World Development, Vol. 14, No. 4, pp. 531–540, 1986.
Printed in Great Britain.

0305–750X/86 $3.00 +0.00
Pergamon Journals Ltd.

Confronting an Unsolvable Problem: Deforestation in Malawi*

DAVID FRENCH
Consultant in Economic Development, Rome

Summary. — In Malawi, the low price of firewood from customary land is a barrier to reforestation. If government were to grow trees and sell them at current firewood prices, subsidies would be so great that only a very small part of wood deficits could be met. Nor will farmers plant enough trees, since many other cash crops give higher returns than firewood. Moreover, there is no way to raise the price of firewood to levels where adequate amounts of tree planting would become economic. Therefore, deforestation cannot be reversed. Under the circumstances, the most important obligation is to minimize the damage done to agricultural land as trees disappear. This means that all of the (relatively few) trees planted must fulfill a soil-protection function. A tree planting strategy based on these realities will be very different from a strategy that assumes the deforestation problem can be "solved."

1. INTRODUCTION

People in developing countries have traditionally relied on firewood and charcoal for fuel. There are obvious reasons why this has been so. In most places, trees have been readily available. End-use technologies have cost little or nothing: consider, for example, the three stones that comprise the basic stove in many rural areas. All things considered, indigenous woodlands have been the closest that humanity will ever come to having a free source of energy.

The cost of wood fuel is rising as scarcity forces it to be transported long distances to users. Except in very extreme cases, however, indigenous wood will continue to be the cheapest fuel available, dung and crop residues excepted. Commercial substitutes do exist: electricity, kerosene, coal, solar energy, wood from energy plantations. However, these imply a high cost either for the fuel itself (electricity, plantation wood, kerosene) or for conversion devices (solar collectors, stoves).

Under the circumstances, people have every reason to continue stripping indigenous woodlands of their trees for use as fuel. At the same time, population pressure is forcing people to cut still more trees to clear land for agriculture. The disappearance of the trees adds to family labor, erodes the productivity of the land, and generally does mischief to the economy and to people's lives.

It seems an intolerable problem. As shown below, however, to say that the problem is intolerable does not necessarily mean that it can be solved.

The data in this article come from Malawi, one of the few countries to have completed socio-economic surveys of the entire system by which wood fuels are produced, marketed, and used. However, drafts of this paper have been shared with people working on similar problems worldwide. Their comments suggest that many countries may share Malawi's problems. Readers can test this by substituting data from other countries for the Malawi data in the analysis below.

2. NON-SOLUTIONS

Policy-makers in Malawi have considered various ways of dealing with deforestation. One obvious measure is to try to plant new trees as replacements for the ones being cut down. In addition, there have been attempts to improve the efficiency of fuel use and to find alternative

*Earlier versions of this article were presented at the BioEnergy 84 World Conference (Göteborg, June 1984) and at an international symposium on biomass energy systems sponsored by the World Resources Institute and the Rockefeller Brothers Fund (Airlie House, Virginia, January–February 1985). The paper is based on the author's work in Malawi, where he served on contract with the World Bank from 1980 to 1984 as director of the Energy Studies Unit, Ministry of Forestry and Natural Resources.

sources of energy. To make new forms of energy more competitive, consideration has also been given to ways of raising the price of wood and charcoal from trees on customary land. These measures will be considered in turn.

(a) *Planting trees*

If we start to think now about tree planting projects, these could yield firewood no earlier than 1990. In Malawi, about 10 million solid cubic meters of wood will be used for energy during that year. Of this, about 6 million cubic meters will be consumed by rural households. The rest will be used in urban areas (1.6 million cubic meters), by tobacco estates (2.0 million cubic meters), and by other businesses (0.4 million cubic meters).[1]

During 1990, total wood energy consumption will be about 4 million cubic meters more than the natural growth increment in Malawi's woodlands. At least as much wood again is likely to be cut in clearing land for agriculture to meet the needs of a rapidly growing population. This means that at least 8 million cubic meters more wood will be cut than will grow, placing heavy pressure on Malawi's stock of trees. To replace these trees, either the government can plant them or farmers can do so.

(i) *Government plantations*

To meet the wood deficit of 8 million cubic meters in 1990, government would have to establish about 800,000 hectares of plantations (based on current average increments of 10 cubic meters of wood per hectare per year). This implies an investment of about $360 million, assuming establishment costs of $450 per hectare (the actual cost of government plantations during the first phase of Malawi's Wood Energy Project, 1980–85). However, these figures reflect experience with centralized plantations. Dispersing plantations to bring trees within the reach of most villagers could easily increase costs by 50%, bringing initial investment alone to at least $540 million. To this would have to be added the cost of maintaining the plantations until harvest. Discounting these cash flows and assuming that all the plantation wood could ultimately be sold, government would have to charge at least $20 per solid cubic meter just to break even on its investment.

There is little likelihood of this. Currently, 59% of all wood used for energy is consumed by rural households. About 90% of these households collect all their own wood; the remaining 10% buy some of their wood (say, an average of 40% of their requirements)[2] at prices in the order of $0.50 per solid cubic meter. The *average* cost of the firewood used in rural households is therefore about $0.02 per solid cubic meter. To say the least, government might encounter market resistance if it tried to replace this with plantation wood costing 1000 times as much.

The remaining 41% of wood energy is used by urban households, estates, and other businesses. The delivered price of this wood can be high, especially when it is sold as split pieces in urban markets. However, the price paid *at source* (farm, customary land, or government reserve) ranges from nothing to not more than $2 per solid cubic meter. A very high estimate of the average price at source of the wood used by businesses or urban households would be about $1 per solid cubic meter.[3] Here again, it is hard to imagine much enthusiasm for government wood costing $20 per cubic meter at the plantation.

Of course, the government could subsidize its wood, competing in each market on the basis of existing wood prices. This would imply average earnings of about $0.42 for each cubic meter sold at the plantation. Given sales of 8 million cubic meters per year, this would result in annual earnings of $3.4 million for wood that cost $160 million to grow. This should be viewed in the context of a Forestry Department whose budget for all purposes is now about $5 million per year — and whose small staff is hard pressed to manage even that amount effectively. Under the circumstances, it is simply inconceivable that the government could plant enough trees to make a noticeable impact on wood deficits.

(ii) *Planting by farmers*

Silviculturally speaking, there is nothing to prevent farmers from growing enough trees to become self-sufficient in wood energy, with enough left over to supply the needs of cities and estates. Are farmers likely to come to the rescue in this way?

An immediate problem is that farmers do not share the government's sense of crisis when it comes to wood energy. Although rural women in Malawi say that firewood is increasingly scarce, their patterns of energy use remain largely unaffected. Even households that find firewood collection relatively difficult have not yet been forced to cut back on fuel-consuming tasks (cooking, heating water, brewing beer). Only small numbers of people have had to begin purchasing firewood or making extra use of crop residues and inferior fuels. Although wood collection is a burden, it remains less so than other jobs women do: pounding maize, hauling water, growing food. In short, from the farmer's

point of view, there seems little urgency in planting trees for firewood.[4]

Suppose that through "education," the government or nongovernmental groups could encourage people to pay more attention to this issue. Smallholders would still have to decide whether self-sufficiency in wood production was a worthwhile objective, given alternative uses of their time, land, and money.

At least in Malawi, there is some doubt as to exactly what is implied by self-sufficiency in trees. For the purposes of the Wood Energy Project, the World Bank and the Malawi Department of Forestry agreed that each family would need to plant 1,000 trees, or a woodlot of roughly 0.4 hectares. At a Mean Annual Increment (MAI) of 10 cubic meters per hectare, the woodlot would produce 4 cubic meters of wood per year, equivalent to estimated family consumption of firewood.

Some foresters now argue, however, that the same amount of firewood can be produced from many fewer trees. At the extreme, it has been suggested that 30–50 trees scattered around a farm could meet a family's need for wood. This assumes that a tree grows much faster in isolation than it does when bunched together with other trees in a woodlot.

Since there are few hard data to support any of these estimates, we can only guess at what might be plausible models of firewood production. On the "pessimistic" side, let us first assume that MAIs in Malawi can be expected to reach "only" 20 cubic meters per hectare, or *double* the World Bank's estimates for the Wood Energy Project. At this level of output, each family would have to plant about 500 trees to meet its need for wood.

Given land scarcity, however, to plant these trees would mean withdrawing 0.2 hectares from maize production. At the moment, farmers can sell the hybrid maize grown on 0.2 hectares for just over $60. Taking account of all costs, and assuming farmers value their labor at $0.40 per day, this leaves an annual profit of at least $15.[5]

We have already noted that the average cost of firewood in rural families is about $0.02 per cubic meter, or $0.08 to meet annual needs. The cost of seedlings and labor to produce this wood is about $2.20 per year over a four-year rotation. In other words, to become self-sufficient in firewood implies sacrificing $60 in maize profits over four years in order to incur losses of $8.48 in wood production. Even if some saving resulted in wood collection time, it is hard to imagine that any significant number of families would choose to lose this much scarce cash by abandoning their maize.[6]

Even if some farmers planted trees for their own use, it is improbable that they would do much planting of trees for sale. Some wood products may be profitable to grow. An example would be building poles, which have to come from straight, termite-resistant trees. Since these trees disappear first when there is pressure on the forest, their price is comparatively high. However, markets for such products are very limited. Most wood continues to be used for fuel. Since almost any kind of biomass can be used for this purpose, fuel prices are too low to justify planting of firewood.

In Malawi, for example, enough "free" trees remain that the *maximum* price of firewood for estates or urban users is about $2 per cubic meter at its source. Again assuming annual production costs of $2.20 for 4 cubic meters, this means that $23.20 can be realized in fuelwood profits over four years by sacrificing $60 in maize profits. Moreover, the maize profits are gained annually, while the fuelwood profits only begin to materialize after several years. Growing firewood for sale to estates or in cities will therefore be an extremely unattractive use of scarce resources.

A more optimistic scenario would accept the guess that family needs for firewood can be met by as few as 30–50 trees. These could presumably be scattered around the house or on farm boundaries without interfering with crop production. If this proved feasible, many more farmers, at least theoretically, would be able to grow enough wood for their own use. However, production could still not be expanded to allow for *off-farm* sales without confronting the land conflicts outlined above.

Given these realities, the potential for reforestation by smallholders is extremely limited. Under the most ideal conditions, we could expect that some smallholders would meet their own needs for firewood, with some additional trees grown for sale as poles. If one-fourth of all Malawi smallholders were to become self-sufficient in wood production, claims on wood from customary land would drop by 1.5 million cubic meters per year. However, this assumes both an implausibly high estimate of the number of farmers who will pursue self-sufficiency and an implausibly low estimate of the number of trees actually required for this. In reality, we should expect to achieve much less.

Whatever our assumptions, since Malawi's wood deficit will be at least 8 million cubic meters by 1990, even an implausible degree of self-sufficiency on the part of smallholders would lead only to a marginal decrease in the rate of deforestation. At least under current market conditions, there is no hope whatever that

smallholders will act in ways that would cause deforestation to stop.

This will be true no matter who raises the idea that farmers should plant trees: government agencies, nongovernmental groups, village leaders, etc. For example, nongovernmental groups in Malawi might work more vigorously to mobilize people for tree planting, as has already been done in countries such as Kenya. However, this sort of action can only ensure that people plant trees to the point where it stops being rational to do so. As demonstrated above, that point is far short of the level of tree planting required to reverse deforestation.

As trees grow scarcer in the future, their value will increase. However, good agricultural land will also be growing scarcer, resulting in at least as great an increase in the value of food crops. Under these conditions, most farmers will never find it economic to grow firewood instead of food. Even if some people find it rewarding to grow some firewood for sale, it is inconceivable that land enough will be withdrawn from food production to keep up with the total need for wood energy. That way would lie starvation, a choice that nobody is going to make.

(b) *Improving the efficiency of wood use*

A number of problems arise in trying to improve the efficiency of wood use. For one thing, the adoption of more efficient technologies is inhibited by the relatively low cost of wood. For example, if wood is "free," charcoal makers will have little incentive to economize on its use by spending money on new kilns. Since charcoal from "free" wood can be sold relatively cheaply, urban users in turn have a reduced incentive to invest in improved braziers. Some braziers and kilns will still be sold, but rates of adoption will be far less than would be the case if trees were priced at their replacement cost.

Even more basic is the fact that traditional patterns of wood use may not be especially inefficient. For example, it is widely assumed that traditional, earth mound charcoal kilns waste twice as much wood as "improved" kilns. However, in a series of trials in Malawi, the Energy Studies Unit (ESU) found that carefully-tended earth mound kilns produced charcoal at efficiencies of 21.5% by weight. This compares very favorably with the ESU's "improved" metal kilns, which produced at fairly standard average efficiencies of 24.2%. The metal-kiln charcoal was of higher quality, so that energy efficiencies were more divergent. Even so, the "improved" kilns hardly represented a dramatic improvement.[7]

The same proved true of "improved" mudstoves for village use. In an outdoor demonstration area, the ESU's best stove saved 50% of the wood used to cook standard meals on three stones. When trials were moved to villages, however, the ESU found that women cooked *indoors*, in order to keep their fires from the wind and use wood as efficiently as possible. When both the ESU mudstove and a three-stone stove were used by women inside their own kitchens, the mudstove on average saved only 5% of the wood required to cook on three stones.[8]

Equally important is the fact that even real improvements in efficiency may not save many trees. Whatever the actual increase in stove efficiency, several adjustments must be made in the figures before we can predict the impact on deforestation. For example, there are a number of wood-using jobs for which such stoves cannot be used at all (space heating, lighting, beer brewing). There are fuels used seasonally for which the stoves are inappropriate (e.g., maize cobs). There are times of year when people would go back to three stones (especially the cold season, when the insulating properties of mudstoves make for a clammy kitchen). In any case, rural households account for only a part of the fuelwood used each year, and fuelwood accounts for only a part of the trees cut down.

Taking these factors into account, the ESU estimated that even a program to install its stove in 50% of rural households would save *at most* 0.7% of the trees now being cut each year. Even to get results this high, it was necessary to assume that the stove might ultimately save 20% in cooking standard meals, four times better than actual results in village tests. Given the enormous extension costs involved, this would be a dubious activity at best.[9]

Some stove-builders claim to get results much better than the ESU's. However, even if fuel savings were 50% (ten times the ESU's results), the national savings in *trees* cut each year would be less than 2%.

Research on efficient wood-using technologies should continue. Given the kinds of realities sketched above, however, there is no reason to expect these technologies to make a significant difference in the struggle to reverse deforestation.

(c) *Using alternative sources of energy*

In theory, a solution would be to stop using

wood fuels altogether and to start using alternative sources of energy. However, the low price of indigenous wood makes this difficult to achieve.

For example, kerosene could be used in place of wood fuels for cooking and heating. This would be most likely in cities, where wood is especially costly. In Malawi, people who buy wood by split pieces in urban markets can pay $30 or more for the equivalent of a solid cubic meter. For the same amount of energy, piles of charcoal cost twice as much. Not everyone buys wood fuel in these relatively expensive forms, but the average urban family spends close to $70 per year for firewood and charcoal.[10]

Even at these prices, however, families consider wood fuels to be more attractive than kerosene. Only the occasional cup of tea or bowl of porridge is cooked over kerosene in urban Malawi, and this amounts to only about 1% of all fuels used for cooking. Firewood and charcoal constitute 90% of cooking fuels, with electricity in high-income homes accounting for most of the rest.

Not only are households dependent on wood fuels, but they are becoming more so. Eight percent of urban households report a shift in recent years from kerosene or electricity to wood energy; nobody reports a shift from wood to kerosene. Except for lighting, kerosene is a luxury item. As a sluggish economy puts the squeeze on urban incomes, families return to the wood fuels they can best afford.

In rural areas, it is sometimes suggested that cooking and lighting could be done with biogas, and water heating with solar collectors. However, rural families now pay about $0.08 per year for their wood and perhaps another $10 for kerosene. It seems hardly credible to suppose that anyone would want to save current costs of $10.08 per year through an investment of, say, $500 for a biogas unit and another $250 for a solar heating system.

It could be argued that the government should subsidize such systems because of their economic value to the country as a whole, regardless of their financial appeal to individual smallholders. However, even if the economic benefits of such technologies were to exceed their costs, budgetary constraints could prevent government from disseminating them widely. For example, to place biogas digesters in all rural Malawi households would cost close to $1,000,000,000 in initial expenses alone. The money to do this is simply not available.

The economics of the situation are changing as wood grows scarcer and has to be brought longer distances to users. However, the distances would have to be very long indeed before wood fuels became too expensive to use. In Malawi, for example, much wood now has to be trucked 40 kilometers or more to urban markets. Even so, transport costs represent less than one-third of the market price of wood. If wood had to come from twice as far away, its cost in urban markets would have to increase by only 30%. This would hardly be enough to reverse the present tendency of urban families to rely on wood fuels, especially since the cost of alternative fuels such as kerosene would probably be rising at least as fast.

In rural areas, wood scarcities are even less likely to force people into use of commercial fuels. The poor do not buy electric ranges simply because wood has become hard to find. Instead, they cut back on fuel use and move down the "energy ladder" to crop residues, roots, shrubs, or dung. This has the same basic effects as deforestation itself: a lowering of living standards, along with destruction of the environment.

There is little reason to push the argument further. For at least the next generation, the people now dependent on wood fuels will continue to be so.

(d) *Raising the price of wood*

As long as there is "free" indigenous wood, people will neither grow many trees nor turn to alternative sources of energy. The situation is comparable to that of petroleum before 1973, when oil in the ground was considered free for the taking. During those years, oil was burned up at a rate that bore no relationship to its increasing scarcity.

The wasteful use of oil began to stop when OPEC raised prices in 1973. Almost immediately, people moved to conserve energy and find substitutes for oil. The same would happen to indigenous wood if we could raise its price sharply. Is such an "OPEC solution" possible when it comes to firewood?

(i) *Rural users*

In Malawi, 59% of the trees consumed for energy are now burned in rural households. Almost all this wood is collected by family members from their own farms or from nearby customary land. Perhaps 1.5 million people are involved in this process, scattered through many thousands of villages across the country. There is no way that government could administer a tax on this wood to raise its price.

Another 29% of the trees are used by rural businesses producing tobacco and tea, charcoal and bricks, smoked fish and meat, and so on.

Since there are thousands of such businesses, often in very remote areas, it is difficult to imagine a reliable system for influencing the cost (if any) of wood they acquire from customary land. Government could only raise the price of the wood it sells to businesses from its own reserves, but this would simply mean that people would stop buying there and would turn instead to the "free" wood on customary land.

In sum, there are no plausible means to raise the price of the trees currently used in rural areas for energy. Since these represent 88% of all trees used for energy in Malawi, any "OPEC solution" would (at best) leave a large part of the deforestation problem untouched.

(ii) *Urban users*

A more likely target for a price increase is the wood used in cities. This appears easier to control and tax than rural wood, since it often follows a limited number of routes to urban markets. Not much wood is involved in Malawi, where only 12% of trees cut for fuel now end up in cities; but this percentage will be higher in countries that are more urbanized or that rely more on charcoal for urban energy. If prices could be sharply increased, urban consumption of wood fuels would fall, while farmers would find it profitable to plant trees for sale.

Observers sometimes feel that wood prices at the farm can be raised simply by squeezing what seem to be the exorbitant profits of middlemen. For example, a solid cubic meter of wood bought on a Malawi farm for perhaps $1.50 costs as much as $30 when converted to split pieces and sold in an urban market. At first glance, this 20-fold increase seems unreasonable.

In fact, however, there may be no profiteering here at all.[11] The person who buys a cubic meter of wood for $1.50 on the Matope road then pays $9.50 to have the wood transported to Blantyre. If it takes two weeks to split the wood into small pieces and sell it, he will have paid $3 in market fees over this period. Another $4 could go to hire someone to help with splitting the wood and minding the business. If he sells the wood for $30, he will have made a profit of $12, or about $1 for each of his working days.

Similarly, a number of women in the Zomba area pay $0.05 at the forest reserve for headloads of wood that they resell in town for $0.25. Again, this might seem an unreasonable markup in percentage terms. However, since it takes a half day to collect, carry, and sell each load, what is actually happening is that each woman is working to haul wood for a daily wage of $0.40. In neither this example nor the Blantyre case does there seem to be much middleman fat to trim.

Even given the marketing process as described above, it remains theoretically possible to raise wood prices very considerably at the farm without having to impose a proportional increase in the city. Suppose, for example, that the government concludes smallholders will grow firewood only if they can sell this at the farm for at least $25 per solid cubic meter.[12] To raise the price to $25 from its current $1.50 is an increase of 1,567%. However, assuming that transport, preparation and selling costs remain the same, the final price of split pieces for the urban buyer will have to rise only from $30 to $53.50, or an increase of 78%. In principle, this is an "OPEC solution": farmers are encouraged to grow trees, and city-dwellers to conserve on their use.

There is no way government could directly enforce such price increases at the farm level; there are simply too many separate places from which wood comes. A possible strategy would be to post revenue collectors on major roads into cities. These officials would tax indigenous wood at a rate, say, of $25 per solid cubic meter; exotic wood planted by farmers for fuel would pass free. This would mean that farmers could charge $25 for a cubic meter of exotic fuelwood and still undersell any indigenous wood being sent to town.

Although the theory is simple, any attempt to apply it could run into problems. First, government would have to establish a round-the-clock, temptation-proof enforcement service to police every plausible trade route into major cities. It stretches the imagination considerably to think that this could be done.

Second, a very stiff charge would have to be imposed on charcoal made from indigenous wood. This charge would have to allow for both the wood in the charcoal and the wood that was lost in making it. If this were not done, charcoal made from exotic trees could not compete with charcoal made from indigenous trees. In Malawi, this implies a tax of $6 on a 30-kilogram bag of charcoal that now costs $3, or a threefold increase in the final price. This would shift demand from charcoal to firewood, raising the average cost of transporting wood fuels to town and driving up the price of firewood as well. As a result, each family's total expenditure on wood fuels would more than double, not an outcome that any government would lightly choose to pursue.

Third, none of this is possible unless each member of the enforcement service can be trained to distinguish accurately between indigenous and exotic firewood, as well as between charcoal made from each kind of wood. While it may not be difficult to tell the kind of

tree from which firewood comes, it is doubtful that the system could be counted on to reliably separate charcoal made from different tree species.[13]

Fourth, even assuming the above obstacles could be overcome, government would have to decide whether it really wanted to divert land from food production to tree production. By 1990, to meet the woodfuel needs of Blantyre alone would require at least 45,000 hectares of woodlots, even assuming a dramatically improved MAI of 20 cubic meters per hectare. However, much of this is the land from which the city's food now comes. If maize is replaced by eucalyptus, what will people eat?

All these things considered, there seems no reasonable prospect that government could (or would even want to) influence the price of the indigenous wood being cut for use as fuel in urban areas.

(e) *Summary*

The economics of reforestation in Malawi can be summarized as follows:

— Given the price of fuelwood, government cannot reverse deforestation.
— Given the price of fuelwood, farmers will not reverse deforestation.
— Little or nothing can be done about the price of fuelwood.
— Therefore, deforestation cannot be reversed.

The only escape from this situation would be an increase in family incomes so dramatic that large numbers of people could switch from wood to electricity or other commercial fuels. This is clearly not imminent in Malawi, where economic growth is hardly keeping pace with population. Under such circumstances, it seems necessary to abandon further talk of reversing deforestation.

As already noted, many other countries to some extent share Malawi's tree problems. Whether deforestation is inevitable in a given country can be determined by carrying out the kind of analysis outlined in the previous sections. As shown below, it is important to do this work *before* setting wood energy projects in motion.

3. RESPONDING TO REALITY

It is difficult to accept the idea that deforestation is a problem we cannot solve. As trees disappear, we know that people and economies will suffer. The usual response is to say that we cannot afford to let this happen. At least in some cases, however, the reality is that we have no choice.

This requires a shift in consciousness on the part of professionals who are used to "solving problems." The idea of coping with the unsolvable is not a familiar one. It will have to become so if we are to respond effectively to real conditions in countries like Malawi.

Under the circumstances, people concerned with trees have a primary obligation to minimize damage done to agricultural land as deforestation proceeds. If this land is left unprotected, soils will wash or blow away, as well as losing the nutrients and texture that trees provide through their leaves and root systems. Unchecked, this process would transform the wood energy problem into a more serious crisis in food production. It therefore seems vital that *all* of the (relatively few) trees planted fulfill some soil-protection function.

In the case of Malawi, there are several lines of attack that would respond to these realities. For example, farmers can be encouraged to do the kinds of planting that *they* find attractive. By and large, we can forget about firewood trees, in which farmers are (quite reasonably) not much interested. Instead, farmers can be helped to plant trees for building poles, fruit, and shade. Of course, farmers will harvest some firewood from these trees as well, reducing the amount of wood energy that must be gathered from customary land.

Such planting should always be done with soil protection in mind, an idea that farmers can be expected to consider seriously. In a national survey carried out by the ESU, 55% of the smallholders interviewed said that the cutting of trees had reduced the fertility of their farms. Most of these respondents explained that trees prevent soil erosion and gullying, drop leaves that decompose and enrich the soil, and improve the local microclimate.[14] Given these understandings, farmers may well find attractive a kind of "agroforestry" that provides various tree products while protecting the soil.

Farmers in Malawi already plant 7–10 million trees per year.[15] With proper support by government and by nongovernmental organizations, it might be possible to triple this, meeting agroforestry objectives at the same time.

Schools and other institutions can also be mobilized to participate in National Tree Planting Day. All such planting should be on bare hillsides, in watersheds, or in other places where a soil-protection function can be served. From past experience, it is plausible to suppose that another 10 million trees might be planted annually in this way.

In various ways, government can influence tobacco estates to expand their tree planting. This now amounts to about 3.5 million trees per year, a number that could be tripled with government help.[16] Estates should have a natural interest in planting these trees in ways that would protect their land.

The government can itself plant trees for sale in urban areas. Given the resources that might become available, this could proceed at a rate, say, of 2,500 hectares, or 6.3 million trees, per year. Since this is only a fraction of the total urban requirement for wood, planting should be strictly concentrated in the Blantyre region, where the need is greatest. At least for the time being, only limited help could be provided to other cities, perhaps by managing nearby forest reserves to produce the greatest possible amount of fuelwood on a sustained yield basis.

Finally, small steps could in principle be taken to economize on use of wood fuels. For example, the ESU's stove work suggested that consumption of wood in rural households could be reduced by roughly 100,000 cubic meters annually through the dissemination of efficient mudstoves. Improved wood-using technologies might also save as much as 100,000 cubic meters each year on tobacco estates and 50,000 cubic meters in urban areas.[17]

Assuming all the above programs worked very well, roughly 56 million trees would be planted annually. This translates into annual yields at maturity of about 450,000 solid cubic meters, assuming an average MAI of 20 cubic meters per hectare (2,500 trees). Another 250,000 cubic meters would be saved each year by greater efficiency in the use of wood fuels.

Given a vast, multi-faceted, and completely effective attack on the problem, Malawi could therefore cut its tree deficit by no more than 700,000 cubic meters per year, or less than 9% of the deficit expected in 1990. In other words, everyone's best efforts would barely slow deforestation. If the strategy outlined above were followed, however, everything possible would have been done to avoid the destruction of the land's capacity to produce food.

It must be stressed that this strategy is fundamentally different from a strategy that pretends deforestation can be reversed. Whether planners "respond to reality" or pretend they can "solve the problem" will lead them to very different kinds of projects.

If planners pretend to be "solving the problem," for example, there is limited incentive for a strict sense of priorities in spending money. Funds might as well be put first into things that are politically or bureaucratically attractive, leaving things that are just useful or necessary until a later stage. Perhaps things should not work this way, but they do; people now involved in fuelwood projects can provide their own examples of the tendency in action.

On the other hand, priorities will be very different if planners "respond to reality" in the face of a problem they know cannot be solved. Attention from the outset must be given to the areas of most critical concern, since it will be apparent that many parts of the problem can never be touched.

If planners pretend they are "solving the problem," project components may also be overbuilt. In Malawi, for example, the Wood Energy Project provided for 88 seedling nurseries around the country, each with the capacity to make large numbers of villagers self-sufficient in wood production. Since farmers are not about to solve Malawi's problems by becoming self-sufficient in wood production, the nurseries have operated at 10–20% of capacity, and a great deal of money has been wasted in trying to keep them going.

If the Wood Energy Project had been "responding to reality," it would have built only those nurseries it had reason to believe would meet some special local need. A dozen nurseries would probably have done the trick, and large amounts of money would have been available for better uses.

Similarly, the choice of tree species will depend on what planners think they are doing. If planners are making everybody self-sufficient in firewood, for example, they may push eucalypts, which are fast-growing and burn well. If they are primarily trying to meet the more limited demand for building poles, however, they may avoid eucalypts, which termites like to eat.

The extension message will also differ. To pretend they are "solving the problem," planners will have to find ways to tell farmers how to grow the woodlots that will make the country self-sufficient in trees. If it is recognized that this is impossible, on the other hand, the extension message will emphasize instead how small numbers of trees can be planted in ways that will protect the soil.

Finally, research programs will vary in response to expectations. To pretend to "solve the problem," planners must arrange to study the sorts of fast-growing energy trees that are suitable for intensively managed woodlots. If nobody is going to establish such woodlots, however, to "respond to reality" means concentrating research on the kinds of agroforestry problems already described.

It should be obvious that "responding to

reality" is not simply a scaled-down version of "solving the problem." The two approaches are categorically different, implying different priorities, different activities, different kinds of extension and research, and so on.

One strategy is correct if deforestation can be reversed; the other is correct if it cannot. As indicated above, a project that expects to reverse deforestation will necessarily do everything wrong if deforestation in fact is inevitable. This will be true no matter how carefully the project is thought through in accord with its own (incorrect) assumptions. There is no alternative: where deforestation cannot be reversed, tree planting projects must be designed from the outset with this reality in mind.

One final observation. To respond to reality requires that planners know what reality *is*, as described by the kinds of information included in this article: patterns of fuel use in urban and rural areas; farmers' attitudes toward tree planting; the marketing system for firewood and charcoal, including prices at various points from farm to ultimate users (rural, urban, and commercial); the economic and technical performance of energy systems; costs and benefits to farmers of using land in various ways; and so on.

To collect this information need not be expensive. Each of the ESU's surveys (on rural energy, urban energy, and smallholder tree planting) took 6–8 months to complete at a cost of about $75,000. However, time and expenditure could have been sharply reduced by using "rapid appraisal" techniques for gathering information. In other words, a basic package of surveys should add less than 1% to the cost of a medium-sized tree planting project. This seems a reasonable price for bringing such projects into contact with reality.

Malawi is one of the very few countries to have carried out comprehensive surveys of its tree planting realities. It may be the only country whose Department of Forestry has established a permanent studies unit staffed by the kinds of professionals required to do this work properly: economists, engineers, specialists in social survey techniques. If the conclusions of this article are even remotely correct, other countries might profit from following the Malawi example.

NOTES

1. Unless otherwise specified, all estimates are by the Energy Studies Unit (ESU) of Malawi's Ministry of Forestry and Natural Resources (Lilongwe). As indicated in the notes below, most data are from surveys carried out by the ESU itself. All of the work cited was done under the author's direction.

2. Energy Studies Unit, "Malawi Rural Energy Survey," December 1981, p. 6. Price estimates based on field observations by ESU staff.

3. Based on preliminary findings of national ESU survey of tobacco estates, 1984, along with observations from the ESU's fuelwood and charcoal marketing surveys, 1982–83.

4. ESU, "Malawi Rural Energy Survey," December 1981, p. 18.

5. Figures supplied by the Senior Land Husbandry Officer, Lilongwe Agricultural Development Division, Malawi, 1984.

6. These figures refer to an "average" family that buys 4% of its wood. However, even a family that buys *all* its wood will spend only $2 per year for this, or less than the cost of planting 500 trees.

7. ESU, "The Feasibility of Plantation-Based Charcoal Production" (draft), 1982.

8. Information in this section is from ESU, "Design and Testing of Fuel-Efficient Mudstoves for Use in Rural Areas of Malawi," 31 August 1984.

9. Stoves have other advantages in terms of health and safety. The point here is that not many trees will be saved, even if stoves are disseminated for reasons such as these.

10. Information in this section is from ESU, "Malawi Urban Energy Survey," September 1984.

11. Information in this section was gathered during the ESU's fuelwood and charcoal marketing surveys, 1982–83.

12. Author's estimate of the minimum price required to make planting of trees for firewood attractive in comparison with alternative uses of land.

13. This particular difficulty could be avoided by imposing the same tax on wood fuels regardless of the kind of tree from which they come, and by then paying farmers a direct subsidy for wood from exotic trees only. However, this would double the administrative burden, requiring separate systems for levying taxes and for paying subsidies. Moreover, the other problems listed in this section would remain unresolved.

14. ESU, "Malawi Smallholder Tree Planting Survey," 22 September 1982, pp. 2–3.

15. ESU estimate, based on findings of rural surveys.

16. Based on preliminary findings of ESU tobacco estate survey, 1984.

17. Author's estimates, based on ESU data. These estimates are optimistic in technical terms and assume a commitment of governmental resources to the problem that is unlikely to be forthcoming in practice. In reality, fuelwood savings will almost certainly be far less.