are strictly firewood oriented. In addition, in no community is fuelwood the only need. Forestry programs will interest participants only insofar as they also address other perceived needs such as improved crop production, added food or forage, a source of income, environmental improvement, etc.

One experienced project designer reports that in harsh environments requiring lengthy growing periods for trees, residents will opt for other uses of time and land unless they are paid for tree planting. (Weber and Dulansey, 1978) However, payment for planting trees may have negative results for a project and for future or neighboring projects. Participants paid to plant trees may assume that the project manager or government owns the tree and will fail to maintain it.

In Senegal, one project paid farmers a small amount each year for three years for each living tree. They found that the survival rate was almost 100 percent compared to about 20 percent in another project in which they paid farmers only to plant trees. In the FLCD concept, if residents needed money while trees were growing, a payment for living trees could be considered an advance toward the future products. The tree still belongs to the farmer but he has sold a portion of the product (firewood, etc.) in advance such as is commonly done with grain.

In India, a forestry project gave land to unemployed and landless people and paid them to plant trees. Every year the project gave each person who had maintained his trees more land to plant. When the trees were grown the participants received a percentage of the harvest and retained the land. ([illegible] 1979) Seedlings for individual plantings may be used as an incentive to participants for communal projects.

Food is sometimes used as an incentive. [illegible] as a lunch for dinner for workers, it fails [illegible] recognized African pattern of the host serving [illegible]

But buying a worker lunch is not the same as paying him and may not be a sufficient incentive for long-term projects unless the worker is otherwise motivated.

Several countries have volunteer programs which are useful especially for consciousness raising. In Dakar, Senegal, during the Day of the Woman, women planted trees around a new social center. Many countries have tree planting days which work with varying degress of success. In the Gambia, trees were planted along the roads during a tree planting day. As frequently happens, trees near the houses were cared for and lived; the others died. Efforts to publicize these projects help educate the populace to the importance of trees and environment. However, volunteer programs are only as good as the technical and management supports permit. Results can only be disheartening unless they are planned and organized with care and receive appropriate follow-through to ensure their success. The forest service should have the wherewithal to encourage such efforts.

When community members participate in FLCD programs, they should consider not only the benefits and support due to them but they should be aware of their responsibilities in making the project successful. Necessary inputs for both beginning and maintaining the project required of the participants should be clear and agreed to before the project begins.

Technical Support Personnel

Just as villagers have rights and obligations in FLCD projects, technical support personnel should have the same. Donors should appraise the time and funding required to carry out each project so that the forester or extension agent is not left with a program for which there is not adequate personnel, material, or logistic support. A liberal amount, perhaps 20 percent of each project budget, should be dedicated to education of personnel and development of appropriate materials. Donors should work with national level services to improve communication and cooperation between various support services so field technicians can have needed input for integrated projects.

Technicians have a right to expect personal benefits from successfully implementing this new type of forestry. They have the right to have their formal and academic training and their rigid pay structure re-examined in light of this new type of forestry. Agents taking specialized training in [illegible] forestry, and working in the field to implement [illegible] projects, should receive merit pay raises.

On the other hand, forestry service goals and rewards must change. Goals such as straight rows of tall exotic trees must give way to emphasis on community participation even if the rows are not quite so straight nor the trees so beautifully planted.

Foresters should focus on developing appropriate technical packages employing low-cost and simple technology. They should provide needed management skills and supports, extension personnel, or project managers. If extension personnel are used they may need training in the two-way communication expected in FLCD.

Donors

Donors also have new expectations and obligations when they participate in this type of approach to forestry. They may expect more active participation from both villagers and technicians. They may expect more and better designed project proposals, and more successfully completed forestry projects.

On the other hand, they will have to be willing to fund the less glamorous support and institution building required by this new approach. They will have to reassess realistic goals for their projects and be willing to support more small, experimental projects before embarking on large-scale showcase demonstrations. They will have to accept flexibility built into project design and designs which differ from village to village and are, therefore, more difficult to administer.

Project Management Agreement

In line with FLCD philosophy, responsibilities and duties of citizens and support agencies should be clear from the beginning of any project. One way of approaching this problem is through a management plan discussed, agreed upon, and signed by all those involved. This agreement, written as part of the project design, will involve local participation and lead to better communication and better planning.

Most of the projects which fail do so because one or more of the following six elements were unclear when the project began:

1. identification of participants
2. long and short range goals
3. site selection
4. start-up and maintenance plan
5. benefit distribution plan; and
6. evaluation plan with feed-back and flexibility potential for altering the program.

A written project management agreement could help clarify these project elements at the design stage. The importance of this type document would increase with the size and complexity of the program, but these six items should be considered even if the project is carried on by individuals on their own land. The format and semantics will vary depending upon the country, the agencies involved, the local administrative structure and on the desires of the participants.

Several types of contracts have been used in community development or production projects. One which has been used in Latin America is in the form of an application for a community service award. Applicants outline elements of their proposed project in a few sentences, listing all participants, and if the application is approved the award is given at completion of the project.

An agreement or contract applicable to FLCD projects is used in the Uttar Pradesh Social Forestry project in India. Called "Proforma Agreement for Village Forests", it is written in formats for either forestry service plantations or village plantations. It gives a seven-page description of the purpose of the project requiring only several blanks to be filled in with such information as the number of days of voluntary labor villagers agree to provide and the amounts of land donated by the government and by the village. A mutually acceptable operational and financial plan is attached. The agreement is specifically designed for one type of forestry project and is reported to be successful, as it is tailored for this specific area where there is strong community organization with a long-standing plan of voluntary community service.

The following is a suggested format for a project management agreement. It is designed to help clarify all obligations and benefit distributions similar to the Indian agreement cited above, as well as to help organize the program. It is designed to be written with local participation.

Suggested Format for a

PROJECT MANAGEMENT AGREEMENT

1. PARTICIPANTS

This would list all participating members; not, for example, just family heads if women and young people were expected to have input. It might include or limit the possibility of adding others wishing to become participants later

because they see the potential benefits more clearly, because they have moved into the area, or because they are young people of the village who have married and established new households. It might establish criteria for participants so that there is a clear understanding of responsibilities and a method of reclassifying those who fail to continue fulfilling their responsibilities.

2. LONG AND IMMEDIATE TERM GOALS

This would not stop, as many projects do, with the number of trees planted, or even the number of trees living, but would consider the desired impact. For instance, the goals could be to make the community, or a defined group of participants, self-sufficient in home cooking fuel wood in X number of years by planting and maintaining X hectares of X (species) trees each year for X years. This way if the goal of self-sufficiency for fuel wood appeared to be in risk of failure because of increased requirements, etc. steps could be taken to increase the area planted or the species might be changed, etc. If, on the other hand, the introduction of modified cooking stoves reduced the demand for fuel, the species which produce fruit could be substituted, charcoal making could be introduced, extra wood could be sold, or the project modified in other ways. If different groups or agencies have different goals these should be expressed here.

3. DESCRIPTION OF PROJECT

This will include an elaboration of step 2 telling how it is to be carried out and establishing a timeframe.

4. PROJECT SITE

This would be a description of the site chosen, how it is to be used, and any time or other limitations on its use. It is to be signed by anyone who is giving up rights to the land, those responsible for distributing land, and those who will participate in its use.

5. START-UP AND MAINTENANCE

This section would describe needed inputs, identify who is responsible for them, and establish a time schedule identifying when they are required. For example, if a working water pump is necessary for project success, then the party who is responsible for its upkeep and repair should be part of the discussion of participant expectations and acknowledge his or her role.

This part of the plan might be written in a schedule format and copied in a large, well-displayed schedule to remind participants of steps to be followed. If responsibilities are by group, such as all male participants are to prepare the soil in April, a representative of the male group could sign that part and be responsible for reminding others when it is time to start. This would be signed by any party or representatives of any agency or group with labor, money or material input expected during the life of the project, such as the forestry service agreeing to supervise planting or to deliver X number of seedlings at a specific time.

6. BENEFIT DISTRIBUTION

This section includes:

A. Range of potential benefits (considering possible risks).
B. Formula for benefit division including the time framework (who, when, what, how).

This will be signed by participants and others responsible for the development of the project, and for benefit distribution. It will often be important that the forestry service, chiefs, or others who participants fear might want to intervene or appropriate some of the benefits sign, though they themselves are not supposed to be involved in the benefit sharing. This may strengthen participant confidence as well as their actual ability to retain ultimate control over benefits.

7. EVALUATION FORMULA

A. Identification of an evaluation committee.
B. Description of when evaluations are to be made.
C. Description of how the report is to be made, and by and to whom.
D. Formula for how the goals are judged to be reached, an evaluation as to whether all parties are up-to-date on their inputs, and an evaluation as to whether benefits are being distributed as planned.
E. Prescribed procedure for revising the project if there are complaints by participants or others, if the evaluation committee feels the program is missing its goals, or if agencies or participants, etc. are not fulfilling their part of the contract.

* * * * * * *

TRANSFORMATION

The major issue in fuelwood transformation is simple: how to limit waste while getting wood from where it is to where it is needed in a way that benefits participants and [illegible]

residents now and in the future. Dealing with this issue, however, is not simple. It requires regional and national planning of resources, fiscal policy and marketing systems and developing local projects within these plans.

Although Ivory Coast officials may be willing to allow residents from neighboring wood-hungry regions to salvage trees from newly cleared agricultural land, they may at the same time need to address the issue of their disappearing forest reserves. Although Kenyan officials may want to subsidize imported fuel while they control the price of wood and charcoal, they will want to control wood smuggling into neighboring countries before large areas of their country are denuded. Organizing harvesting cooperatives to salvage unused wood and introducing more efficient charcoal making are excellent ideas. However, new technology and organizational structures for marketing wood in large quantities must be done not only with the good of the workers and consumers of wood in mind but also with respect to local custom so that residents of the area where the wood is salvaged are not at risk.

Basic to all these considerations is transportation. Much of the wood which is currently going to waste is in areas where transportation expenses are quite high or where no adequate system exists to remove the wood. Governments should seriously weigh the cost of subsidizing transportation of wood especially as a temporary measure to take the pressure off newly planted woodlots or overly exploited lands. Energy considerations should be taken into account in any transportation planning, not only by evaluating energy use in transportation systems, but also by considering transport available to move wood, charcoal, or other energy-producing materials. Funding improved transport systems may be of more long-term benefit than subsidizing imported oil-based fuel, and temporarily subsidizing transportation costs of fuelwood may be essential to many reforestation efforts.

Local projects enabling residents to make the most of available wood resources by improved harvesting, charcoal making, transportation or drying and storing should also be considered in any FLCD project.

UTILIZATION

It is evident that African women have so far found the three-stone stove or other modifications of the open fire-place to be the most appropriate technology for cooking their daily meals. If "appropriate" technology means technology which best satisfies the need in a way that is

and socially affordable, other stove designs have thus far fallen short. It is time to realize the outside-in approach has not worked and develop new stove research design methods using local women themselves.*

The emphasis of this paper on improving wood stoves does not suggest that other approaches should not also be tried to conserve wood. There is a need to explore the use of alternate foods or processes which require less energy. In some communities group cooking might be tried to conserve fuel. Foods preprocessed in a village level industry might be investigated. For example, in Upper Volta a traditional practice is to soak and then pre-cook rice before husking it. This not only cuts down on the time for final cooking but improves the nutrition of the rice. (KiZerbo, 1979). However, none of these ideas should be explored only in an isolated laboratory when the true evaluation of the acceptability and success of any such idea must be made by the consumers themselves.

V. CONCLUSIONS

This paper has been an exploration of issues raised when residents are included in the effort to solve local fuelwood needs through forestry for local community development programs. While FLCD is not an easy approach, it may be the only viable option since top-down forestry is not working. We have looked at various problems which donors, implementors, and participants raise and at possible approaches to program design which mitigate some of these problems.

As is mentioned in the paper, it is always important to keep in mind the distinction between experimentation and dissemination-demonstration. Methodology for implementing FLCD is new and, judging from problems which are raised at all levels, it is still in the experimental stage. Ideas in this paper are not offered as proven solutions but are offered to stimulate discussion while searching for better techniques in a field which is controversial, urgent, and exciting. It is written in the belief that only as one share experiences, tries out new ideas, and documents failure and success, can one hope to deal more effectively with the issues and eventually reach the demonstration-dissemination stage.

Forestry has been one of the last fields to use the community development approach. However, since a sound environment and the availability of forest products are vital to agriculture, industry, and life itself, FLCD is potentially of great interest to community residents. By [illegible] impact in the communities of Africa, forestry [illegible]

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* The original paper included an approach to [illegible] and dissemination.

basis for revitalizing rural communities and a tool with which residents can direct and control their own futures.

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THE ROLE OF EVALUATION IN RENEWABLE ENERGY PROJECTS IN AFRICA

by George Burrill, Ph.D.

INTRODUCTION

Practically the only evaluations related to supplying energy to rural areas have been done on rural electrification projects in the United States and developing countries. 1/ The similarity between rural electrification and renewable energy projects is that they both intend to improve the well-being of the local population in the long term. The difference between them is that renewable energy projects are at an early stage of development while rural electrification is already established. Therefore, the type of evaluation needed in renewable energy projects is quite different from that done in rural electrification projects.

Renewable energy evaluation needs to be feasibility-oriented, using real data from the project's technical output, supplemented by socio-economic data and supported by user opinion and process data obtained from the project staff. A technology or strategy is not ready for widespread distribution until performance is satisfactory in each of four areas: technological, economic, social, and organizational.

A monitoring and evaluation model should emphasize acquiring good local information so the technology can be redesigned during the project if problems arise. For example, developers of the Lorena stove thought that because the local tradition was to cook at ground level, stoves would need to be low in order to be socially acceptable. Only after some time, and through the development of personal relationships with the local women, did they find out that the women preferred waist-high stoves because then it was "a real stove". 2/

1/ See Marquis Childs, The Farmer Takes a Hand: The Electric Power Revolution in Rural America, 1952; Evaluation Planning for the Aquan Valley Rural Electrification Project-Honduras, Practical Concepts, Inc., Washington, D.C.

2/ Lorena Owner-Built Stoves, Ianto Evans, Volunteers in Asia, Stanford, California, January 1979.

To deal adequately with such issues, a learning laboratory approach to evaluation is proposed in place of the traditional project impact measurement approach. Five basic questions that any renewable energy project should address are put forth. Then the steps necessary to design a monitoring and evaluation plan are detailed. The final section of the paper sets forth the categories for data collection, an approach to data collection, and data analysis techniques. 3/

I. THE BASIC EVALUATION QUESTIONS

In the initial stages of developing renewable energy for rural areas, we need to obtain information and empirical data necessary to estimate the costs and benefits of widespread use of renewable energy technologies. This can be done by answering the following five questions: 4/

1) How well does a given device perform technically within the physical conditions of the village where it is being tested? A whole variety of physical factors can affect the operation of a device or strategy, e.g., temperature, wind velocity and variation, amount of sunlight, wind and sand storms, humidity, types and quantities of local biomass, soil conditions, etc. Then, judgements on technical performance, maintenance, and so forth, can be made, allowing inferences about other areas with similar physical conditions.

2) What costs are associated with the installation and operation of the technology, and how do these costs compare to the benefits received and to traditional and other means of accomplishing the same work?

3) How does the technology interact with the local culture and with the social organization of the village and family? Very often local customs, habits, or beliefs are constraints on the use of a particular design or even of the energy source itself.

3/ A full discussion of project planning is outside the scope of this paper. See Dr. George Self, "Design of Community Renewable Energy Projects", (AID/W-NE/TECH/SA), July 1979, and Thomas Graham, "Selected Issues in Rural Africa Energy Assessment" Donovan, Hamester and Rattein, Inc., Wash., D.C., Dec. 1979.

4/ A good discussion of these questions (from which this [illegible] draws heavily)is contained in New Village [illegible] Energy Sources by James W. Howe, Overseas [illegible] Washington, D.C., 1978.

4) How appropriate is the technology for the village institutions or individuals who could own, operate, and maintain it? Level of capitalization, sophistication of the technology, land tenure and ownership patterns, history of cooperatives and private entrepreneurs, etc., are some important village characteristics which could influence the appropriateness of a technology.

5) What can be learned about transferring or adapting the technology to the village? That is, what are the best ways of getting local people involved in the project, demonstrating the technology, using extension services and schools, and using local traditional social structures?

II . HOW TO ANSWER THE QUESTIONS

The Learning Lab

I propose that pilot energy projects be treated as learning laboratories, rather than as strict experiments which are normally designed and evaluated according to more formal scientific method. Some comments on this approach to pilot projects are given by David Korten:

> The full benefits of innovative pilot projects can be reaped only when there is a clear break with the model of the formal or "true" experiment, allowing the pilot project to be fully exploited as a learning laboratory ...that not only is the "true" experiment an unattainable ideal in dealing with complex social phenomena, but furthermore, the effort to make a pilot project's design conform to the conditions of a true experiment may seriously reduce the useful learning which otherwise might derive from it. The choice is faced between two basically different ways of looking at the process by which innovations become established in organizations. One assumes that the basic problem is one of proving the objective superiority of the innovation. The other assumes that the major problem is one of building emotional commitment to the innovation among the organization's members and learning to make the adjustments in organizational routines which it requires. 5/

5/ "The Pilot Project: Formal Experiment or Learning Laboratory?" David C. Korten, The Ford Foundation, Philippines, April 1979.

In my view, we should be attempting to learn how to improve technology design and application, as well as how to develop sound innovation strategy.

Evaluations should be constructed to assess not only the level of output achievement, but how the project was carried out, with specific focus on extracting better concepts and ideas for later project development. If the project shows a negative result, further work on the technology should not be undertaken without removing some of the constraints.

An important concept in the learning lab approach is that all parties involved - people implementing the project, affected organizations, and users of the energy technology - understand and feel a commitment to the project. Without this commitment, not only is the managerial and physical success of the project in doubt (as with most development projects), but adequate information will not be obtained to answer the questions and learn from the experience. One possible way to clarify roles and obtain commitment is through a project management agreement signed or agreed to by all the parties to be involved, particularly the villagers. (See Hoskins' paper.) Information collection responsibilities for monitoring and evaluation could be put in this agreement.

Monitoring and Evaluation Design

The analytical process for energy projects in the learning lab model should follow these steps:

1) Detail the specific economic, social/organizational, and physical/technological issues or questions that the project intends to address. "Specific" means in terms of the particular technology proposed in the particular setting proposed.

2) Set up the data categories necessary to determine feasibility and decide the most efficient ways of collecting the data.

3) Check to see that the plan possesses the following characteristics of a learning lab monitoring and evaluation model:

- Generation of adequate quantitative data on the technology;
- Sensitivity to anticipated key technology and project management problems which may occur and ability to generate information on them at the appropriate times;

- A means for seeking solutions to these problems;
- Generation of adequate information on key changes in technology design and on the reasons the changes were made;
- Generation of good information on user opinion and on project staff opinion and decisions;
- Allowance for identification of what was learned, even if the learning is outside the key project questions.

In sum, the plan should be flexible and forward looking. It must supply the information that will guide development of the energy intervention and allow us to move beyond the initial pilot project phase to the next broader stage of project development. The plan should be a rigorous analytical guide through the learning and concept or technology development process.

III. DATA CATEGORIES, COLLECTION AND ANALYSIS

Data Categories

Data categories should be specific to each project; the socio-cultural factors relevant to use a solar cooker will be different from those relevant to a village woodlot. The following are data categories which can be used to organize information for answering the basic questions raised in the first part of the paper:

1. Technical

   -- Adequate physical data (amount of biomass, wind, solar, etc.) to verify the original assumptions or estimates made during the project design;

   -- Data concerning system installation and performance, and environmental impacts;

   -- Technical changes that might need to be made in the system.

2. Social/Cultural

   -- Relationship of the energy project and technology to the users or to village daily and seasonal life patterns;

-- People's attitudes towards the technology and the project;

-- Behavior of organizations in the project;

-- Other cultural constraints discovered during the project that were not identified by the project planners;

-- Data on performance of the project's ownership strategy and maintenance strategy from a social/cultural standpoint;

-- Equity results of the projects as implemente

- impact on male and female roles
- impact on local income level groups
- impact on ethnic sub-groups and castes
- impact on individual vs. family vs. community.

3. Economic and Financial

In terms of its costs and benefits, an energy system should be feasible from the perspective both of the individual investor (financial analysis) and the society as a whole (economic analysis). To allow such analyses to be carried out, David French has suggested collecting the following information: 6/

-- Value of a system's output (if measurable in market prices);

-- Alternative employment opportunities (to measure benefits if the system chiefly releases labor from former tasks);

-- Costs of site preparation and installation of the system;

-- Direct operating costs.

6/ French, David, "The Economics of Renewable Energy [illegible] for Developing Countries", US/AID, Washington, D.C., January 1979.

- Degree of local unemployment (to find shadow wages);
- Existing uses of raw materials (to find their shadow price);
- Extension costs of introducing the system;
- Market interest rates for local borrowing (to estimate investor's discount rates);
- Characteristic local investments (to suggest willingness to take financial risks).

4. Process Data

When using village level technologies, it is generally acknowledged that active participation of the local people is critical to the success of any project. Problems in project progress or with the eventual acceptance of a technology often hinge on adequate local involvement in decision making, technology design, and control. Therefore, the project should keep adequate data on the process by which the project develops, such as how key decisions were made and major problems that arose. This will provide lessons and strategy for future energy projects. It will also serve to focus project personnel on the human dynamics of decision making.

Data Collection

Data in the four categories should be methodically collected:

Step 1: Compile a detailed check list of information needed to answer each of the five questions from Section II. This list provides a means of generating and organizing information throughout the data collection and documentation process.

Step 2: Develop documentation, interview and discussion schedules. These should cover all of the items on the check list and should be completed by the appropriate project participants. All these should be prepared and kept by project staff, with as much involvement of local groups and individuals as could be arranged. The schedules should be designed not only to elicit quantitative data, but

also to generate ideas on how to solve problems or make the project and technology work better for the users.

Step 3: Periodic staff meetings should be held. At these meetings all documentation should be reviewed to determine the status of problems and issues, and to examine potential solutions and ideas. Records should be kept of each meeting so that staff can review and update the results of past key decisions. Periodic meetings should also be held among (as well as with) local users of the energy project and organizations involved in the project.

Data Analysis

Data analysis should be directed at answering the five questions. As we have seen, learning lab evaluation has two main thrusts: (1) evaluating the "feasibility" of the technology from a comprehensive quantitative and qualitative standpoint, and against clearly stated criteria whenever possible; and (2) evaluating what has been learned by the project that was not known before. Based on these two foci, inferences can be made about potential future impact should more development work or a full field project implementation be planned. Both supports and constraints to transferability, within a similar local area, can be analyzed.

Analysis of technology performance[7/], to be really useful, should be performed on the traditional system (if one exists), on the project technology and, ideally, on possible alternatives to it. Standard technical performance assessment techniques can be used.

The environmental impact of the energy innovation should be compared to present practices and technologies, as well as alternatives. This should be done separately for local, regional or national environmental impact. Such analysis is very important for accurate cost-benefit analysis. Standard environmental impact assessment tools can be employed as a starting point.

7/ For a discussion of evaluating technology performance, see "Technology Evaluation for Renewable Energy Sources: A Framework for Coordinated Action" by John H. Ashworth and Richard E. Meunier (Solar Energy Research Institute, Golden, Colorado) March 1979.

Cost-benefit analysis should be carried out from the perspective of: 1) the village person or group who will acquire the technology, and 2) from the national government perspective. Cost-benefit should also address the problem(s) the technology is attempting to solve. This will clarify conflicts among user, government, and project designer's perceptions of the problem and hence benefit/incentive decisions by users. Good guidance on application of these tools and problem issues surrounding those applications can be found in a number of documents.[8/]

A rigorous descriptive analysis of social and organizational feasibility can be carried out by sociologists and project managers familar with the local area.

The kinds of analysis outlined here should be carried out periodically as the project is being implemented. As problems are identified, adjustments can be made in the systems being tested or in the socio-economic context within which they exist (i.e., in terms of pricing of goods or services produced, management patterns, or other local variables). This continuous process of hypothesizing about possibilities, testing them out, and responding to lessons learned is the essence of the learning lab approach to project monitoring and evaluation.

8/ A good, basic introduction to cost/benefit analysis is Gittinger, J. Price. 1972. Economic Analysis of Agricultural Projects. Baltimore: The Johns Hopkins University Press.

APPENDIX

Senegal - An Example

Major elements of the evaluation system outlined in this paper have been used in an AID renewable energy project scheduled to start during the spring of 1980 in Senegal. One part of this project is the development of a wood stove appropriate for the rural people of Senegal. This project is an excellent example of the learning lab model.

The project calls for development of several prototype stoves at a research institute in Dakar. Then the prototype will be further developed and field tested in rural development centers and in the homes of interested local people. An American Peace Corps volunteer will be the liaison between various activities and institutions in the project. This person will also have the major data collection responsibility under the monitoring and evaluation plan.

As called for in this paper, a check list of problem or issue areas should be developed for each of the key questions the project is addressing. On the following page is a sample check list for question one in the improved wood stove project in Senegal. A similar matrix should be developed for each key question.

The matrix shows the main technical sub-questions that have to be addressed during the course of the project, along with the data sources and methods of collection for each sub-question. The check list also provides space for the project staff to indicate important questions or problem areas that they identify during the project.

DATA CHECK LIST FOR QUESTION ONE:

How well does a given device (wood stove) perform technically within the physical village setting?

Sub-Questions or Problem Areas	Data Sources	Data Collection Method
1. What are the thermal efficiencies of each model developed in the project?	Research institute staff responsible for stove development.	Testing procedures and measurements at the research institute.
2. What are the material components and durability profiles?	Research institute staff responsible for stove development.	Testing procedures and measurements at the research institute.
3. What are the projected lifetimes of the various models? What has been the maintenance experience with each model tested in the field?	Research institute staff, rural development center staff, users, Peace Corps volunteer.	Interviews with research staff, data forms filled out by local trial directors and the Peace Corps volunteer on each stove.
4. What skills are required for construction? Maintenance?	Research institute, installers in rural areas, users, Peace Corps volunteer.	Interviews with research staff, data forms filled out by local trial directors and the Peace Corps volunteer.
5. What important technical innovations or changes were made on field tested models? Why?	Field trial directors and installers, users.	Data records on each stove, end of project interviews by Peace Corps volunteer.
6. (Problem areas identified during project.)	Staff, users, etc.	Staff meetings, user meetings, etc.
7. ETC.		

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