WWS 402f: Sustainable Development- Can We Do It?
Prof. Denise L. Mauzerall

Reducing Indoor Air Pollution in Africa: A Review of Two Successful Intervention Programs and Recommendations for Future Intervention Efforts

Shena M. Elrington
May 2, 2003

I pledge my honor that this written work is my own in accordance with University regulations:

_____

Abstract

Approximately one half of the world's population and up to 90% of rural households in developing countries rely on unprocessed biomass fuels in the form of wood, dung, and crop residue for cooking, lighting, and heating.[1] These fuels are typically burnt indoors in open fires in poorly functioning stoves.[2] The smoke emitted from these stoves contains high levels of particulate matter, including carbon monoxide and soot that adversely affect health.[3] Collecting biofuels, such as wood, degrades the environment, promotes habitat destruction and triggers erosion.

The purpose of this paper is to demonstrate the ways in which the mass adoption of improved biomass stoves can counteract the negative effects of biofuel collection and traditional stove usage within many developing countries. This paper relies on the lessons learned from a stove dissemination program (The Kenya Ceramic Jiko Project) and a multiple intervention dissemination program (The IDTG Smoke and Health Project) implemented in Kenya. This paper holds that the most effective stove dissemination programs are a product of a merger between the KCJ three-tiered dissemination approach (consisting of research and prototype development, training, extension, and demonstration, and the development of productive enterprises) and the ITDG participatory framework, which demands that the community play the key role in any developmental initiatives. In addition, this paper suggests that the role of the government and international organizations in the dissemination process should be relegated solely to the sphere of logistical and some financial support. The aid of local women's groups and local artisans is an essential component of a successful stove dissemination program. Involving the community at each level of improved stove development and distribution ensures that the stove meets consumer

[1] Nigel Bruce, Rogelio Perez-Padilla, and Rachel Albalak, "Indoor Air Pollution in Developing Countries: A Major Environmental and Public Health Challenge," Bulletin of the World Health Organization 78 (2000), p. 1078.
[2] Ibid.
[3] Majid Ezzati and Daniel M. Kammen, "Household Energy, Indoor Air Pollution, and Health in Developing Countries: Knowledge Base for Effective Interventions," Annu. Rev. Energy Environ. 27 (2002), p. 233.

needs. Building upon the already successful efforts of the KCJ dissemination program, this paper suggests that future stove dissemination programs adopt quality control mechanisms to enhance consumer confidence and promote manufacturer accountability.

Introduction

Approximately one half of the world's population and up to 90% of rural households in developing countries rely on unprocessed biomass fuels in the form of wood, dung, and crop residue for cooking, lighting, and heating.[4] These fuels are typically burnt indoors in open fires in poorly functioning stoves.[5] The smoke emitted from these stoves contains high levels of particulate matter, including carbon monoxide and soot.[6] In fact, the smoke emission from the use of domestic energy for cooking and heating is the major source of indoor air pollutants.[7] Adverse health effects, such as the onset of acute respiratory infections (ARI), chronic obstructive pulmonary disease, and lung cancer, result from exposure to biomass particulates.[8] It is estimated that the global mortality rate of exposure to indoor air pollution from sold fuels was between 1.5 million and 2 million deaths in 2000.[9] Because of their customary involvement in cooking, women are more heavily exposed to particulate matter than men. Young children, who are carried on their mothers' backs while cooking is in progress, are also heavily exposed to harmful particulate matter. [10]

Improved biomass stoves present a means to reduce the level of particulate exposure. Unlike traditional stoves, improved stoves are fuel-efficient and emit lower levels of particulates. Despite these advantages, improved stoves have not been widely used. While they are relatively

---

[4] Nigel Bruce, Rogelio Perez-Padilla, and Rachel Albalak, "Indoor Air Pollution in Developing Countries: A Major Environmental and Public Health Challenge," Bulletin of the World Health Organization 78 (2000), p. 1078.
[5] Ibid.
[6] Majid Ezzati and Daniel M. Kammen, "Household Energy, Indoor Air Pollution, and Health in Developing Countries: Knowledge Base for Effective Interventions," Annu. Rev. Energy Environ. 27 (2002), p. 233.
[7] M.A.K. Lodhi and Z. Zail-al-Abdin, "Indoor air pollutants from fossil fuel and biomass," Energy Conversion and Management 40 (1999), p. 243.
[8] Majid Ezzati and Daniel M. Kammen, "Household Energy, Indoor Air Pollution, and Health in Developing Countries: Knowledge Base for Effective Interventions," Annu. Rev. Energy Environ. 27 (2002), p. 233.
[9] Ibid. p. 235.
[10] Nigel Bruce, "Indoor Air Pollution," Bulletin of the World Health Organization 78 (2000), p. 1080.

inexpensive, their cost exceeds that which a majority of families living in developing countries can afford. The purpose of this paper is three-fold: to discuss the environmental and health risks associated with traditional stove usage, to assess the success of two improved stove dissemination programs in Kenya using an environmental, socio-economic, and public health framework, and to suggest ways in which such programs might be implemented elsewhere.

Biofuel Use and Its Associated Health, Environmental, and Socio-economic Costs

Prior to discussing the health and environmental benefits of improved stove usage, it is fruitful to first examine the role of biofuels, which are defined as any material derived from plants or animals deliberately burnt by humans,[11] in contributing to indoor air pollution. Inexpensive biofuels, such as fuelwood and animal dung, are commonly used in rural areas of developing countries for domestic cooking.[12] When burned, these fuels fail to combust properly. By-products of this incomplete combustion process include carbon monoxide, soot, and unburned volatiles.[13] Far from being harmless, these by-products are often poisonous and carcinogenic. Exposure to these pollutants is widely believed to be a risk factor for illnesses such as acute respiratory infections, cancer, cataracts and low birth weight.[14] Studies have revealed that young children in households that rely on solid biomass fuels are 2-3 times more likely to suffer from acute respiratory infections than children in households that use other fuels.[15] Women, who are heavily exposed to biofuel smoke emission, are 2-4 times more likely to develop chronic obstructive

[11] Ibid. p.78.
[12] J.B. Kandpal, R.C. Mheshwari and Tara Chandra Kandpal, "Indoor Air Pollution from Combustion of Wood and Dung Cake and their Processed Fuels in Domestic Cookstoves," Energy Conservation and Management 36 (1995) p. 1073.
[13] Jonathan Rouse, "Improved Biomass Cookstove Programmes: Fundamental Criteria for Success," The Centre for the Comparative Study of Culture, Development and the Environment The University of Sussex (August 1999), p.16.
[14] Bruce A. Larson and Sydney Rosen, "Understanding household demand for indoor air pollution control in developing countries," Social Science and Medicine 55 (2002), p. 572.
[15] Ibid.

pulmonary disorder than other women.[16] The practice of using unprocessed solid fuels (biomass and coal) for cooking in developing countries produces indoor particulate concentrations well above that of the dirtiest cities.[17]

Adverse side-effects from biofuel usage are not solely limited to the public health sphere. Biofuel usage often negatively affects the environment. In particular, fuelwood gathering places enormous pressure on local resources. The loss of trees that results from fuelwood collection degrades the environment and contributes to erosion, loss of biodiversity, and habitat destruction.[18] In addition, using animal dung and agro-waste as fuel deprives the soil of nutrient rich fertilizers that are necessary for increasing agricultural production.[19]

Biofuel collection requires time and energy. Fuelwood gathering, in particular, is a time consuming and potentially labor intensive process. Both time and energy might be better spent on participating in income-generating activities. Biofuel usage is triply disadvantageous. Exposure during its combustion is dangerous-the smoke produced during incomplete combustion is 20 times the level that the World Health Organization considers a serious health risk.[20] Its usage degrades the environment and prevents families from using their time to engage in income-generating activities. Despite these disadvantages, the vast majority of the global population continues to rely on biofuels because they are inexpensive and often more readily accessible than fossil fuels.

---

[16] Ibid.
[17] Kirk R. Smith, "National burden of disease in India from indoor air pollution," PNAS 97 (November 2000), p. 13286.
[18] Solutions Site Case Study, "Research, Development, and Commercialization of the Kenya Ceramic Jiko and other Improved Biomass Stoves in Africa," <http://www.solutions-site.org/textonly/cat2_sol60.htm>. Date of Access: 3/25/03.
[19] J.B. Kandpal and R.C. Maheshwari, "Combustion of Biomass Fuels in Two Cookstoves for their Conservation," Energy Conservation and Management 36 (1995), p. 1015.
[20] Daniel M. Kammen, "Cookstoves for the Developing World," Scientific American (July 1995), p. 74.

Traditional Stoves: What's the Attraction?

Traditional stoves that make use of biofuels are fuel-inefficient and not environmentally friendly. Improved stoves, however, make use of available bio-fuel in a more fuel-efficient and environmentally friendly fashion. Furthermore, improved stoves accelerate the natural progression up the energy ladder. The general pattern in developing countries is that with increasing income people generally move up the energy ladder from fuelwood to charcoal/charcoal briskets or kerosene and then to liquefied petroleum gas, natural gas, or electricity for cooking.[21] The advantages to moving up the energy ladder include increasing fuel efficiency and savings as well as some health benefits. This progression, however, is halted when the income needed to move up the ladder is unavailable as is the case in many developing areas of the world. Until the income needed to move up the ladder is attained or fossil fuels are made more accessible in some areas, improved biomass stoves are necessary to negate the adverse consequences of biomass fuel usage. In this way, improved stoves are a stepping stone between the traditional biomass stoves used by rural and urban poor families and the modern fuels and appliances mainly used by urban, better-off households.[22]

Improved Biomass Stoves: Barriers to Implementation

Many households fail to use improved biomass stoves despite their relative inexpensiveness and fuel-efficiency. Economic logic suggests that household demand for an intervention, such as an improved biomass stove, is equal to the household's willingness to pay for the intervention.[23] Given that some 300-400 million households have not yet adopted such an intervention, it is reasonable to conclude that current household willingness to pay for the

---

[21] Douglas F. Barnes, Keith Openshaw, Kirk R. Smith, and Robert van der Plas, "What Makes People Cook with Improved Biomass Stoves? A Comparative International Review of Stove Programs," World Bank Technical Paper Number 242 Energy Series, May 1994, p. 1.
[22] Ibid, pp. 27-28.
[23] Bruce A. Larson and Sydney Rosen, "Understanding household demand for indoor air pollution control in developing countries," Social Science and Medicine 55 (2002), p. 572.

available intervention is less than the current cost.[24]In sum, despite the numerous advantages associated with using improved biomass stoves, households fail to view these advantages as being significant enough to warrant the purchase and use of an improved stove. These households may have more pressing concerns. Switching from one type of stove to another may not be at the top of these households' priority lists. In addition, changing from one type of stove to another is no simple matter. This change brings about a variety of changes in household activities, including changes in the cost of cooking (e.g. by altering stove efficiency) that could change the amount of food prepared each day, the types of food prepared, the frequency of preparation, and the reallocation of women's and children's time spent gathering fuels.[25]

Improved biomass stoves may increase fuel-efficiency, but efficiency alone is often not sufficient impetus for people to discard the stoves with which they are most familiar. In order for improved biomass stoves to be adopted on a large scale, they must be at least as attractive as traditional stoves.[26] What makes traditional stoves, which often only consist of three stones arranged around a fire, so attractive? Below is a brief outline of factors that contribute to the traditional stove's attractiveness:[27]

- They are cheap and easy to build
- They are easy to use and require no expertise
- They accept many types of fuel, and fuel does not need to be chopped into small pieces
- They can accept any shape of pot or hot plate
- It is possible to keep more than one pot warm simultaneously
- They are familiar objects

---

[24] Ibid.
[25] Ibid. p. 573.
[26] Jonathan Rouse, "Improved Biomass Cookstove Programmes: Fundamental Criteria for Success," The Centre for the Comparative Study of Culture, Development and the Environment: The University of Sussex (August 1999), p.17.
[27] All of the below bulleted points are from: Jonathan Rouse, "Improved Biomass Cookstove Programmes: Fundamental Criteria for Success," The Centre for the Comparative Study of Culture, Development and the Environment The University of Sussex (August 1999), p.17.

If improved biomass stoves fail to provide the majority of the benefits outlined above, the successful implementation of such a stove is dubious at best. The success of the two intervention programs in Kenya, which are discussed below, is due in part to their ability to incorporate some of the benefits of traditional stove usage into consideration.

Kenya: Two Case Studies

Below is a brief description of two successful intervention programs implemented in various regions in Kenya. The primary objectives of these programs included the desire to reduce indoor air pollution, increase fuel efficiency and fuel savings, and improve health. The first program, the Kenya Ceramic Jiko (KCJ) stove dissemination program, relied solely on stove dissemination to accomplish the aforementioned objectives. The second program, the ITDG Smoke and Health Project, however, relied on a more integrated approach. Multiple interventions, including improved stove dissemination, the addition of windows and eaves spaces, and the development of smoke hoods, collectively improved health and reduced both fuel expenditure and indoor air pollution. When taken together, these programs demonstrate the usefulness of merging two approaches, including the three-tiered approach (research and prototype development, production and demonstration, and dissemination) and the participatory intervention approach, which will be discussed in detail below, to most effectively accomplish the aforementioned objectives. The structures of the two programs reveal the types of roles that government, the private sector, non-governmental organizations (NGOs), and local groups need to adopt in order to produce and sustain effective intervention efforts.

Case Study #1: The Kenya Ceramic Jiko (KCJ) Stove Dissemination Program

A large portion of Kenya's population depends on firewood and charcoal for its daily needs.[28] Firewood alone provides 80% of energy used in Kenya. [29] Kenya's dependence on firewood places a burden on forest resources. Concentrating fuelwood collection particularly on the steep hillsides and catchment areas has contributed to soil erosion, flash flooding and drying up of perennial streams.[30] Unlike fuelwood, charcoal is a purchased fuel. A typical household spends up to one quarter of its income to purchase it. In order to alleviate pressures on local resources and respond to the desire for more fuel efficient stoves, a consortium of local and international agencies developed the Kenya Ceramic Jiko (KCJ). This improved charcoal burning stove is found in over 50% of all urban homes and roughly 16% of rural homes in Kenya.[31] The Jiko, a Swahili term for stove, directs 25%-40% of heat from a fire to a stove. This represents a significant increase from an open fire that directs only 10% of the heat generated from a fire to cooking pot. This also represents a significant increase in fuel efficiency from the traditional metal Jiko stove. The traditional Jiko stove design was introduced in Kenya during the early 1900s. Taking approximately 50 years to replace traditional three-stone stoves, the traditional Jiko stove is made of scrap metal and assembled by local artisans.[32] Unlike the KCJ, the Jiko stove is not insulated. As a result, heat from the fire radiates to the air as well as to the pot.

The KCJ has an hourglass shape and is insulated with a ceramic lining. This lining is responsible for trapping the heat that would otherwise be lost. The original design for the KCJ was inspired by an improved stove used throughout Thailand. This stove, the 'Thai bucket,' has an insulating liner composed of ceramic that was cemented from the top to the bottom of the

---

[28] E. Kituyi, L. Marfa, S.O. Wandiga, I.O. Jumbac, M.O. Andreae, and G. Helas, "Carbon Monoxide and nitric oxide from biofuel fires in Kenya," Energy Conservation and Management 42 (2001), p. 1518.
[29] Fibi Munene, "Kimaki Jiko: An Improved Stove for Urban Kitchens in East Africa," The IDRC Reports (October 1985), p. 42.
[30] Ibid.
[31] Solutions Site Case Study, "Research, Development, and Commercialization of the Kenya Ceramic Jiko and other Improved Biomass Stoves in Africa," <http://www.solutions-site.org/textonly/cat2_sol60.htm>. Date of Access: 3/25/03.
[32] Eric L. Hyman, "The Strategy of Production and Distribution of Improved Charcoal Stoves in Kenya," World Development 15 (1987) p. 376.

inner surface walls of the bucket.[33] Excessive amounts of heat were trapped inside of the vessel, which in turn, caused severe cracking. Various agencies, in conjunction with local Kenyan artisans, attempted to solve the problem. Only through the aid of women's organizations, however, was the problem surmounted. Women suggested that the bucket design be changed to an hourglass one (see image on the following page).

The Kenya Ceramic Jiko

This change in shape not only created a more stable cooking device that did not tip over as a result of vigorous stirring but also required that only a portion of the device be cemented. Cementing only a portion of the device made it less susceptible to overheating and cracking. The changes suggested by Kenyan women are significant for two reasons. First, it demonstrates the benefits of local involvement in stove program dissemination. Had local women not been involved in the process it is plausible to believe that stove designers might not have thought of reshaping the stove in such manner. Secondly, creating a stove specifically tailored according to consumer preferences facilitates its broad based acceptance.[34] Currently, over 780,000 KCJs are used throughout Kenya with an additional 13,000 manufactured each month. The KCJ stove continues to evolve according to field tests and consumer feedback.

Between 1981 and 1985, the Kenya Renewable Energy Development Project (KREDP), funded by USAID, promoted the creation of ceramic liner stoves such as the KCJ. To

[33] Daniel M. Kammen, "Cookstoves for the Developing World," Scientific American (July 1995), p. 73.
[34] Ibid.

successfully disseminate the stoves, the KREDP focused on three areas: 1) applied research and prototype development, 2) training, extension, and demonstration, and 3) the development of productive enterprises.[35] KREDP enlisted the aid of Max Kinyanjui, a local energy planner with a thorough understanding of small-scale producers in Kenya.[36] Kinyanjui's involvement was integral because of his ability to communicate and understand the concerns and support needs of local small-scale producers. The KREDP also sponsored a trip for designers to study the stove designs and dissemination process in Thailand. During this trip, the KREDP was initially introduced to the Thai bucket stove, which eventually evolved into the KCJ,

The KREDP project rested on three basic premises. First, the efforts of NGOs and the government would be most useful if instead of assuming a large role in the production and dissemination of the stoves, they supported the Kenyan private sector which already had some experience in the manufacture and distribution of stoves. Relying on the private sector also kept the cost of the stoves down. Local artisans already had access to inexpensive raw materials. In addition, local artisans generally relied on inexpensive labor to produce their goods. Secondly, the KREDP believed that in order for households to purchase stoves that cost more than traditional ones they would need to see considerable benefits. This could be achieved only through the private sector's role in introducing a large variety of households to the improved stoves. And, thirdly, project coordinators realized that increasing efficiency alone did not guarantee that Kenyan households would adopt new stoves. Improved stoves would have to match consumer preferences, cultural practices, and cooking habits at least as well as traditional stoves did. To surmount this obstacle, the Kenya Energy and Environment Non-Governmental Organization (KENGO) and other organizations distributed 450 stoves throughout Kenya as part of a field test. From this test, KENGO was able to better understand local needs and consumer preferences. In

[35] Eric L. Hyman, "The Strategy of Production and Distribution of Improved Charcoal Stoves in Kenya," World Development 15 (1987), p. 379.
[36] Ibid.

addition, this field test yielded much information about the stove's durability and fuel-efficiency under actual cooking conditions.

The second area of focus for the KREDP revolved around training, extension, and demonstration. The KREDP enlisted the aid of local artisans already involved in traditional Jiko making. It also reached out to other artisans and actively trained them in making the stoves. It offered specialized training to some on how to create the new ceramic lining. For the most part, training was offered on site at artisans' establishments. The KREDP also created mobile training units that traveled to the worker sites in order to reach a larger production base. The KREDP's effort was not without kinks. Many artisans complained that appropriate materials needed for the training process were unavailable.

To encourage households to use the stoves required some sort of demonstration. In order to reach a broad base of consumers, the project demonstrated the benefits of the improved stove at agricultural fairs. These demonstration efforts, however, were modest at best. The most powerful demonstration came from soldiers who were given the stoves to make their own fuel and food. Friends and relatives of soldiers saw the benefits of the stoves and spread the word to their other friends. Currently, improved stoves are made available by many retailers and artisans. The first purchasers of the improved stoves tended to be those from the middle class, who were more willing to take financial risks. Some suggested that the stoves be subsidized in order to reach the lower class. This suggestion, however, was not implemented. Underlying this decision is the belief that people just do not value things that are given to them.[37] In addition, offering subsidies might have slowed the adoption rate of the stoves since many families would wait for the subsidies to come before they purchased improved stoves. Furthermore, subsidies would have stifled innovation, such as the creation of an alternative cheaper stove to suit the needs of lower-income families.

---

[37] Douglas F. Barnes, Keith Openshaw, Kirk R. Smith, and Robert van der Plas, "What Makes People Cook with Improved Biomass Stoves? A Comparative International Review of Stove Programs," World Bank Technical Paper Number 242 Energy Series (May 1994) p. 25.

Although the price of the KCJ has fallen from $2-$5 to $1-$3, many Kenyans still cannot afford them. To address the needs of the population that cannot afford the KCJ, women's organizations and government aid organizations forged an alliance and created a simplified and affordable version of the KCJ called Maendeleo. This stove, similar to the KCJ, has a ceramic lining which increases fuel efficiency and reduces particulate emissions. The Maendeleo, however, lacks the metal outer covering that the KCJ has. Maendeleos, which cost between $0.80 and $1.20, are significantly cheaper than KCJs. The production of the Maendeleo is significant because it demonstrates the power of local groups to forge an alliance (with the guidance of aid groups) to create more suitable alternatives to fit their own needs. The Maendeleo also demonstrates the flexibility of the KCJ design, which increases its ability to be altered and distributed elsewhere.

KCJ stoves offer a multitude of benefits to the user. Its design makes it lighter and more portable than the traditional Jiko stove. The KCJ is also cheaper to produce than the traditional metal stove. In addition to being fuel-efficient, KCJ stoves emit far fewer harmful particulates than traditional stoves. One study estimates that emissions were reduced by 20%.[38] In addition, users spend considerably less time buying or collecting biofuels and charcoal. In Kenya, charcoal use among a sample of families using the KCJ fell from .67 to .39 kg/charcoal/day- a savings of over $60 per year.[39] This amount represents about one-fifth of the annual income earned by many people living in Kenya.[40] Many Kenyans have used their fuel savings to invest in small

[38] Solutions Site Case Study, "Research, Development, and Commercialization of the Kenya Ceramic Jiko and other Improved Biomass Stoves in Africa," <http://www.solutions-site.org/textonly/cat2_sol60.htm>. Date of Access: 3/25/03.
[39] Ibid.
[40] Daniel M. Kammen, "Cookstoves for the Developing World," Scientific America (July 1995), p. 74.

businesses or to pay school fees for their children.[41] In addition, the KCJ program has increased employment in the stove and informal ceramic industry.[42]

International and local Kenyan groups trained stove manufacturers, vendors, and consumers on how to use the product and informed them through rigorous campaigns about the environmental, health, and economic benefits of KCJ stove usage. KENGO, particularly during the 1980s, rigorously marketed the benefits of the KCJ through advertisements in national newspapers. Since Kenya enjoys a relatively high literacy rate, newspapers are effective means of reaching a large portion of the population.

While the KCJ program has enjoyed success, it has also encountered a number of barriers. These barriers include the difficulty of convincing users that the benefits of the KCJ outweighed its initial cost. Another barrier lies in the realm of quality control. Stoves produced under different circumstances and conditions vary not only in price but in quality as well. Local artisans alter improved stove designs in order to cut cost or incorporate readily available materials. These alterations often negatively affect the fuel-efficiency, durability, and overall attractiveness of the improved stove. Often those who perform these alterations are local artisans who were not properly trained thus revealing the deficiencies of outreach training programs. Artisans are not the only groups that improperly produce improved stoves. Some large manufacturers have produced stoves that have cracks in the ceramic liner. Often, these cracks are not visible, particularly after metal cladding is placed over the stove. These cracks shorten the life span of the stoves and reduce their efficiency.

In order to make ceramic liners, artisans and manufacturers need clay. All types of clay, however, do not produce the same results.[43] Some clay mixtures are more durable than others. It

---

[41] Ibid.
[42] Solutions Site Case Study, "Research, Development, and Commercialization of the Kenya Ceramic Jiko and other Improved Biomass Stoves in Africa," <http://www.solutions-site.org/textonly/cat2_sol60.htm>. Date of Access: 3/25/03.
[43] Eric L. Hyman, "The Strategy of Production and Distribution of Improved Charcoal Stoves in Kenya," World Development 15 (1987), p. 382.

is difficult to assure that the proper clay mixture is used by all manufacturers and artisans. The differences in clay used affect product quality as well. Stoves of poor quality destroy consumer confidence in new technology and may sour the experience that some have with KCJ models.

Despite the above mentioned barriers, the KCJ dissemination process has been largely successful. It is useful to highlight the factors that contributed to the KCJ project's success in order to assess how or in what capacity the program might be applied elsewhere. Below are the aspects of the program that have most heavily contributed to its success:

- The KCJ program demonstrates that local management and involvement is necessary for success. Local artisans are a rich resource base for the implementation of a stove program.
- The primary role of nongovernmental organizations and the government is to provide logistical support, training, and outreach services. NGO's and the government, however, should not be heavily involved in the actual manufacturing process.
- Subsidies are not necessary. They stifle innovation and slow down stove adoption rates. While the initial cost of stoves may deter consumers, viewing the benefits of having an improved stove eventually overrides consumer trepidation. Through innovation, cheaper stoves are created to serve the needs of populations that would otherwise not be able to afford improved stoves.
- Researching consumer preferences and needs are necessary components of any successful stove program. Stoves must be at least as attractive as traditional stoves in order to gain broad based acceptance.
- Creating a knowledgeable consumer base is also important. Knowledgeable consumers are able to avoid purchasing products that are poor in quality.

The KCJ project has also highlighted the need for quality control measures in order to garner and maintain consumer confidence. In addition, it demonstrates the need for ongoing and rigorous training for local artisans and manufacturers.

Case Study #2: The ITDG Smoke and Health Project

The primary objective of the ITDG Project, which began May 6, 1998, was to reduce indoor air pollution in rural households in Kenya. In order to achieve this goal, the ITDG Project relied on a participatory developmental approach, which demands that the community play the principle

role in any development initiative.[44] This framework assumes that the community itself is best suited to access its own needs and determine the forms of intervention that are most appropriate. In addition, under a participatory developmental approach, the role of governments and non-governmental organizations is solely to provide logistical and some financial support for local efforts. The ITDG Project chose two areas, including Kajiado and West Kenya, to apply its participatory developmental approach. Levels of indoor air pollution within both of these areas greatly exceeded the standards set forth by the Environmental Protection Agency. In Kajiado, for example, the 24-hour average of irrespirable particulates was 5526 $\mu g/m^3$- over one hundred times greater than EPA recommended values.[45] Prior to discussing the forms of interventions implemented by the ITDG Smoke and Health Project, it is useful to first examine some of the factors that affect health, quality of life, and fuel-dependency in both regions. These factors include low incomes, increasingly sedentary lifestyles, and the materials used to construct homes.

Low wages and incomes characterize both Kajiado and West Kenya.[46] These low incomes make it difficult for families to adopt interventions that are even moderately priced. In addition, the distribution of income among men and women is not equitable. Often, women do not have access to income. This complicates intervention efforts because they are often targeted toward women, who are responsible for cooking, gathering fuel, and performing other domestic duties. In order to surmount this obstacle, the ITDG Smoke and Health Project spend a considerable amount of time convincing men, who earned and managed household incomes, of the benefits of interventions.

In addition to low wages, an increasingly sedentary lifestyle affects health and fuel usage within homes in both regions. This lifestyle particularly characterizes the people of Kajiado, who previously enjoyed a semi-nomadic lifestyle. Reasons for this shift are numerous and debatable

---

[44] Practical Answers to Poverty, "Reducing Indoor Air Pollution in Rural Households in Kenya: working with communities to find solutions" The ITDG Smoke and Health Project 1998-2001 (January 2002) p.2
[45] Ibid. p.1
[46] Ibid. p.7

but for the purpose of this case study, this shift is significant because it indicates that individuals are spending more and more time within or very close to their homes. These homes tend to be poorly ventilated because many homes lack windows. The lack of windows results not only in poor lighting but also in increased exposure to high levels of indoor air pollution.
The level of indoor air pollution is further exacerbated by the fact that people in both regions fail to out their fires at night. Instead, they allow it to smolder until the morning when it is rekindled. The particulate emissions emitted from the three-stone stove predominantly used in West Kenya reach dangerously high levels within most households.

The ways in which homes are constructed as well as the materials that are used to construct them play a major role in determining the types of interventions that are most appropriate for achieving ITDG Project objectives. In West Kenya, as in much of Kajiado, homes are built of mud. Unlike in Kajiado, kitchens in West Kenya are built separate from the homes. Families who live in homes that are separated from the kitchen are less exposed to particulate matter than families whose kitchens are located within the main home. It is important to note that some homes that do have the kitchen within the home do have small circular windows. These windows, however, allow very little ventilation.

The ITDG Smoke and Health Project: A Discussion of Project Framework, Participants, Key Players, and Implementation Techniques

As previously noted, the ITDG Project relied on community participation for the development, implementation, and monitoring of its interventions. Community participation enabled the people for whom the project was developed to serve to articulate their needs and preferences within their own cultural and socio-economic frameworks. To this end, the ITDG Project held several focus group meetings throughout the duration of the intervention in order to

allow men and women to demonstrate their understanding of the adverse health effects of indoor air pollution and articulate the forms of interventions that they felt best suited their needs. Prior to implementing the suggested interventions, which included improved biomass stoves, smoke hoods, and eave spaces, ITDG Project coordinators performed qualitative as well as quantitative tests to determine actual indoor pollution levels as well as women's exposure levels.

Fifty households in West Kenya and Kajiado participated in the project. Particular household were chosen according to the following criteria: 1) willingness to participate in the project, 2) the presence of children under the age of five, and 3) the degree to which households represented the majority of households in the area. Tests were conducted within each of the fifty households to qualitatively determine actual levels of indoor air pollution. ITDG Project coordinators measured the level of respirable particulates and carbon monoxide using an air sample and stain tubes, respectively. To measure actual exposure levels, project coordinators instructed women to wear non-intrusive CO monitors. Both measures exceeded recommended EPA values. In addition to quantitative measures of particulate and exposure levels, ITDG coordinators took qualitative measures of perceived health effects associated with indoor air pollution. Questionnaires distributed to each of the fifty households included questions such as the following:

- Is smoke an issue?
- When a fire is lit, where are you?
- How is fuelwood collected? How much time is spent gathering fuelwood?
-

Questions such as those above gave project coordinators an idea of the degree to which women found smoke and indoor air pollution to be problematic.

Following this initial baseline assessment, the ITDG Smoke and Health Project held several focus group meetings. The purpose of these meetings was to get a general understanding of the types of interventions that would best suit household needs. Focus groups generally consisted of women, who were primarily responsible for cooking and performing other domestic duties. These meetings were also conducted in order to give project coordinators a sense of the

ways in which household used smoke (to dry fuelwood, repel insects, and preserve cereal) and of traditional beliefs that might complicate intervention implementation (e.g. smoke has medicinal value). Focus group meetings revealed that women believed that the forms of interventions that would be most appropriate for their needs included improved biomass stoves, smoke hoods, windows, and eaves spaces. Many households in both regions adopted multiple interventions. In addition to focus meetings, the ITDG Project facilitated exchange visits between those who had had interventions installed and those who had not. This form of community participation played an important role in local dissemination.[47]

Before discussing the benefits and drawbacks of the interventions, it is useful to examine the role of women's groups, the government, NGOs, and the private sector in making these interventions possible and effective. Key players throughout the intervention process included local women's groups, local government ministries, the African Medical and Research Foundation, The Maasai Technical Training Institute (MTTI), and the Jua Kali Sector. Women's groups played an integral role in mobilizing communities, sharing information, and raising concerns. The African Medical and Research Foundation actively collaborated with the ITDG Project coordinators in order to improve homes and environmental health. MTTI designed and fabricated interventions like smoke hoods and provided training to local artisans. Lastly, the Jua Kali informal manufacturing sector, comprised of local artisans, constructed improved biomass stoves, smoke hoods, and various parts that were durable as well as affordable.

Intervention Benefits

As a result of ITDG Project interventions, women in both regions experienced a dramatic decline in time spent cooking. Homes in Kajiado experienced a 39% reduction and homes in West Kenya enjoyed a 17% reduction. Eaves spaces and windows, which increased the amount of light entering the home, were primarily responsible for reducing the time spent cooking. Light

[47] Ibid. p.11

enabled the women to see what they were doing. Prior to ITDG intervention, women had a difficult time seeing what they were doing within the home. While eaves spaces and windows provided considerable benefits, they also had negative effects. Women expressed concerns that windows and eaves spaces would decrease privacy and make homes more likely to be robbed. To deal with this concern, ITDG Project coordinators placed wire mesh screens over windows and installed slides so that windows could be opened and closed according to individual wishes.

Many households in West Kenya already used improved biomass stoves prior to ITDG intervention. These stoves, termed Upesi stoves, reduce fuel use by approximately 40% compared to traditional three-stone fires.[48] These stoves were successfully adopted throughout the region because producers, sellers, and promoters of stove usage had been trained in appropriate dissemination techniques. These techniques, which include extensive training and product demonstration, closely mimicked those used by the KCJ stove dissemination program. Upesi stove usage promoted cleaner kitchens and decreased the number of fire-related accidents within the home. In addition, households using Upesi stoves report a significant increase in fuel savings.[49] Unlike households in West Kenya, households in Kajiado did not adopt improved biomass stoves. These households also did not express any desire to introduce this form of intervention. Instead, these households opted to cut out windows on their walls. Windows were preferred to eaves spaces because home structures made it difficult to cut these spaces from the wall.[50]

Twelve smoke hoods were installed in Kajiado and five were installed in Kenya during the intervention. The decision to implement this form of intervention was a result of focus group meetings between women's groups and project coordinators. Households in both regions experienced a significant reduction in respirable particulates. Smoke hoods were used rather than chimney stoves. In Kajiado, the government unsuccessfully attempted to encourage the use of

[48] Ibid. p.19
[49] Ibid.
[50] Ibid.

chimney stoves. None of the stoves installed by the government, however, had been used. The failure of the broad acceptance of chimney stoves reflects the unfavorable consequences of involving the government, rather than the private sector, in the actual production of interventions.

The overall effects of combined interventions resulted in a 36% reduction in Pm-respiration in Kajiado and a 60% reduction in Pm-respiration (a measure of particulate exposure) in West Kenya. Women reported fewer ailments and hospital visits for illnesses such as eye irritations, coughs, and chest pains—all of which are associated with prolonged exposure to indoor pollutants. The ITDG Project yielded not only health and environmental benefits but socio-economic ones as well.

Socio-economic Impacts of Intervention

The ITDG Project intervention had profound positive effects on poverty within both regions. These positive effects include an increase in income for local artisans, who produced and sold interventions. In addition, the light created by windows and eaves spaces enabled women to engage in more income-generating activities, such as bead work, basket weaving, and pottery. Interventions also reduced the amount of soot in the household, which enabled women to spend less time cleaning and more time participating in the aforementioned income-generating activities. Light from windows also decreased the need for kerosene to light lamps. As a result, households enjoyed considerable savings in fuel. Women in communities were also empowered by interventions. The successful implementation of ITDG interventions depended on women's continual input and feedback. While the various interventions provided numerous benefits, they did have some drawbacks as well.

Negative Impacts

Windows and eaves spaces made many households draughty and cold, especially during periods of inclement weather and high winds. The wind often blew wick lamps out. In addition,

the cost of implementing multiple forms of interventions was quite steep. Many households, particularly in Kajiado, were unable to pay for the interventions. In the interest of conducting their study, ITDG paid for their interventions as well as for a portion of the cost of multiple interventions in West Kenya. Without the aid of ITDG financial support, many of the interventions would not be financially feasible for households in both regions.

The purpose of including the ITDG Smoke and Health Project case study in this paper is to demonstrate the power of a participatory technology development framework. Community involvement at each level of intervention development and dissemination helps to ensure program effectiveness. In addition, community involvement gives project coordinators valuable access to indigenous knowledge, which reveals the extent to which community members view problems such as indoor air pollution to be a health threat. Indigenous knowledge makes coordinators aware of any traditional beliefs that may complicate intervention efforts. It must be noted that the results of the ITDG project are limited by its small sample size. Despite this limitation, the ITDG approach offers several benefits (derived from its participatory technology development framework) that might be used to enhance the effectiveness of more extensive intervention efforts, such as the KCJ stove dissemination process.

Policy Recommendations

An improved stove dissemination program that draws on the learned experiences of the ITDG Smoke and Health Project and KCJ program is likely to enjoy success. Merging the three-tiered approach of the KCJ program with the participatory framework of the ITDG Project will yield a dissemination program that is comprehensive, adaptable to community needs, and built upon the foundation of community involvement. As noted previously, this level of community involvement is necessary to ensure that interventions suit community needs. These two approaches also demonstrate the need for sustained logistical support from governments and non-

governmental organizations as well as the need to involve local artisans in the production and dissemination of improved stoves. Particularly noticeable with the KCJ stove dissemination program is the lack of quality control measures. These measures are integral to the success of any program because they increase consumer confidence and build in a system of accountability. Below is a description of the key components of a successful improved dissemination program. The purpose of this description is to give governments, NGOs, and other interested bodies the information that is necessary for applying successful programs elsewhere.

Merging Two Approaches

Various developers of the KCJ stove, including organizers of the Kenya Renewable Development Project (KREDP), relied on a three-tiered approach, which included research and prototype development, training, extension, and demonstration, and the development of productive enterprises and intervention dissemination, to successfully disseminate their stoves. A participatory framework, such as that implemented by the ITDG Smoke and Health Project, could be integrated into each of the three tiers.

Tier 1: Research and Prototype Development

Partially funded by USAID, KREDP sponsored a trip for designers to study the stove design of the Thai bucket used throughout Thailand. As noted, the KCJ is derived from this stove design. Organizations seeking to emulate the KCJ program would profit from sponsoring such a trip to a country or region that has a successful program. Such a trip would reveal valuable information not only about stove design but also about suitable dissemination techniques. Adopting the stoves used in a particular region would be the first step to creating an improved stove that suits the cultural and economic needs of a particular community. The adopted stove could then be altered to fit consumer preferences (much in the same way as the Thai bucket was redesigned to meet Kenyan cooking needs).

Integrating a Participatory Framework

Upon adopting a stove design that has been successfully adopted in a particular region, it would be useful to conduct focus group meetings with local women's groups or other relevant parties to alter the design to best match consumer preferences. To demonstrate the usefulness of focus group meetings, recall that the hourglass shape of the KCJ design came only at the suggestion of women during focus group meetings. These meetings give women the impression that they are involved in the process. A sense of ownership of the process will facilitate later stove adoption because women will feel as though they have a stake in the process. Focus group meetings also give developers and organizers an opportunity to understand the extent to which local women view indoor air pollution as a health risk. Information obtained during these meetings will indicate whether women view improved stove adoption as a top priority. Research has shown that programs enjoy the greatest success when the problem a program is designed to target is viewed as a top priority.

In addition to assessing perceptions about the problem and consumer intervention preferences through focus group meetings, it would be useful to issue questionnaires to households. Sample questions would mimic those of the questionnaires distributed by coordinators of the ITDG Smoke and Health Project. These questions include: Is smoke an issue? Do you think smoke affects your health adversely? How do you think you can make smoke less of an issue? These questionnaires could be administered verbally to populations that are largely illiterate.

In addition to qualitatively assessing the problem and consumer preferences, it would be beneficial to assess actual exposure and particulate measures. This could be done by selecting a particular number of households and monitoring exposure and particulate levels within those households using instruments such a carbon monoxide monitors. To encourage households to participate in this initial phase of quantitative assessment, program coordinators could offer some

form of monetary incentive. The number of households participating in this assessment would be determined by the size of the population that the intervention would target. The KCJ program, for example, was targeted to reach hundreds of thousands of people. To test its initial prototypes, it sent KCJ stoves to almost 500 households. The preliminary measurements are necessary for future assessment of intervention effects. Comparing preliminary measures to those taken after an intervention is adopted will indicate the effectiveness of the intervention.

Tier II: Training, Extension, and Demonstration

The second phase of the approach adopted by the KREDP consisted of training, extension, and demonstration. The KREDP trained local artisans, who already had experience in making traditional Jiko metal stoves, in how to make improved KCJ stoves. It offered specialized training to some artisans on how to create the new ceramic liners. Training was done both on and off-site. The KREDP also sponsored mobile training units to reach rural areas that would otherwise have very limited access to this form of training. In order for similar programs to successfully foster the development of an informed and highly trained production sector, they will need to offer similar forms of training. Local artisans, especially those who are already trained in making stoves, are the most favorable group to produce improved stoves. Because they rely on local scrap materials, they tend to keep the prices of improved stoves relatively low. Local artisans can also use their own knowledge about community needs to improve upon stove design and suitability. Improved stove production also presents an additional means through which local artisans can earn income. Keeping this income within local communities sparks local economies. This would not be possible if large distant corporations were primarily responsible for the production process.

Demonstrations that convey the importance and attractiveness of interventions are a necessary component of any successful program. The KCJ and ITDG projects offer suggestions for appropriate demonstration techniques. KCJ stoves were displayed at local agricultural fairs,

which sparked some consumer interest. The ITDG Project coordinators took pictures of interventions within homes and showed them to homes in distant areas. These photographs increased awareness about the availability and potential desirability of improved stoves. ITDG project coordinators also facilitated visits between families who had interventions installed with those who did not. These visits, termed 'exchange visits,' enabled women in particular to see interventions 'in action.' This increased their desirability and reduced the degree of trepidation women and men had about adopting new interventions, such as improved biomass stoves. Newspapers and radio commercials offer another venue through which governments and NGOs can advertise improved stoves.

Integrating a Participatory Framework

Involving local artisans in stove production is a form of participatory development since it taps into the indigenous knowledge base. Enlisting the aid of some families who are willing to show their interventions to other families during home visits is a form of community involvement. It is more personal for people to view their neighbors or fellow countrymen using an intervention than it is for them to see it in a newspaper or other publication. Of course this does not mean that such advertising would be fruitless, but rather, as the ITDG Smoke and Health Project demonstrates, that more personal forms of advertising facilitate and encourage intervention adoption rates. Advertising improved stoves in newspapers is especially favorable in areas where a large percentage of local populations are literate.

Tier III: Developing Productive Enterprises and Stove Dissemination

Tier II dealt with the effective training of local artisans. Tier III is devoted to creating and sustaining productive enterprises that would facilitate the dissemination process. The success of the KCJ Project partly relied on its ability to harness the skills and energy of local artisans to

mass produce improved stoves. Stoves that are mass produced by a group of artisans or a small factory are disseminated far more quickly than custom-built models whose construction and installation depend on the availability of trained technicians or installers.[51] The production of various portions of the improved stoves operates most efficiently when labor is specialized. For example, metal smiths might produce the metal outer layering while potters might construct ceramic liners. In this way, a potter and a metalsmith can produce far more stoves working together under factory-like settings than could one on-site stove maker. One study estimates that two or three workers could turn out approximately 2,500-5,000 mass-produced stoves each year, while it would take 20-40 trained installers to produce the same number of custom-made stoves.[52] Efficient stove production requires that labor be divided and specialized. This approach enables local artisans to use their own specialized training to create specific portions of the stove. Centralized production also helps with quality control issues because it demands that artisans meet standard specifications for various stove parts. Without these specifications, even the smallest variation in stove parts might significantly decrease efficiency.[53]

The actual successful dissemination of stoves requires that stoves are easily accessible. The KCJ Program advertised its stoves at agricultural fairs and also gave consumers the opportunity to purchase them at the fairs. In addition to making them available at fairs, stove producers could also make them available at local markets and on-site at the establishments of local artisans. In more urban areas, stoves might be sold in stores.

Integration a Participatory Framework

Consumer feedback plays a key role in this developmental phase. As stoves are disseminated, questionnaires and surveys distributed to consumers would give local governments

[51] Douglas F. Barnes, Keith Openshaw, Kirk R. Smith, and Robert van der Plas, "What Makes People Cook with Improved Biomass Stoves? A Comparative International Review of Stove Programs," World Bank Technical Paper Number 242 Energy Series (May 1994), p. 30.
[52] Ibid, p.31.
[53] Ibid.

and sponsoring organizations insight into the desirability and efficiency of improved stoves. Post-intervention focus group meetings might also provide a venue through which consumer feedback might be gathered.

Key Players

As the KCJ Program had demonstrated, the success of any intervention program partially depends on the types of partnerships upon which it is built. The KCJ program enlisted the aid of non-governmental organizations, the Kenyan government, the local manufacturing sector/local artisans, women's groups, the private sector and international funders such as USAID. The role of governments is to provide logistical support as well as some financial support (to finance start-up costs and research trips to other areas). The ITDG project demonstrates that governments should refrain from partaking in the actual production and dissemination of stoves. Doing so, as was done in some regions of Kenya with chimney stoves, might jeopardize the success of the program.[54] Long-term support is preferable to short-term support. Non-governmental organizations, with the aid of women's groups and local artisans, are best suited to take the lead in the stove dissemination process. The importance of the participation of women's groups is not to be understated. Women are often solely responsible for cooking. As such, their viewpoints must be taken into consideration when designing a stove for their use.

International organizations also play an important role in replicating successful stove dissemination programs. International support can be of tremendous value in the extension and support of the dissemination process and in the exchange of technical information and lessons between countries and regions with active or planned stove programs.[55] International involvement

---

[54] Ibid. p.32

[55] Daniel Kammen, ""Research, Development, and Commercialization of the Kenya Ceramic Jiko and other Improved Biomass Stoves in Africa," In Dept Solution Coverage < http://www.solutions-site.org/docs/2_60/2_60.htm> Date of Access: 3/25/03.

that is characterized by extended and stable is favorable to short-lived episodic funding.[56] Long term support protects against complacency and ensures that local groups have the sustained support that they need to function efficiently. International organizations as well as local governments can also provide a system of incentives that encourages the involvement of the private sector in producing, distributing, and selling improved stoves.[57] This system of incentives might include credit facilities for stove makers, facilitation of the availability of raw materials, and promotional support.[58]

Funding

To fund KREDP, organizers relied primarily on the aid of USAID and Kenyan government funds. These funds were used to sponsor trips to Thailand as well as for initial production, administrative, start-up, and training costs. These funds, however, were not used to subsidize the costs of stoves. Underlying this notion is the idea that people do not value things that are given to them. Programs that rely on subsidies create a sort of dependence. Consumers come to depend on the government or outside donors for their needs. They lack ownership. The purpose of stove dissemination programs is not to create a dependent relationship between consumer and program operators but rather to create an empowering one. Empowerment is possible when families purchase their own stoves and feel as though they personally have some sort of stake in their investment. Subsidies also potentially stifle innovation, such as the development of the cheaper Mandeolo stove. Those wishing to adopt a similarly successful program as the KCJ program, therefore, should refrain from offering subsidies.

Quality Control

---

[56] Ibid.
[57] Douglas F. Barnes, Keith Openshaw, Kirk R. Smith, and Robert van der Plas, "What Makes People Cook with Improved Biomass Stoves? A Comparative International Review of Stove Programs," World Bank Technical Paper Number 242 Energy Series (May 1994), p. 32.
[58] Ibid.

The KCJ Program, despite its success, encountered some barriers, many of which lie in the realm of quality control. Local artisans rely on local scrap materials to produce stoves. The availability of different types of scrap metals differ from region to region and over time. These differences produce variations in the quality, durability, and attractiveness of improved stoves. To address this problem, it would be beneficial to create some sort of quality control device. This device could take many forms, including warranties against defective merchandise. The government could also develop a list of standards that improved stoves must meet in order to be sold. Products that meet these standards would earn a government seal of approval.[59] In addition to seals of approval, the government could also perform routine, yet random, product tests by collecting sample stoves from select local artisans and testing their durability and efficiency. Artisans that fail to produce stoves that meet government standards could be fined. The purpose of these forms of quality control is to maintain consumer confidence in improved stoves and build in a system of accountability for stove producers.

Measuring Program Success

Several measures may be used to assess the success of an improved stove dissemination program. The primary goals of such programs include the desire to reduce indoor air pollution, improve fuel efficiency and fuel savings, and improve health. All of these goals can be qualitatively and quantitatively assessed. Questionnaires could be issued post- intervention to indicate perceived health benefits and fuel savings that are associated with improved stove usage. In addition, program coordinators could select random households and quantitatively gauge post-intervention pollutant and exposure levels (and compare these values to pre-intervention measures) using CO monitors and stain tubes. Addition indicators of program success include the

[59] Eric L. Hyman, "The Strategy of Production and Distribution of Improved Charcoal Stoves in Kenya," World Development 15 (1987), p.382.

number of new improved biomass stoves adopted and the reduction in the number of traditional stoves utilized.

Conclusions and Next Steps: Can programs similar to the KCJ and ITDG projects be applied elsewhere?

The KCJ program has been implemented in other nations, including Ethiopia, Malawi, Niger, Rwanda, Senegal, Sudan, and Uganda. [60] The design of the KCJ stove has been adapted to suit the needs of communities in each of the aforementioned regions. Below is a chart indicating the number of stoves adopted within various regions:[61]

Table 1: [62]
Estimates of the number of improved stoves disseminated in eastern and southern Africa
(Karekezi and Ranja, 1997).

Country	Urban	Rural	Total
Kenya	600,000	180,000	780,000
Tanzania	54,000	--	54,000
Uganda	52,000	--	52,000
Ethiopia	23,000	22,000	45,000
Rwanda*	30,000	--	30,000
Sudan	27,000	1,400	28,400
Zimbabwe	11,000	10,000	21,000
Burundi*	20,500	--	20,500
Somalia*	15,400	--	15,400

* Civil strife has significantly impacted stove programs and/or reduced the number of improved stoves in use. (--) indicates data not available.

As the data in Table 1 reflect, improved stoves are disproportionately adopted by people living in urban areas. One reason for this occurrence is that the KCJ stove is a charcoal burning stove. People in rural areas tend to rely more on fuelwood than on charcoal. As such, these people

[60] Daniel Kammen, "Research, Development, and Commercialization of the Kenya Ceramic Jiko and other Improved Biomass Stoves in Africa," In Depth Solution Coverage < http://www.solutions-site.org/docs/2_60/2_60.htm> Date of Access: 3/25/03.
[61] Ibid.
[62] Table adopted from Daniel Kammen's "Research, Development, and Commercialization of the Kenya Ceramic Jiko and other Improved Biomass Stoves in Africa," In Depth Solution Coverage < http://www.solutions-site.org/docs/2_60/2_60.htm> Date of Access: 3/25/03.

would profit more from an improved fuelwood burning stove than a charcoal burning stove. The three-tiered participatory framework of the KCJ and ITDG projects will still be useful for the successful dissemination of improved stoves to rural areas. Another type of stove, particularly one that burns fuelwood, will need to be adopted instead of the KCJ stove. This type of stove could potentially be an adaptation of the KCJ.

The use of biofuels, particularly in traditional biomass stoves, is dangerous both from an environmental and health perspective. The loss of trees that results from gathering fuelwood (or to provide the wood needed to make charcoal) causes erosion and habitat destruction, which result in a loss of biodiversity. The pollutants released from burning biofuels negatively affect health and have been linked to the onset of various cancers and respiratory illnesses. The populations most at risk for these illnesses are women and children who spend a considerable amount of time near stoves. Burning biofuels in biomass stoves is often fuel-inefficient. Improved biomass stoves, such as the KCJ, increase fuel efficiency considerably. This increase in efficiency alleviates pressures on local fuelwood and charcoal resources. Additionally, stoves such as the KCJ emit lower levels of pollutants, which is likely to improve the health of users.

While improved stoves offer a host of benefits, these benefits alone are not enough to propel consumers to purchase them. Promotion is necessary as is the creation of a stove that suits consumer preferences. The KCJ project addressed these needs rather successfully and as a result the KCJ is currently used in hundreds of thousands of Kenyan households. The ITDG Smoke and Health Project's participatory developmental framework provides a means to strengthen the KCJ approach. Enabling community involvement at each stage of the development and dissemination process facilitates the broad based acceptance and usage of improved biomass stoves. Both projects highlight the need for logistical support from NGOs, governments, and international organizations. They also demonstrate the power of involving local artisans in the process. Programs such as the KCJ and ITDG project are applicable elsewhere. Project and program

organizers must lean on the lessons learned from these projects to create successful programs that reduce indoor air pollution, increase fuel savings and efficiency, and improve overall health.

Source List

Ballard-Tremeer, G. and H. H. Jawurek, "Comparison of Five Rural, Wood-Burning Cooking Devices: Effectiveness and Emissions," Biomass and Bioenergy 11 (1996) pp. 419-430

Barnes, Douglas F., Keith Openshaw, Kirk R. Smith, and Robert van der Plas, "What Makes People Cook with Improved Biomass Stoves?" World Bank Technical Paper Number 242 Energy Series (May 1994)

Bruce, Nigel, Rogelia Perez-Padilla, and Rachel Albalak, "Indoor Air Pollution in Developing Countries: A Major Environmental and Public Health Challenge," Bulletin of the World Health Organization 78 (2000) pp. 1078-1092

Bruce, Nigel, Lynnette Neufeld, Erick Boy and Chris West, "Indoor Biofuel Air Pollution and Respiratory Health: The Role of Confounding Factors among Women in Highland Guatemala," International Journal of Epidemiology 27 (1998) pp. 454-458

Ezzati, Majid and Daniel M. Kammen, "Indoor Air Pollution from Biomass Combustion and Acute Respiratory Infections in Kenya: An Exposure-Response Study," The Lancet 358 (August 2001) pp. 619-24

Ezzati, Majid, Bernard M. MBinda, and Daniel M. Kammen, "Comparison of Emissions and Residential Exposure from Traditional and Improved Cookstoves in Kenya," Environmental Science and Technology 34 (2000) pp. 578-583

Ezzati, Majid and Daniel M. Kammen, "Evaluating the health benefits of transitions in household energy technologies in Kenya," Energy Policy 30 (2002) pp. 815-826

Ezzati, Majid and Daniel M. Kammen, "Household Energy, Indoor Air Pollution, and Health in Developing Countries: Knowledge Base for Effective Interventions," Annual Review of Energy Environ 27 (2002) pp. 233-70

Hyman, Eric L., "The Strategy of Production and Distribution of Improved Charcoal Stoves in Kenya," World Development 15 (1987) pp. 375-386.

Kammen, Daniel M., "Cookstoves for the Developing World," Scientific American (July 1995), pp. 72-75.

Kandpal, J.B. and R.C. Maheshwari, "Combustion of Biomass Fuels in Two Cookstoves for their Conservation," Energy Conservation and Management 36 (1995) pp. 1015-1021.

Kandpal, J.B. R.C. Maheshwari, and Tara Chandra Kandpal, "Indoor air pollution from Domestic Cookstoves using Coal Kerosene and LPG," Energy Conservation and Management 36 (1995) pp. 1067-1072.

Kandpal, J.B. R.C. Maheshwari, and Tara Chandra Kandpal, "Indoor air pollution from combustion of wood and dung cake and their processed fuels in domestic cookstoves," Energy Conversion and Management 36 (1995) pp. 1073-1079.

Kishore, V.V.N. and P.V. Ramana, "Improved cookstoves in rural India: how improved are they? A critique of the perceived benefits from the National Programme on Improved Challas (NPIC)," Energy 27 (2002) pp. 47-63.

Kituyi, E., L. Marufu, S.O. Wandiga, I.O. Jumba, M.O. Andreae, G. Helas, "Carbon monoxide and nitric oxide from biofuel fires in Kenya," Energy Conversion and Management 42 (2001) pp. 1517-1542.

Larson, Bruce A. and Sydney Rosen, "Understanding household demand for indoor air pollution control in developing countries," Social Science and Medicine 55 (2002), pp. 571-584.

Lodhi, M.A.K. and A. Zail-al-Abdin, "Indoor air pollutants produced from fossil fuel and biomass," Energy Conservation and Management 40 (1999) 243-248.

McCraken, John P. and Kirk R. Smith, "Emissions and Efficiency of Improved Woodburning Cookstoves in Highland Guatemala," Environment International 24 (1998) pp. 739-747.

Munene, Fibi, "Kimaki Jiko: An Improved Stove for Urban Kitchens in East Africa," The IDRC Reports (October 1985).

Ndiema, C.K.W., F.M. Mpendazoe and A. Williams, "Emission of Pollutants from a biomass stove," Energy Conservation and Management 39 (1998) pp. 1357-1367.

Parikh, Jyoti, Kalpana Balakrishnan, Vijay Laxmi, and Haimanti Biswas, "Exposure from cooking with biofuels: pollution monitoring and analysis for rural Tamil Nadu, India," Energy 26 (2001) pp. 949-962.

Practical Answers to Poverty, "Reducing Indoor Air Pollution in Rural Households in Kenya: working with communities to find solutions," The ITDG Smoke and Health Project 1998-2001 (January 2002).

Rouse, Jonathan, "Improved Biomass Cookstove Programmes: Fundamental Criteria for Success," The Centre for the Comparative Study of Culture, Development, and the Environment: The University of Sussex (August 1999).

Smith, Kirk R., "National Burden of disease in India from indoor air pollution," PNAS 97 (November 2001), pp. 13286-13293.

Smith, Kirk R., Jonathan M. Samet, Isabelle Romieu, Nigel Bruce, “Indoor Air Pollution in developing countries and acute lower respiratory infections in children,” Thorax 55 (2000) pp. 518-532

Smith, Kirk, “National Burden of disease in India from indoor air pollution,” PNAS 97 (November 2000)

Solutions Site Case Study, “Research, Development, and Commercialization of the Kenya Ceramic Jiko and other Improved Biomass Stoves in Africa,” <http://www.solutions-site.org/textonly/cat2_sol06.htm> Date of Access: 3/25/03