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Conserving Biomass Energy in Sub-Saharan Africa:

An Assessment of Experience

NOVEMBER 1992

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Conserving Biomass Energy in Sub-Saharan Africa:

An Assessment of Experience

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This study was completed under a cooperative agreement between the United States Agency for International Development and the Center for International Development and Environment of the World Resources Institute.

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A. Executive Summary

This desk study synthesis of lessons learned from biomass conservation interventions in sub-Saharan Africa is based upon a review of the literature and visits to projects in Kenya and Niger. The purpose was to describe and analyze trends and issues identified by donor agencies and organizations implementing such programs, as well as energy analysts, and to highlight findings and lessons of experience from other studies.

The study has found that progress has been made in biomass energy conservation, in terms of technical knowledge, dissemination methodologies, and monitoring and evaluation techniques. However, these lessons learned have not been widely communicated to national governments, donor agencies, and non-governmental organizations which are responsible for implementing programs. As a result, much effort has been dissipated through trial-and-error approaches which erode the potential impact of project interventions, and have undermined the credibility of the technologies in some cases.

Experts disagree as to the environmental benefits from efforts to make biomass combustion more efficient. Empirical studies are scarce, but a growing number of analysts doubt that fuelwood consumption by itself is a major cause of deforestation. For this reason, some organizations are no longer active in the household energy field, and others have redefined their objectives to emphasize health and other benefits. Many rural energy programs have been phased out, and some of the remaining ones have been incorporated into other extension programs in areas such as health, nutrition, and adult literacy. In some cases, organizations have shifted conservation efforts toward institutional or commercial users because, first, they may be more responsive to financial arguments for increasing end-use efficiency, and, second, they may derive more of their fuelwood supplies from unsustainable sources.

Biomass represents the largest share of final energy consumption in most African countries, and there is little prospect for this pattern to significantly change in the foreseeable future. Substitution of modern fuels such as kerosene, electricity, and liquified petroleum gas in lieu of biomass is being recommended in many urban areas, but for several reasons it is likely that biomass fuel will continue to dominate African energy supply well into the next century. Several steps can be taken to begin making better use of biomass energy. These include better dissemination of lessons learned, stronger technical support to projects, greater attention to long-term sustainability of production, and more focused analysis of local patterns of biomass energy supply, marketing and consumption.

The experience of USAID in private sector development and natural resources management could be a valuable resource for donors and implementing agencies active in the household energy field in Africa.

B. Introduction and Terms of Reference

This study has been carried out under a Cooperative Agreement between the U.S. Agency for International Development and the Center for International Development and Environment of the World Resources Institute. The Cooperative Agreement includes support for policy studies in the area of environmental planning and management. The present study was requested by the USAID Africa Bureau to provide a perspective on recent developments in the area of biomass fuel consumption and conservation in sub-Saharan Africa, to identify trends and issues among other donor agencies and implementing organizations, and to highlight findings of other studies and lessons of experience in this field.

The scope of work included the following topics:

1. What energy problems were such programs designed to address and what was their justification?
2. What impact have such programs had in urban and rural areas?
3. What were the key constraints inhibiting the implementation of these programs?
4. Have certain types of programs been systematically more effective in overcoming specific constraints than others and, if so, which types?
5. To what extent did local people -- particularly women, both rural and urban, participate in the design and implementation of these programs?
6. How have programs changed over the years and why?
7. Given past successes and failures, what sorts of programs should be considered over the next decade?
8. How can monitoring and evaluation of future programs be improved?

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C. Methodology

This report is a desk study synthesis of information gathered from a variety of sources, and was carried out in several stages:

1. A subcontract was awarded to the Nairobi-based Foundation for Woodstove Dissemination (FWD), to conduct a document search and to prepare a report summarizing findings from a large number of biomass project interventions carried out in sub-Saharan Africa since the early 1980's.

2. The author reviewed the literature available on the topic of conservation of biomass energy in Africa, and interviewed a number of specialists to discuss recent research.

3. A field visit was made to Kenya and Niger, to interview donor organizations, NGOs, and others active in biomass projects. Interviews were also conducted in Cote d'Ivoire and Europe.

4. This final report was prepared, summarizing the findings of the FWD study as well as those from the case studies of Kenya and Niger.

No original research has been carried out in the course of this study, which should be understood as primarily a desk study which has been supplemented by travel to a very limited sample of project sites. The study reflects a synthesis of presently available research and documentation on the topic, as well as judgements of energy analysts and other observers who shared their views with the author.

This study was not intended to be limited to improved cookstoves, but these represent one of the major interventions for conserving biomass fuel, and therefore dominate the analysis. Since the focus was on the consumption of biomass fuel rather than its production, forestry projects as such are not treated here except in the context of biomass energy markets.

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D. Summary of Findings

The findings are organized in the order of the research topics listed in the terms of reference, above. The FWD report is summarized in the next section, and is available separately from World Resources Institute.

1. What energy problems were such programs designed to address and what was their justification?

✦ Identification of the Problem

Worldwide, it is estimated that the value of fuelwood marketed is as high as $7 billion, and provides employment for some two million persons.[1] The important role of woodfuel in the energy supply of developing countries has long been known, at least by foresters and energy analysts, but it was not until the mid-1970's that it became clear to the wider development community that this could represent an important global problem.[2] In retrospect, a fuelwood analogy to the "oil crisis" was inevitable, as the petroleum price shocks of 1973 and 1979 drew attention to the Third World's particular reliance upon biomass fuel.

The fact that this resource - biomass fuel - was under threat was brought to the world's attention by the Sahelian droughts of the 1970's and 1980's, which vividly illustrated the environmental and human consequences of deforestation and desertification. A United Nations conference was convened in 1977 to call attention to the issue of "desertification." It was not long before a fuelwood energy crisis was perceived to already exist, or to be in the process of developing, across a wide band of arid and semi-arid zones, not only in the Sahel, but also in southern Asia and many other tropical areas.

This scenario is described in publications such as Fuelwood: the Energy Crisis that Won't Go Away[3] and The Other Energy Crisis: Firewood.[4]. With the benefit of hindsight, such documents are now considered alarmist, based upon extrapolation from extreme cases with little understanding of how situations varied geographically and over time. They are cited here in order to illustrate the depth of concern which drove the search for ways to conserve biomass energy, especially in fragile areas such as the Sahel.

> Firewood is a scarce and expensive item throughout the sub-Saharan fringe of Africa, all the way from Senegal to Ethiopia, but citizens in towns like Niamey are paying a much higher cost than they realize for their cooking fuel. The caravans that bring in this precious resource are contributing to the creation of desert-like conditions in a wide band below the desert's edge. Virtually all trees within 70 kilometers of Ouagadougou have been consumed as fuel by the city's inhabitants, and the circle of land being "strip-mined" for firewood - without reclamation - is continually expanding.[5]

It was feared that a rapidly shrinking supply of fuelwood would not only bring serious environmental consequences, it could also exact a heavy toll from some of the world's poorest and most vulnerable populations. Peasants and urban slum dwellers would be hard pressed to meet their domestic energy needs, because of skyrocketing prices for scarce fuelwood combined with the lack of access to modern alternatives. In rural areas, people would be forced to use animal dung and agricultural residues, depriving the soil of vital nutrients and further deepening the environmental crisis. In towns, people would scavenge for scraps of cardboard or other combustible

1 Douglas F. Barnes, Keith Openshaw, Kirk Smith, and Robert van der Plas. What Makes People Cook with Improved Stoves? A Comparative Review. Washington DC: World Bank, 1992; p. 26

2 One of the earliest references on this topic is Keith Openshaw, "Wood Fuels the Developing World," New Scientist Vol. 61 No. 883, 31 January 1974

3 E. Eckholm, G. Foley, G. Barnard, L. Timberlake. Fuelwood: the Energy Crisis that Won't Go Away. London: Earthscan, 1984.

4 E. Eckholm. The Other Energy Crisis: Firewood. Worldwatch Paper. Washington DC: Worldwatch Institute, 1985

5 Eckholm 1975, p. 9

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material from garbage dumps. Many households would be forced to cook fewer meals because of the shortage of fuel.

The fundamental assumption underlying this scenario is that harvesting of woody biomass resources for energy consumption has, in one country after another, surpassed the rate of natural regrowth of trees. The hypothesis that fuelwood demand exceeds sustainable supply is often referred to as the "fuelwood gap." To a large extent the calculations used to demonstrate the presence of a gap tended to overlook the widespread use of other sources of biomass fuel which do not cause deforestation: gathering of dead branches, trimmings from shrubs and hedges grown around household compounds, and the use of crop residues.

A World Bank review, published in 1984, gives a succinct description of the scenario of rapidly increasing fuelwood consumption leading to deforestation in Africa:

> In Africa around 90% of the population use fuelwood for cooking, in the equivalent amount of roughly 1.5 tons of oil per family per year...The annual rate of consumption has now reached the point where it is estimated to exceed the annual rate of additions to supply through the growth of trees by the following margins (estimates rounded):
>
> - in Senegal, by -35% (a slight surplus)[6],
> - in the Sahelian countries, by 30%,
> - in Niger, by 200%,
> - in Northern Nigeria by 75%,
> - in Ethiopia, by 150%,
> - in Sudan, by 70%.
>
> Forestry plantations and fuelwood plantations currently account for very small percentages (less than 5%) of supplies; fuelwood demands are thus being met increasingly by the consumption of tree stocks. Furthermore the tree stocks are declining at an accelerating rate because consumption is increasing exponentially with population growth while the annual additions to supply through new tree growth (the mean annual increment) are declining in proportion to the volume of stocks.[7]

Acknowledging serious gaps in the data available for studying this issue, the authors nevertheless concluded that:

> There is, however, general agreement on the underlying trends and on the likely economic and ecological consequences.[8]

A report issued by the Overseas Development Council in 1980 described the situation in even more stark terms:

> Given present rates of deforestation, Senegal will be bare of trees in 30 years, Ethiopia in 20, Burundi in seven. Outside of Ouagadougou, the land has been stripped of trees for 45 miles in all directions. In Accra and Lagos, people in search of fuel tear the scaffolding from construction sites. According to a 1978 experts' report, much of the eight nation region of the Sahel will have become desert by the year 2000 unless massive reforestation and fuelwood planting -- "50 times" the present plans -- is undertaken soon.[9]

Further impetus was provided by the United Nations "Conference on New and Renewable Sources of Energy," held in Nairobi, Kenya in 1981. For the Nairobi conference, FAO produced a set of estimates of the global fuelwood supply and demand situation, which was eventually followed by a more detailed study entitled "Fuelwood Supplies in Developing Countries."[10] The FAO calculations showed that 100 million

6 A positive number means that consumption is greater than regrowth; a negative number indicates that consumption is less than regrowth.

7 Dennis Anderson and Robert Fishwick. Fuelwood Consumption and Deforestation in African Countries. World Bank Staff Working Paper No. 704. Washington DC: World Bank, 1984; pp. 1-2.

8 Anderson and Fishwick, p. 3.

9 James W. Howe and Frances A. Gulick. Fuelwood and Other Renewable Energies in Africa: A Progress Report on the Problem nd the Response. Washington DC: Overseas Development Council, 1980; p. 5.

10 Food and Agriculture Organization. Fuelwood Supplies in Developing Countries. Forestry Paper 42. Rome: FAO, 1983.

people in developing countries were living in a situation of acute fuelwood shortage which threatened their ability to meet daily energy needs. More than one billion people were estimated to be living in situations where fuelwood demand exceeded supply, leading to depletion of the forest stock with potentially disastrous consequences.[11]

The Energy Sector Management Assistance Program (ESMAP), a joint program of the World Bank and UNDP, carried out a series of energy studies in developing countries in the early 1980's. ESMAP's report, published in 1984, provided detailed statistics underscoring the developing world's heavy dependence upon fuelwood as an energy source.[12] A World Resources Institute report, published in 1985, found that nearly two-thirds of the developing countries had fuelwood stocks insufficient to meet demand.[13]

A particularly influential publication in the ESMAP series was the energy sector study for Ethiopia, published in 1983. This report concluded that, in Ethiopia, the progression from localized over-harvesting of timber to desertification was well advanced, and "*has reached the terminal phase in parts of Tigrai and Eritrea.*"[14] This analysis was widely cited in subsequent proposals (not only in Ethiopia) for large-scale fuelwood plantations and other tree planting campaigns to avert the disaster of desertification as well as the rural exodus associated with it.

Yet it would be inaccurate to imply that the fuelwood gap theory was merely a Malthusian model requiring simplistic and deterministic assumptions of irrational resource exploitation by populations expanding out of control. Social and political inequities were often identified as major contributors to the problem: issues of land tenure, access to natural resources, and political control had also to be addressed in attempting to reverse the consequences of the anticipated fuelwood gap. Beginning in the 1970's, the United Nations Decade for Women also stimulated greater awareness of the difficulties faced by rural women in meeting daily needs such as collection of cooking fuel.

The graphically titled Cold Hearths and Barren Slopes: the Woodfuel Crisis in the Third World[15] offers a wide-ranging critique of many donor-financed efforts to reverse the fuelwood gap on the grounds that they had generally failed to recognize the range of human issues underlying the problem. Many authors have also emphasized the importance of the land tenure dimension. Yet until fairly recently, it has been rare for analysis to seriously question in empirical terms the existence of a growing gap between supply and demand; the recent development of skepticism on this point is treated later in this report.

✦ Responses to the Problem

Given the severity of the problem as it was understood at the time, it is hardly surprising that numerous donor-financed interventions were implemented in response. Implicitly or explicitly, these project interventions have tended to accept the existence of a fuelwood gap, and have directed their efforts toward bridging the gap through increasing the supply of woodfuels, or reducing levels of demand, or both.

The forms of project intervention have been numerous, and their impacts have varied widely. The following list merely suggests the range of activities which has been undertaken in many countries of sub-Saharan Africa, and does not attempt to identify those which have fared better or

11 A useful summary of these events is provided in a study by the Dutch Biomass Technology Group (BTG) entitled A Decade of Wood Energy Activities Within the Nairobi Programme of Action. Rome: FAO, 1991.

12 ESMAP. Energy Issues and Options in 30 Developing Countries. Washington DC: World Bank/UNDP, 1984.

13 World Resources Institute. Tropical Forests: a Call for Action. Washington DC: World Resources Institute, 1985.

14 Quoted in Anderson and Fishwick, p. 22.

15 Bina Agarwal. Cold Hearths and Barren Slopes: the Woodfuel Crisis in the Third World. Riverdale, Maryland: The Riverdale Co. Inc., 1986.

worse than others, or to itemize their advantages and disadvantages.

- Peri-urban fuelwood plantations intended to expand the urban supply of biomass fuel, and to halt the mining[16] of remaining natural forest areas for urban fuelwood supplies;
- Promotion of community woodlots and other social or community forestry initiatives to expand the local (rural) fuelwood supply in order to reduce the exploitation of natural forest areas;
- Agroforestry initiatives promoting on-farm tree growing, raising crop yields as well as the supply of woody biomass for fuel, building poles, and other tree products;
- Governmental policies regulating the harvest and marketing of biomass fuels, by restricting the sale of charcoal, by licensing wood cutters, or by levying taxes on transporters or sellers;
- Promotion of alternative forms of energy, such as hydropower, solar energy, and biogas, as well as densification (briquetting) of agricultural residues such as cotton or millet stalks, coffee husks, or groundnut shells, and agro-industry or forestry byproducts such as sawdust or sugarcane bagasse, and sometimes the combustion of used motor oil;
- Demand modification programs designed to induce urban consumers to reduce consumption of fuelwood and charcoal through increases in conversion efficiency and end-use efficiency, and through shifting consumption toward commercial energy in the form of kerosene, LPG[17], or electricity;
- Extension programs promoting energy-conserving kitchen practices such as presoaking of legumes, the use of lids on pots, the use of lightweight aluminum pots, or the cutting of food into smaller pieces which cook more rapidly. In a few cases the introduction of insulated containers for retained heat cooking ("hay box cookers") has been included in extension efforts to modify kitchen practices, sometimes in combination with the introduction of improved stoves.

This report is concerned primarily with demand side interventions; supply side activities have generally been better documented, and have received much more attention from analysts. This has much to do with the fact that the forestry sector has absorbed far greater resources than the household energy sector, where most demand interventions have been targeted. By one estimate, some $160 million has been spent on setting up fuelwood plantations in the Sahelian countries alone;[18] this is roughly 60% more than has been spent on all known improved stoves programs worldwide (see budget figures for stove programs, page 13).

It should be noted that demand modification also occurs spontaneously and may take various forms. Such changes may reflect changing tastes, or convenience and time-saving needs associated with urban life. For example, urban populations in developing countries have tended to adopt new dietary patterns, replacing slow-cooking traditional staples such as millet or sorghum with rice or bread. The new foods may cook faster, or are bought already prepared. These trends may conflict with food self-sufficiency policies in cases where the new foods are imported. From an energy point of view, however, this evolution of dietary habits may also represent a reduction in the per capita requirement for fuel used in the preparation of staple foods.

In much of Africa, biomass is the major source of energy consumed. According to ESMAP estimates, biomass accounts for 74% of final energy consumption in Africa as a whole. In some countries, the figure is much higher: 95% and 96% in Burkina Faso and Ethiopia, respectively.[19] The household sector accounts for most of the biomass

16 Harvesting that reduces remaining tree stocks instead of harvesting from the increment of annual regrowth.

17 Liquified Petroleum Gas.

18 Walter Elkan, "Alternatives to Fuelwood in African Towns," in World Development Vol. 16 No. 4, April 1988, p. 531.

19 Paul Ryan. Some Policy and Economic Realities of Biomass Development and Management in Africa and Asia. (unpublished) Washington DC: World Bank, 1991.

consumption: 96% in the Central African Republic and Cameroon, according to ESMAP data.[20]

Most of the energy used by the household sector, in turn, is used for cooking. In Kenya, wood used by households for cooking and heating was found to account for 46.3% of the country's total energy use in 1980. In comparison, commercial energy (petroleum, gas, electricity) accounted for only 28.4% of total energy use by all sectors of the economy: households, industry, commerce, transportation, and agriculture.[21] Even in urban areas of sub-Saharan Africa, woodfuel dominates the energy sector. A recent survey in Niger found that 93% of Niamey households depended upon wood as the primary fuel for cooking.[22]

Even those who normally use commercial fuels may find themselves resorting to use of biomass fuels when supplies of the former are disrupted, or when prices rise significantly. This pattern of multiple energy sources and substitution depending upon availability and price is characteristic of many sub-Saharan African countries. The table below presents comparative data for wood energy consumption in several countries.

Biomass Energy Consumption in Africa[23]

Percent of Final Energy Consumption, 1990

Burkina Faso	95%	Nigeria	65%
Cote d'Ivoire	65%	Rwanda	89%
Ethiopia	96%	Senegal	64%
Ghana	74%	Somalia	87%
Kenya	72%	Tanzania	92%
Malawi	86%	Uganda	96%
Niger	86%	Zambia	66%

Because the household sector generally plays the dominant role in biomass energy consumption, and because cooking represents the most common end-use for household energy consumption, many projects have been designed to improve the efficiency of energy use at this level. Since traditional cooking techniques, particularly the use of the open or "three stone" fire, are widely perceived as being highly inefficient and wasteful of scarce fuel resources, they have been obvious candidates for improvement or replacement by better technologies.

Many stove projects have been carried out since the 1970's: probably every country in sub-Saharan Africa has had at least one, and most have had several, financed by various bilateral or multilateral agencies, and implemented by a wide range of governmental and non-governmental organizations. Most of these projects have been quite small, however, and often have been attached to much larger forestry sector or energy sector programs. As of 1984, stove projects accounted for 1% or less of total project costs in 15 World Bank forestry projects which included improved stove activities.[24]

Worldwide spending on improved stoves has been estimated at less than $100 million.[25] A recent survey of contemporary improved stove activities tallied 137 projects worldwide, spending approximately $20 million over five years.[26] By comparison, World Bank lending for 21 energy sector projects totalled $3.4 billion in 1989.[27]

Most stove projects have been justified on the basis of the fuelwood gap hypothesis described above. Not all interventions

20 1990 data for C.A.R., 1988 data for Cameroon, from most recent ESMAP energy assessment reports.

21 Beijer Institute data cited in U.S. Office of Technology Assessment, Energy in Developing Countries, 1991, p. 63; note that although biomass fuels are often marketed, they are not normally considered "commercial" fuels.

22 Energie II. L'Indicateur Energie Domestique Niger. Niamey: Imprimerie Nationale, 1991; p. 9.

23 Ryan 1991, p.5.

24 Anderson & Fishwick, p. 33.

25 Emma Crewe, "The Ups and Downs of Stove Funding," Boiling Point No. 25, August 1991; p. 3.

26 Barnes *et al*; p. 20.

27 World Bank. Recent World Bank Activities in Energy. Washington DC: World Bank, 1989; p. 70.

assume an explicit connection between inefficient cooking and deforestation, but in arid zones such as the Sahel such a connection tends to play an important role in the understanding of the dynamics of deforestation. This is reflected, for instance, in a historical analysis of Sahelian deforestation:

> Deforestation and desertification have advanced in tandem in the Sahel throughout much of the twentieth century. Desertification is the consequence and deforestation the intervening variable. The sufficient (if sometimes unnecessary) causes of deforestation include population growth, low-efficiency stoves, and sometimes inefficient land use techniques (extensive) rather than intensive farming practices. Land and tree tenure rules that often discourage investment in future supplies must also be counted among the causes of deforestation.[28]

As this statement suggests, the introduction of fuel-saving cookstoves has long been considered one of the most important strategies in trying to combat the effects of drought and desertification. At the risk of over-simplification, improved stove projects in Africa have tended to take two forms:

- In rural areas, most efforts have concentrated on high-mass woodstoves, sometimes with a chimney, built on site from earth or clay; examples include the Ban ak Souf stove in Senegal, the Albarka stove in Niger, and the Maendeleo stove in Kenya. Many early programs focused on dissemination of low-cost, owner-built stoves adapted from the Guatemalan "Lorena" stove design, but projects have tended to turn away from owner-built stoves, which have proven difficult to disseminate and whose performance has often suffered due to the lack of quality control.[29]
- In urban areas, the focus has been on the promotion of lightweight stoves burning wood or charcoal, typically a modification of traditional stoves made from scrap metal; examples include the Kenyan ceramic jiko, and the Ouaga metal stove in Burkina Faso. Some of these reflect simple designs (the "Malgache" in West Africa, the "jiko" in East Africa) introduced earlier this century by Asian laborers, or by soldiers returning to Africa from colonial campaigns during which they were exposed to cooking devices which had not previously been known in Africa.

Most improved stoves are intended to save fuel by improving the process of combustion and/or by reducing heat loss to the environment. The adoption of improved stoves by significant numbers of households was expected to result in a savings of biomass by reducing the amount of fuel necessary for cooking. The 1984 World Bank review projected that fuelwood consumption in rural areas, given the successful introduction of improved stoves and cooking utensils, could be reduced from 0.8 cubic meters per capita to 0.2 cubic meters; "this would greatly help to reduce both fuelwood scarcity and the rates of deforestation..."[30]

The magnitude of savings expected from technical innovations has steadily dropped over the years, from the 75% level implicit in the 1984 World Bank report, above, to the 50% level frequently claimed during the mid-1980's, to the present day in which 20% is a frequently cited figure. Some of the early optimism was based upon the tendency, already noted, to underestimate the performance of traditional cooking methods. In addition, performance testing was for several years an evolving art, and the relationship between laboratory results and actual kitchen performance was inadequately understood.

The savings figures reported by field surveys were sometimes based upon anecdotal information rather than precise measurements. For example, in some cases cooks were asked to recollect how much fuel they had used before they adopted the new

28 James T. Thomson, "Deforestation and Desertification in Twentieth-Century Arid Sahelien Africa," in John F. Richards and Richard P. Tucker (eds.), World Deforestation in the Twentieth Century. Durham and London: Duke University Press, 1988; p.70.

29 Krugmann, pp. 8 - 10.

30 Anderson and Fishwick, op. cit., p. 33.

stove, and how much they used afterward. It was not unusual for the responses to come in very rounded figures: "With the old stove I used to buy two [bags, tins, other volume unit] of charcoal per month, now I only use one." Assessments of fuel savings based upon this type of information were not unusual five or ten years ago, but are less common now.[31]

Over the years, the goals of stove programs have also evolved, and stabilization of fuelwood consumption levels is now considered a more realistic objective than reduction of demand in absolute terms.[32] This is partly due to a growing recognition of the practical constraints to the real-world performance of improved stoves, plus the fact that population growth can erode any aggregate fuel savings generated by conservation programs.

There is a growing tendency, as well, to question whether reductions in the demand for wood fuels can significantly affect deforestation rates. Since the mid-1980's a number of influential books and articles have raised this issue, and have suggested that there is little reason to expect major savings.[33] These issues are discussed in more detail in the next section of this report.

Stove designers and promoters have responded by identifying a broad range of household and individual level benefits attributable to the use of improved stoves, apart from national goals of energy conservation. This redefinition of objectives and benefits has sometimes been referred to as a "third phase" in stove programs, the first phase being the early programs of the 1950's and 1960's, and the second the projects which followed the petroleum crisis of the 1970's. In this context Joseph, Prasad and van der Zaan have noted "*an inescapable slant away from energy conservation.*"[34]

Among the most commonly cited of these benefits one finds:

- The potential to reduce the incidence of eye and respiratory ailments by lowering the level of emissions in kitchens and enclosed courtyards; some of these emissions may also be linked to cancer.[35]
- Time savings to households through faster cooking and less time spent on collection of fuelwood. The distances women and children must walk to find readily available fuelwood are often cited as a major burden of daily life, and alleviating this burden is one of the most appreciated aspects of improved stoves mentioned by their users.
- Less risk of burns, especially to children, through the use of insulation and better stability of the stove and cooking pot.
- Greater cleanliness in kitchens due to lower levels of smoke and soot from biomass combustion.
- The ability to cook more meals with the same amount of fuel, or to keep water hot for preparing tea or coffee, or for washing, without using additional fuel.
- A feeling of satisfaction or pride in owning a more modern stove. In some cases this satisfaction has been said to increase receptivity to other extension messages on topics such as health or nutrition.[36]

Interestingly, some of the earliest improved stove programs, carried out in India

31 Most of the fuel consumption data for the Kenyan Ceramic Jiko, for example, were of this type; see Jones, 1989.

32 See, for example, ESMAP, Household Energy Conservation and Substitution strategy for Niger. Activity Completion Report No. 082/88, 1988, UNDP/World Bank; p. ii, pp. 45-53.

33 See Gerald Foley, Patricia Moss, and Lloyd Timberlake, Stoves and Trees: How Much Wood Would a Woodstove Save if a Woodstove Could Save Wood?. London and Washington DC, Earthscan, 1984. See also Foley's article "Exaggerating the Sahelian Woodfuel Problem" in Ambio vol. 16 No. 6, 1987, pp. 367-371. Also see Gerald Leach and R. Mearns, Beyond the Fuelwood Crisis: People, Land, and Trees in Africa. London, Earthscan, 1988. Also the article by Jas Gill "Improved Stoves in Developing Countries: a Critique" in Energy Policy Vol. 15 No. 2, April 1987, pp. 135-144. A useful review of these issues is found in Hartmut Krugmann, Review of Issues and Research Relating to Improved Cookstoves, Ottawa, IDRC Manuscript Report series, 1987.

34 Stephen Joseph, K. Krishna Praad, and Hanske B. van der Zaan, Bringing Stoves to the People: An Assessment of Impact, Nairobi, Foundation for Woodstove Dissemination and African Centre for Technology Studies, 1990.

35 See Barnes *et al* for a summary of research on this topic, p. 9.

36 Personal communication, Noel Chavangi (GTZ), Vivienne Abbott (ITDG), Teresia Mudhui (Kenya Ministry of Agriculture), 1992.

in the 1940s and 1950's, were also promoted on criteria of health and cleanliness, under the rubric "smokeless kitchens for the millions."[37] These programs were in part inspired by Mohandas Gandhi's ideals of improving village life for the rural masses. The present trend of emphasizing the importance of welfare benefits to consumers is once again drawing attention to the potential for improved stoves to help alleviate a variety of problems and burdens faced by the poor in developing countries.

This emphasis on welfare benefits is seen by some energy analysts as an admission that improved stoves are incapable of generating significant energy savings. This in turn has provoked a sometimes sharp reaction from proponents of improved stoves. In a recent letter to the journal Boiling Point, Waclaw Micuta justifies continued investment in improved stove programs, by linking energy benefits with environmental and health issues, and criticizes what he describes as:

> ...the almost complete indifference to the large and increasing role of the use of charcoal as a fuel in developing countries. Charcoal is the main killer of forests and the women who cook with it. The shift from charcoal to firewood, when burned in fuel efficient stoves, could result in an enormous economy in firewood.[38]

One of the most important welfare benefits directly related to economies in consumption of fuel[39] is the savings in monthly fuel expenditures by households using improved stoves. As fuel expenditures are often a significant proportion of household outlays,[40] savings attributable to the adoption of improved stoves could be particularly important to lower income households with limited discretionary income. The importance of helping to stretch the energy budgets of low income households is noted by one analysis which concludes that, "though improved stoves may not save trees or forests, they can improve the daily lives of human beings."[41]

In cases where energy prices are very high, the payback periods for improved stoves may be very short, and the savings to households can be considerable. In Rwanda, a household investment of $1.48 in the "Rondereza" improved stove results in average fuel savings greater than $115 over the useful life of the stove, typically 18 months.[42] The capital outlay for the improved stove would be recovered through fuel savings within the first month, according to this calculation.

Finally, the global climate change issue is now beginning to be raised in connection with combustion of biomass fuels. This issue may offer a significant incentive to devote more resources to improvement of the combustion efficiency of biomass energy use in developing countries. This is because efficient combustion, <u>if supplied from sustainable sources of biomass</u>, would have much less global warming potential than combustion of non-renewable fossil fuels. Carbon dioxide released by combustion would be offset by carbon dioxide sequestered through photosynthesis in growing vegetation.

Thus, with respect to the carbon cycle, sustainable biomass combustion would be preferable to fossil fuel combustion. On the other hand, low end-use efficiency in biomass combustion also releases a variety of products

37 S. Raju (1953), <u>Smokeless Kitchens for the Millions</u>, Christian Literature Society, Madras; cited in Hartmut Krugmann (1987), <u>Review of Issues and Research Relating to Improved Cookstoves</u>, Ottawa, IDRC.

38 <u>Boiling Point</u> No. 26, December 1991, p. 30.

39 Certain benefits such as health improvements or safety advantages, are not directly related to fuel savings, while others are only achieved to the extent that the improved stoves actually save fuel; household expenditure savings fall into the latter category.

40 Most African countries lack hard data on this topic; Elkan finds estimates as high as 40% of household income to be unrealistic, and suggests 20% as a more likely maximum; Elkan op. cit., p. 527.

41 Foley et al, p. 5.

42 Barnes *et al*, p. 17.

whose global warming effect is not yet clear but is thought to be at least a contributing factor.[43] To the extent that such emissions represent a significant source of climate change potential, improving the efficiency of biomass combustion could prove to be an important step in trying to mitigate atmospheric greenhouse gas emissions.[44]

This report will focus on what has been the primary justification of biomass conservation projects, i.e. the goal of alleviating environmental degradation and deforestation. Health benefits have become increasingly important justifications for projects in recent years, but to date it has proven difficult to separate the effects of biomass smoke from other risk factors in developing countries. Similarly, the climate change issue has only recently been raised in connection with biomass consumption in Africa, and there have been few studies explicitly examining the connections although interest in the topic has been growing.[45]

2. What Impact have such programs had in rural and urban areas?

After more than ten years of experience, opinions are sharply divided as to the benefits produced by biomass conservation programs. Beginning in the early 1980's, doubts began to be expressed about the effectiveness of many improved stove projects. In many cases, these had failed to achieve significant rates of adoption among the target population. Joseph, Prasad, and van der Zaan noted that ten major stoves projects around the world[46] had disseminated a total of less than 50,000 improved stoves as of 1984.[47] By another estimate, some 100 stove projects had disseminated a total of roughly 100,000 stoves by 1983, of which 20% to 30% were only in use periodically, and another 10% to 20% were not in use at all.[48]

On the other hand, production levels rose substantially by the mid-1980's. Extremely large numbers were reported in China (40 million) and India (2.5 million) by 1987,[49] and even in sub-Saharan Africa significant numbers of stoves were being produced in Niger (200,000 units), Burkina Faso (150,000 units), and Kenya (500,000 units).[50] As the following analysis unfolds, it is important to distinguish between the sometimes spectacular failures of early stove programs ("improved" stoves which consumed more fuel than traditional ones, for example) and the majority of contemporary programs, which are far more sophisticated, and have in a few cases significantly displaced traditional modes of cooking.

Yet even where significant dissemination has occurred, it is rare to find unambiguous evidence of a beneficial change in the biomass situation. In part this is due to inherent difficulties with identifying causal relationships in a situation as complex as the supply and the consumption of biomass energy within developing countries. Methodologies presently do not exist for linking changes in behavior at the household level to remote events such as fuelwood harvesting. It can only be assumed that fuel savings at the household level have a corresponding effect of sparing trees which otherwise would have been felled: that trees are saved as a result of saving woodfuel.

Even at the household level, most projects are able to provide only rough estimates of the rate and direction of change in consumption based upon surveys of limited

43 By releasing carbon in the form of methane, carbon monoxide, and higher hydrocarbons instead of as CO_2.

44 See Barnes et al (draft), p. 11, and Floor & van der Plas (forthcoming).

45 See BSP/WRI/NASA, Central Africa Global Climate Change Study, (forthcoming) for a review of the issues.

46 Guatemala, Indonesia, Sri Lanka, Burkina Faso, Nepal, Niger, Senegal, Ethiopia, Kenya, and Mali.

47 Joseph et al., p. 4

48 Manibog, 1984, cited in Krugmann, op. cit., p. 4.

49 Joseph et. al., p. 3.

50 Ogunlade Davidson & Stephen Karekezi, A New, Environmentally-Sound Energy Strategy for the Development of Sub-Saharan Africa, Nairobi, AFREPREN, 1992, p. 16.

sample size. Findings from these surveys are then extrapolated to the larger population, under a set of assumptions for per capita fuel consumption, average household size, and average fuel savings from improved stoves, thereby arriving at a level of savings attributable to the project intervention. These demand-side calculations, however, are seldom if ever complemented with the supply-side data which would be needed to demonstrate that household energy savings were in fact resulting in lower levels of fuelwood harvesting.[51]

For example, an agro-forestry project in the Maradi area of Niger has calculated that the fuelwood savings due to the project's improved stoves activities totalled 116,200 kilograms for the year 1991. This result was based upon the construction of 398 stoves, each assumed to save 20% of the fuelwood used by a three-stone fire, and that these stoves were being used by households averaging five persons, whose average daily fuel consumption per person (based upon World Bank data) is taken as 0.8 kg. Thus the formula:

398 X 5 X 0.8 X 365 X 20% = 116,200 kg.

has been used to calculate the aggregate woodfuel savings attributable to the improved stoves component of the project.[52]

This calculation is conservative in comparison with the projections of savings commonly claimed for improved stoves in earlier programs, which often were on the order of 50% and higher. This illustrates the point that project managers are beginning to have a more realistic sense of the difficulties involved in transferring laboratory performance figures into actual household settings. Yet several problems still remain in the above example. For one, the year's total stove output - 398 units - is assumed to be in service for the entire year. This is a fairly minor quibble, and could be overcome by phasing-in savings at a rate which reflects the actual rhythm of installation of improved stoves.

A more serious, but again not insuperable problem, lies in knowing the actual utilization rates of the improved stoves. Are all 398 in use every day of the year, and have they replaced 100% of the use of traditional stoves? Households may use a traditional stove for some purposes and an improved stove for others, complicating the calculation of overall fuel savings.

Also, stove deterioration is known to adversely affect fuel savings, and the Albarka design promoted in rural Niger is one which requires simple but fairly regular maintenance.[53] Deterioration and breakage affect many if not most types of improved stoves; for example, a survey conducted in Khartoum by the author found that many of the improved charcoal stoves tallied within the household sample were no longer in use.[54] Such issues could be monitored through follow-up surveys, and appropriate adjustments could then be made to the savings calculations to better reflect actual trends.

The daily fuel use figure and the average household size estimate, represent a more serious problem. Fuel is not consumed by individuals, but by households, and the amount consumed does not vary in direct relation to household size. In general, fuel consumption per capita drops as household size increases: the amount of additional fuel

51 An ambitious attempt to do just this is found in the World Bank Energy II project in Niger, discussed later in this report.

52 CARE International, Maradi Agro-Forestry Project, End Of Year Report, December 1991, p. 9.

53 An important task for GTZ extension personnel is monitoring of stove maintenance; personal communication, Ute Fischer 1992.

54 J. F. Swartzendruber, A Market Study for Improved Charcoal Stoves in the Greater Khartoum Area, Burlington, Vermont: ARD Inc., 1990; see also discussion of stove "half-life," below.

needed declines as the amount of food cooked increases. In other words, energy is used more efficiently in larger households. Cline-Cole et. al. have shown the importance of using accurate and sufficiently disaggregated data on the size of consuming units (households) in assessing fuel consumption trends.[55]

However, in most of Africa, such data are notoriously hard to get and what is available is often of uncertain accuracy. Projects are usually obliged to generate the necessary information themselves, and because they are normally carried out under less than ideal circumstances, the results sometimes fluctuate significantly from one study to another.[56] A 1988 ESMAP report cites an average of six persons per household in Niamey, yet a 1987 study (published in 1988) found average household sizes ranging from 7.5 (users of traditional stoves) to 8.8 (users of improved stoves).[57] Previous surveys in Niamey, published in 1982 and 1984, had reported average household sizes of 9 and 7.5, respectively. The table above illustrates the variation in average household size for various locations in Niger, cited from different surveys.

It is possible for the average household size within a population to vary over time and from one location to another, for example due to rapid urban migration, or because of population movements in time of drought. The definition of "household" may also vary from one survey to another. The number of persons taking meals from a given kitchen, the criterion normally used in cooking studies, is not necessarily identical to "household size" as this would be defined by other researchers. The differences shown above could also simply be artifacts of sampling problems. In the absence of any explanation for variations of this magnitude, however, it is prudent to treat survey findings

Average Household Size in Niger

Location	Survey Date	Persons
Maradi, rural	data not given	5
Maradi, urban	1984	14
Agadez	1984	11.2
Agadez	1985	9.4
Niamey	1982	9
Niamey	1984	7.5
Niamey	1987	8
Niamey	data not given	6
Tessaoua	1984	13.3
Tessaoua	1985	8.4

Sources: CARE 1992, ESMAP 1988, G. Dechambre 1988

with caution. These problems can be overcome to some extent by better sampling and surveying, and although these are difficult to organize and costly to carry out, techniques have been developed which make the process somewhat more manageable.

Consumption studies should be done in a longitudinal format rather than being derived from cross-sectional data. Cross-sectional studies take less time to perform, and generally are simpler to implement, but require detailed knowledge about the sample population. In the Niamey study cited above, the inability to match the two sample groups (improved stove users and traditional stove users) for household size and income level was identified in the report as a significant problem in analyzing the differences in fuel consumption between the two groups.

Fuel consumption should also be measured by trained enumerators, rather than asking cooks to state how much fuel they purchase in a given period. It is true that this can be a time-consuming and costly process, and when improved stoves were believed to generate fuel savings on the order of 50%, a relatively lower priority may have been given to the need for precise measurements. However, it is now widely accepted that savings are likely to be much

55 See Cline-Cole et. al., op. cit. for a detailed discussion of this issue in urban African settings.

56 Trained statisticians or demographers are seldom available, and pre-existing sampling frames are rare; sampling is often non-random, and no stratification is done because necessary data are not available; see Swartzendruber, "Sampling Problems in Khartoum," Boiling Point No. 23, Dec. 1990, for a discussion of these issues.

57 ESMAP 1988, op. cit., p. 2; Gilles Dechambre, Etude Economie de Bois a Niamey, Niamey, Projet Foyer Amelioré, Ministere de Mines et de l'Energie, 1988; p. 13.

lower, in the range of 10% to 20% in many cases. This means that fairly precise measurements are required, since verbal statements and *post hoc* recollections of fuel use are unsuitable for assessments at this level of precision.

Properly carried out, these studies can reveal far more about real-world performance of the new technology and can highlight problems requiring attention from project managers. The GTZ rural stove program in Niger, which also promotes the Albarka stove, has measured savings in the range of 10% to 12%.[58] Their findings shed light on some of the factors which contribute to lower levels of fuel savings. Some stoves have been poorly built, resulting in reduced fuel efficiency; in some cases, consumers ask artisans or stove builders to make modifications which can impair fuel efficiency, for example by enlarging the fuel inlet door.[59] As noted above, lack of maintenance can also impair the stove's performance as well as its durability.

Some cooks use improved stoves improperly, and fail to achieve fuel savings.[60] Such occurrences tend to pull down the average fuel savings experienced by improved stove users as a group.[61] In the 1987 Niamey study, it was reported that 30% of improved stove users were correctly operating the stove, saving 29.5% of fuel, whereas the remaining 70% were using it in ways which reduced fuel savings to a mere 3%.[62]

Similar findings have been reported from a GTZ study in Mali. Households using the "Teliman" stove correctly (57%) recorded savings of 42% of fuelwood compared to households using a three stone fire. In comparison, households using the improved stove incorrectly (43%) saved just 15% of the fuel used by the three stone fire.[63] (In Niger, fuel savings are calculated relative to the "Malgache" stove, while in Mali the three-stone fire is used as a benchmark.)

The measurement of fuel savings is now understood to be imprecise and subject to a great variety of technical and human foibles, and even well designed and carefully implemented studies should be understood in this light. One widely noted report from Burkina Faso found that the act of measuring and recording fuel consumption was sufficient to stimulate a 25% reduction in fuel use prior to the introduction of improved stoves.[64] The presence of observers measuring and recording cooking behavior and fuel consumption can make some cooks very self-conscious and more aware of the amount of fuel they are using during tests. The degree to which this "Hawthorne effect" may distort survey results is not known, though it is assumed that over the course of a longer test period, behavior would tend to regress toward a norm.

Of course, household behavior is not necessarily stable over time. Household energy consumption may vary according to factors such as the weather, the seasonal availability of fuel (including crop residues) and/or the labor available to collect it, deterioration in the condition of the stove, and so on. In some areas, food cooked varies according to the time of year, as does the quantity. For example, festivals and celebrations may account for a significant share of annual energy consumption. Stoves may be used for space heating in cold weather - an application for which the improved stove is less useful than traditional stoves.

But having said all of this, it is important to note that one may find situations in which all of these questions may be answered with clear indications of positive savings.

58 Djedje and Fischer, op. cit.

59 Personal communication, U. Fischer, 1992.

60 Dechambre; Gajo, 1991.

61 Though careful follow-up and monitoring can - at a cost - alleviate many of these factors; this point is discussed later in this report.

62 Dechambre, p. 35.

63 Michel Gajo, Enquete sur la Consommation de Bois de Feu, Bamako, Direction Nationale des Affaires Sociales, 1991, p. 11.

64 Timothy Wood, cited in Foley et al., p. 80; however, most improved stoves probably would not show as much variation in consumption as the three-stone fire demonstrated in this case.

Nevertheless, it may not be possible to clearly establish that as a result, biomass fuel, which otherwise would have been consumed, has been conserved, or to quantify such savings. As mentioned above, to some degree this is inherent in the nature of the production of biomass, which varies according to unpredictable factors such as climate, as well as a great many intervening variables of human origin - of which fuel collection is but one.

It is important to acknowledge that different observers approach the issue of proving biomass fuel savings from quite different starting points, and that the starting point influences the conclusions drawn. One approach is based upon the belief that unsustainable woodfuel harvesting is a significant source of deforestation, and that successful interventions can help to stabilize or even reduce aggregate levels of biomass consumption. Where this assumption is believed to be valid, the historically poor performance of projects may be attributed to flaws in project design, ineffective dissemination strategies, or technical mistakes.

By applying the lessons learned from unsuccessful projects, one expects to increase the chances of success in future interventions. Some of these lessons are discussed elsewhere in this report. Indeed, the growing rate of improved stove dissemination since the mid-1980's suggests that a number of important lessons have been learned, and that projects have substantially refined and focused their efforts, with considerable success in some cases.

A contrary view is also widespread: that deforestation is seldom caused by fuelwood harvesting, and that interventions designed to reduce biomass fuel consumption should not be expected to make a significant change in rates of land conversion or environmental degradation. In many parts of Africa, the harvesting of biomass fuel is now thought to represent a minor source of deforestation, in comparison with agricultural clearing. If the conversion of forest or woodland to cropland and pasture is driven by population growth and by the need for export products, then the production of fuelwood and charcoal may be understood as a by-product of this process. Where this is so, changes in the demand for biomass fuels are unlikely to affect the pattern and rate of land use change.

Other objections to the fuelwood gap theory and to some of the interventions designed to address it include the following observations:

- pricing trends may be poor indicators of the physical scarcity of woodfuel resources, and adaptations to scarcity can influence the long-term supply;[65]
- woodfuel harvesting can in some cases stimulate faster regrowth of trees and thus does not necessarily lead to depletion of stocks;[66]
- planners have seriously underestimated the volume of biomass available for energy use, even on degraded land;[67]
- high population density may not lead to deforestation and may even lead to increased levels of planting or intensive management of remaining trees;[68]
- wood will be treated as a "free good" if it comes from open-access lands, thus any attempt to change supply and demand for

65 See P.A. Dewees, "The Woodfuel Crisis Reconsidered: Observations on the Dynamics of Abundance and Scarcity," in World Development Vol. 17 No. 8, August 1989, pp. 1159-1172.

66 Dewees, op cit.

67 Foley 1987, pp. 369-370, Openshaw, pers. comm. 1991.

68 See R.A. Cline-Cole, H.A.C. Main, and J.E. Nichol, "On Fuelwood Consumption, Population Dynamics and Deforestation in Africa," in World Development, Vol. 18 No. 4, April 1990, pp. 513-527; also see Dewees, op. cit.

biomass fuel must first deal with the issue of market distortions and land use policy;[69]

- in the absence of increasing incomes and reliable access to alternative energy supplies, households are unlikely to give up the use of fuelwood, even where more modern fuels such as kerosene or LPG are subsidized.[70]

Certain issues, such as the costs and benefits of fuel switching programs, are complicated by the dearth of studies on important variables such as demand elasticities for various kinds of fuel.[71] Perhaps the most important point at issue, however, concerns the degree of scarcity of biomass fuel. According to one energy analyst, most of the recent evidence points to the conclusion that, at least at the aggregate level, there is not a scarcity of biomass fuel in sub-Saharan Africa.[72] Where there are problems, such as in the supply of charcoal for various urban markets, these are localized shortages which must be examined on a case-by-case basis.

One of the reasons for the over-estimates of the scarcity of biomass fuel has been the lack of adequately detailed biomass supply inventories, especially with regard to woody biomass. Often the existing inventories have not had proper ground-truthing, and, in many cases, inventories have focused on only the commercial timber species. From the traditional forestry management perspective, the emphasis on commercial timber is to be expected; the problem lies in using such inventories as the basis for projecting aggregate biomass supply, which may be a very much higher figure. For example, Keith Openshaw notes that an estimate of biomass fuel supply for Ghana had calculated that annual demand was three times the mean annual increment of regrowth. His own assessment was that the mean annual increment was roughly twice the level of annual fuelwood demand; in other words, instead of finding a national fuelwood gap in Ghana, Openshaw's assessment was that there is actually a surplus.[73]

Such discrepancies can arise because of the use of inventory data that have not been adjusted to take into account woody biomass present outside the forest, which often provides the major share of the local fuelwood supply. Another problem with many inventories is that they measure the stem volume of trees rather than the total volume. Foresters estimating the commercial potential of forest resources naturally are concerned with calculating the amount of commercially useful wood, i.e. the stem volume, and in a commercial forestry context, this is the correct measure to use. But when fuelwood resources are being considered, it is important to look at the total wood volume available, since much of the consumption will consist of branches, twigs, or even leaves which would have been excluded from stem volume calculations.[74]

Bearing in mind that these issues are currently very much in dispute, and that much evidence remains to be collected, assessment of the impacts of biomass conservation projects must proceed on two levels. First, biomass projects must be evaluated in terms of their own targets of modifying household consumption patterns. The second, and much more difficult task, is to try to assess the degree to which such projects have resulted in changes in the aggregate supply and demand for biomass fuels. In other words, first one must assess whether projects have been able to modify biomass consumption patterns through interventions such as the introduction of improved stoves, and then one must also

69 See Mercer and Soussan, 1990, for a review of these issues.

70 Walter Elkan, "Alternatives to Fuelwood in African Towns," in World Development Vol. 16 No. 4, April 1988, pp. 527-533; see also Leach & Mearns, op. cit., and D. Evan Mercer & John Soussan, "Fuelwood: An Analysis of Problems and Solutions for Less Developed Countries," an unpublished paper for the World Bank Forestry Sector Review dated Dec. 5, 1990, p. 41.

71 See Harry R. Clark and Ram M. Shrestha, "Traditional Energy Programs and the Theory of Open-Access Forest Resources," in The Energy Journal, Vol. 10 No. 3, 1989.

72 Phil O'Keefe, personal communication, 1992.

73 Keith Openshaw, personal communication, 1992.

74 Keith Openshaw, personal communication, 1992.

attempt to determine whether such changes, where they have occurred, have had the desired result of slowing deforestation and environmental degradation.

Based upon the evidence available at present, there is little basis for a firm conclusion on either of these points. There are several reasons for this. First, few biomass projects have produced data adequate for an assessment of their impact on the natural resource base. In many cases, time frames have been too short for such effects to be visible.

In addition, little baseline information has been available against which to measure change: levels of demand, sources of supply, and other important topics are typically unknown or are roughly estimated. The resource base itself is variable and not easily monitored: woody biomass grows not just in forests, but on nearly all kinds of land, and the supply of biomass is affected by weather patterns as well as by human interventions. It is inherently difficult to identify and separate the effects of factors external to a project when assessing its impact.

Even in the case of improved stoves that have been disseminated on a massive scale, the impact on aggregate biomass supply has seldom been documented satisfactorily. In part this is because of the nature of biomass fuel markets, which are normally located within the informal sector, for which trends are seldom captured in trade statistics and taxation records. (And in the case of rural fuel use, there is often no market to study in any case.) The result of all of this is that impact measurements are nearly always indirect.

The most successful improved stove in Africa has been the Kenyan ceramic jiko (KCJ), a hybrid design combining a ceramic liner/grate adapted from the Thai "bucket stove" with the traditional Kenyan charcoal stove or "jiko," made from scrap metal.[75] The KCJ presently accounts for a significant share of the Nairobi market for charcoal stoves, at an estimated production volume of 7,000 units per month.[76] The total number of KCJs produced since its introduction in the early 1980's has been estimated at up to half a million units.[77] The KCJ design has also been transferred to a number of other countries including Rwanda, Tanzania, Sudan, Ethiopia, and Senegal.[78]

There has been little or no monitoring of the KCJ in Kenya since the mid-1980's, and as a result its impact on Kenya's biomass fuel supply is essentially unknown. Household surveys conducted in 1982 and 1986 found a pattern of mixed savings among sampled households, ranging from 10% to 50%.[79] However, these studies were compromised by a number of methodological problems, and some analysts have been reluctant to accept these findings as proof of energy savings. In 1988-89 a second analysis was performed on the earlier household survey data, and identified average savings ranging from 15% to 40%, although some discrepancies in the data were unresolved due to loss of the original computer files and questionnaires.[80]

Along with non-random sampling, a serious drawback to the Kenya surveys is that most of the sampled households, with

75 See Eric L. Hyman, The Experience with Improved Charcoal and Wood Stoves for Households and Institutions in Kenya. Washington DC: AT International, 1985; pp. 21-27.

76 Joseph et al, p. 78. A 1986 study estimated a market share for the KCJ of 17% in Nairobi and 4% in Kisumu; cited in Mike Jones, 1989.

77 Davidson and Karekezi, op, cit., p. 16.

78 In Rwanda the KCJ has reportedly been eclipsed by an all-metal design; in Ethiopia, the KCJ required substantial modification to out-perform the best traditional model.

79 Joseph et al, p. 88.

80 H. Mike Jones p. 34, 42; personal communication S. Joseph 1991, Mike Bess 1992.

the exception of a small sample of 30 households, were asked to recollect how much fuel they had bought during a given period, rather than having fuel weighed by trained enumerators.[81] Verbal statements of this type are by their very nature highly imprecise, and while the 1989 study devoted considerable effort to reanalysis of the data, there was little to be done about the fact that most of the original data set was based upon "*approximate recollections of charcoal use.*"[82] Because of these problems, and because follow-up studies were not done, the issue of the magnitude of charcoal savings resulting from the dissemination of the KCJ remains somewhat controversial.

There is also disagreement concerning the supply side implications of fuel savings from the KCJ. According to one analyst, there is an abundant supply of charcoal to the Nairobi market, and in real terms, prices are 50% lower than they were fifteen years ago.[83] This could reflect the impact of improved stoves in easing pressure on biomass fuel supplies. Stagnating charcoal prices could equally well indicate a strong supply from charcoal producing areas, due to continued large-scale clearing for agriculture. And it has already been noted that wood fuel prices are not necessarily reflective of physical scarcity, except perhaps in the longer term.

Equally important, there are no studies of the rates at which households are adopting the use of other energy sources such as kerosene, LPG, or electricity. Stable prices for biomass fuel may be partially due to the increased use of more modern fuels, a normal energy transition in growing economies. On the other hand, some have argued that the presence of improved biomass stoves may be delaying the shift to more modern fuels by making available an intermediate product. Some evidence for this was found in the KCJ assessment, which reported that 41%, 49%, and 57% of households using kerosene, LPG, and electricity, respectively, had reduced their consumption of these fuels in favor of charcoal after they began using the KCJ.[84]

One interpretation of this finding could be that the improved stove may indirectly contribute to greater use of charcoal rather than less, by providing an attractive technology for consumption of a traditional fuel.[85] According to the KCJ survey results, the improved stove has been primarily adopted by middle and upper income households.[86] A reflection of this can be seen by the fact that some KCJ's - but not the traditional jiko - are sold not only in outdoor markets such as Shauri Moyo but also in Nairobi supermarkets such as "Uchumi" which cater to the middle and upper classes. These observations lend at least indirect support to claims that the KCJ has made little impact on fuel conservation among the urban poor, and that among the middle and upper classes, its net effect may be to delay a natural tendency to shift to use of kerosene or LPG.

On the other hand, the continuing popularity of the KCJ over the years has convinced many observers that the stove probably does save fuel at the same time that it offers other desirable attributes such as an attractive appearance, durability, and speed. The fundamental issue, therefore, is: who bears the burden of proof, and what level of evidence is required to provide a satisfactory answer? Energy analysts are understandably reluctant to accept the KCJ's commercial success as proof of energy efficiency, and even if they did, they would not know how much energy was being saved.

While there is, therefore, some evidence that many KCJ's are bought by relatively prosperous households, most of the stoves are sold in open-air markets which essentially

81 See Mike Jones, p. 33 and 43-44.

82 Jones, p. 33.

83 Mike Bess, personal communication, 1992.

84 Jones, p. 42.

85 Calestous Juma, personal communication, 1992.

86 Joseph et al, p. 88.

cater to lower income groups. The urban Kenyan market has not been adequately studied, but it is difficult to plausibly argue that all KCJ's are bought for ceremonial or status purchases, when most of them are sold in markets which primarily supply simple utensils to consumers with limited means. In addition, low-income buyers are likely to be the heaviest users of charcoal. Middle and upper classes may invest in an improved charcoal stove to have one available in times when other fuels are scarce, or even as a status symbol. However, such households normally rely upon kerosene or LPG, and charcoal is used as an occasional, "last resort" fuel. The meals cooked by the wealthy are probably also different than those for which the KCJ was designed. For such groups, the importance of charcoal savings are much less significant in comparison with those who rely upon it daily.

Another reason for skepticism regarding the environmental benefits of biomass conservation projects is related to the magnitude of conservation likely to be realized. This can be illustrated by the following hypothetical example. Assume that an improved stove reaches 20% of a given market, and that households using the improved stove save on average 20% of the fuel they would otherwise have used (some might save more, while others, for various reasons already mentioned, would save little or nothing). This program would, therefore, account for an aggregate fuel savings of 4% (0.2 x 0.2 = 0.04). While this is merely an oversimplified hypothetical example, it coincides with to the findings of Joseph, Prasad and van der Zaan, who have estimated the charcoal savings attributable to the KCJ at roughly 20,000 tons per year, or 4% of total national consumption.[87]

A concerted dissemination and education campaign might be able to expand the market share, though it is unlikely that the new stove would totally displace its traditional rivals.[88] Such an effort might also improve the skill of cooks and lead to higher levels of fuel savings in daily use. Doubling both figures gives a market penetration of 40% and average fuel savings of 40%, for an aggregate fuel savings of 16% of total consumption.

The obvious question raised by such calculations is, how significant are savings of this magnitude? It has usually been thought that production of charcoal is particularly destructive, involving the wholesale cutting of trees which were then converted to charcoal in highly wasteful traditional ways. Raising the end-use efficiency for charcoal could, in principle, produce great benefits on the supply side, since the overall production system efficiencies are so low.

Some analysts now question the validity of this scenario. By one estimate, only 20% of the charcoal supplied to the Nairobi market results from "mining" of forests or woodlands; some 40% derives from sustainable sources, and the remaining 40% originates from land cleared for agriculture.[89] In the case of agricultural clearing, conversion of the cleared trees into charcoal for urban markets may be preferable to burning it on-site, or leaving it to rot, as is often the case.[90] From this perspective, it makes more sense to implement land use management policies which can increase the proportion of sustainable supply in the market, and reduce or eliminate "mining" altogether, than to try to shift production patterns through small percentage-point changes in end-use.

Yet these options need not be mutually exclusive, and there may be other reasons

87 Joseph et. al., p. 136.

88 See J. F. Swartzendruber, "A Two Sector Model for Commercialization of Improved Stoves," in Proceedings of Regional Workshop on the Commercialization of Improved Cookstoves, Khartoum: Energy Research Council, 1939. In Niger, the market share of the Mai Sauki stove is in decline, and that of the KCJ in Nairobi appears to be maintaining a plateau reached several years ago. See also Foley & Moss, 1983, for a discussion of reasons why traditional stoves may remain popular among consumers.

89 M. Bess, personal communication, 1992; some analysts question the long-term sustainability of even the 40% cited here as from "sustainable" sources, however. And others estimate 20% as a more realistic figure for sustainablity of present supply.

90 Gunter Schramm, personal communication, 1991.

why efforts should continue to raise the efficiency of end-use. It has also been noted that more and more stove programs are emphasizing benefits other than energy savings, as the difficulty of demonstrating aggregate energy savings has become clearer. This view is echoed in a recent article in a World Bank publication, which makes the observation that:

> ...although the improved stoves save on fuel, it appears that fuel consumption does not decline as a result. Rather, nutrition and health improve, because women use the money they save on fuel to buy extra food and cook it more than before.[91]

There is also disagreement concerning the practicality and desirability of promoting a shift toward modern fuels; this depends on whether one considers it more important to conserve biomass, which is, after all, a renewable resource, or foreign exchange, which is needed to pay for imported modern fuels and most of the devices which use them. Where fuelwood is considered to be in a situation of acute scarcity, shifting consumption toward alternative fuels is, of course, a sensible strategy.

Some analysts also point out that the economic dislocations associated with structural adjustment programs may result in increased use of traditional fuels.[92] Even households already using kerosene, LPG, or electricity may find themselves resorting to use of woodfuels in times of fuel shortages or power cuts. In many African cities, households may invest in several difficult cooking devices, and will switch from one to another depending on the price and availability of fuel.

3. What were the key constraints inhibiting the implementation of these programs?

The key constraints have included:

a) technical problems associated with improving the performance of biomass combustion technologies;

b) unsustainable production and dissemination strategies;

c) overly ambitious objectives, inadequate financial and technical resources, and short time horizons.

These constraints have tended to erode the credibility of conservation efforts, even where important lessons were learned and significant improvements introduced into project interventions. The following section discusses item (a), while (b) and (c) are discussed in the next section, #4.

✦ Technology

The complexity of the technical dimension of biomass projects has often been underestimated. It was initially thought that the development of stoves more fuel efficient than traditional stoves or open fires would be a rather simple task, and that these improved devices would be readily adopted by users of biomass fuels. The open fire, and most traditional stoves, have been typically perceived as primitive, dirty, unsafe, inefficient, and therefore ripe for replacement by something better. The open fire was believed to represent a gross waste of energy, with combustion efficiency generally put at 5% to 10%, and sometimes as low as 3%.[93]

Yet in practice, the task of developing improved designs capable of satisfying consumer needs at reasonable prices has not always been achieved, and dissemination rates have often been disappointingly low. Certain design features which could increase combustion efficiency or reduce emissions need to be weighed against other criteria such as cost, manufacturing complexity, or practicality of use. This requires a process of optimization of a variety of factors, often with limited knowledge of market requirements and consumer preferences.

91 Quoted in "Fuelwood a Burning Issue in the Third World," in Boiling Point, August 1991, p. 9.

92 Personal communications, Hartmut Krugmann, Stephen Karekezi, 1992.

93 For discussion of the source of these estimates see J. Gill, "Improved Stoves in Developing Countries: a Critique" in Energy Policy, April 1987, pp. 135 - 144; but see also data from Baldwin, below, indicating much higher efficiency for the 3-stone fire. Also see Bellerire Foundation for discussion of overall biomass energy "system efficiency."

Similarly, biogas and briquetting technologies which had claimed success elsewhere (i.e., China and India in the case of biogas, Western Europe in the case of briquetting) have proven to be difficult to transfer to sub-Saharan Africa. In some instances this is because conditions in Africa were quite different from those in other parts of the world, in ways which undermined the appropriateness of the technology. However, it should also be pointed out that the nature of the "competition" was poorly understood: little systematic study was done of the existing devices or practices which were to be replaced by the new technology.

It is now widely accepted that the performance of traditional technologies was in many cases seriously under-estimated. In some cases, the new devices were unable to match the traditional technology, especially in cost/performance terms.[94] In this part of the report, technical constraints experienced by biomass energy saving initiatives are discussed. Other constraints are discussed elsewhere in the report.

Samuel Baldwin, a key figure in the development of improved woodstoves in West Africa, identifies several reasons why biomass energy consumption in developing countries has been a problematic field for the development of improved technologies. His analysis runs counter to the widespread view that technical research and development has been over-emphasized at the expense of dissemination and related activities.

First, the scientific understanding of biomass combustion is limited in important respects, especially in the case of open fires and simple stoves in which air flow is unregulated. It is difficult for laboratory experiments to replicate real-world conditions, which cover a wide range of fuel stock, calorific values, moisture content, and operating conditions. The combustion process, which involves thousands of interacting chemical species, and the heat transfer process, particularly in the case of natural convection, are extremely complex. In the early days of stove research and development it was not fully appreciated that these are among the most difficult branches of combustion and heat transfer engineering. Even now, accurately modeling the performance of simple woodstoves is beyond the capability of supercomputers.[95]

In addition, the research and development effort has been fragmented, generally tied to individual projects with unrealistically short time horizons and limited R&D resources. Many projects experienced a trial-and-error process of discovering basic principles and lessons, while few have been able to advance beyond fairly limited standards of performance. Much of the money was spent on household surveys and dissemination activities, and stove designs tended to become "frozen" at an early stage. Of the total spent on stove programs (see page 13, above) relatively little has been invested in technical development: Baldwin estimates that the total research and development expenditure to date has probably been on the order of $10 million.[96] Few improvements in stove design and performance have been seen since the early 1980's, and most improved stoves remain unsatisfactory in terms of turn-down ratio (ability to regulate power output) and levels of emissions.

Baldwin also notes that much of the laboratory work which took place was far removed from the rural and low-income urban settings in which biomass stoves are used. As with other appropriate technology efforts, there has been insufficient application of principles such as peer review and competition, accountability for results, or independent testing and verification of

94 For a review of these issues see Krugmann, op. cit.

95 Samuel Baldwin. Biomass Stoves: Engineering Design, Development, and Dissemination. Arlington, VA: VITA, 1986, p.55 and pp. 175 - 186; per. comm., 1992.

96 Personal communication, 1992.

results in the research and development process.[97]

The combustion efficiency of the simplest cooking device, an open fire, is admittedly not high, but its performance relative to other technologies has been the subject of considerable controversy. As measured by the percentage of heat utilized (PHU), the simplest international standard for measuring thermal efficiency, the open fire has generally been rated as low as 3% to 10%, although Baldwin gives a figure of 17%, noting that field results may be higher or lower depending on wind conditions.[98] The performance of the open fire is also sensitive to other factors, including the skill of the person tending the fire. For example, cooks will often shelter the fire from wind, or make adjustments to the fire if they wish to save fuelwood.

The simple metal "Malgache" stove, widely used in West Africa, registers a PHU of 18%, but can show a substantial efficiency gain through the addition of a grate, raising PHU to nearly 25%.[99] Baldwin notes that, in many cases, such traditional stoves represent a design which has been optimized through years of trial-and-error modifications by artisans. Some of these designs incorporate simple but effective techniques for improving cooking efficiency, for example by optimizing the stove's diameter in relation to the distance from the fuelbed to the cooking pot. Such principles were discovered by improved stove designers after early models failed to achieve the expected levels of fuel savings.[100]

Improved stoves have also been shown to vary widely in PHU terms. Simple improved stoves might reach 28% while insulated models can attain levels as high as 40%. Experimental models have reportedly achieved even higher efficiencies, though these remain at the prototype stage. The improved stoves may be somewhat less sensitive to environmental factors such as the presence of a draft, although the skill of the cook remains an important variable. A sample of PHU values, for a variety of improved and traditional stoves, is shown in the table below, and on the attached chart.

Comparative Wood Stove Performance[101]

Percent Heat Utilized

Wood Stove Type		PHU (%)
Traditional	Three stone fire Malgache stove	17.0 18.2
Modified Traditional	Malgache with grate	24.7
Improved High-mass	Single pot Multi-pot	18.0* 20.0**
Improved Portable	Metal Ceramic Metal+insulation	29.1 34.0* 42.6

* average for 2 types
** average for 9 types

It is important to bear in mind that higher efficiency does not necessarily equal fuel savings in actual cooking, a point which is discussed in more detail below. Overly optimistic hopes for improved stoves were based upon two assumptions: (a) that traditional cooking is very inefficient because of inefficient combustion, and (b) that stoves with higher PHU values would produce proportionate reductions in fuel consumption. The 1984 World Bank report mentioned above discusses the possibility of a four-fold increase in fuel savings from adoption of improved stoves.

The PHU figures shown above are presented to give a sense of the magnitude of variations at the level of basic combustion performance between different woodstove types, in controlled tests. A more comprehensive suite of testing would include not only the water boiling test, from which

97 Samuel Baldwin, personal communication, 1992.

98 Baldwin op. cit., p. 90 and p. 257.

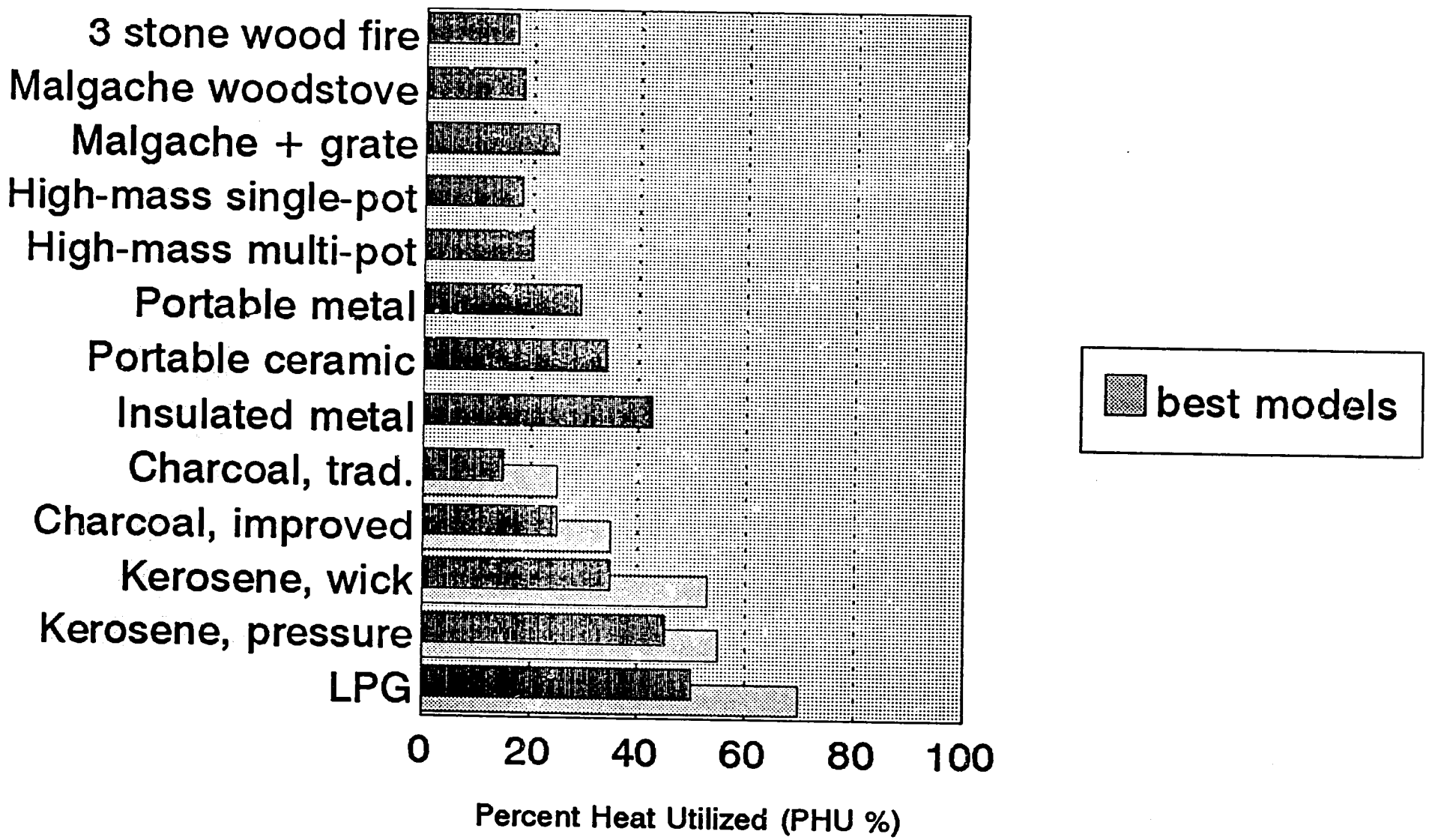
99 Baldwin, p. 90.

100 Baldwin, personal communication, 1992. See also his article, "New Directions in Woodstove Development," VITA News, January 1984.

101 Adapted from Baldwin 1986, p. 90.

PHU Values for Stove Types

Laboratory Water Boiling Tests



source: Baldwin, 1986

the PHU values are derived, but also a controlled cooking test and a kitchen performance test. Results for controlled cooking tests depend upon the particular dishes or recipes selected for the test. A stove which does well in a stir-frying study will not necessarily do well in simmering a pot of beans, and vice versa. This means that it is important for programs promoting a particular stove model to have a good understanding of local cooking habits and preferences, a point which has sometimes been overlooked.[102]

The process of developing and optimizing a stove design for dissemination would normally include all three tests; the last test, the kitchen performance test, would be a longitudinal study of day-to-day performance in real kitchens, and would be a prerequisite for assessments of fuel savings. These results may differ considerably from the laboratory findings. In general, therefore, comparisons should be case specific, and should be based upon results from all three types of tests. In the present report, however, only results from the water boiling test are mentioned, as the others are too site and situation specific to permit useful generalizations encompassing a range of countries.

It can quickly be seen, for example, that the group of high-mass models (including 9 models with a chimney and 2 models without a chimney) offers very little in terms of efficiency improvement over the Malgache stove, and only a slender increment of improvement over the three stone fire. When the thermal efficiency of the three stone fire was thought to be 10% or less, the performance of the high-mass type was viewed as a significant improvement. Over time, appreciation has grown for the ability of individual cooks to squeeze the most useful energy out of the three stone fire, and the reputation of high mass designs has correspondingly declined. The PHU values shown above illustrate that, in general, high mass designs are little better than an open fire in terms of energy efficiency. In many cases, high-mass stoves have been found to consume more fuel than the three-stove fire.[103]

One reason that the open fire is "inefficient" is that much of the heat released by combustion does not reach the cooking vessel, but instead escapes through the open air surrounding the fire. The high mass stove design is intended to prevent this from happening, by enclosing the sides with earth. In practice, however, much of the heat energy released by combustion is absorbed by the walls of the stove, which becomes in effect a heat sink. For this and other more technical reasons, the amount of useful energy reaching the pot may be little more than in an open fire. Over long cooking periods, some of the heat retained by the stove's mass might be expected to radiate back to the cooking vessel, thus contributing to the stove's performance at least in certain cooking tasks. This effect has been measured, however, and appears to be much less significant than expected.[104]

These stoves may offer other advantages, of course, and not only "welfare benefits" such as reduced levels of smoke or greater safety. High-mass models which were less sensitive to draft, or easier to regulate, could show even greater performance over the traditional stove in actual cooking. The same advantages, however, could also accrue to the lightweight stoves, which display significantly higher PHU values in general. Also, high-mass stoves often proved to be surprisingly sensitive to draft despite being enclosed, and tended to be awkward to operate. In most cases, efforts to develop high-mass stoves suitable to African conditions were unsuccessful, and some of the remaining rural stove programs have switched to a more compact design,

102 In the author's experience, it has not been unusual to find stove projects staffed by persons with little or no direct experience with cooking.

103 Samuel Baldwin, personal communication, 1992.

104 See Baldwin, p. 36.

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sometimes including a ceramic combustion chamber[105] to improve performance and durability. Designs with chimneys have also tended to fare poorly, both due to higher installation costs and because of the need for periodic cleaning and eventual replacement. Interestingly, a simple modification to the traditional "Malgache" stove - the addition of a grate - raises its PHU well above the average performance of high-mass stoves.

It has often been found that consumers may be more interested in cooking speed than in fuel savings. This has proven to be an advantage to lightweight stoves and a disadvantage to high-mass stoves, in which a considerable proportion of available heat energy is dissipated at the beginning of cooking in the form of heat absorbed by the walls of the stove.

On the other hand, many cooking tasks cannot be made significantly faster once the food has come to a boil: atmospheric pressure dictates the boiling point of water, and this cannot be changed by increasing the power output of the stove. By using a high power output, water can be made to evaporate faster, but this does not speed the cooking process since the temperature cannot exceed boiling point.[106] Using a higher than necessary power output also tends to require periodic topping-up with water, to replace water lost through evaporation and to prevent scorching of the food; this represents energy wasted as this cold water must be brought to the boiling point so that the cooking process may be resumed.

As noted earlier, the limited facility for power regulation is a major drawback to many improved stove designs. For example, in one test it was found that one of the most economic stoves was a ceramic model from Somalia which, while it had relatively low PHU efficiency compared to improved designs, was able to simmer foods more economically due to its lower power output.[107] A widespread tendency to use more power (and hence, more fuel) than necessary was noted in the 1987 Niamey fuel consumption study, which estimated that perhaps 10% of fuel consumption by improved stoves was wasted through evaporating excess water in everyday cooking.[108]

This observation suggests the need to modify the assumptions upon which early stove projects were based: that traditional cooking is inefficient because of poor combustion engineering, and that introduction of improved stoves would, by improving combustion efficiency, thereby increase the energy efficiency of cooking. In fact, what has often been found is that the overall efficiency of cooking has as much to do (if not more) with the actions of the cook as with the design of the stove being used. Failure to regulate heat output can negate energy savings from improved combustion efficiency.

In some cases, projects have recognized this fact and tried to introduce cooking demonstrations or other educational components along with the dissemination of improved stoves. The Niamey study found that cooks who had attended cooking demonstrations showed higher fuel savings than other cooks.[109]

In Kenya, the Bellerive Foundation has gone even farther, suggesting that improving fire management practices is a more practical strategy than introducing improved stoves into households. Bellerive has focused on improved stoves for institutional users of biomass fuel (e.g. schools) while launching an educational campaign, "Cooking to conserve" through the primary school curriculum, as its strategy for reaching the household level. Household improved stoves were dropped in

105 Notably the Maendeleo stove in Kenya.

106 Pressure cookers are the exception, as they raise the pressure inside the pot and thereby shorten cooking times.

107 Cited in UNEP/Bellerive 1989, p. 33.

108 Dechambre, p. 39.

109 Dechambre, p.24.

1987, after concluding that these had little impact on reducing fuelwood consumption.[110]

An important advantage of liquid and gas fuel stoves (i.e. kerosene and LPG) is that the power level is more easily regulated than in solid-fuel stoves, at the same time that their overall combustion efficiency is much higher than in simple biomass stoves. Most contemporary biomass energy conservation programs are adopting a multifaceted approach, combining the introduction of improved stoves with measures to encourage the use of fuels with higher end-use efficiency, notably kerosene and LPG. Where the latter rely upon pricing subsidies, however, the long-term sustainability of supply may be in doubt.

For this as well as other reasons (population growth, declining disposable incomes) some countries may find that biomass fuels will remain the dominant form of energy for many years to come, and in many other developing countries, biomass fuels will be "last resort" energy options even among middle and upper class urban consumers, when supplies of commercial fuels are interrupted.

There is also evidence suggesting that subsidies for modern fuels primarily benefit upper income groups, and do not necessarily help lower income groups to change their energy consumption patterns.[111] For the poor majority, biomass fuels are not a last resort, but the only fuel available as a practical matter.

In Africa, certain middle-income countries may be able to implement effective fuel substitution programs, provided they are able to introduce undistorted markets for commercial fuels and to assure a reliable volume of supply.[112] Many of the lower-income countries in sub-Saharan Africa, however, are unlikely to be candidates for such a strategy. A large share of the population of the continent is likely, under almost any plausible scenario, to continue using biomass fuels well into the next century.

It should also be kept in mind that in many sub-Saharan countries, the biomass fuel markets employ large numbers of people in both rural and urban areas, at little or no cost to the public sector. In fact, these are often among the most efficient markets to be found, and replacing them is not a prospect to be taken lightly. To the extent that fuel substitution programs require a long-term commitment of public sector resources, including foreign exchange allocations, such programs must be assessed very carefully. Poorly implemented, they may have unintended effects, including disruption of energy supplies and a potentially significant displacement of jobs within lower income groups.

The present evidence suggests that improved technologies for biomass combustion are likely to remain an important issue in much of sub-Saharan Africa. Since it is now realized that improving biomass combustion involves a daunting range of technical and practical difficulties, this finding will not be welcomed by planners who had hoped that the problem would resolve itself through a more or less automatic process of shifting of consumption up the "energy ladder" from biomass fuels to more modern ones. There are good reasons to propose that this shift should not be encouraged, and that better use should be made of locally available resources.

4. Have certain types of programs been systematically more effective in overcoming specific constraints than others and, if so, which types?

Biomass conservation programs have differed in significant ways, some of which can in retrospect be identified as important predictors of the overall impact that has been achieved. Some of the key variables are:

110 Chris Davey, personal communication, 1992.

111 See Douglas F. Barnes. Understanding Fuelwood Prices in Developing Nations. Washington D.C.: World Bank, 1986.

112 See D. Evan Mercer and John Soussan, Fuelwood: an Analysis of Problems and Solutions for Less Developed Countries. Paper for the World Bank Forestry Policy Review. Washington D.C.: World Bank, 1990; pp. 39-43.

a) the choice of the target population,

b) the production and dissemination strategies adopted, and

c) the ability to monitor events, and to detect and respond to problems.

✦ Target Population

Initiatives to conserve biomass energy have focused on both urban and rural populations, though it is widely accepted that urban dwellers are more readily reached and are more likely to participate in the cash economy in which stoves and fuel are bought. Rural dwellers are less likely to make cash outlays for biomass fuel, and would normally use a homemade three-stone fire for domestic cooking. While GTZ maintains strong support for rural stove programs in Kenya, Niger, and Mali, and ITDG is actively promoting rural stoves in Kenya, most contemporary programs emphasize urban settings.

In some cases, the rural fuelwood supply is thought to be less of a problem than the urban supply, and this is another factor in the predominance of urban biomass energy programs. Rural dwellers normally collect wood, and while they often report that fuel is less abundant than in the past, it is seldom considered as serious a problem as, for example, access to water, better housing, or the need for cash income.[113] In rural areas with a low population density, the collection of fuelwood (usually dead branches, twigs, etc.) has a negligible effect on the environment since it is spread over a fairly wide area.

In urban areas, in contrast, biomass fuel is likely to be a market commodity, and a presumed perception of scarcity and value on the part of consumers is expected to reduce resistance to investing in fuel-efficient stoves. Merchants who ship truckloads of wood to urban markets are more likely than rural households to fell whole trees, and probably cause more environmental damage in the areas from which they draw their fuelwood supplies (although this is not always true).

Rural stove programs, where they still exist, are more likely to be integrated into broader development programs: included within agroforestry projects, for example. As noted elsewhere in this paper, most stove programs have been financed as a component of a larger initiative, typically in the forestry or energy sector. However, urban stove projects are more likely than rural projects to be implemented on a stand-alone basis, independently of other extension activities. This may represent a long-term weakness of urban stove efforts, especially where such projects lack access to the expertise necessary to address issues such as cooking practices, which can undermine the expected fuel savings.

In a few instances, projects have selected specific target groups. For example, the cooking done by institutions such as schools or restaurants has sometimes been identified as an important consumer of marketed fuelwood. These institutions represent a sector in which financial arguments for investing in fuel-conserving devices may be more effective than in the case of individual households. Where the skill of the operator represents an important determinant of fuel economy, the smaller numbers of users in the institutional sector make the task of outreach more feasible than in the case of households.

Other commercial users of biomass fuels have also been identified: brick kilns, bakeries, drying or curing of crops such as tobacco, and so forth. The technologies and management practices required to improve fuel efficiency differ in each case, but as in the case of schools or hospitals, the smaller numbers of users and their sensitivity to financial considerations suggest that energy conservation interventions can be made more readily than at the level of individual households.

Experience to date suggests that the choice of the target population as such has been less important as a predictor of effectiveness, than the methods used in reaching a given group. It is clear that many

113 See, for example, Chinwe Anowai, Comparative Study of Users of "Maendeleo Jiko" and Three Stone Stove among Muthara Women (Meru District) in Kenya, GTZ Special Energy Programme, Nairobi, January 1992, pp. 46-48.

rural programs have failed, but the same has happened to some urban initiatives. As discussed below, more important factors have been the continuity of effort, the access to capable technical expertise, and the ability to adjust to unexpected results and problems as these arise.

✦ Production and Dissemination

Three modes of production can be identified: (1) production within the formal sector, by private or governmental workshops, (2) production by informal sector artisans, and (3) production on-site, by owners or extensionists. In most cases, marketing or dissemination tends to follow the choice of production mode: products manufactured in the formal sector tend to be sold in shops, and artisanal products are sold in open-air markets or by door-to-door vendors.

Production for urban markets has shifted over time from an early reliance upon formal sector workshops to the present trend of emphasizing the importance of the informal sector. In part this is because the market typically perceives biomass stoves as simple devices which should not cost much. Formal sector workshops have seldom been able to produce stoves competitive in price with the traditional products of informal sector artisans. Even though the higher price of the improved stove is expected to be recovered through fuel savings, this by itself has not always been a sufficient motivation for consumers to switch to the newer product.

One reason for this reluctance may be that households willing to invest money to upgrade their cooking technology typically do so by switching to use of a fuel higher on the energy "ladder," such as kerosene, LPG, or electricity. These energy sources are considered superior in terms of cleanliness and convenience, and are associated with modern lifestyles and economic progress. In many cases they are also less costly to use (after the purchase of a stove) because of their higher end-use efficiency and the concentrated form in which the energy is delivered. Other things being equal, these attributes of commercial fuels are powerful inducements over the long term to switch from use of biomass fuels.[114]

In some cases, the improved biomass stoves have been simply too costly to interest the majority of consumers, who were unwilling to spend the required sum on an improved device for burning a "primitive" fuel. Often, these devices were produced in fairly modern metal workshops, a choice which had been deemed necessary in order to achieve the desired technical quality, but which also drove up the price of the product to levels well above the market's willingness to pay.

Also, these firms often lacked an effective marketing mechanism for this type of product, limiting their role to manufacturing on a contract basis for donor financed projects. The project often undertook the marketing task directly, for example delivering the stoves to shops on a consignment basis, effectively serving as a wholesaler, the intermediary between the producer and the retailer. In other cases, projects distributed improved stoves through government offices, womens groups, or NGOs. The need for a direct role in dissemination was often described as a temporary but unavoidable stage to be phased out at a later date. In practice, the transition to more sustainable marketing channels independent of project support has proven to be an elusive goal, and many projects ended without achieving it.

The widely noted absence of long-term impact is perhaps best understood as the result of an inability to effectively link production modes with marketing channels, in ways applicable to local conditions and habits and which would attract the interest of entrepreneurs and consumers. In some cases, inventories of stoves can still be found, years after the closing of the project which paid for

114 Although commercial fuels have often been subject to price controls, making them even less costly to use, in practice these controls have often been overshadowed by parallel markets, selling in smaller quantities at higher unit prices; also, prices are now facing upward pressure from structural adjustment programs. Unreliable supply of commercial fuels has often been a greater constraint to broad-based fuel-switching than price levels. The higher price of appliances using these fuels is another constraint.

them, in workshops which did not consider marketing to be their responsibility. In technical terms, some of these models were superior in design to others still on the market.

The informal sector has always dominated production and marketing of traditional stoves, and many projects have also come to depend upon artisans working with simple hand tools not only for manufacturing, but also for the marketing of improved stoves. There are problems associated with this approach, notably the difficulty of identifying, training, and monitoring large numbers of artisans, some of whom may be suspicious of the motives of "official" visitors. Quality control is also significantly more difficult to ensure, and where combustion efficiency depends greatly upon adhering to predetermined manufacturing standards, this can pose serious obstacles to reliance upon artisanal production modes. Nevertheless, many projects have concluded that the best course is to build upon existing structures, and in most cases this has meant working with the informal sector.

One of the reasons for the success of the Kenya Ceramic Jiko has been the presence of high-volume production and sales through the same artisans who produce the traditional charcoal stove, with the addition of a mass-produced ceramic liner which serves as a grate. The liners are bought-in at low unit cost from potters and larger ceramics workshops, and are inserted into a metal casing or cladding made from scrap metal using the same techniques as traditional "jikos." The use of the ceramic liner, cemented into place with an insulating mixture of vermiculite, reduces the need for precision in the manufacture of the sheet metal cladding, and allows the use of traditional metal-working tools and techniques with no fuel-efficiency penalty. Costs are held down by fierce competition between producers (metal artisans as well as ceramics producers), and sales volumes are high in part because the improved stoves are sold alongside traditional stoves which are bought in large numbers by Nairobi households.[115] Consumer feedback is immediately available to the producers, who can adjust their prices, quality, and output levels accordingly.

In Kenya, larger workshops have sensibly avoided entering this market, realizing they could not compete with high-volume, low-overhead artisanal producers who also control the marketing channels for charcoal stoves. While some KCJs are sold in shops such as the "Uchumi" supermarket chain, the numbers are insignificant in relation to the sales at traditional open-air markets. The cooperation of producers within different sectors (metal workers and clay workers, established workshops and artisans) raises a variety of practical problems, however. Some of the dynamism of the Kenya improved stoves market may be due to the creativity with which this relationship has been established in Nairobi.

However, in other cases the presence of a "sectoral gap" has slowed implementation and generally complicated the process of putting production on a self-sustaining basis.[116] In some countries, the KCJ design has been introduced with variations in the production and marketing approaches, for example by focusing on larger ceramics workshops which buy-in metal claddings from artisans, with the larger firm controlling the assembly and marketing of the finished product. This approach generally requires marketing through channels other than the informal sector market for traditional stoves, and for the reasons already mentioned, this has proven a difficult task. The larger firms have sometimes been reluctant to deal with independent-minded artisans, and have tried to hire the metalsmiths as laborers - a move which has generally been resisted by the artisans.

In Niger, the agency responsible for dissemination of the Mai Sauki improved

115 See Hyman 1986, Swartzendruber 1988, and Jones 1989.

116 For discussion of this issue, see Swartzendruber, 1989.

stove has concluded that it must be made more distinct from the traditional Malgache stove in order to justify the higher price anticipated when production shifts to formal sector workshops using new sheet metal, and marketing through shops catering to more affluent buyers.[117] This shift is in response to a shortage of scrap metal which is blamed for a steep decline in output of the Mai Sauki by artisans (although the Malgache continues to be produced on a large scale).

At the other end of the spectrum, few owner-built stove programs have survived to the present, for several reasons: (a) most of these have been earthen, high-mass designs, which have generally shown poor performance and durability; (b) owner-built stoves suffer from many quality defects, which as a rule cannot be monitored and rectified; and (c) dissemination rates have been very low, and fuel savings have been negligible or even negative.

Some rural stove programs have taken the path of training extensionists to install stoves, following up these extensionists with monitoring and retraining where necessary. This approach, while somewhat costly and slow, has been more fruitful. In some locations where extension programs are particularly effective, stove dissemination rates have reached significant levels. To a considerable extent this depends on the quality and continuity of program management and funding. The GTZ program in Niger, for example, has reached some 77 villages in the area of Dosso, disseminating some 2,500 to 3,000 Albarka stoves since 1990.[118] In some villages the Albarka appears to have largely displaced the use of the traditional three stone fire or the Malgache stove. Similar results are reported in Kenya, with the Maendeleo stove used by up to 10% of households in some districts.[119]

Such an approach, however, is only sustainable where a long-term commitment has been made to continuing the extension service - a commitment most donors and even governments may be reluctant to make. To be effective, these rural delivery systems require careful monitoring and a certain level of continuing technical assistance. The latter is necessary to ensure that stoves produced continue to meet basic design and construction standards, and that their performance is satisfactory. To the extent that these extension systems depend upon external financing and technical assistance, the viability of rural energy programs must be considered in jeopardy, for it is clear to everyone concerned that the successful programs have required considerable support to reach their present levels of dissemination.

✦ The Need for Increasing Production Volumes

More important than the number of stoves produced is the number still in use. This is difficult to establish, and requires carefully designed household surveys to monitor over time. Cumulative production data for a period of years are sometimes cited without taking into account the attrition from worn-out or broken stoves. This can provide a seriously misleading impression that improved stoves are rapidly taking over the market.

Timothy Wood has proposed using the concept of a "half-life" for stoves, along the lines of the method used in physics for predicting the rate of decay of radioactive elements or isotopes over time. The life-span of any individual stove cannot be predicted, but for a larger population of stoves a formula can be derived which demonstrates the effect of attrition on the total number remaining in use at a given time. The cumulative number of units in use is a function of both the production rate (more precisely, of the dissemination rate) and the attrition rate. This concept illustrates an important but sometimes overlooked aspect of improved

117 Personal communication, Jean Pierre Jambes, 1992.

118 U. Fischer, personal communication, 1992.

119 Noel Chavangi, personal communication, 1992.

stoves programs: where the product has a relatively short life-span, it is critical to rapidly achieve high levels of production to replace units lost through attrition.[120]

With a stove type whose life-span is estimated at two years, the half-life (the period during which one-half will be lost) then will be one year. This means that one-half of the stoves can be expected to be lost each year. Thus, the total number in use quickly reaches a plateau, given a constant level of production. Increasing the average life-span of the stove has surprisingly little effect on increasing the total number of units in use; a plateau is again reached, but at a somewhat higher level. Instead, expanding output is needed if the total number in use is to be significantly increased. Where production decreases, as has recently occurred in Niger, the total number of units in service can be expected to fairly quickly decline.

A survey conducted by the author in Khartoum, for example, found that most of the improved stoves (a Sudanese version of the KCJ) in the household sample were no longer in use due to breakage. Another clue to the rapid turn-over in the market for charcoal stoves was found in the very high production levels for traditional charcoal stoves.[121] Typically, improved stoves have a longer half-life than the common, flimsily-built traditional stove.[122] Even so, it can be shown that increasing the scale of production has a greater effect on raising the number in use, in comparison with enhancing durability. Extending the product's life-span does expand the total number in use at a given time, but inevitably a levelling-off will occur.

The key to the success of the traditional Sudanese charcoal brazier is the extremely high output levels of the Omdurman tinsmiths. To displace such a traditional product, an improved stove must also be produced at very high levels, failing which it will remain a marginal factor in the total market for stoves. In Nairobi, after several years of impressive gains in market share, the KCJ appears to have reached a plateau, with little apparent gain in recent years. This can also be explained as a function of market saturation for a given product at a given price.[123]

One predictor of the success of stove projects, therefore, is the scale of production which can be sustained over time. Without a self-sustaining and growing base of production, the number of stoves in use is likely to sink to insignificant levels soon after project support (e.g. producer or buyer subsidies) comes to an end. What is remarkable about the KCJ is not that it has failed to completely displace the traditional jiko, but that production has continued many years after project support ended. Furthermore, this development has occurred in the absence of producer or consumer subsidies, and prices for the improved stove have declined to levels only slightly above those of traditional models.

In Niger, production of the improved Mai Sauki stove, which at one time had averaged 2,000 to 3,000 units per month, has now dropped to less than 1,000 units monthly. In comparison, production of the traditional Malgache stove continues at an estimated 10,000 units each month. In February 1992, production of the Malgache stove was estimated at 16,000 units, compared with Mai Sauki output below 800 units.[124] Applying a half-life analysis to this situation, one can predict that, even though the Mai Sauki is considerably more durable than its traditional rival, the proportion of Niamey households using improved stoves could rapidly dwindle unless production rates can

120 Timothy Wood, 1982; technically, the life-span of a given stove type might better be described as a mean value, but this would make little difference in the pattern of attrition.

121 Swartzendruber, 1990.

122 Although poor maintenance can lead to deterioration which degrades performance of the stove.

123 There has not been a market study for stoves in Nairobi, thus no one knows how KCJ sales are affecting other stove sales, and what would be required to boost KCJ sales above the present plateau.

124 For more detail, see Annex "Review of Site Visits," below.

be boosted to their previous levels. Being out-produced on a scale of 20:1 by a cheaper product signals a very dangerous predicament for the Mai Sauki.

✦ The Need for follow-up

One fairly common finding of improved stove projects has been that fuel savings can be minimal unless the cook has acquired a certain level of skill or training, and that poorly manufactured or improperly used stoves can in some cases consume more fuel than traditional stoves. GTZ staff in Niger have measured household fuel savings ranging from 0 to 30% depending on the quality of the stove and the skill of the cook. Typical savings are said to be in the range of 10% to 12% although, with persistent extension efforts and careful monitoring of producers, this level can be improved substantially.[125] Similar results have been reported for rural stove programs in Kenya and in Mali.[126] The issue is discussed at greater length elsewhere in this report.

One implication of this experience is that periodic follow-up is needed; without it, one cannot be sure that stoves presently being produced adhere to the important design criteria, nor that users are correctly operating the stoves in ways which save fuel. Improved stoves should be understood as holding the potential for fuel savings - it is seldom inherent in their design. Whether stoves actually save fuel or not depends on how well they have been built, whether they have been used correctly, and how much deterioration or damage they have experienced over time.

These important variables can only be monitored through properly designed and carefully implemented follow-up studies. In most cases, monitoring activities have not been conducted beyond the life of the project which introduced the improved stove. As a result, little is known about long-term trends, not only in cases of unsuccessful projects, but also where interventions have been more successful. As noted elsewhere, it is largely for this reason that many energy analysts are now skeptical of the fuel-saving potential of improved stoves at the aggregate level.

5.To what extent did local people -- particularly women, both rural and urban, participate in the design and implementation of these programs?

The issue of local participation, and especially the role of women, has become an increasingly common point of criticism of projects of all types, and not just those in the biomass energy field. Raising the level of active participation of local residents is now widely recognized as crucial, although donor-funded programs have often found this principle difficult to accomplish in practice. Most projects have very limited time horizons, and are designed by professionals who face a variety of budgetary constraints and policy guidelines. These may dictate the project's location, staffing and budgetary levels, the choice of implementing or collaborating institutions, and so forth. Only after the program has begun, does the issue of local participation typically enter into the picture and by then, of course, it may well be too late to make major changes to the project plan.

David Hall cites the Baringo Fuel and Fodder project (BFFP) in central Kenya as a rare case in which a project was given sufficient time to consult with local residents, and to experiment with a variety of activities to find those which showed promise while being locally accepted. In Hall's view, most biomass conservation projects have failed because of overly ambitious targets and pressure to maintain unrealistic schedules, compounded by a lack of responsiveness to the perceptions and priorities of local residents. For these reasons, the impact of most biomass conservation projects to date has been "negligible."[127]

The Baringo project, which focuses on rehabilitation of arid land, is now nine years

125 Personal communication, Djedje and Fischer, 1992

126 Personal communication, Vivienne Abbott and Rose Ochuka, 1992; Gajo, op. cit.

127 David Hall, personal communication, 1992.

old, yet is just beginning to move out of an experimental phase and into larger-scale dissemination activities.

> ...if the BFFP had forged ahead without understanding the needs of local people, it would not have gained the necessary local support.
>
> Only now, some nine years later, does the BFFP have an idea of what is possible (and the considerable problems involved), and can, therefore, make goals that it can attempt to honour... Changes can be stimulated but only with the realization that biomass is one part of the overall problem of the development within given environmental constraints.[128]

ITDG's rural stoves program in Kenya deliberately adopted a go-slow strategy early on, to avoid becoming locked-in to certain approaches before the preferences of local residents became clear. ITDG staff feel that it is now evident that the Maendeleo stove is capable of saving fuel, and that many rural women want to have one. However, most women are not adopting the stove primarily because of fuel savings, nor because they perceive a threat to the environment. Rather, they appreciate such factors as cooking speed, cleanliness, and safety, and are willing to invest approximately the price of one chicken (roughly 30 Kenya shillings) to have such a stove.

A smaller group of beneficiaries, the women who produce the stoves, is identified by ITDG as another justification for the project, which the agency considers an income-generation activity for rural women as much as it is an energy conservation program. According to project manager Vivienne Abbott, if the project had been focused solely on energy savings and deforestation, it probably would have been discontinued once it became clear how difficult it would be to prove the results. Yet the demand for the stoves is growing, and a production target of 20,000 units per year has been established for western Kenya.[129]

A new UNDP regional project based in Mali, the "Women and Energy Project," is attempting to address some of these issues from the outset. The project is explicitly focused on women, a feature which has led to recognition of the need for strong outreach and participatory activities much earlier in the design process than has been true for most biomass energy projects in the past.

> Studies in the Sahel suggest that the women are the most important target group for community forestry and stove projects since it's the women who do all the collecting of forestry products (leaves, nuts, berries); they also collect fuelwood...and are sometimes involved in the commercial production of charcoal and fuelwood.
>
> However, women tend not to be targeted, or are simply ignored and thus don't really participate in village programs. In the Sahel the vast majority of women are illiterate. Programs targeting them must therefore rely on village extension agents who work directly with village women. Training materials need to be carefully designed and tested and are written in the local languages for those women than can read. Training also takes place in training centers used for literacy programs, and the animatrices will also try to strengthen the organization of village women so that the women are more confident of taking action.
>
> So the essential elements of the project are its strong extension component, its direct support at the village level, and its specific focus on women. Technically, there really isn't anything new; it's the approach that's different.
>
> The support at the rural level is coupled with efforts to influence Government policy. So we will organize a high-level meeting to discuss strategies intended to promote renewable energy, including forestry and stoves, and to propose policy measures which will strengthen the role of women. A National Action Plan is to be prepared....This will propose specific measures to be undertaken at the ministerial level which the project will continue to follow and support, to make sure the proposed policy initiatives are actually carried out.[130]

It is significant that this project explicitly links participatory activities at the local level

128 D. O. Hall, F. Rosillo-Calle, and P. de Groot, "Biomass Energy: Lessons from Case Studies in Developing Countries," Energy Policy Vol. 20 No. 1, January 1992, p.72.

129 V. Abbott, personal communication, 1992.

130 Martin Bush, personal communication, 1992.

with policy reforms at the national level, and identifies the need to ensure consistency and follow-up in the implementation of these reforms. This kind of multi-level approach is becoming recognized as essential in a wide range of development activities, not only those directed toward biomass energy conservation. Indeed, many natural resources management projects now being implemented incorporate at least some elements of both participatory and macro-policy strategies, and this trend seems likely to become increasingly widespread in the future.

6.How have programs changed over the years and why?

Many changes have been noted in this report. Among the more important changes are the general decline in the number of rural stove projects, and the near-disappearance of owner-built stoves. This latter has sometimes been identified as part of a so-called "romantic phase" of the appropriate technology movement which has become somewhat discredited.

Another form of intervention which has been discredited is the peri-urban fuelwood plantation. These have proven to be extremely expensive to establish, yet have generally had little impact in changing the structure of supply of fuelwood to sub-Saharan African cities. In an influential analysis of the case of Malawi, David French calculated that it would cost $160 million to produce plantation fuelwood whose local market value would be only $3.4 million.[131]

Among other problems, the fact that most tree-planting programs take place on communal or public land has tended to undermine individual incentives to actively participate and to ensure protection for young seedlings. So long as open-access timber resources continue to be available for collection of fuelwood, plantation forestry for fuelwood supply (whether large-scale or not) will be seriously handicapped, perhaps fatally so.[132] In the case of Malawi, French estimated the break-even price of plantation fuelwood at $20 per cubic meter; in comparison, existing average rural fuelwood prices were in the range of $0.02 per cubic meter (solid) while average urban prices were about $1.00.[133] The subsidies necessary to bridge a gap of this magnitude are simply not available in most countries.

Demand modification,[134] and policy measures to improve management of natural forest and woodland areas, have generally superseded the reforestation approach to mitigating fuelwood supply problems. Some related supply-side activities continue: briquetting of residues, for example, or production of biogas, but these have generally had very little impact to date and remain technical curiosities in most countries.

Another change has been the questioning of the very existence of a "fuelwood supply problem." Most analysts now believe that the situation is highly location-specific, and that general statements and policy prescriptions are to be avoided. However, it is clear that in many cases serious mistakes were made in estimating deforestation rates, or in attributing these to household activities such as cooking. Even in the Sahel, fuelwood supplies continue to be readily available - at stable or declining real prices - in urban markets, an outcome which would not have been predicted ten years ago.

The importance of the private sector in commercializing technologies is now widely accepted, and it is rare now to find projects which directly control production and distribution. The need to link different entities dynamically to build on particular strengths has become recognized by most observers. For example, non-governmental organizations (NGOs) often have excellent techniques for outreach. Publicity about new

131 David French, "Confronting an Unsolvable Problem: Deforestation in Malawi," in World Development Vol. 14 No. 4, April 1986; p. 532.

132 See Mercer and Soussan, pp. 25-27.

133 French, p. 532.

134 Policies to shift consumption patterns through changing energy prices, or by making end-use more efficient.

programs or technologies, and organizing local groups to become involved, are roles well suited to NGOs and community groups.

Production and marketing are best left to the private sector (which may, however, require assistance, especially in the start-up phases). Governmental agencies need to monitor events, and to assess the effects official policies have on facilitating or inhibiting the desired outcomes. Universities and research institutes can play useful roles in research and testing, and also in studying the policy environment and proposing changes.

Financing for producers, where it is indicated, should be handled by specialized organizations with experience in credit management. Projects which have assigned this role to inexperienced NGOs or governmental bodies without strong credit management systems have sometimes been embarrassed by the results, with funds being misplaced or misappropriated, or being channeled into activities with little prospect for commercial viability.

7. Given past successes and failures, what sorts of programs should be considered over the next decade?

The major finding of this report is the lack of a clear basis with which to judge the effectiveness of interventions to conserve biomass fuel. The very existence of a biomass fuel problem which justifies intervention is questioned by a number of influential energy analysts and natural resource specialists. Current trends are not well understood, and predictions about future levels of supply and demand are entirely speculative.

It seems evident that more attention needs to be given to determining realistic and achievable targets for baseline data collection, and for monitoring of trends. Without this, discussion of the merits of various strategies - including doing nothing - will remain matters of individual opinion. Many donors may find it easiest to quietly abandon the field, given the lack of consensus on the nature of the problem and even less how to address it effectively. This process appears to have already begun.

It may seem quixotic to be calling for more research and data gathering in times of tight budgets and general economic constraints. Yet it is difficult to justify any other course of action in the short term, for the present base of information is in most cases inadequate to support decisions which need to be made on long-term policies on issues of energy pricing, regulation, or possible subsidies. FWD is very likely correct in pointing out that biomass fuel consumption will surely increase in economies which are in decline, and that substitution campaigns with a high foreign exchange cost probably cannot be sustained for long. Petroleum prices in local currency terms are on the increase in many parts of sub-Saharan Africa, as currencies are devalued and pricing subsidies are phased out under structural adjustment programs. As a result, the proportion of the population relying upon biomass fuels, or resorting to them when other fuels are unavailable, is likely to remain high for the foreseeable future, thus the issue of production and consumption of biomass cannot simply be left to resolve itself.

On the other hand, some useful lessons have been learned about how to design and implement effective projects in this sector. Much of this learning has been documented previously, but is not widely available, in part due to the lack of coordination between agencies. At relatively little cost, some of this information could be made more widely available and translated as appropriate. As will be seen in the discussion of the visit to Niger, it is evident that many elementary mistakes with regard to subsidies and control of prices continue to be made because of the failure to effectively communicate what has been learned to a wider audience, or because of a persistence in emphasizing dirigiste approaches toward interventions.

Also, the availability of technical expertise has declined rapidly. At present, the East Africa region has no on-going facility capable of carrying out even simple design and testing procedures for biomass stoves. The Kenyatta University College Appropriate Technology Center has been inoperative for some time, and the consortium of Kenyan energy and environmental non-governmental organisations (KENGO) has also ceased work

in this area. Other countries in the region have also seen facilities shut down as projects ended and staff were reassigned to other programs. Several institutions might be capable of resuming useful work in this area, with modest levels of support. Research facilities formerly involved in this work, notably at Eindhoven in the Netherlands, are no longer active. In any case, it would be preferable to develop local expertise.

The USAID evaluation of the Kenya improved jiko project, released in 1989, recommended setting up a regional "center of excellence" to provide a stable and technically competent resource for testing, research, and development, and to provide governments, donor agencies, and implementing organizations with sound advice on effective dissemination and commercialization strategies. To date, no action has been taken.

A similar situation appears to exist in West Africa, where facilities have gradually fallen into disrepair and staff have moved on to other work. In Niger, controlled measurements of fuel consumption at the household level have not been done in several years, some of the equipment is in disrepair, and experienced personnel are leaving. Similar situations are reportedly found in other countries in the region. Again, a regional "center of excellence" with a mandate to provide technical support to various country programs would be a useful contribution, but no such initiative is in sight at present. Indeed, budgetary pressures are causing concerns for the continuation of even the present modest levels of support.[135]

Certain European donors have recently begun to organize themselves to counteract the declining priority of the household energy sector. This effort should be supported, and could serve a useful function in helping to disseminate some of the lessons learned, especially with regard to project sustainability and the need for a prominent role for the private sector; this is an area in which the new network, discussed below, might benefit from a broader base of support.

8. How can monitoring and evaluation of future programs be improved?

The need for monitoring and evaluation is widely acknowledged, and most biomass conservation programs now have some system in place. In general, it appears that rural stove programs have made the greatest investment in on-going monitoring and episodic evaluation exercises. This may be related to the fact that rural stove programs have worked closely alongside other rural extension activities, and can use similar techniques for training, management, record-keeping, and so forth.

In general, these provide a useful level of information about project activities and beneficiaries, but analysis of trends and implications of results is sometimes lacking. For example, the Maendeleo program in Kenya has produced an impressive volume of regular monitoring reports. One monitoring report, covering the dissemination of Maendeleo stoves in Muranga'a District, contains some 27 pages of statistics and charts illustrating rates of stove acceptance, responses to demonstration sessions, and expenditures on fuelwood.[136] The report represents a competent and diligent approach toward documenting activities and responses, something which was often lacking in earlier stove programs.

Yet in this report, which is also intended to serve an evaluation function, no analysis is offered of the implications of these findings, nor of any problems or opportunities which might be reflected in the raw data which are summarized in the report. It is difficult to gain any sense of the overall direction and impact of a program from reviewing monitoring reports which do not move beyond the simple reporting of data gathered at this

135 Although USAID and Appropriate Technology International are promoting the KCJ in Senegal, with the intention of replicating the successful commercial aspects of the Kenya experience.

136 Musa Njoka, Monitoring and Evaluation Results, Muranga'a District: March 1991. Nairobi, GTZ/SEP, Women and Energy Project, 1991.

level. External evaluation tends to occur at infrequent intervals, and it is important for programs to develop the ability to carry out regular self-evaluation as well.

It should be noted that several initiatives have been launched in recent years, with the aim of improving and coordinating the monitoring and evaluation systems of cookstoves projects. These efforts have been supported primarily by the FAO, by the German technical assistance agency GTZ, and by the British charity ITDG.[137] The German appropriate technology agency, GATE, now collaborates with ITDG in publication of the periodical Boiling Point, and the two agencies also cooperate on activities such as seminars for stove project managers and extension workers. The FAO has published a set of guidelines for the design and implementation of stove projects.[138] GTZ and ITDG are also collaborating on the development of a monitoring and evaluation system, published in draft form in 1991.[139] These are all positive developments, and suggest that this field is moving in the right direction in many ways.[140]

At a more fundamental level, insofar as energy conservation is concerned, there remain problems with precise measurements of change. Many of the studies which were carried out in the past suffered from problems of research design, selection and training of enumerators, and data analysis. Sampling problems have been ubiquitous, and stratification of samples nearly non-existent. Often cross-sectional studies have been used where longitudinal designs would have been more appropriate (though admittedly more costly). In some cases, instrumentation has been inadequate to the task, or instruments have not been properly calibrated and regularly checked for accuracy.

More attention needs to be given to accurate and replicable baseline and follow-up measurements, with emphasis on cost-effective sampling techniques and consumption tracking. Poorly implemented impact assessments and unrealistic claims have done much to undermine the credibility of projects which may in certain respects be performing quite well. More broadly, such weaknesses have undermined the credibility of the entire field of biomass energy conservation. Yet cost-effective methods now exist for improving the validity and reliability of assessments, and these should be more widely disseminated. Most of these techniques are not complex, and can be implemented by most organizations currently involved in dissemination of stoves.

137 Intermediate Technology Development Group.

138 See Joseph, 1990.

139 See Crewe, 1991; see also Karekezi, 1990.

140 Although it may be too late in cases where donors have "given up" and shifted their attention to other topics.

E. Summary of FWD Report

The Nairobi-based Foundation for Woodstove Dissemination (FWD) received a subcontract from the World Resources Institute as one component of the present study on Biomass Energy Conservation in sub-Saharan Africa. FWD's task was to review its extensive library of publications and project documents pertaining to this topic, and to prepare an annotated bibliography summarizing and analyzing the contents of these reports. Also, FWD was to prepare a report synthesizing the experience reflected in this literature, as well as its own institutional activity in the field of biomass energy.

The full FWD report is available separately from WRI. The following section highlights some key aspects of the FWD study, and its findings are discussed in the final section of the present study.

The first document prepared by FWD is an annotated bibliography, which summarizes more than 50 documents on the topic of biomass energy; some of these are general, while others deal specifically with activities undertaken in sub-Saharan Africa. The report also includes a listing of 33 documents available from the ICRAF library, and a computer listing of more than 200 documents.

FWD has also prepared a paper discussing the importance of biomass energy in Africa, the experience of past efforts in this field, and prospects for future activities. The report, written by FWD Executive Director Stephen Karekezi, begins by noting that biomass supplies most of the energy for sub-Saharan Africa, yet analysis of this sector is subject to widely varying assumptions and a serious shortage of data.

The report reviews the potential for large-scale biomass energy conversion in Africa, focusing on production of ethanol from agricultural crops, and cogeneration using agricultural or forestry residues as feedstock. While the long-term potential for such technologies may be considerable, at present they play limited roles in sub-Saharan Africa due to a variety of technical, institutional, and economic factors. On-going programs, such as the blending of ethanol with gasoline in Kenya and Zimbabwe, have been successful but are seriously affected by the recent drought, which has greatly reduced ethanol output.

Karekezi finds that the small-scale biomass energy sector has been much more dynamic in Africa, and lists a number of technologies already in use, both traditional and modern. The most significant traditional use of biomass energy is the use of woodfuels for domestic cooking, including the conversion of wood into charcoal for urban consumption. Modern activities have focused to some extent on the biomass supply, including the introduction of agro-forestry, improved methods of conversion of charcoal, the briquetting of agricultural and forestry residues, and the production of biogas. On the demand side, small industries play an important role in the consumption of woodfuel, for example in brickmaking, drying or smoking of crops and fish, and beer brewing. Improved cooking stoves have been introduced as a measure to control woodfuel consumption by households. The most sustained area of intervention, according to FWD, has been in the area of introduction of improved stoves and fuel switching campaigns.

Three phases of stove development are identified:

(1) an early phase, lasting from the late 1950's to the early 1970's, in which social issues were the primary justification of programs;

(2) an intermediate phase, from the early 1970's to the early 1980's, which emphasized the role of improved biomass stoves as a technical solution to the problem of deforestation, as well as a means of reducing dependence on imported petroleum fuels; and

(3) a third phase, beginning in the early 1980's, in which social and economic benefits to users are again prominent, while technical concerns are shifting toward issues of emissions.

Karekezi finds that many of the lessons learned from the less successful activities of the past have now been incorporated into more recent initiatives, bringing corresponding gains in the dissemination

rates experienced in recent years. He also questions the long-term sustainability of current fuel-switching programs, which are based upon the tendency for urban consumers to gradually adopt the use of modern fuels such as kerosene and LPG. Population growth and stagnant economies combine with limited distribution networks and inefficient markets to undermine the viability of this option in much of the African continent. What is more likely to happen, according to Karekezi, is a growing reliance upon biomass fuels, as the modern sector is increasingly hard pressed to cope with even current levels of demand.

The charcoal industry is viewed as particularly problematic given the high energy losses associated with traditional conversion methods. While recent evidence calls into question a direct link between woodfuel use and deforestation, in the case of charcoal Karekezi finds that the link is less controversial: "trees are cut down in large numbers to meet urban charcoal needs."[141]

Karekezi also finds that rural stove programs remain popular with grassroots organizations, despite the widespread view that the collection of wood as a "free good" in rural areas undermines the need for stoves. On the contrary, Karekezi finds evidence that rural stove programs can bring substantial benefits to rural women, a group which has often been bypassed in development planning. Linkages with extension networks and incentives for promoters or producers have proven to be essential components of successful projects. Building on existing resources and properly recognizing the human factor are among the most important lessons to be learned from African experience with improved stoves.

Looking toward the future, Karekezi assesses the prospects for an increased importance of biomass energy in sub-Saharan Africa. Because of the diversity of sources of biomass as well as the numerous means of converting it into useful energy, biomass offers great potential for meeting Africa's future needs. Properly managed, biomass fuels do not contribute to global warming, and offer environmentally sound ways of creating large numbers of jobs. Rather than experimenting with unproven technologies, however, the best strategy for Africa is to concentrate on well understood technologies which can be adopted by the private sector. The public policy and institutional frameworks, which are vital for this to happen, need to be strengthened and act as facilitators, rather than inhibitors of the sustainable development of biomass energy across the continent.

141 Stephen Karekezi, Biomass Energy: an African Perspective - Literature Review. Nairobi, FWD, 1992; p. 25.

F. Conclusions and Recommendations

A summary of what was learned during site visits to Kenya and Niger during March 1992 is presented as an Annex to the present report. This summary has not been extensively edited, and the points it contains have not been organized by topic. Instead, the summary is presented in the context of interviews carried out with organizations, consultants, and others knowledgeable about the topic of biomass energy in each country. This has been done in order to provide a sense of the difference in viewpoints which one finds in discussing this topic, illustrating the complex nature of the issue, and the wide disparity in assumptions with which it is approached.

Kenya and Niger were selected to be visited for the present study, for two major reasons. Both countries have had a history of well regarded project interventions to conserve biomass fuel, notably through the large-scale dissemination of improved household cooking stoves. Also, they represent different geographic and climatic zones, giving the study a diversity of contexts within which to consider the significance of what has been tried, what has succeeded, and what has been learned.

By African standards, Kenya is a relatively prosperous country, and has also been the recipient of a very large volume of donor assistance for many years.[142] The country has enjoyed a comparatively stable political and economic environment, and contains the region's most developed physical infrastructure and a relatively skilled manpower base. As Kenya is smaller than many of its neighbors, trends and developments here should be more easily monitored than elsewhere. Project interventions in Kenya are generally less prone to disruption by the kinds of circumstances which often exist in other countries in the region: civil unrest, power and telecommunications failures, shortages of fuel, lack of foreign exchange, internal travel restrictions, and so forth. For these reasons, it would be expected that many projects would have been implemented, and that considerable data would be available on the nature and severity of the biomass fuel problem, and the effectiveness of measures which have been introduced in response.

Niger presents a somewhat different situation. A landlocked Sahelian country, it has been the focus of intense interest from the development community since the drought of the mid-1970's. A wide range of biomass oriented projects has been carried out in Niger, by agencies too numerous to list. The physical infrastructure of the country is relatively well developed, at least by Sahelian standards, and most sectors of the economy have been recipients of some form of donor assistance in the past. Here too, it had been expected that there would be considerable information available on the nature and extent of the fuelwood problem, as well as the efforts which have been undertaken to counter it.

Yet in both Kenya and Niger, one of the most significant findings is that the information available is limited, often contradictory, and generally insufficient to draw firm conclusions about biomass conditions and trends. On the positive side, it is evident that neither country has yet experienced a biomass energy crisis of the type described at the beginning of this report. However, there are widespread doubts about the sustainability of present resources, despite the fact that supplies continue to be available in both countries.

While many different conservation and substitution projects have indeed been implemented in Kenya, few are still active, and in many cases there is little "institutional memory" of the lessons learned. There has been practically no monitoring of the Kenya Ceramic Jiko since the mid-1980's. Given that the KCJ is widely regarded as the most successful case of a demand modification

142 This may be changing with recent political unrest.

initiative in sub-Saharan Africa, the absence of a plan to monitor its impact over time is a significant omission. The technical facilities which had been responsible for the development and testing of the KCJ during the early and mid-1980's are now largely out of service, key personnel have moved on, and organizations have shifted their priorities elsewhere.

The program has been highly successful in a commercial sense, with production expanding for several years without external support or assistance. Yet analysts disagree as to the environmental effects of the KCJ's dissemination to date. This debate is likely to continue because of the lack of information about the status of biomass fuel supplies and markets in Kenya, and about the trends which affect them. This makes it difficult to judge the importance of trying to revitalize institutional capacity in Kenya to plan and implement demand management strategies. On the one hand, the program has clearly been self-sustaining, but on the other, little effort has been made to document its impact on households and on the environment. The lessons learned from this experience have also not been effectively communicated beyond the East African region: many contemporary stove programs continue to underestimate the importance of the informal sector, and the need to stress commercial viability from the outset rather than as a final "phase" of project design.

In Niger too, the severity of the fuelwood problem remains a topic for speculation. To counter statements that overexploitation is causing severe environmental damage, some analysts suggest that as much as 95% of fuelwood collection is of already dead wood.[143] A variety of interventions to reduce consumption of woodfuel has been implemented since the mid-1980's, and the policy mechanisms of government have been engaged in this effort to a greater extent than in most of sub-Saharan Africa. Yet it remains unclear whether the aggregate consumption of biomass fuel has been modified to a significant extent, and if not, whether a continuation or expansion of present initiatives would have this effect. At present the evidence is contradictory, and based largely upon secondary indicators and anecdotal information, both pro and con.

Exceptions to this dearth of information on trends and impacts are the monitoring of retail charcoal prices in Nairobi, presently done on a voluntary basis by a private consultant, and the monitoring of wood prices in Niamey and other towns in Niger, carried out since 1989 by the Energy II project. Interestingly, in both cases the data show that biomass fuel prices, when adjusted for inflation, have been stable or in slight decline for several years. This should not be taken as evidence that the biomass supply is sustainable under present conditions. There may be several reasons why prices in urban markets would not necessarily indicate a localized pattern of over-exploitation of the resource. Yet this price stability, and the presence of well-stocked woodfuels markets in both countries, tend to contradict long-standing and widely held beliefs about tightening supplies of biomass fuel with serious negative impacts on households.

The sustainability of some of the present initiatives in Niger is uncertain, as for example the current structure of the improved stoves program, or the subsidized fuel switching program. If these programs are discontinued, for budgetary or other reasons, no one knows what implications a reversion to traditional cooking patterns would hold for biomass fuel demand, nor what the effect might be on the natural resource base. This depends very much on the degree to which these demand modification initiatives have been effective in suppressing demand for woodfuels; since at present this is unknown, it is difficult to assess whether ending these programs would result in a surge in consumption, and whether this in turn would have negative consequences for the environment.

143 Why the wood is dead, however, and what this implies for the longer term, are important questions. This 1984-85 drought could be responsible for this supply of "fossil wood", but no one is sure how much of the present supply is from this source and how much more remains, and, most importantly, what will happen when it is finally exhausted.

Taking the programs discussed in this report in a broader perspective, it is apparent that to a certain extent they have all suffered from a common dilemma. Measuring changes in biomass fuel consumption is an inherently difficult task, and attributing changes to particular events or interventions is especially problematic. Studying the linkage between consumption patterns and the production and harvesting of biomass fuel is even more complex, and in fact has seldom been attempted in a systematic manner.

To the extent that programs have been justified on the grounds of helping to conserve the biomass resource base, the inability to meaningfully assess results has, over a period of several years, begun to erode the credibility of the programs. This erosion has been accompanied by a growing feeling that (a) biomass energy consumption is not on the whole a significant problem in Africa, and (b) demand side interventions cannot do much to change rates of biomass production and consumption.

Some of the organizations working in this field have recognized their dilemma, and have responded in different ways. In some cases, the target population has been redefined, for example to emphasize the institutional sector, which is more easily monitored and which presumably has a greater financial motivation to conserve. In other cases, the benefits to households have been redefined, side-stepping the problems cited, by stressing non-energy issues such as health, job creation, or the status of women. And some organizations have simply ignored the growing skepticism about the conservation benefits of improved stoves, or react by pointing out that their detractors also lack empirical support for their arguments.

Several of the organizations contacted during this course of this study - NGOs and donors - spoke of greater competition for resources and increasing pressure to cut budgets. Under such conditions, which seem likely to be increasingly common in sub-Saharan Africa, it should be expected that the criteria for appraising and selecting project proposals will become more stringent. Technical interventions which cannot clearly demonstrate results, or whose benefits are seen to have been redefined as their lack of impact became apparent, are going to find it increasingly difficult to secure support in the future.

And yet, this study has suggested that the problem may not be so much one of a lack of impact, as in the failure to adequately measure it. Furthermore, much time and many resources have been dissipated through repeating similar mistakes in one project after another, in one country after another. A great deal has been learned, for example on techniques for measuring household fuel consumption, or on commercializing technologies in ways that maximize chances for long-term sustainability. These lessons have not been widely enough disseminated, and it is apparent that the process of "re-inventing the wheel" continues to the present.

Fortunately, there are some signs of positive movement too. As mentioned earlier in this report, several initiatives have been taken with the intention of harmonizing monitoring and evaluation standards and procedures. Testing standards, which were established during the early 1980's under the leadership of VITA, are now widely recognized (although variations can be found from place to place, and interpretation of results sometimes is more an art than a science). A household energy network (HEDON) is being organized by several European donor agencies and university researchers, and this could also prove to be an important step in the right direction.

Based upon the findings of the present study, several areas can be identified as priority topics for any further work in this area:

1. Future demand side interventions should be based upon a reasonably detailed analysis of locally prevailing biomass fuel supply and marketing, complemented by an analysis of demand, sufficiently detailed to devise criteria for monitoring and evaluation. Without a sound understanding of where supplies come from and how they are consumed, it will be extremely difficult to design appropriate interventions, and to evaluate their usefulness.

Among other things, this means that biomass inventories must be more

comprehensive than those typically available from commercial forestry inventories. Properly designed market studies and household energy surveys are also important. Prices for biomass fuels will not necessarily remain stable, particularly if rates of agricultural clearing begin to decline. It is important to understand the dynamic nature of this market, and to constantly monitor developments which could impact issues such as land use, energy pricing, and other factors.

2. Facilities for technical support must be provided, preferably in the form of in-country or regionally-based institutes with a solid research and development program and the ability to deliver effective technical assistance on a long-term basis. Of the facilities built during the past ten years, few remain in operation, and overall technical capacity appears to be in decline throughout sub-Saharan Africa.

Some observers may have assumed that technical problems have largely been solved, or that existing facilities are available to address them. On the contrary, many technical problems remain, and the capacity to carry out competent research and development in this area is surprisingly limited. Regionally based institutes should also be able to provide support with techniques for field-testing, for optimizing designs for local conditions, and for maintaining quality control standards. In addition to such "hardware" issues, these institutes should also be able to provide expertise in "software" topics such as the organization of monitoring and evaluation systems, commercialization and dissemination strategies, and so forth.

3. When new interventions are proposed, commercial viability and sustainability criteria should be specifically addressed in the project design and appraisal process. The long-term sustainability of production and marketing should be a priority from the outset, rather than being raised at later stages when other approaches have failed, or when costs begin to rise beyond control, or when donor financing expires. Many projects have tried to exercise too much control over producers, and as a result the latter have often lost interest and reverted to production of traditional items they find more profitable to sell. A better understanding of the process of commercialization of technology is required if this pattern is to be changed for the better.

4. Biomass fuel as an energy source should become a more visible topic in national energy planning and forecasting functions; at present, forestry and agriculture services deal with biomass, while energy and finance ministries or departments focus on commercial energy (fossil fuels and electricity). Energy pricing and fuel switching strategies require better information than is presently available in countries where biomass energy remains effectively outside the system for gathering information about supplies, markets, and trends. Forestry services don't know enough about energy demand and marketing, and energy planners don't know enough about how biomass differs from other energy sources. Constructive ways must be found of bridging these gaps, since in much of sub - Saharan Africa biomass or "non-commercial" energy supplies by far the largest share of national consumption.

5. Recently a number of northern European donor agencies and researchers active in the household energy field began to organize a network to discuss issues of common interest.[144] It appears that part of the stimulus for this initiative has been concern over the credibility of improved stoves, as well as the reorganization of the ESMAP program, which is expected to result in a sharp drop in support for household energy programs from the World Bank. This may present an opportunity to review some issues which have been identified in this study, and to suggest an agenda for addressing them in future projects in this sector.

USAID has not been active in the area of household energy in sub-Saharan Africa for several years and has not been involved in the organizing of the HEDON network. However, USAID has a strong commitment to natural resource management, an understanding of the importance of both macro policies and of local participation in natural resource management, and finally, considerable experience in private sector development. All of these elements have proven to be important determinants of successful programs to conserve biomass fuel, and for this reason USAID should consider how it might participate in the household energy network.

144 Household Energy Development Organisations Network: HEDON, organized by GTZ andd the University of Lund in 1991.

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Annex - Site Visits and Interviews

The author travelled to Kenya, Cote d'Ivoire, and Niger from March 1 to April 3, 1992. The purpose of this travel was to visit donor agencies, NGOs, and others knowledgeable about the impact of projects intended to conserve biomass fuel, and to observe a sample of projects. A brief visit to the Frankfurt area to meet with the German technical assistance agency, GTZ, and the German appropriate technology agency, GATE, was included in the beginning of the trip. Several similar stops planned for Britain and France were cancelled as a result of scheduling problems. In Nairobi the author reviewed the reports prepared by the Foundation for Woodstove Dissemination (FWD), under a sub-contract from WRI, and recommended additional topics and material to be incorporated into the final report (available separately from World Resources Institute).

The notes which follow are based upon discussions with a variety of organizations and observers familiar with efforts to introduce energy-saving technologies in sub-Saharan Africa. Where contradictory statements appear, this simply reflects the differences between observers and the current lack of consensus in this field. The material has been presented in this manner in order to give a sense of the contrasts one finds between different organizations working in this area, and of the different approaches taken to interventions to conserve biomass. The opinions expressed are not necessarily those of the author. By the same token, these should not necessarily be understood as reflecting the official position of the agencies identified in the notes. The comments which follow reflect the opinions of a wide range of individuals, but the author takes responsibility for any inaccuracies in the way they have been presented here.

Germany

GTZ and GATE -- Contacts: Dr. Agnes Klingshirn, Jurgen Usinger

These agencies have been long-time participants in household energy activities, including not only improved stoves but also solar cookers, biogas digesters, etc. GTZ is concerned with an apparent withdrawal of World Bank support from the household energy programs of ESMAP, and together with several other agencies in Scandinavia and the Netherlands, is trying to organize a broad-based donor response. This could be in the form of efforts to press the Bank to reverse its recent decisions concerning ESMAP, or alternatively, to try to organize new activities which could help to take up the slack left by the departure of ESMAP from the household energy scene.

The next meeting of the new group, which is known as the Household Energy Development Organizations Network, or HEDON, is scheduled for Eschborn in June 1992. GTZ is hoping to maintain its present level of support for projects in the biomass energy sector, though it is facing a series of realignments of budgetary priorities partially as a consequence of the German reunification process.

GTZ's view is that many donors have exhibited a tendency toward "fads" in development, and have lost interest in such activities as household energy / renewable energy once it became apparent that these were difficult fields in which to show accomplishments quickly. GTZ views its experience in this sector as a positive one, and feels this has strengthened its ability to work with rural and low-income groups. Improved stoves have facilitated access to such groups by providing an entry point for other extension messages, for example on unrelated topics (family planning) as well as related topics (nutrition).

KENYA

USAID -- A visit was made to the USAID Kenya office; the environmental officer at REDSO was out of the country at the time. Contact persons at USAID Kenya were Victor Masbayi, Jim Dunn, and Stafford Baker.

At present USAID has little involvement in the energy or biomass sectors in Kenya. A PVO/co-financing project includes a grants mechanism specifically available for biodiversity activities, but there has been

little response. The few proposals received have been too research - oriented and did not qualify for USAID support. With the present round of budget cuts (25% was mentioned) it is likely that this program will be ended next year. No one presently in the Mission has information on the current status of the Kenya Ceramic Jiko, developed in part with USAID funding during the early 1980's. There is no longer an energy advisor in the regional office (REDSO/ESA). Household energy is not one of the priority areas for the Kenya Mission, and in recent years this topic has not been followed by its personnel.

IDRC -- The Canadian International Research Development Centre. Contacts: Hartmut Krugmann, Sylvain Dufour.

IDRC has not been active in the biomass energy sector for several years. Krugmann feels that there is still a need for work in this area, though here was too much naivete in the early stages of most programs. Traditional stoves were better than anyone imagined, and more difficult to displace. The sustainability of improvements in many cases is doubtful. Donors face constraints in delivering assistance - their time horizons are too short, for one thing. These projects should be seen as elements of a broader approach. This requires a much more flexible approach to the whole issue of natural resources management, especially in fragile areas. But most donor activities need to show positive results in short order, and to move large amounts of money, larger than are appropriate for many biomass energy projects.

Natural resource management requires more decentralized approaches to management. Some examples where this is taking place are Zimbabwe, Uganda, Mozambique, and Tanzania. This has implications too for biomass energy: more local control over resources, for example. The structural adjustment programs (SAPs) could result in greater use of traditional fuels and stoves, at least in the short term. The KCJ appears to be successful. It has sustained itself, and very likely is saving fuel and money for its users. The question is, what would have happened if this stove had not been introduced? This is hard to assess, but the fact of its continued sustainability is very positive.

Recent evidence from Rwanda illustrates that farmers will respond positively to incentives to plant trees, under the right circumstances. But it requires secure access to the natural resource plus a long-term interest in investing in and managing the resource. The government cannot control this in a centralized way; the government can ensure that the policy context is favorable but the activity must be locally run. One problem in Kenya is that the history is of fairly centralized control.

In Rwanda, rural brick-making enterprises are being helped to improve the efficiency of kilns, which improves the quality and value of the bricks, and reduces loss rates. Production loss rates have dropped dramatically (from 40% to 0.2%) and the energy consumption per brick has also dropped. Previously, around 1.66 cubic meters of wood were needed per 1,000 bricks; now only half this amount of fuel is used. At the same time, farmers, knowing they will have a market selling wood to these brick enterprises, are planting trees as an energy crop.

GTZ Special Energy Programme -- Contacts: Noel Chavangi, Musa Njoka. Discussion also included Teresia Mudhui, Ministry of Agriculture extension service.

Most assessment of the savings from improved stoves are based on womens recollections of fuel use or expenditure. GTZ does regular monitoring and impact assessment, but uses this technique primarily. Improved stoves are reaching as many as 10% of households in some districts, and 80,000 have been installed since 1986. However, some womens' groups have become politicized and are no longer effective in promoting use of stoves, or have ceased this activity in favor of more political kinds of work.

The Agriculture Ministry home economics staff are heavily involved in dissemination of improved stoves, along with community health workers, NGOs, church groups, and other agencies such as ITDG. The improved stove is seen as a useful entry point into the

rural household for a variety of extension messages, not just about stoves, but also on issues such as health or nutrition, even family planning. Where fuel is perceived as more scarce, adoption of the stove is more rapid. The Ministry of Energy is financing the training of field staff in areas where GTZ is not operating.

The cleanliness of the stove is seen as a major advantage, along with reduction of smoke. A study in Embu and Muranga showed a link between the availability of wood, the number and quality of meals cooked, and the health of children.

Portable Maendeleo stoves are now being sold in towns, though this is in the early stages. The Kuni Mbili ("two sticks") stove promoted by Kenya Energy and Environmental Non-Governmental Organisations (KENGO) has had little impact. KENGO appears to be concentrating on other work, and its regional centers are more involved in information activities than stove dissemination.

Land clearing is steadily reducing the access to fuelwood in Kenya. In western Kenya people are now using agricultural residues, leaving less to be used as fertilizers for crops. Agroforestry projects have had to try to find species of trees which take up little space, so that they can fit into small "shambas" (plots) as farmers resist replacing their cropped area with trees, especially where land is scarce.

The production figures for Maendeleo stoves are not completely reliable, as there has been some double counting by producers and extension workers. Generally the level of record keeping has been poor, and it has been difficult to ascertain exactly how many have been disseminated. On the other hand, GTZ is implementing a regular monitoring and evaluation system for its own work, and this is producing regular reports documenting what is happening, at least for the GTZ supported producers.

Bellerive Foundation -- Contacts: Chris Davey, Tom Blomley, Hudson Isagi, Tony Potterton.

Bellerive feels that the direct impact of stoves on wood supplies is minimal. The issue must be approached from a broader resource utilization base. Their focus on institutions is because there are fewer users to reach, and they pay for their fuel, most of which is logged. Bellerive wants to develop better management of firewood supply systems, including where and how the wood is collected, how it is processed (splitting, for example, to promote faster drying) etc. Results are promising. To date roughly 500 institutions out of 2,500 identified in Kenya have installed stoves. Their domestic (household) stove program was dropped in 1987 because of poor results. Rural households seldom buy wood, and have little incentive to invest in a stove which saves fuel, although in some parts of the country this is less true.

Management of fuelwood is seen to be as important as the "gadget" which burns it. The skill of the user is critical. In institutions this is particularly true, as hired cooks have no direct interest in conserving fuel for their employer. Bellerive has developed educational materials for the primary school curriculum, "Cooking to conserve." They are also looking at other ways of getting conservation messages out to the public: radio, extension services, etc. On the policy side, Bellerive feels that there is a serious problem needing to be addressed. The price of modern fuels is being held unrealistically low, and the sustainability of this subsidy is doubtful. If/when an economic "crunch" comes and prices rise or supplies are disrupted, there could well be a major shift back to the use of biomass fuels. By the same token, the market prices for biomass fuels are too low, and do not reflect the economic costs of production.

Along with the installation of institutional stoves in schools, Bellerive is introducing a supply program, in which schools plant trees to provide some of their own fuel. Planting solely for fuelwood has seldom worked anywhere, and they do not expect this to be a breakthrough here. However, they are trying to develop a multi-purpose package which can interest schools. But they have generally found it easier to introduce stoves than to introduce the idea of growing trees for fuelwood. They are working on tree management, and intercropping with food

crops such as maize or beans, to reduce the weeding necessary, which no one wants to bother doing for trees.

Schools are the biggest institutional network in Kenya, Bellerive views this is a very important niche for introducing fuel saving techniques. There is said to be an increasing perception that fuelwood is costly, at least among institutions, which are under budgetary pressure and trying to squeeze the most out of their resources. The fuelwood harvested for the institutional users is far more likely mined than in the case of household users, and this is another reason for focusing on the larger-scale consumers, as they often buy truckloads of fuelwood at a time.

Some government policies in this area have been counter-productive. The ban on cutting indigenous trees, for example, has discouraged farmers from planting these species, since they don't benefit from trees they are forbidden to use. In the gazetted forests, the threat is not agricultural clearing as it is in the other areas. Rather, the problem is the existence of logging and charcoal production, even in supposedly controlled areas, and this is often followed by grazing, burning, and eventually planting. There have been armed confrontations between charcoal producers in gazetted forests and forestry guards. In general there is little sentiment for issues such as biodiversity, conservation, and so on.

Migration and refugee movements are another important factor in the use of biomass fuels. In some areas, there were traditional techniques for fire management which could conserve fuel in times of scarcity. However, much of the population has shifted over time to new areas, and a great deal of this traditional knowledge has been lost. Also, refugees and migrants often are forced to produce charcoal as their other options are very limited, and in any case, they don't expect to remain long enough to face the consequences of any environmental problems they create.

Keyo Womens Group, Kisumu District -- Contacts: Rose Ochuka, Stella Nyagol

This group of women potters (28 members) has been involved in production of stoves since 1984, producing KCJ liners and Maendeleo stove liners. At present they produce 1,000 to 1,200 Maendeleo stoves per month, and 500 KCJ liners. They are feeling pressure from competition, particularly informal sector artisans in Kisumu, who they feel are selling at "throw-away prices." Their best customer has been the Ministry of Agriculture, which is buying stove liners for their extension program. They realize that this makes them dependent and hope that if the MoA program phases out, other womens groups installing stoves will pick up the slack and buy their liners. They don't want to revert to making pots as they did before 1984, since these are less profitable: they have to pay to transport them to market in Kisumu, and then pay a fee for use of the market, as well as transport to return unsold pots back to Keyo.

Another womens group producing stove liners near Kisumu is the Mawembe Womens Group, in production since 1990. Production is still at a low level, roughly 70 per month, and they are experiencing problems with losses in firing the liners. In the meantime they continue to produce pots, as they are more familiar with this technology and their loss rates are much lower. This illustrates the continuing need for technical assistance, as up to now they have not been able to get help in reducing their loss rates. ITDG is hoping to have a technician available later this year to work on such issues. In the meantime, I suggested they shield their pit firing with broken pots, as it appears that windy conditions are the prime factor in cracking while firing. In the long term they would like to have a kiln, but cannot afford one at present levels of production. Keyo is the only group in the Kisumu with a kiln (a half-finished unit begun under an ATI project in 1986 which was never completed; it functions essentially as a shielded pit and works very well as such); six other groups all use traditional pit firing techniques.

According to the womens groups, the improved stoves are popular with rural women, for several reasons. They feel it cooks faster, and can cook effectively using even twigs which normally would not provide

enough heat in an open fire. The improved stove is also perceived to enhance the status of the kitchen, as it is cleaner, has less smoke, and provides a platform on which to place utensils. Neighbors are said to be favorably impressed by the installation of a stove. On the other hand, an evaluation of the GTZ rural stove project cited some women's feeling that the use of the traditional fire maintains a cultural connection with their ancestors, that it is a tradition which has been handed down and which not everyone is willing to give up.

The potters producing the stove are pleased with the income it provides. They feel it gives some independence from their husbands' income, and they are better able to afford the school fees and other household expenses. In some cases they can even afford to hire extra labor when they need to work on their plots.

ITDG -- Contact: Vivienne Abbott

ITDG is shifting its emphasis from the energy savings of stoves to the benefits to women, in part because of the difficulty of proving a link to deforestation. Their approach is meant to be more people-oriented, focused on two groups of beneficiaries: the womens groups who produce the stoves, and the households who use them. The extension programs have picked up the stove as an effective device for reaching rural households, and are very pleased with the success they have had in this regard. Women who appreciate the stove are presumably more receptive to hearing other extension messages, and the stove is seen as a kind of stepping stone for a variety of extension programs.

Demand for stoves seems to be very high, but there are worries about marketing. The former GTZ approach involved a subsidy in the form of covering transport costs, and this is to be phased out soon, with unknown effects. The former approach was thought to not be sustainable and this is why it will be changed.

The production target for western Kenya is now set at 20,000 units. Stove life-span is thought to be longer than previously expected. The first 30 were installed in 1986, and 28 were still functioning by 1990. However there is a fair degree of training and follow-up required for best use of the stove.

Another reason for the switch to rural stoves, which goes against the common wisdom these days, is that their assessment of the Maendeleo is that it is achieving better fuel savings in real life than was indicated in laboratory tests. In contrast, they feel that the KCJ has not shown significant savings; reportedly some of the findings of the 1986 field study were never released, as they showed poor performance in the sampled households.

Along with introduction of the stove ITDG is emphasizing the overall aspects of fuel management: more attention to cutting and drying the wood, and to properly tending the fire. The awareness of users needs to be raised on these topics to get the most out of the installation of an improved stove. They also would like to produce a larger model Maendeleo stove for use in restaurants and other commercial users of wood stoves.

Commonwealth Science Council -- Contact: Peter de Groot

The "problem" with biomass energy probably has more to do with its production than its consumption. There is a wide range of under-utilized crops, such as cassava, which could be exploited but until now little has been done in this regard. Improved stoves seem to have made a good showing in Nairobi, but outside of the capital area there is little evidence of any impact. Conservation of biomass energy might better be focused on improved utilization of waste products - there is too much emphasis on energy, too much attention has been given to stoves, although the efforts to introduce institutional stoves probably make more sense.

The situation must be analyzed according to specific locations, since conditions vary so widely. Land issues, adjudication, fencing, and many others influence what can be done or will work in any given place. There has also been too much focus on forests, while neglecting the significance of grasslands. These probably contain more soil carbon, for example.

Consultant: Mike Bess

There is no "charcoal problem" in Kenya, at least not as it is usually understood. In real terms, adjusted for inflation, charcoal is half the price of 15 years ago. A study carried out for the Canadian International Development Agency (CIDA) looked at the issues of land use changes, charcoal production, etc. in 32 districts of Kenya. The conclusions were that roughly 40% of Nairobi's charcoal supply is provided on a sustainable basis, for example black wattle production, and from small-holders supplementing their income from crops. Another 40% is from newly cleared land; the charcoal they sell might make it more profitable to clear, but they would have cleared even if charcoal were not being produced as a by-product. The remaining 20% is "mined" but this is seasonal, and fairly randomly scattered, localized. In drought times there is a surplus. Wage rates and land use account for most of the activity, and changes in the wood fuels market shouldn't be expected unless these factors can be modified.

The issue of fuel savings of the KCJ is controversial. The 1986 study was seriously flawed and the results are not to be taken as a true indication of the KCJ's performance at the household level. In fact, publication of the report was probably a mistake.

Kenya Indigenous Forest Conservation Project (KIFCON) -- Contacts: Peter Wass, D.K. Mbengei

This is a 3 year, 4.8 million pound sterling Overseas Development Agency (ODA) project to introduce sustainable forest management regimes in three indigenous forest areas of Kenya: one near Mt. Kenya, one near Kakamega in the west, and one near Malindi on the north coast. The plan is to experiment with innovative approaches to forest conservation, emphasizing biodiversity, in remaining closed canopy forest areas. The three pilot zones will be surrounded by buffer zones, into which forest dwellers will be resettled. They will be permitted access on a controlled basis to the protected forest areas, for hunting, collection of products such as honey, and so forth. There is now a census of forest dwellers taking place. Their numbers are not yet known, but many are thought to be Dorobo, of the Okiek clan. They formerly migrated through the forest as far north as Pokot and Mt. Elgon on the Uganda border. Now these routes are cut off, and they have no real choice but to cooperate with the government to try to establish a stable and sustainable mode of exploitation of the remaining closed canopy forest. They will be given 99 year leases on 5 acre plots per family.

Indigenous logging has been banned since 1986. KIFCON is now doing an inventory in the remaining closed canopy areas. The present figures are that 2.2 million ha. remain, of which 1.7 million are in gazetted forest, and 0.5 million non-gazetted. They estimate 0.25 million has been lost to agricultural clearing since Independence.

African Centre for Technology Studies -- Contact: Calestous Juma

Most of the biomass energy programs have been based on a technical "fix" approach, but have generally failed to adequately monitor the results. Some projects claim to be successful, but there is not even enough information with which to assess whether increased biomass consumption could be taking place, instead of reducing it. Perhaps the presence of a popular charcoal stove has provided an incentive for consumers to switch to the use of charcoal, a kind of negative fuel switching program. There is simply too much "noise" in the system to answer such questions at present: there have been no studies up to now.

Price controls on charcoal may also be having the effect of increasing the amount supplied, in order to produce the same income for those in the charcoal trade. The overall economic environment is an important factor in what happens in biomass energy markets. While the technical innovation - the improved stove - has been the focus in most cases, there is actually no evidence that it has reduced biomass consumption. The KCJ has mostly been adopted by upper income households who are not sensitive to charcoal consumption, but buy it for other reasons (status, etc.) and may not care whether it is saving or not.

Some other initiatives have held interest temporarily, then been dropped over time. For example, residue stoves, which would burn coffee husks, were at one time considered a useful innovation but now there is almost nothing going on in this regard. There is no funding available, and no follow-up of what was done previously.

The technology drove the programming, even for donors who never really believed that energy consumption was a significant source of deforestation. It was "a solution looking for a problem." After the 1981 UN conference renewable energy was a popular topic which became institutionalized, and the issue was defined by images rather than by a close examination of the real factors at work.

Structural adjustment programs have been a significant factor, driving up coffee production to meet export targets has lead to large-scale clearing of forested areas. Government policy in this and other areas is a major determinant of what happens. In Kenya there are serious issues of the constitutional basis of environmental conservation, of private sovereignty over land use. Many of the "gazetted forests" now exist only on paper. An amendment has been proposed to the constitution to provide a better basis for environmental management. The present awareness of problems outstrips the ability to do anything about them.

For example, agroforestry is often viewed as the solution, yet it is illegal to intercrop in coffee growing areas, which have been officially gazetted. It is illegal to uproot coffee plants without prior governmental approval, also in the case of tea.

Anti-desertification programs have failed, and this requires a change in the basic perception of the biomass issue. What is needed is not reduction of consumption, but increase in production, in biomass cover on the land. On the consumption side, there are many possible responses to scarcity; farmers may plant hedges around their houses or fields, etc. Also, the time needed to collect firewood is often cited as a constraint in rural areas, yet this ignores the social aspects of the wood collecting groups. This illustrates that technical solutions may overlook the presence of intangible factors difficult to quantify.

The justification of stoves projects sometimes assumed that time savings will be used in some "productive" fashion; in reality, it may be instead used for non-economic purposes, such as attending funerals, a major social function in Kenya. These days people feel too busy to attend as many funerals as they once did; they are not only "social," but also are important occasions for local decision making. Many rural Kenyans would attend more funerals given additional time, rather than planting more crops or other economic activities.

ACTS would like to see more commitment to on-going monitoring of projects, supported by a longer time frame among donors. Some of the Scandinavians are moving in this direction. This is crucial because at present there is so little information on which to evaluate what has happened. Long-term environmental monitoring is almost non-existent in Kenya, and local NGOs mostly have a poor record of monitoring projects or evaluating their work. As an entrepreneurship project, the KCJ has been highly successful; as an energy project, its impact is less clear.

KENGO -- Contacts: Achoka Aworry, Brazil Musomba

KENGO has little involvement presently in this area, although it is becoming active in the photovoltaic area due to renewed donor interest. KENGO hosted a solar energy workshop during this visit. KENGO has not been monitoring stoves in general, and has little information to provide on recent developments.

Note: during my visit, several key KENGO staff were out of the country, including the head of the Regional Wood Energy Program for Africa, and others were busy with a solar workshop being held at that time. The KENGO office in Kisumu was closed during my visit, due to the riots which had taken place that week in western Kenya.

COTE D'IVOIRE

USAID -- The REDSO West/Central Africa office in Abidjan was visited, contact person: Bob Hanchett.

At present there are no dedicated AID projects in the biomass energy area, though there are a few which are components of other projects, for example a plantation program in Cape Verde. The REDSO natural resources economist has done a study in Niger on biomass but the results are not yet available. Most of A.I.D.'s work now is in the NRMS area, especially on-farm interventions. In Senegal there is a remote sensing biomass inventory, and also in Gambia with GTZ financing for aerial photos. Ghana has a surplus of energy but there is little promotion of electricity as yet. ODA is heavily involved in forestry in Ghana. AID has only been involved on a bilateral basis in Cote d'Ivoire since 1990, and at present are only involved in the health sector.

What is lacking in general in west Africa is any focus on the low-tech use of solar energy, for example along the lines of the Israeli solar ponds. Oil prices in Abidjan are the highest in the world, and in Lagos the lowest. This had caused some serious regional problems because of the gross disparities that exist in energy prices.

There has been heavy deforestation in Cote d'Ivoire, and now there is a planting program for teak (monoculture). There is still little concept of biodiversity. French companies have logged in forest areas, and settlers have moved in behind them using the logging roads and trails. Some of the present logging schemes are only viable with soft loans from the Asian Development Bank (ADB). Japan is paying for a NEAP in Cote d'Ivoire, though perhaps it is too late.

The pattern of biomass energy exploitation in the region is not hard to detect. The "urban halo" around Bamako is one example, though Lubumbashi is the worst case. Charcoal production moves gradually further away from the cities, in strip developments along the edges of roads. Many of these are associated with clearing for crops, however, and the money produced from sale of charcoal helps tide the farmer over the first year before he has a crop to sell.

Cote d'Ivoire has off-shore natural gas, which they want to use to power their refinery, and also to generate electricity, replacing imports from Ghana as well as imported oil. If they still have a surplus beyond this they could sell to Niger. Yet there is no woodfuel shortage in Cote d'Ivoire. What is needed is to encourage sustainable use of biomass instead of shifting to the use of imported fossil fuels.

In markets around Abidjan there are improved charcoal stoves available, which sell for about 50% more than traditional Malgache stoves. There wasn't time to trace the history of this development, beyond learning that no one at AID or ADB was aware of it or had any idea who had introduced the stoves.

NIGER

GTZ Special Energy Programme -- Contacts: Melanie Djedje, Ute Fischer

There is a Canadian project looking at development of coal resources in the Agadez area. The coal would need to be cleaned before it could be suitable for household use, and the economics are not yet sure. The World Bank Energy II project has been running since 1989; the GTZ stoves program is attached to the Energy II Demand Office. The GTZ component works with both urban and rural woodstoves. Other offices in the Energy II program deal with kerosene stoves and LPG promotion campaign, the latter financed by the EC.

Some integrated rural development projects have dropped improved stoves from their portfolios. A Caritas project had been giving free stoves, but abandoned the stoves work due to poor response. There had also been a unit for coordinating household energy but this too has been allowed to lapse. At present there is little coordination between donors, of which there are perhaps too many in Niger, all with their own priorities etc.

At the end of the 1st phase of improved stoves work, a survey was done which found that 70% of the stoves were not being used properly, which was reducing the savings possible from the stove. In rural areas, the first priority for cooking is protection from the wind, some areas are extremely windy, and

this makes cooking both very difficult and very energy inefficient. Women like the cooking speed of the improved stove in addition to the fact that it shelters the fire from wind. However, they can't provide accurate estimates of how much fuel they use. They often claim savings of 50% but this is not realistic in many cases.

In doing household studies it has been hard to match income levels and other important factors between users of improved stoves and non-users, due to sampling problems. In Niamey, 25% to 30% of households have an improved stove; in other towns the level ranges from 15% to 40%. The rural program has worked in 160 to 170 villages, in which 30% to 100% now have the stove. Most households would have two stoves, one for cooking the staple, and one for sauce. Stoves comes in various sizes, and the pot must be correctly matched to the stove. Most households use a round bottom pot, locally cast from scrap aluminum.

In the second phase of the project the level of assistance to producers has been reduced. This was intended to help boost the sustainability of production. However, since last year there has been a shortage of scrap metal, and stove producers find it hard to compete with other uses of the available scrap. Stove prices have been fixed since 1985. One problem is that artisans seldom have any working capital, and production is sometimes controlled by merchants, who place orders and may finance the materials needed.

A survey in February found production of 15,000 Malgache stoves, compared to 760 improved ("Mai Sauki") stoves. The Malgache costs 200 CFA to 250 CFA, while the Mai Sauki costs 350 CFA to 750 CFA.

A new approach is going to be tried in Niamey, to shift production toward the formal sector, since the artisans are not coping with the present problems. Sheet metal will be imported from Czechoslovakia by the World Bank Energy II project. This is recognized to pose problems of sustainability too, but unless something is done quickly to rekindle production of the Mai Sauki, there is a risk the program will fail. Nigerian merchants have been buying up the local supply of scrap metal.

In other respects things have gone well. The quality of production is good: in Niamey over 90% of stoves are of acceptable quality. In other towns this is not quite as satisfactory. The average Malgache stove lasts roughly 6 months, while the Mai Sauki can last from 3 to 5 years. But the village women don't think in terms of a payback period, they just see the higher price of the improved stove. The Malgache stove can be made of inferior quality material compared to the Mai Sauki.

Production of the Mai Sauki had peaked at around 1,000 to 1,100 per month, and has now dropped to 500 to 700 units. Yet even with the shortage the price has not gone up. In Phase I, the project made a strong publicity campaign teaching people the correct price for each size of stove; now they are stuck with this fixed price, and people refuse to pay more even though conditions have changed. In Phase II the project has tried to liberalize prices, but without success so far. One approach which will be tried is to shift production from the artisanal sector to the formal sector. The latter will make a better product, including a coat of paint, which may help consumers perceive it as a product commanding a higher price.

The project will aim at a different market niche. Energy II will finance the workshop producing the stoves, as it now finances the production of the kerosene stove. The workshop will also take care of marketing the stove in areas outside the Katako market where it is now produced and sold by artisans. The Mai Sauki has not spread to secondary markets, and this has hindered its availability in some neighborhoods. The project had established a number of retail outlets scattered around Niamey, each with a sign advertising the stove, but now, with so few being produced, this has been given up and the signs were recollected by the project.

Low quality sheet metal from Nigeria is still available, but too thin for the Mai Sauki. In Mali the improved stove is made from new sheet metal, and the stove is less costly than in Niger, so the project hopes they can also switch to use of new metal.

GTZ's objective is to try to reduce the consumption of woodfuel by 5%, through improved stoves and substitution of kerosene or LPG for wood. Two years elapsed between the 1st and 2nd phases of the project, and there has not been an assessment since the end of the first phase.

Little or no charcoal is used in cooking, and this fuel has not appeared to be significant in Niger up to now. The economic cost of wood, however, is much higher than the market prices. Only 10% of wood presently entering the market comes from controlled sources. But people will resist paying higher prices. This is going to complicate efforts to put woodfuel production on a more rational basis, but somehow it must be done. The Energy II Supply office is in charge of this aspect of the program.

The project faces budget limits, and has made some use of local consultants. In some rural areas, other organizations have adopted the rural stove promoted by GTZ, the "Albarka," and some have also adopted the GTZ monitoring and evaluation system. The World Bank has tried to get the project to subsidize the price of stoves, but this has been refused. It has proven difficult to organize artisans and this has slowed the production and sales of the improved stove. Naturally, there is pressure to show results, and this is one of the reasons for the new strategy to shift the Mai Sauki to production in a formal sector workshop.

In rural areas the improved stoves are installed by extensionists trained by the project. Local women are expected to pay something for the stove, possibly 100 CFA, or an in-kind payment such as offering refreshments. Mostly the extensionists are linked to the local environmental office, and also carry out regular follow-up visits. There has been the usual variety of problems, including high turnover of extension staff and counterparts. The European Development Volunteer assigned to the stoves project has had three counterparts in two years. The Energy II project works only with urban stoves, and GTZ handles the rural component.

Women generally don't think in terms of a "payback period" - this is to abstract. Cash in hand often determines the purchase decision, which is not viewed as an "investment." Wood is perceived as scarce and costly. The disposable income of most households is very low, and wood can be a significant share of expenditure in urban areas. In some areas people are reportedly reducing the number of cooked meals to reduce their fuel costs, and there is also more use of residues, dung, etc. More green wood is being cut in rural areas, evidence of scarcity as this kind of cutting is illegal and formerly was rare. Environment officers are supposed to confiscate any green wood they find. But there is heavy cutting along the main roads, and wood cooperatives are having trouble selling their wood.

Yet local women do not always perceive a connection between wood savings and reduced costs of wood. In one study, 63% of these women reported wood savings as the #1 advantage of the stove, but only 4% cited money savings. The poor are the ones most affected.

Little need is seen for a long-term R&D or stove testing program. The stove is thought to be well understood and its technical results are well known. No need is seen to spend more time or money doing such studies, though there is an issue of the need for long-term monitoring of results. It is known that different results have been shown in different field tests, but this may have been due to sampling problems mentioned earlier.

Phase I had been very successful, disseminating 40,000 stoves compared to a target of 20,000. Phase II began, two years later, with high expectations but with a limited budget, and now are having difficulty regaining the momentum of Phase I. One of the reasons GTZ is focusing on the rural stove is because of doubts about the long-term market for the Mai Sauki in urban areas. However, it is clear that rural work requires a long-term investment in extension and training resources. Yet, it is felt that once this is in place, rural households are in some ways easier to reach than urban households: city dwellers lack any sense of community, and don't respond to the same kinds of initiatives as rural people.

The Albarka stove requires a minimal level of maintenance but this is important for the stove's durability and efficiency.

Ensuring quality control requires regular follow-up of the extensionists, while encouraging households to perform the necessary maintenance also requires effective training from the beginning.

In some villages the majority of households now have the stove. Along with the stove, many of these have installed a simple sun shelter overhead which makes cooking more pleasant and comfortable. Fuel savings and cooking speed are considered the biggest advantages of the stove, and in windy areas protection of the fire is also a major improvement over the traditional three stone fire. Some women who formerly collected wood four times per week now go only once.

The project has substantially refined its approach to rural extension work. Much more advance work is now done, before introducing stoves. Extensionists are expected to spend some time living in a new village, carrying out a variety of information gathering and priority identification exercises. In some cases, literacy classes may be started before any stove related work is begun. Integrated rural development projects have not proved to be effective channels for dissemination of the Albarka stove, as they are normally geographically dispersed and cannot carry out the necessary training and follow-up visits.

World Bank Energy II Project, Demand Office -- Contacts: Jean Pierre Jambes, Malam Abdou

The project's goal is to stabilize urban wood consumption at the 1990 level; demand for household energy above this level is to be met by switching households toward use of LPG and kerosene. The goals are to place 80,000 kerosene stoves in 50,000 households, 110,000 improved woodstoves in 60,000 households, and 15,000 LPG stoves in 12,000 households. By the year 2000, wood consumption should be stabilized at the 1990 level in the four major urban areas of Niger.

There is little relationship between wood and commercial fuels in Niger. The project is studying a consumer panel on a long-term basis to find out what their preferences and attitudes are concerning switching to other fuels. Improved stoves have already reached 15% to 20% of households, but these were probably the "early adopters" and the easiest segment to reach, with higher disposable income, propensity to innovate, etc. They have access to radio and television, understand French, and in other ways are easier to reach. Now the project must try to reach the "followers."

The strategy has been changed for dissemination of the Mai Sauki. The Malgache stove is sold door to door, by itinerant artisans and vendors. The project has had little success competing with this market. Therefore a concerted effort will be made to shift the Mai Sauki toward a more up-market niche, by using new sheet metal, fabrication in a large workshop, painting the final product, etc. Basic socioeconomic factors are important: average household size in Niamey is 7 persons.

The EC is funding a program of promoting LPG. The price of LPG is subsidized at a level of 27%. The price of stove and cylinder are also subsidized. Wood prices have been stagnant or declining in real terms. Kerosene is price-controlled, but rarely finds its way into homes at the official price. Most of the supply is smuggled from Nigeria, which has extremely cheap petroleum supplies. This is a major fact of economic life in the southern region of Niger: the price of petroleum fuels depends on distance to the Nigerian border.

During the early 1980's, a high mass stove with a chimney had been introduced, unsuccessfully. The present Mai Sauki model represents a locally modified version of the Burkina Faso "Ouaga metallique" stove. The original design was felt to be too smokey and affected the taste of food, so the design was modified to allow easier escape of smoke. It is presumed this had no serious effect on fuel efficiency.

The Energy I project distributed 40,000 units through the Associations de Femmes Nigeriennes (AFN), Niger's women's association. At the end of the project, they halted their role as they had no financial interest in continuing. Artisans have continued production, but sales have been largely limited to the Katako market in Niamey, which has restricted sales somewhat. The Phase I project had not

wanted to involve merchants who might have been able to market the stoves more widely.

Sales of the Mai Sauki levelled off at around 400 to 500 units per month. With large-scale promotions sales have sometimes gone as high as 3,000 units per month, but it isn't known how many of these are new buyers and how many replacement buyers. The traditional, Malgache stove market, is estimated at around 10,000 per month.

A study was done to identify reasons for the slow sales of the Mai Sauki. One conclusion was that it is not considered enough of a prestige purchase for households, in that it is not sufficiently distinguished from the Malgache and does not look more modern. Also, people have not responded to the message that using a fuel efficient stove is a way of fighting desertification. People feel that environmental issues are the government's problem and don't see the point of changing individual behavior in the interest of the collective good. The message needs to be retargeted to highlight individual and household advantages of using the improved stove: save time, save work, save money.

The project has tried selling through street vendors, which is how the Malgache is marketed, door-to-door. But the Mai Sauki is difficult to carry in this way, and the experiment was not successful. Another attempt at broadening the base of distribution involved selling through small retail shops, but these felt there was insufficient margin at the prices fixed by the project. The controlling of retail prices, which was an important aspect of the Phase I strategy, is now thought to have been a serious mistake, and they are trying to "liberalize" prices. It reflected a "European mentality" toward retailing which ignored the way artisanal products are marketed in west Africa. It also stifled price competition between producers. Since the stove was somewhat more awkward to produce and transport, keeping the margins too low effectively killed any interest in the stove on the part of artisans.

The project has learned from this experience that the stove must not be seen as a "state" activity, by exerting so much control over who may produce, where and at what price it may be sold, etc. This greatly undermined commercialization of the product. Also, working too closely with the women's association, AFN, was not sustainable. The political goals of the organization were not identical to the economic goals of the project. Often women didn't pay for the stove, which was viewed as a promotional item. Now they are reluctant to pay for another stove, and many have lost interest. It was a good way of getting many stoves out to households in fairly short time, but caused serious long-term problems which are still being faced today.

The project is looking for middlemen now, as with the kerosene stove. But it is felt this will require the use of new metal, to raise the consumer's perception of the stove as a prestige product. This implies taking production and marketing out of the informal sector altogether. The project doesn't view this as a detriment, however, to the extent that the artisanal connection handicaps marketing of the stove to status-conscious buyers. After all, street vendors and shops don't sell artisanal products. A compromise is being tried, with one merchant contracting two artisans to produce the Mai Sauki for him on a regular basis.

It is not yet clear whether these initiatives will be successful in boosting the sales of the Mai Sauki, and there are drawbacks associated with all of the approaches mentioned. If nothing works, the improved stove will be dropped at the end of the project.

Quality control has been an issue too. Some of the artisans produce grates which don't have enough holes, which results in smoky cooking. Artisans don't like making the grate, which is fairly laborious work. The project is experimenting to see if eliminating the grate has a significant effect on performance. A sample of 30 households will be studied to see whether this and lowering the fuel inlet are feasible modifications.

With regard to the fuel substitution program, pilot tests have been done in 12 neighborhoods, and advertising on television and radio is taking place. Signs have been erected around Niamey, identifying local outlets for the "Tchip" kerosene stove. The

stove is based on an Indonesian model with high power output, which was considered essential to cook the traditional millet porridge. A study was done, outside Niger, which identified a limited range of options from which the present design was selected. The stove is modified by the addition of a sturdy steel frame which can hold the large, round-bottom pots used in Nigerien households.

The project is absorbing the cost of setting up an after-sales service network in the major towns. This will do basic maintenance and repair, as well as selling and installing replacement wicks for the burner. The project has faced numerous problems in timely import of the components for the stove, and production has been slowed or halted by various problems. The project plans to turn over manufacturing and marketing to a private sector firm before long, so that it can pass these business issues on to someone more experienced in dealing with them. The project had little idea of the practical problems involved in international procurement, for example, or in arranging inland transportation and customs clearance, and hopes to get out of this area as soon as possible.

The actual costs of cooking with kerosene or LPG in comparison with wood are not yet known. The project wants to study this at the household level, to assess the policy implications of a large-scale substitution campaign. The price of kerosene varies widely at the local level and at the small quantities in which it is normally bought. The fuel substitution campaign assumes the stability of relations between Niger and Nigeria, since the supply of commercial fuels comes entirely from Nigeria. The border, 2,000 km. long, is basically unregulated, and one assumes there is no likely scenario of an interruption of supply. There is presently a very wide price differential between the two countries: in Nigeria, kerosene costs the equivalent of about 12 CFA per liter, while in Niger the official price is 95 CFA, and the market price is around 67 CFA.

However, there have recently been supply fluctuations. The price of kerosene jumped from 1,200 CFA per 18 liter tin to 1,800 in one month, and many households which had begun using the Tchip stove reverted to using wood. Niger hopes to arrive at a bilateral agreement with Nigeria on fuel pricing and assured access, which would ease many of the fears of the security of supply. Also, there is a possibility of manufacturing the kerosene stove burner in Nigeria instead of importing from Indonesia, to reduce costs and time needed for shipment of components.

There is some concern whether the Energy II forestry proposals will be practical, in particular the idea of gradually halting the uncontrolled harvest of firewood in favor of supply from managed areas. This plan assumes that prices will rise in order to reflect the economic cost of wood. But if consumers resist price increases, which is likely, then the additional taxes or royalties levied by the government on marketed wood will be at the expense of the rural poor who provide the labor in this system. Merchants and transporters have a stronger bargaining position than peasants, and will press the latter to work for less, or will harvest more wood to maintain the same revenue.

A World Bank condition for the approval of the Phase II project was reform of the wood market, however, and the project will proceed with trying to implement these policy changes. How this will turn out in reality is unknown.

Energy II Supply Office -- Contacts: Hassan Djibo, Boureima Amadou

The first steps toward bringing the supply of wood under management are now in motion. The first supply zone, within a 50 km. radius of Niamey, is being controlled. Studies have been done of the potential under management for these areas, including social questions and biomass inventories. Exploitation on the scale of 5 cu. meters per hectare is envisaged, through wood sellers co-operatives using a 12 year rotation. In these areas, royalties on cutting will be raised, to levels set according to the productivity of the specific location. This is to encourage harvesting in areas of higher potential, and to discourage exploitation of less favorable zones.

The present royalty is 350 CFA per stere (cubic meter stacked) of wood cut. The new royalty in the high productivity controlled areas will also be 350 CFA. In the intermediate zones, not fully managed but higher productivity, the royalty will be 380 CFA, while fees from uncontrolled zones will be set at 650 CFA per stere.

The program requires forestry control, which means that preventing fraud will require more personnel and vehicles to conduct patrols. Also, the new system involves transferring to the local population more of the control over their own lands.

Some merchants are already complaining about higher prices. It is true that in some areas, cutting is a result of agricultural clearing rather than for fuelwood directly. In some cases, where illegal cutting has occurred, the land may be confiscated and the peasant ordered to replant what was cut. But the national policy of food self-sufficiency conflicts to some extent with the needs of the forestry policy. Classified forests can now be used by the local population, on a subsistence basis, but are not to be used for commercial purposes. But sometimes peasants move the boundary markers in order to operate within classified forest areas without being caught by forestry guards.

Niamey's supply of fuelwood currently is around 132,000 tons per year. Dead wood still represents the bulk of this supply, around 95%, and only 5% of the supply is from green wood. The catchment area for harvesting is advancing, to Dosso in the east and to the Burkina border to the west, along the main supply routes. There are large areas of dead wood, and collection here doesn't necessarily cause environmental damage. But in the future, after this resource has been exhausted, there will be serious problems if the present volume of harvest is made up from green wood.

Africare -- Contacts: Jeff Grey, Peter Robinson

Wood is still readily available in town, and at low prices, but this is because wages to labor in harvest areas are extremely low.

Up to one day's work brings in as little as 150 CFA. Also transport costs are low because of cheap diesel from Nigeria in the border areas. There are checkpoints along roads to stop illegal wood, but the drivers simply detour through the bush and avoid these places. There may also be a lot of collection still taking place of wood which died during the severe 1984-85 drought. Even where LPG is cheap, wood still seems to be the fuel of choice. Perhaps there is some resistance to change traditional cooking practices. The kerosene stove introduced by Energy II is sometimes used by roadside tea and coffee sellers, but it is not widely used in homes.

There are serious economic difficulties in Niger. Civil servants have not been paid since December. There is a national conference ongoing, which will decide a wide range of political and economic issues, in the meantime donors are waiting to see the outcome. Most government offices have little or no money for recurrent expenditures. There is no transport in many offices, which remain fully staffed, so almost no extension work is taking place now except where paid by a donor.

Africare is hoping to experiment with various innovative ways of introducing sustainable natural resources management in Niger. This involves a follow-on to the Goure Rehabilitation Project, which will identify local organizations of various types, to select the most suitable for different project activities, also using the participatory rural appraisal methods developed in Kenya. Before making commitments to specific types of activity - e.g. tree nurseries - the project will find out in detail what are the real local priorities, what people are willing to invest their time and efforts/resources in. This implies a different role for government, and there will be a need for training and support for the government to understand its new role and to perform it competently.

Political and economic constraints are going to impose certain limits, undoubtedly, and it is not clear how issues of local political control are going to be resolved. Many of the failures of central government intervention have tended to strengthen the traditional chiefs, and these may represent an important

resource in some communities if projects can work constructively with these leaders.

ONERSOL (solar energy research institute) -- Contact: Soumana Boubacar

ONERSOL carried out many of the laboratory and controlled cooking tests which were run on improved stoves in Niger. The Malgache stove is used as the reference, not the three stone fire, as in some other countries. They are now involved in tests of coal briquettes from the Canadian project in Tchirouzerine, near Agadez. A coal stove has been designed but there are problems of emissions, also lighting is difficult and fuel consumption is too high. A Chinese model is available but has not been tested.

CARE has introduced a stove for residues, similar to the "multimarmite" improved stove.

The "Tchip" is the kerosene stove produced for the Energy II project. ONERSOL did the tests of this model, and is currently doing the fabrication of the steel frame, and painting of the completed unit. This model uses 36 wicks, and has a very high power output. It uses an Indonesian burner, and is probably too powerful. Local wicks are being tested as replacements for the imported ones, but results thus far are not positive. They are considering reducing the number of wicks to 20 or 24 to reduce power output and fuel consumption. This would also reduce the number of wicks required for replacement, which is proving more of a problem than originally expected.

ONERSOL is also working on a shielded gas burner, which might save some energy, and a two-ring gas burner, locally designed, the "Tandem" stove. It has relatively low power output, but acceptable efficiency.

There is no on-going program of R&D or testing. It is done at the request of organizations or donor agencies. But the performance of the Mai Sauki is thought to be adequate. The Albarka clay stove, however, is not considered to be popular with households, but a scaled-up model is being developed for artisanal salt production, which could save up to one-third of the wood used normally. There have been problems of electricity supply in this part of Niamey, and this has hindered much of the work.

The Tchip kerosene stove is assembled by ONERSOL for the Niamey market, and by different workshops in Zinder and Tahaua. The landed price of the Indonesian burner is 3,500 CFA and the finished cost is 14,500. A subsidy of 5,000 CFA per stove is paid by Energy II, and the stove is wholesaled to shops at 9,500 CFA. The project plans to phase out the subsidy as well as its role of importer.

At present the workshop is holding inventory equivalent to several months of production, due to delays encountered in the inland shipping of burners and also power failures. The Indonesian producer is limited to 1,000 units per month, which represents another constraint on the project's output of kerosene stoves. When the project phases out its direct role, the merchant who takes this over will have to quickly establish cost cutting measures, as the Energy II market study showed that the price limit for a kerosene stove would be around 10,000 CFA. He will have his own workshop and his own quality control and management, so should be able to accomplish this one way or the other. A similar project is being undertaken in Mali, also with technical assistance from the Dutch group BTG. In Bamako they are aiming at local production of the entire unit, but for Niamey this is not considered realistic.

USAID -- Contact: Barry Rands

A.I.D. is emphasizing NRMS, and the promotion of biomass as a renewable resource, to ensure it is sustainable and attractive to users, not necessarily to reduce demand for biomass. But population growth must also be seen as a critical factor in the demand for biomass fuel: without controlling population growth, little can be achieved in other sectors.

The policy goal of devolving control over natural resources to the local level is an important priority for USAID. A.I.D. has worked for 10 years in Guesselbodi as an example of natural forest management, with several objectives: (a) local partnerships in decision making, and (b) active management of natural resources, including exploitation, enrichment planting, and soil conservation.

There has been a substantial exodus from the north, of Tuareg. The 300mm isohyte has shifted south, and now large areas in the north of the country no longer support millet cultivation. This population shift has implications for settlement and natural resource issues in Niger.

Different systems of natural forest management are being practiced. Guesselbodi limits access to local community users, excluding migratory Fulani. Other areas are more lenient, allow traditional herders and wood gatherers to have continued access.

WRI is among some environmental groups which have made alarmist statements in the past about the anticipated disappearance of all trees from the Sahel. This has not happened, and these organizations should be looking more closely at why and what it means instead of continuing to repeat these statements.

The problem of deforestation, even in Niger, probably still has a lot to do with land clearing for agriculture, especially millet. Replanting of trees cannot fill the gap. Instead, better management of natural forest and agroforestry are needed. More trees need to be on farmers' fields, where the main impacts of deforestation are being felt. This can help extend yields, etc.

Estimates of biomass densities in Niger differ considerably. A recent conference (Feb. 1990) included presentation of different estimates. Around urban areas, clearing is energy related. In rural areas, it is more related to agriculture. Wood for construction is also a significant source of demand, which sometimes escaped notice of analysts. Projects on woodless housing are making interesting innovations in this regard. In the north, domes have always been traditional but haven't yet made much impact in the south. Plantations for energy are very unlikely to succeed, but some individuals are now planting for poles, on their farms.

Peace Corps -- Contact: Chris Hopkins

Hopkins is a forester who has recently finished two years working on several forestry projects in Niger, including the well-known Guesselbodi project.

Much of the wood coming into the Niamey market is dead wood, or "fossil" wood, though why this is so isn't sure. Some of it may be due to the 1984-85 drought, but there is also the possibility that tree diseases may be responsible. There is some "barking" of trees to circumvent restrictions on cutting live trees, but probably not a significant proportion. The price of fuelwood had been expected to rise sharply due to overcutting, but instead the real price has dropped over the past 10 years. Cheap fuel from Nigeria helps transporters to bypass co-ops, driving further into the bush to collect unregulated wood. Co-ops are having great difficulty staying in business. The second rotation cuttings have proven to be very small and spindly pieces, which the wood transporters don't want to bother with because it takes much more labor to fill a truck with the smaller pieces and they bring lower prices in the market. Also the co-ops are charging higher prices because they are in managed areas, while the transporters can pay local peasants very low wages to gather wood in an uncontrolled fashion.

The system of selling wood harvesting licenses is not working. In the Gaya forest area, only one license has been sold in the past three months, yet trucks carrying wood can be seen every day. This pattern is somewhat less true nearer Niamey, which is more controlled. The wood cut for agricultural clearing rarely reaches fuelwood markets: most is simply burned on-site to fertilize fields, in the traditional manner.

If it is mostly dead wood being cut, there is relatively little environmental impact, although soil depletion could be a concern. Recent tests cuts in Guesselbodi, 10 years after baseline work in 1982, showed that yields have been much lower than expected - as low as 1/8th - and the cuttings are so thin as to be nearly worthless in the local fuelwood market. This would have serious implications for plans to manage fuelwood marketing as the World Bank Energy II project is trying to introduce. There is also doubt about the reliability of the existing biomass inventory data. Not enough is known about the previous conditions, and there still is not enough ground truthing of satellite imagery or aerial photos.

Fuelwood collection is continuing on a kind of high-grading basis, "hunt and peck" searching for the size and type of trees most in demand for the market. There is little evidence of rural people using dung for fuel, though occasionally residues are used when in good supply. In some places it appears that flying beetles eat much of the green wood which has been cut. Perhaps converting this to charcoal would be a way of reducing the wood wasted in this way.

Katakou Market -- Contact: Suleiman Karim

Originally trained as a teacher, Suleiman Karim has been a metal artisan making the Malgache stove for many years. He was trained to produce the Mai Sauki in 1984, and now only produces improved stoves. He has recently had to reduce his work force from 6 to 4 assistants due to the drop in sales. At present there are perhaps 30 artisans in all producing the Mai Sauki. The supply of suitable sheet metal is becoming a serious problem. One could raise the price, and even though experienced users of the Mai Sauki would probably pay, many customers would not. The cost of the raw material - used sheet metal - has doubled, from 1,000 - 1,200 CFA per sheet to 2,000 CFA.

The profit margin on improved stoves is too low at present. The stove already sells for roughly double the price of a Malgache stove: the #2 Malgache sells for 200 - 400 CFA, while the #2 Mai Sauki sells for 650 CFA. Even though the price of materials is also hurting the traditional stove producers, their prices are held down by the large number of relatively unskilled apprentices who can cheaply sell low quality stoves and undersell anyone else. Efforts to improve the perception of the stove and justify its higher price, for example by painting it, have not worked: people feel the paint will quickly disappear and they aren't willing to pay a premium for this.

The proportion of Mai Sauki stoves in the market is dropping. In February 1992, an estimated 16,000 Malgache stoves were produced, compared with only 760 units of the Mai Sauki.

CARE International -- Contacts: Peter von der Lippe, Gaya Issa

Both CARE and the government of Niger are trying to find ways of better organizing management of biomass resources, to put exploitation on a sustainable basis. The reasons for over-exploitation are felt to be (a) demand for wood energy, (b) shifting cultivation, (c) drought, (d) population growth, and (e) urban growth. Wood prices are believed to be rising, and it is surprising to hear of studies which dispute this. The wood cutting permits control to some extent the cutting, though it is also clear that much wood evades the system.

Biomass inventories are now being updated. Most of the trees which died during the 1984 drought are gone by now, and the wood supply is probably coming from cutting of live trees. Checkpoints are being set up on roads to study what is being transported, and where it is coming from. The Energy II idea of promoting use of modern fuels such as LPG and kerosene is excellent, especially if wood prices are higher than in the past so that people feel an incentive to switch fuels.

A big problem is that local people don't have secure tenure or authority over their lands. Financing is also a problem. Without sources of external funds, activities introduced by projects such as the USAID Guesselbodi project rarely continue once the project has ended.

CARE has worked with improved stoves in Niger, both the Mai Sauki and the Albarka. Both work well, but rural and low-income people prefer the Albarka, which also may have a slight performance advantage.

It appears that more wood is being cut green, although this is not legal. Agricultural clearing is also responsible. Clearing for groundnut planting was particularly destructive, though agroforestry techniques have been introduced and now more and more farmers are leaving trees in their fields when they plant.

Migration from the north is putting great pressure on remaining forest areas. Niger is likely to see permanent conversion of forest areas, and it may not be possible to "manage" the forest. Tree planting is not viable.

Survival rates in past projects have been very low. Yet until the forests have been cleared, there will be little incentive to develop alternative systems for production of woodfuel. The economic calculations of individuals are the primary determinant of what happens. (Also, the basic ecological instability is a problem in the Sahel.) People plant trees where it is profitable. This implies the wisdom of promoting multi-use planting, not just planting for fuelwood. Woodlots and mini-nurseries have promise in this respect.

The biggest priority is to work in farmers' fields to prevent loss of soil fertility. Very little biomass is left in fields, and residues are being sold as fodder. Improving farm conditions could obviate the need for more encroachment into remaining forest areas. This would be preferable to costly efforts to rehabilitate depleted land. Studies have shown the long-term decline in per capita productivity of agriculture, estimated to fall to perhaps one-half of present levels by the year 2025.