FIREWOOD SURVEY: THEORY AND METHODOLOGY

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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 OP 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.

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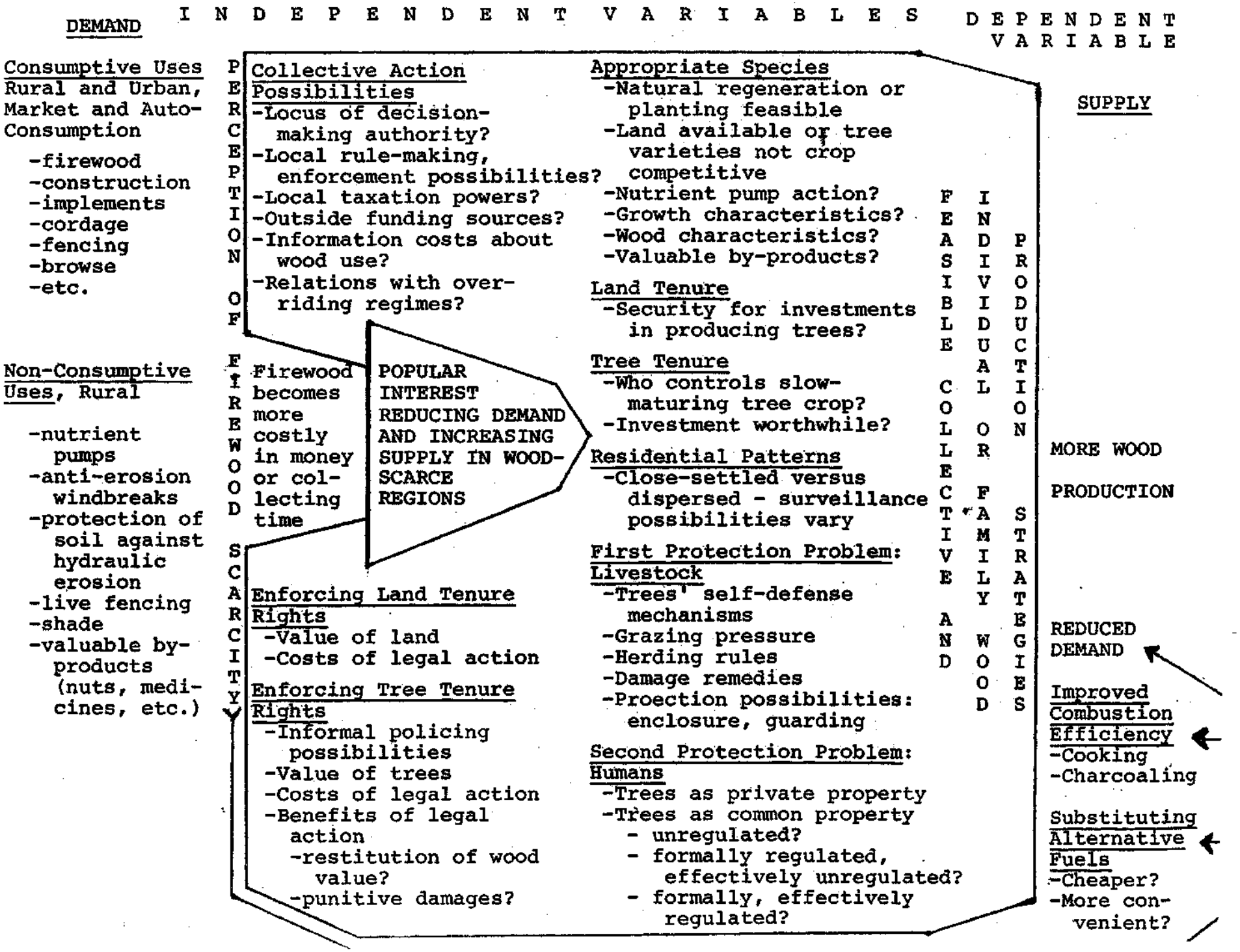
* This is a partially fictionalized account which illustrates some of the constraints to fuelwood production in a Sahelien context.

FACTORS INFLUENCING FIREWOOD PRODUCTION



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.

Puelwood 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 (or 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-Roltzsch, 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 Cthornless, 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 Crates 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 pre&sure will further reduce costs.

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

4. The Second Protection Problem: Trees versus People

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 [1] 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 hot 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 Csale? 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 CD on Whether their decisions are subject to review by superior officials Cand 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 woodstoek.

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 treea 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 he 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 firewood 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. CSee 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: CD 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 he 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, C2} 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 respondents 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 pdssibilities. 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[1] 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.

Prom this range of cases, however, certain guidelines for effective fuelwood management projects ban 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 fire-wood demand in the two survey cities and projection of probable fuel use patterns. Petroleum price escalations during recent years have changed urbanites[1] 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 wprk 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 Rattien, 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.