THE KENYA CHARCOAL STOVES PROGRAM:

INTERIM REPORT

Prepared for:

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FOREWORD

The information presented in this report is largely derived from the author's experience while working as a consultant with the USAID-assisted Kenya Renewable Energy Development Project in the Ministry of Energy and Regional Development. This report reviews the activities undertaken during March 1982 to March 1984 in developing and introducing fuel efficient charcoal stoves for household use.

Project files and internal reports are the main sources of the information presented. Participant observation, site visits, study tours, interviews with stove makers, users and extension workers provided the author with additional insights into wood fuel problems and feasibility of the improved charcoal stove technology in Kenya.

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I. INTRODUCTION

One of the three components of the Kenya Renewable Energy Development Project[1] is the improved wood fuel stoves program. Enhancement of the heat transfer efficiency in wood and charcoal stoves is a main priority for wood energy conservation policy in Kenya.

This report describes the work done so far in development and dissemination of improved stoves. A schedule of the planned activities through June 1985 is also presented.

A. The Problem

The importance of wood energy to Kenya's 19.7 million people is well documented.[2] In 1981, wood fuel constituted 96% of all non-commercial energy and 71% of total energy consumption in all sectors. Demand for firewood is rising at 3.6% annually and that of charcoal at 6.7%. With a population growth rate of over 3.8% and declining real incomes, Kenyan households are bound to depend increasingly on locally available energy resources, especially wood fuel for cooking and heating.

Kenya's wood fuel problem is characterized by a demand-supply imbalance caused by an increased resource depletion rate without a matching increase in the replacement rate. The undesirable effects of wood fuel scarcity are already being suffered by many Kenyan communities. These effects include:

- Increased time, labor force and distances for the procurement of wood fuel;
- Escalating prices of firewood and charcoal; and
- Increased deterioration of vital ecosystems.

It has been predicted that the wood fuel problem will become a crisis of unmanageable proportions by the year 2000 unless a production and conservation policy is actively pursued.[3]

B. Policy Options

In dealing with the wood energy problem, Kenya has three major feasible policy options:

- Promotion of widescale adoption of agroforestry land use practices together with increased afforestation and biomass plantation efforts in order to increase the supplies of wood fuel;
- Substitution of wood fuel by other forms of energy, e.g., biogas, solar and wind; and
- Wood fuel demand mitigation through reductions in per capita consumption by introducing more efficient conversion and end-use devices and methods.

These options are all being pursued at different levels in Kenya today. The experience and lessons learned from efforts to develop and introduce efficient wood and charcoal stoves are the subject of the following discussion.

C. Improving Stove Efficiency

Tests of traditional stoves indicate that a great opportunity to conserve energy lies in reducing the wastefulness experienced in stoves such as the open fire or the traditional all-metal charcoal stove. On the average, heat transfer efficiencies ranging from 5-10% and 15-20% are obtainable from the open fire and the traditional metal stoves respectively. Laboratory and pilot field tests from around the world show that it is possible to enhance the heating efficiency to 25% for woodstoves and to 30% for charcoal stoves. This translates into at least a 30-40%

reduction in the amount of fuel required to cook a meal. A widespread adoption of stoves with 30% efficiency could lead to a reduction of annual wood fuel need per capita from 840 kg[4] to 588 kg.

A key attraction of stove efficiency improvement as a conservation measure experienced in Kenyan projects is that once an acceptable, affordable stove is developed and on the market, wood fuel consumers have had no hesitation in investing in (and, thus, actively supporting the dissemination of) the device. A self-sustaining mechanism for transfer and adoption of new stoves technology can, as in Kenya, take root in less than five years.

II. THE CHARCOAL STOVE PROGRAM

A. Development Objective

A long-term objective of the Kenya stove program is to assist the Government of Kenya (GOK) to combat the adverse effects of a worsening wood fuel problem. This is to be achieved through design, development, testing and large-scale production and diffusion of fuel efficient wood and charcoal stoves for household use. The assistance includes expansion and support for existing institutions, organizations and industry engaged in planning, funding, coordinating and implementing improved stoves projects.

Another long-term objective is to relieve substantially the increasing financial burden imposed on households, especially low-income groups, by the larger proportion of income needed to purchase wood energy. For those still able to collect it free, a long-term goal is to reduce time and labor spent collecting firewood.

B. Immediate Objective

The immediate overall objective is, over a three-year period, to build an institutional capability and develop the entrepreneurial skills needed to:

- Plan, evaluate, and implement stove programs;
- Produce and distribute improved stoves; and
- Monitor and evaluate the impact of improved stoves.

This capability is being built within both Governmental and non-Governmental institutions through their participation in the implementation of the charcoal stove dissemination program.

C. Program Strategy

The program strategy calls for a multi-sectoral approach involving external technical inputs, international aid organizations, Government agencies, private volunteer organizations, formal and informal private sectors and stove users in the development and dissemination of charcoal stoves.

The program has four main components:

1. Applied Research and Prototype Development

This involves surveys and assessments of existing energy technologies; user characteristics; use patterns; social needs for stoves; testing stove materials; formulation of design criteria; prototype design and laboratory testing; field testing and performance monitoring.

2. Training, Extension and Demonstration

Training is provided for trainers, artisans, extension workers and program managers through participation in seminars or hands-on training workshops of short duration.

3. Production Enterprise Development

Technical and material assistance are provided to selected artisans, potters and existing stove makers to enable them to set up improved stove production enterprises. This assistance is provided through the Energy Development Fund, a small grants program for promoting the commercialization and spread of improved stoves and other renewable energy technologies.

4. Monitoring and Evaluation

This calls for regular follow-up of field activities and analysis of data collected in order to identify any constraints to stove adoption and assess the impact of the various program activities.

D. Performance Targets

The targets originally set for the project include:

- Introduction of about 5,000 improved stoves in rural and urban poor households;
- Building within the Ministry a technical capability to identify, plan, implement and evaluate improved stove programs; and
- Demonstration of improved stoves in at least 20 districts in Kenya.

As project implementation got under way, these targets were better defined in quantifiable terms and some others added.

Additional targets include:

- The building of a capability among energy non-Governmental organizations (NGO's) to implement stove programs; and
- Establishment of a network of up to 20 self-sustaining stove production enterprises.

E. Institutional Framework

Before the launching of the Kenya Renewable Energy Development Project (KREDP), the then Ministry of Energy had already been invited to collaborate with non-Governmental organizations (NGO's) in energy conservation extension work. The Claystove Working Group, an association of individuals working in wood energy (later to become KENGO) had received a small Ministry grant to enable them to exhibit stoves during the 1981 United Nations Conference on Renewable Energy.

The Ministry of Energy, being new and lacking a field extension network, needed to quickly develop collaborative ties with field operating NGO's in order to achieve an impact with the cookstove program during the life of the project. The establishment of direct GOK-NGO working linkages

provided an immediately effective institutional framework for stove dissemination. The task was to identify a suitable organization to coordinate NGO and Government activities. Fortunately, at that time KENGO (Kenya Energy Non-Governmental Organizations Association) had already organized a national forum for NGO's working in renewable energy. This provided a vehicle for the Ministry to reach stove consumers through a complex network of national and local groups. The major institutions involved in the cookstove program and the functions they perform are outlined in Figure I.

Figure 1

KENYA COOKSTOVE PROGRAM - INSTITUTIONAL FRAMEWORK

Institution	Role	Major Functions
Ministry of Energy and Regional Development	Project Host	-Policy formulation and guidance -Channeling donor funds -Contractor management
USAID	Project Sponsor	-Funding -External evaluation
Energy/Development International	Project Contractor	-Provision of technical advisors -Project implementation -Documentation
KENGO (Kenya Energy Non-Governmental Organizations Association)	National NGO-GOK Coordinator (Project Subcontractor)	-Extension -Demonstration -Technology evaluation -Monitoring and follow-up -Training -Technical offerings -National coordination
ITDG and other foreign technical groups	Technical Collaborators	-Technical assistance -External evaluation -Documentation -Technology transfer -Training of stove technicians

Institution	Role	Major Functions
CARE-Kenya	Operating NGO	-Field operations -Training, extension, demonstration -Financial and technical services -Monitoring and evaluation
Appropriate Technology Advisory Committee	Operating NGO	-Training and demonstration -Financial support -Monitoring -Private sector programs
ATC, Kenyatta University College and the University of Nairobi	Technical Collaborators	-Prototype design -Materials testing -Laboratory testing of stoves -Instructional materials -Surveys and research
PVO income-generating groups	Operating NGO's	-Training and demonstration -Stove production
Private sector	Stove production	-Stove making and distribution
Churches, Chiefs' camps, Government field extension centres, market places and retail shops	Stove distribution	-Stocking and selling stoves to users
Rural and urban households	Stove users	-Applied evaluation of stoves -Saving energy through use of efficient stoves

III. PROGRAM IMPLEMENTATION

The Cookstove Implementation Plan[5] groups cookstove activities into three main categories:

- Social needs and technology assessment surveys;
- The Prototype design process; and
- Dissemination.

A. Social Needs and Technology Assessment Surveys

At the beginning of the program, several surveys were undertaken in order to define the baseline situation. Ongoing cookstove production and dissemination activities were reviewed[6] in order to identify and evaluate existing promising technologies and extension approaches.[7] Because of the nature of USAID's target population for project benefits, it was necessary also to understand the structure of the informal sector cookstove industry with its proven capability to mass produce the widely used traditional metal stove for charcoal. An informal survey of this industry was carried out.[8] Related to this was a technical tour to Thailand where 16 claystove factories were visited. The technical team studied the Thai methods of production and marketing of the widely-used Thai stove for charcoal and wood.[9]

Field experience and studies previously carried out on household energy consumption patterns in Kenya were equally helpful in defining needs for stoves, criteria for stove adoption and in identifying a programmatic approach and action priorities.[10]

Priority action on improving and introducing charcoal stoves was preferred as it began with a geographically compact system that could be easily monitored. With charcoal stoves, it was felt that the greatest impact both in terms of fuel quantities and money saved could be made in

the shortest time. This would serve as a good demonstration and teaching model on how to go about the more diffused and complex problem of the introduction of wood stoves.

In addition, a look at the existing infrastructure for stove production and distribution, the existing economic demand for charcoal and the available technical options revealed that improved charcoal stoves stood the best chance for commercial dissemination while improved woodstoves needed more diversified and location specific extension strategies.

The pre-surveys also revealed a great demand for energy-efficient stoves particularly among households that purchased wood fuel. The strongest economic demand is in the urban areas, small townships, settlement schemes and among commercial and institutional users of charcoal and firewood. Currently, over 1.5 million traditional charcoal stoves are estimated to be under use with a replacement rate of 400,000 units per year. Thus, the case for the commercial dissemination of improved charcoal stoves is self-evident. However, for wood stoves, there are no records yet of a successful case of significant diffusion of wood stoves among the poor in Kenya through commercial production.

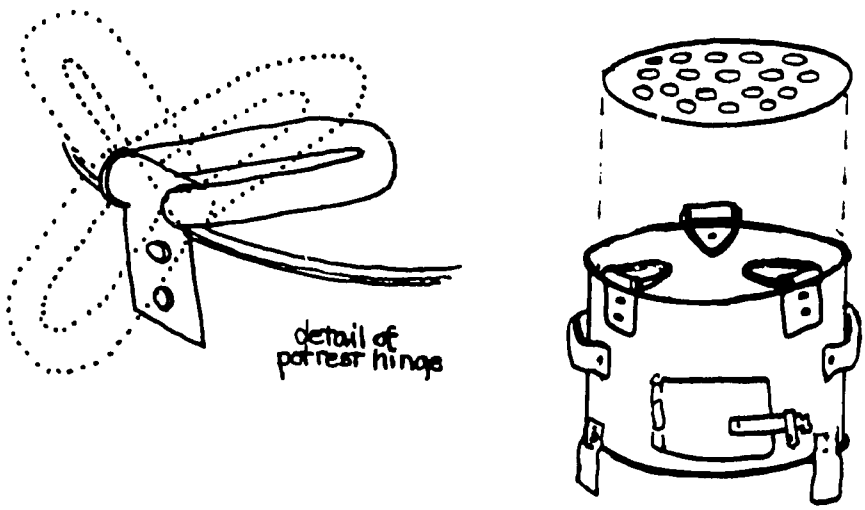
Another finding from the surveys was that in Kenya, stove dissemination work has been carried out mainly by:

- Largely uncoordinated local and international organizations undertaking ephemeral projects in stove development; and
- The traditional stove industry successfully servicing the market for the highly inefficient traditional charcoal stove (see Figure 2) and providing regular employment for over 5,000 artisans.

These have been two unrelated domains, each working independently of the other. It was recognized at an early stage that the improved charcoal stove must aim to displace the traditional one. Therefore, the need arose to establish early links between the promoters of improved stoves and the

Figure 2

THE EAST AFRICAN TRADITIONAL CHARCOAL STOVE



Origin of Stove:	India, reportedly in the 1930's
Description:	One pot, portable all-metal stove
Standard Weight:	Ranges from 3.5 kg - 15 kg
Range of Sizes:	12-64 cm diameter and 14-48 cm high
Lifespan:	6-12 months with regular use
Cost:	KShs. 15-350, depending on size
Rated Heat Transfer Efficiency:	15-20% on water boiling
Design Features:	Pot rests, legs, handles, grate, controllable primary air
Construction Materials:	Scrap sheet metal, iron bars and rivets
Dissemination:	Through widely spread small-scale artisan production. Stove is used by 83% of urban households and 17% of rural households.

producers of the unimproved ones: the former had the innovation, the latter a grip on the market.

B. The Prototype Design Process

The development of stove prototypes was a cyclical process involving formulation of design criteria, materials identification and testing, prototype design, laboratory and field testing, final modification of prototype and going back to reformulation of design criteria when the prototype proved unacceptable.

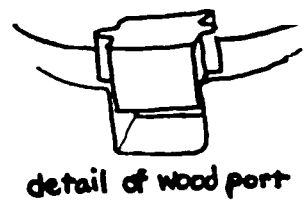
Experience elsewhere and stove testing done in Kenya show that a combination of metal and fired clay or other insulation materials gives the best charcoal stove performance in terms of fuel economy and stove durability.[11] Much of the design time was therefore spent on finding acceptable ways of adopting the Thai bucket stove (see Figure 3) to Kenya's cooking requirements and existing stove production/distribution network.

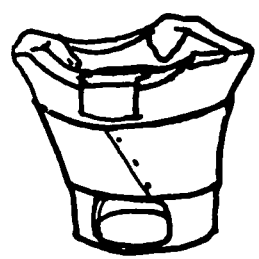
At this stage, collaboration with the ITDG Stoves Project was established to assist in training stove testing personnel and for further testing of the new charcoal stove prototypes. A stove testing center at Kenyatta University College was reactivated, a laboratory technician trained and a systematic laboratory testing program began at the Appropriate Technology Centre. Kenya standard procedures for testing charcoal stoves[12] were drafted and used to test all the prototypes.

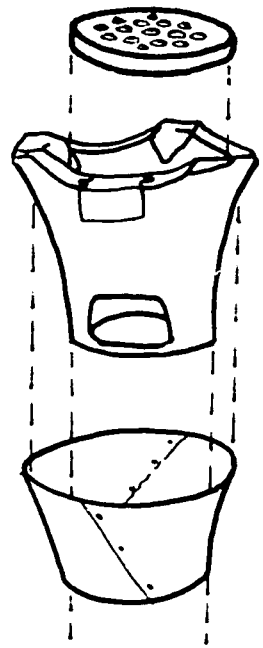
Several promising stove designs (see Annex 1) were evaluated and compared to each other. These included the traditional metal stove, the pipeliner, the Umeme Jiko (by UNICEF) and the Kenya version of the Thai Bucket. Later, another model lined with a mixture of cement and vermiculite was included (see Figure 4). All these designs showed a marked improvement over the traditional metal stove with each giving over 25% reduction in charcoal use. This was confirmed for both water boiling and cooking tests.[13]

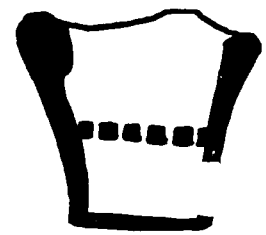
Figure 3

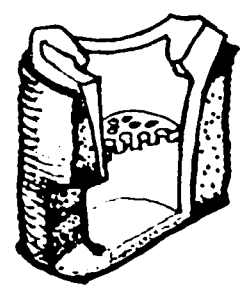
THE THAI CERAMIC-METAL STOVES

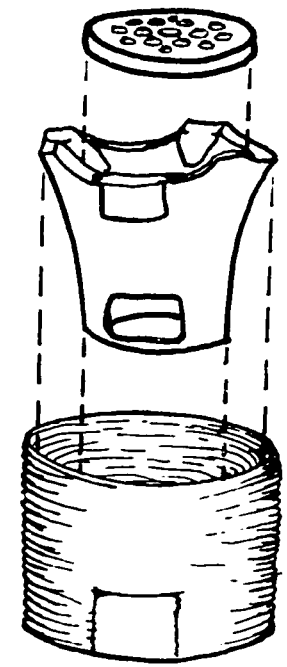












Origin of Stove: Reportedly China, 1920

Description: Portable, single-pot, charcoal stove

Range of Sizes: 10-36 cm diameter and 14-32 cm high

Standard Weight: 7-12 kg

Lifespan: 5-24 months

Cost: KShs 20-100

Rated Heat Transfer Efficiency: 30-32% in water boiling tests by ITDG

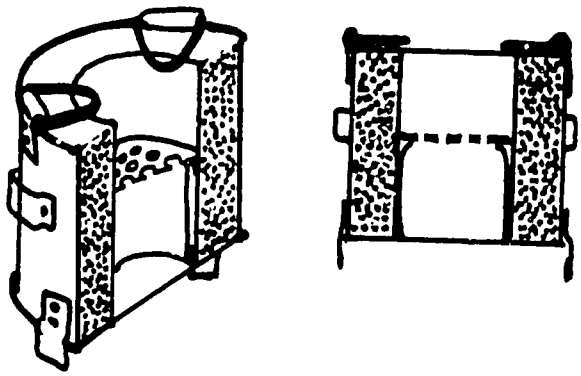
Design Features: Clay pot rests, handles, grate, primary air supply with and without control

Construction Materials: Clay, rice husk ash, cement, sheet metal, old cans

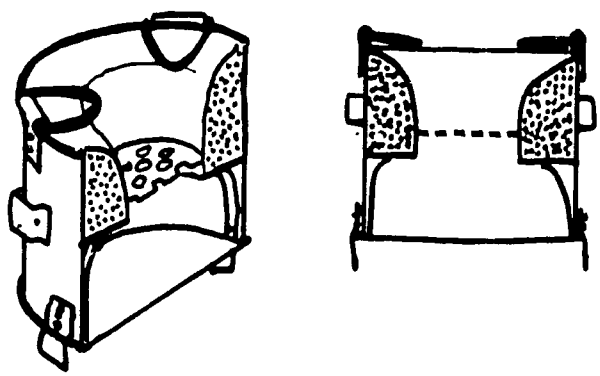
Dissemination: Through well-managed family factories spread out all over Thailand

Figure 4

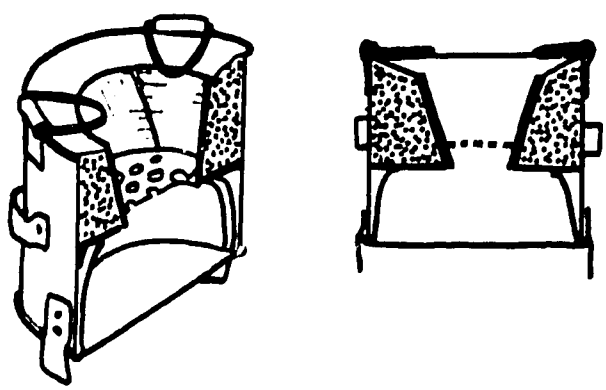
THE EVOLUTION OF THE CEMENT/VERMICULITE STOVE



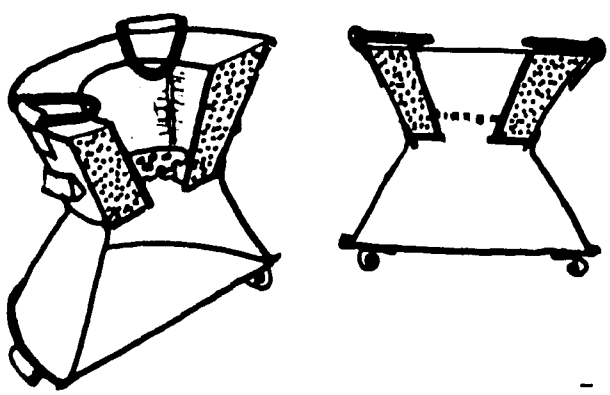
The traditional metal stove lined with insulation all the way down. Proved to be too bulky and weighty.



Metal stove lined halfway with insulation and supported with a metal collar. Appearance of cracks discour- aged buyers.



As in model (b) above, but a sheet metal sleeve inserted inside firebox to protect insulation from cracking and burning out too fast. The sheet metal warped quickly because of high temperature and the grate sank to stove bottom.



The shape of cladding changed to obtain uniform thickness of lining and reduce cost and weight.

An evaluation of materials and engineering costs involved in producing standard sizes of these promising prototypes while maintaining rated fuel economy indicated that the Kenyan version of the "Thai Bucket" stove was the most cost-efficient and adaptable to locally available skills and materials. A decision was therefore made to carry out further evaluation of this design in order to test its social acceptability.

The Kenya Ceramic Jiko, like its counterpart the Thai Bucket stove, with a 30% heat transfer efficiency in water boiling tests performed best among those of comparable cost and durability (see Table 1).

In adapting the Thai Bucket to Kenya's conditions, the following changes were made:

- The clay pot rests were removed from the ceramic liner and replaced with metal ones resting on the metal cladding. This protected the liner from the heavier pots used in Kenya and simplified its construction by removing the need to carve the clay pot rests into proper shape (in Thailand, this process, known as stove cutting, requires relatively high skills).

- Short legs were built in to keep the stove from rocking to and fro on an uneven kitchen floor.

- A tighter fitting inlet air door was installed to enable better regulation of power output: standard meals in Kenya require both high and low power output at different cooking stages.

- The metal casing was made out of the same heavier gauge sheet metal used for the traditional metal stove. Although this was unnecessary, stove buyers are used to associating stove durability with the heaviness of materials used.

- The bucket-shaped metal cladding of the Thai stove was replaced with a hourglass-shaped one. Some meals require heavy mashing and stirring -- forces that could easily topple a stove whose basal area is smaller than the pan area.

Table 1

COMPARATIVE PERFORMANCE OF TWO CHARCOAL STOVES *

Stove Type	No. of Tests	Time to Ignite/Boil Secs.	Time to Ignite/Boil Mins.	Door Position	Charcoal Used gms.	Water Evaporated gms.	Evaporation Rate gms./min.	PHU 2 %	Power Output
Pottery Liner	2	45	16	Open	234	664	22	32.0	2.5
	2	45	16	Shut	176	351	12	28.0	1.8
Traditional Jiko	4	45	24	Open	202	272	9	21.5	3.6
	4	45	24	Shut	184	202	7	20.3	3.3

* Based on tests done by ITDG in U.K. in 1983.

The modified charcoal stove was then subjected to a six-month field test. The aims of the field test were:

- To assess the social suitability and acceptability of the stove;
- To determine whether performance results obtained in laboratory tests are replicated in actual household conditions;
- To determine the durability of the stove;
- To evaluate the technical feasibility and economic viability of the production technique, thus testing the transferability of Thai stove technology;
- To demonstrate improved stoves and raise public awareness of energy-saving opportunities; and
- To test the marketability of the stove and establish economic price structures.

The field test program cost approximately KShs. 70,000 in stove materials, transport, wages for survey assistants and administrative support. The program was carried out by several NGO's and coordinated by KENGO under a grant from the KREDP.

First, five hundred households were selected to receive a free sample of the Kenya Ceramic Jiko. One hundred of these were surveyed in detail to determine their charcoal use patterns before introduction of the stoves. Fifty of these were treated as the control group and the other fifty were the test group. The other 400 received stoves but were not monitored as intensively.

In the meantime, a small pottery firm in Nairobi (Jerri International Ltd.) had been taught how to produce the test prototypes. Previous interest in improved stoves and demonstration of capability to replicate and commercialize the stoves were some of the reasons for selecting Jerri International as a collaborator in the field test. During the production of the stoves, a refinement of the production method was made and a production cost analysis concluded indicating that the stove can be fabricated profitably and sold for KShs. 45 wholesale price.

The field test was officially launched by an Assistant Minister for Environment and Natural Resources at a colorful and well-attended ceremony on November 5, 1983. This ceremony underscored the effectiveness of interaction between technicians, public opinion leaders, extension workers, Government agents and stove users in a campaign to give stove programs the credibility required for successful implementation.

The launching ceremony was preceded by a week's training workshop for those extension workers and survey assistants to be involved in monitoring and reporting field test progress. This workshop was officially opened by the Minister for Energy and it was well covered by the local press.

As stoves rolled off the production line at Jerri, they were distributed in batches to the households and thus began the evaluation of the stoves under household use.

During the first month, several problems were immediately reported.[14] The ceramic liner in several stoves had come loose and many grates had broken rendering the stoves useless. Problems of ignition and complaints about the stove's weight were also received. Factory price of these stoves was quoted at 1½-3 times that of the traditional metal jiko of the same size. It was feared that this may make the stove inaccessible to most people. In spite of these problems, 80% of the working stoves were reported to be giving fuel cost reductions of 30-50%.

The final prototype of the Kenya Ceramic Jiko included the following modifications:

- The cylindrical metal cladding was constricted at the "waist" so as to conform to the liner's inward slanting upper walls to anchor the liner more firmly. The cladding's lower half flared out to give more space in the ash chamber. This improved ignition time. The new shape of cladding also used a less expensive grade of scrap metal than the cylindrical one and cost 8% less in materials. Incidentally, the introduction of a new appearance in the charcoal stove drew more user attention and went a long way in convincing skeptical customers that improvements had indeed been made.

- Instead of loose ash in the space between the cladding and the liner, a wet mixture of cement and vermiculite was used to hold the liner firmly against the cladding walls.

- A half-liner model was introduced to reduce the weight of the stove. This also resulted in slight reduction of construction costs.

In the meantime, Jerri International was gradually expanding the stove production line and creating a national distribution and marketing network. Information and stove user complaints obtained by extension workers were channelled to the stove program consultants who worked with the producers as part of the program's technical assistance service.

A variation of the Kenya Ceramic Jiko is a version with a cement/vermiculite lining. These were field tested in Mombasa town and proved equally promising. Although not as durable as the ceramic version, the cement/vermiculite lining is quite inexpensive to fabricate adding less than 5% to the price of traditional stove. If properly constructed, this stove has the same durability as the ceramic model. However, hairline cracks appear with initial firing. These do not inhibit performance or durability but they discourage discerning customers.

C. Dissemination

The primary goals for the charcoal stove dissemination strategy are:

- To develop a cadre of technicians, trainers and extension workers skilled in stove production, promotional methods and program activity monitoring and evaluation;

- To create a national network of stove artisans and entrepreneurs skilled and involved in fabrication and repair of improved stoves; and

- To achieve a large-scale adoption rate of proven improved stoves by rural and urban households.

The main components of the dissemination strategy are:

- Training and extension;
- Production development;
- Demonstration and publicity; and
- Monitoring and evaluation.

1. Training and Extension

Three basic training strategies have been implemented:

- Informal on-site training for cookstove artisans through the Mobile Training Unit;
- Formal training workshops and seminars for trainers; and
- In-service training at the cookstove production centers.

The purpose of the training is to teach trainers, stove-makers and extension workers required skills and techniques for designing, fabricating and disseminating improved stoves.

The activities of the Cookstove Mobile Training Unit are targeted on the informal sector stove makers and potters. The Mobile Training Unit is the basic vehicle for extending training and follow-up services to all participating NGO's. Equipped with trainers, stove demonstrator, tools, templates and stove prototypes the Unit visits preselected groups to offer on-site training. Most trainees can fabricate the cladding to a specified standard after only 3-4 training sessions since they are already conversant with sheet metal work. Potters take a bit longer--at least one month's intensive training.

Special advantages of these on-site visits are:

- Artisans can participate in the training without having to leave their place of work;

- Training techniques can quickly be adapted to the technical and social-economic production conditions found on site; and
- Skills are directly transferred to the sector already involved in production of the traditional metal stove.

The traditional stove is the main target of the charcoal stove improvement efforts and it becomes essential to engage those involved in its fabrication in the production of the improved fashion.

Evaluation of impact of the training is fairly easy. All the artisan has to do is fabricate, under trainer's observation, several units which are then examined and rated for quality, conformity to specifications and speed of production.

Follow-up visits are made to monitor progress and provide any necessary technical assistance. In some cases, individual artisans who show exceptional interest and entrepreneurial capabilities are given small grants in the form of jiko-making tools and materials. During the training session, a stove demonstrator is busy showing the new stoves at the local market place and receiving orders from potential buyers. These are turned over to a local trade shop or to the stove makers and customers are directed to collect stoves from there at a later date. Thus, the Mobile Training Unit also helps in establishing a local sales network as well as in publicity and promotion of stoves. This is an important task because most artisans and potters will not readily invest in a new technology unless its economic viability or potential market demand are convincingly demonstrated.

The second training scheme involves five to ten days workshops and seminars for trainers and extension workers. Participants representing different NGO's are invited for short, intensive training sessions. Combining formal lectures and practical participation on the production line, the trainees are exposed to the major theoretical and practical considerations in stove development and dissemination.

Again, trainee follow-up is an essential component of this scheme. The follow-up involves visits to monitor and assess on-going field work and occasional short seminars for exchange of field experience, lessons learned and new information.

The third training scheme is again for artisans but this one is aimed at creating mid and high level technical skills, entrepreneurial skills and ability to evaluate different cookstove designs. This training takes place at the Government's Renewable Energy Demonstration Centres, last three months and involves small groups of five to seven individuals. Testimonials are issued on successful completion of the course. Qualifying candidates are generally well-prepared to work as field technical officers with Government, local and international NGO's involved in stove work.

The basic challenge in stove training work is to create an effective country-wide network of technicians, artisans, trainers and extension workers to service the growing cookstove industry. Without necessarily formalizing the informal sector, an institutional structure for stove production must be developed if energy-efficient stoves are to spread widely and quickly.

2. Production Development

This component of the dissemination strategy is time consuming, demands skills in small enterprise development and calls for innovative approaches. Production development work is aimed at:

- Assessment and demonstration of the technical feasibility and economic viability of alternative production and distribution schemes for improved stoves;
- Extension of technical and material resources to individuals, private business and voluntary organizations to help in establishing self-sustaining production units for improved stoves and other wood energy conservation devices;
- Monitoring and evaluation of performance of production and sales of stoves; and

- Continuing research in materials, product engineering, tools and production technology.

To date, activities in production development have included: technical assistance in setting up a small-scale stove manufacture enterprise; assistance in setting up a rural community group's facilities for producing fired-clay stove components; establishment of a network of informal sector stove makers producing components for the improved stoves and the establishment of NGO-run production-cum-training centers.

The transfer of these skills is being institutionalized around and within selected regional production units. Private enterprise production units are developed through a unique method of technical collaboration between KENGO, KREDP and a selected entrepreneur. A turn-key offering is made and the entrepreneur enters into a legally binding technical assistance agreement with the Program. (The Program provides all the technical and the bulk of the financial support required to initiate the manufacture of stoves. The client will make some contribution in cash or in kind, and will refund total start-up cost once production becomes a viable business.)

Grant funds have been set aside under the Ministry's Energy Development Fund (EDF) to be used as the main resource for facilitating establishment of production units for improved stoves. Although these funds have so far been unavailable (due to administrative bottlenecks), the EDF grants should become a critical factor in large-scale dissemination of improved stoves through private enterprise development. Negotiations are on schedule to review the EDF grant criteria in order to render the fund more accessible to the real target population.

3. Demonstration and Publicity

Field experience has shown that unless new stoves are effectively publicized and convincingly demonstrated, adoption rates can be disappointing. Not unlike other sectors of the population, wood fuel users

are naturally suspicious of new devices. Demonstration and publicity of the new stoves should be carefully synchronized with availability of such stoves. Therefore, production development, demonstration and publicity activities are implemented concurrently.

On-going stove demonstrations in open air market places have proven to be useful forums for the general public to express their views and problems on stoves. Other demonstrations are held at trade fairs, public institutions and at the agroforestry centers. The basic stove demonstration technique is to address the stove users' needs by presenting an easy-to-follow comparative performance "test" involving the traditional stoves used locally and the proposed improved counterparts. A simple meal, e.g. boiling maize and beans, is usually cooked. An assessment of the impact of the demonstration is often done by noting numbers of users willing to purchase stoves on the spot, those willing to place serious orders and the general responses from the public.

Mass publicity of improved stoves is frequently done through the public media. Inauguration ceremonies for new production/training centers, regional training/workshops and formal launching of community-based stove development projects are normally officiated by public opinion leaders. The attendant press coverage of these events are useful publicity opportunities for the country stove program.

4. Monitoring and Evaluation

The program managers in conjunction with participating NGO's maintain a constant contact with on-going activities to monitor progress and program impacts. The monitoring/evaluation methods include surveys of stove production and sales,[15] taped interviews with stove users, experts' discussion meetings and analysis of field reports. The specific aims of the monitoring/ evaluation exercise are:

- To determine whether quality stoves are being produced, sold and adopted by the project target population, i.e., whether an effective network for stove dissemination is developing;

- To identify needs for further technical assistance in product development;
- To assess the degree of consumer satisfaction with the stoves and identify constraints to adoption;
- To identify and document the social, economic and environmental impact of the stove program; and
- To develop replicable models and approaches for stoves dissemination work.

IV. PRELIMINARY ASSESSMENT

A variety of methodological and conceptual problems are commonly encountered in assessing the impact of improved stove technologies. Objectively verifiable indicators of program impact are difficult to observe or accurately quantify. The relationships between a stove's rate of efficiency, cost of stove, number of stoves in use and the actual or potential macro-savings in wood fuel remain vague, sometimes tenuous and fundamentally complex.

The expected impact of the stove program is:

1. Reduction of specific fuel consumption during cooking, i.e., less amount of charcoal consumed per meal cooked. It is expected that this would result in progress towards achieving a balance in wood fuel demand and supply. At the household level, this would lead to a reduction of cooking energy cost per meal.

2. Establishment of a formal institution for transfer of conservation technologies.

3. Creation of employment opportunities in the new stoves industry.

A. Program Achievements

After two years of development work, headway has been made in the areas of institution building, training, extension and publicity, enterprise development and stove dissemination.

To date, nine production centers spread around the country are involved in production and sales of stoves. Over 24,000 units have been sold at factory prices ranging from KShs. 85-99 for the Kenya Ceramic Jiko, KShs. 35-55 for a cement-vermiculite stove and KShs. 15-30 for an

all-ceramic charcoal stove. These prices compare with the ones for the traditional metal stove (KShs. 25-45).

The field test reports indicated reductions in charcoal use of 30-50% per meal. This translates to a cash savings of KShs. 60-90 per month for heavy users of charcoal. It is difficult to translate such savings into actual fuel wood or trees and their costs so as to quantify the potential environmental impact of the charcoal stoves. Benefits to the individual are self-evident and the rate of stove adoption is increasing steadily.

Institutional building is well underway. A national network for stove extension has been created (KENGO) and staffed with key personnel. Representatives of 50 NGO's are currently involved in stove promotion work. Over 30 artisans are now earning all or part of their incomes from manufacture of improved stoves while several salespersons have found jobs distributing these stoves. With training facilities established at several Government and NGO centers, opportunities now exist for formal training in stove making.

It is estimated that there are close to 1.5 million traditional metal stoves for charcoal in Kenya. The annual replacement rate is estimated at 400,000. The number of improved stoves sold so far represents only about 8% penetration rate.* In order to accelerate diffusion, many small-scale production units will have to be established throughout the country. Since the dissemination strategy for the Kenya Ceramic Jiko is through the normal commercial production and distribution network, a significant adoption rate for this stove will be self-evident when:

1. The number of traditional metal stoves offered for sale at open air markets and trade shops decreases noticeably;

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* Base estimation parameters are: Percentage of national population, urban = 15%; number of urban households = 540,000; number of rural households = 3,000,000; incidence of use of charcoal jikos = 83% of urban and 17% of rural households.

2. Improved charcoal jikos take a growing share of the market; and

3. Conditions (1) and (2) are sustained over a long period.

During the planning of technology development and dissemination activities like the Kenya stove program, crucial assumptions must be made about the potential problems and constraints. Serious mistakes in these assumptions may later slow down or seriously impede implementation.

The Kenya program has encountered significant, unforeseen problems and constraints and innovative approaches have had to be worked out to resolve some of these. Technical, institutional and resource problems have appeared from time to time.

B. Technical Constraints

Prototype development work has been constrained by lack of technical facilities adequately equipped for laboratory design and testing work on materials and stoves. Availability of formal technical guidelines on stove design process and evaluation was a problem compounded by the limited range of choices of proven designs of efficient stoves.

To cope with this problem, the program enlisted the collaboration of the Intermediate Technology Development Group who provided basic stove testing instruments and cooperated in designing standard testing procedures for Kenya charcoal stoves. The Aprovecho Institute was also called upon to provide technical inputs in the identification and simple testing of ceramic materials.

Stove making is traditionally an informal private sector activity. Tools and equipment are poorly developed and often of makeshift type. The production of improved stoves requires a fairly high level of standardization to duplicate desired quality and maintain critical dimensions in the product. This further requires standard tools and equipment which are generally not available. Improvement of the production

tools and equipment being used is a major task, and the program has made innovative attempts to standardize and upgrade traditional production techniques.

Design, testing and dissemination of improved stoves were originally scheduled to be complete in 18 months. Implementation encountered a variety of resource and institutional bottlenecks that resulted in delays and the need to extend project life by another 18 months. Experience has shown that a stove development program generally requires at least five years funding if a national impact is to be realized.

Funds are being sought from the Government and donors to sustain the Kenya stoves program beyond June 1985.

C. Resource Constraints

The program has been severely constrained by lack of area program managers, extension workers, trainers and skilled personnel to maintain a close follow-up of field operations. Project and Ministry staff have been overstretched as requests for technical assistance have flooded in from Kenya and elsewhere.

Efforts to recruit support staff have been hampered by sheer unavailability of appropriately skilled local and overseas personnel. Participating individuals, local trainers, extension workers and virtually all staff categories first had to receive in-service training as mainstream program activities proceeded. This has naturally been a time-consuming activity.

The cookstove program has not been allocated the level of funding needed to make a national impact with stoves within the project life. In this respect, a financial resource constraint has been encountered. However, in spite of delays in authorization and release of program funds, the contractor has frequently instituted abbreviated procedures to facilitate quick access to funds required for field operations.

The Energy Development Fund (intended to assist demonstration, production and commercialization of renewable energy technologies) initially promised to be a most effective vehicle for dissemination. However, grants from this fund have been virtually frozen due to the lack of an institutional framework for implementation. In addition, the criteria for EDF grant application tends to inadvertently disqualify a large part of the production sector that services the needs of USAID's target population for the cookstove program.

The contractor has made detailed suggestions for a review of EDF grant procedures. Ways are being sought for facilitating the smoother flow of grant funds more directly to the implementing agencies and organizations with closer links with the intended beneficiaries.

D. Institutional Constraints

At the outset, implementation of stove activities encountered hardships due to weaknesses and shortcomings in the institutions that were intended to provide logistical support. Protocol problems regularly arose in attempts to coordinate stove activities between Government agencies, non-Governmental organizations and the informal private sector. Functional linkages are traditionally not well-established between these sectors.

Some key development aid agencies (e.g., GTZ, Bellerive Foundation and UNICEF) have also been active in stove promotion during this time. Each agency has its own stove design and unique dissemination strategy. However, initially, institutional channels for coordination of these efforts were lacking. Thus, the technologies being considered appeared to be competing rather than complementing each other. This problem was resolved in 1983 by establishing an interagency Technical Committee on Fuelwood Conservation (TCFC) within KENGO. This provides a forum for donors, Government officials, stove designers, program managers and extension workers to come together and review technical, ethnological and economic issues in stove work.

The following section summarizes some of the useful lessons learne during the implementation and monitoring of the charcoal stove program.

V. LESSONS LEARNED

The useful lessons learned from the stoves program have been discussed in great detail by Stephen Joseph.[16] His discussion covers the areas of policy, technology design process, dissemination strategy and organizations, personnel development and program financing. The major points include:

- The average kitchen system is extremely complex and varies with ethno-ecological conditions rendering it quite difficult to change or modify. Any efforts to introduce a new stove must therefore be matched with intimate knowledge of the needs and limitations of a specific target population.

- The development and widespread introduction of improved stoves is a process requiring considerably more resources than previously thought. Benefits can be either long- or short-term, accruing to institutions, individuals or the environment in different ways and degrees of impact.

- Dissemination of proven stove designs heavily relies on training trainers and artisans or other producers in fabrication techniques. Training most people in stove building is a time-consuming task. Stove making, like other handicrafts, is a profession requiring high craftsmanship and involving fairly complex thermal engineering principles. Artisan trainees cannot, therefore, be expected to master the skills through a short course without frequent follow-up of their work in the field. Very often substantial technical and material assistance are needed if the trainee is to become a self-sufficient, fully skilled stove maker.

- An effective stove dissemination strategy depends on:

  - a stove designed in accordance with well-known functional objectives, and a variety of social and economic considerations;

  - a field-tested product;

  - a clearly defined, well serviced, motivated and frequently monitored target population;

  - use of existing institutions for extension work, production and distribution though ensuring that tasks allocated do not overload institutional capability. For example, government agencies are most effective in policy guidance and legitimation of a technology. They

are not so good at setting up self-sustaining service delivery enterprises. The private sector has shown to be more effective in sustained stove production and servicing;

- convincing the user about the benefits accruing to the individual - few, if any, stove users have environmental conservation as their motive for adopting a new stove. A demonstrated (or claimed) fuel economy and a stove's customer appeal seem to be the leading reasons for changing to new stoves; and

- ensuring a reliable supply of stoves within the price ranges and in models desired by users.

Improving stove efficiency alone is not enough to mitigate the wood fuel scarcity. Neither can the large scale adoption of improved charcoal stoves be expected to automatically result in a reduction in the number of trees cut down each year. The tremendous fuel and hence cash savings obtained by using the new Kenya charcoal stove could well be offset by increased national consumption of charcoal (though lower per capita demand). This could result if widespread fuel-switching took place as more households found it cheaper to cook more meals with charcoal than gas, electricity or firewood.

VI. PLANNED ACTIVITIES

The following is a schedule of the major activities to be undertaken by KENGO-E/DI-Ministry staff in implementing the revised 1984-85 workplan.

There are four activity categories:

- Applied research and development;
- Training, extension and demonstration;
- Production enterprise development; and
- Monitoring and evaluation.

A. Applied Research and Development

Sub-activities in this category include:

- Identification and testing of stove construction materials in different locations;
- Field-testing of a newly designed woodstove, the Kunimbili Jiko, and finalization of prototype designs; and
- Survey and analysis to facilitate evaluation of program impacts.

B. Training, Extension and Demonstration

Efforts to achieve a national impact with the charcoal stoves will be expanded and strengthened through training of additional stove makers and NGO extension workers. Technical assistance will continue to be provided to NGO's and demonstration of stoves will be carried out in at least 20 districts.

To increase awareness of conservation needs and available opportunities, 20 district-level conservation seminars will be held with participants representing local educational institutions, women's groups, church groups and Government extension workers. A Mobile Training Unit has been launched to service the technical needs of these seminars and provide on-site training to artisans.

C. Production Enterprise Development

A block EDF grant has been proposed to enable KENGO to provide technical, financial and management services to small-scale NGO and private sector stove production units. Up to 20 regional production units will be established, with 10 of them being in the commercial sector, 6 in Government Agroforestry Centres and 4 of them with non-profit community organizations.

The private enterprise strategy consists of:

- Identifying suitable private sector collaborators;
- Preparing a technical package and drafting terms and conditions for a technical assistance agreement between KENGO and the collaborator;
- Procurement of tools and equipment, initiating production of field-proven stoves, establishing a marketing network and offering the production unit on a turn-key basis to the collaborator once its economic viability is demonstrated; and
- Continued monitoring, provision of technical services and promotion of the established production units.

D. Monitoring and Evaluation

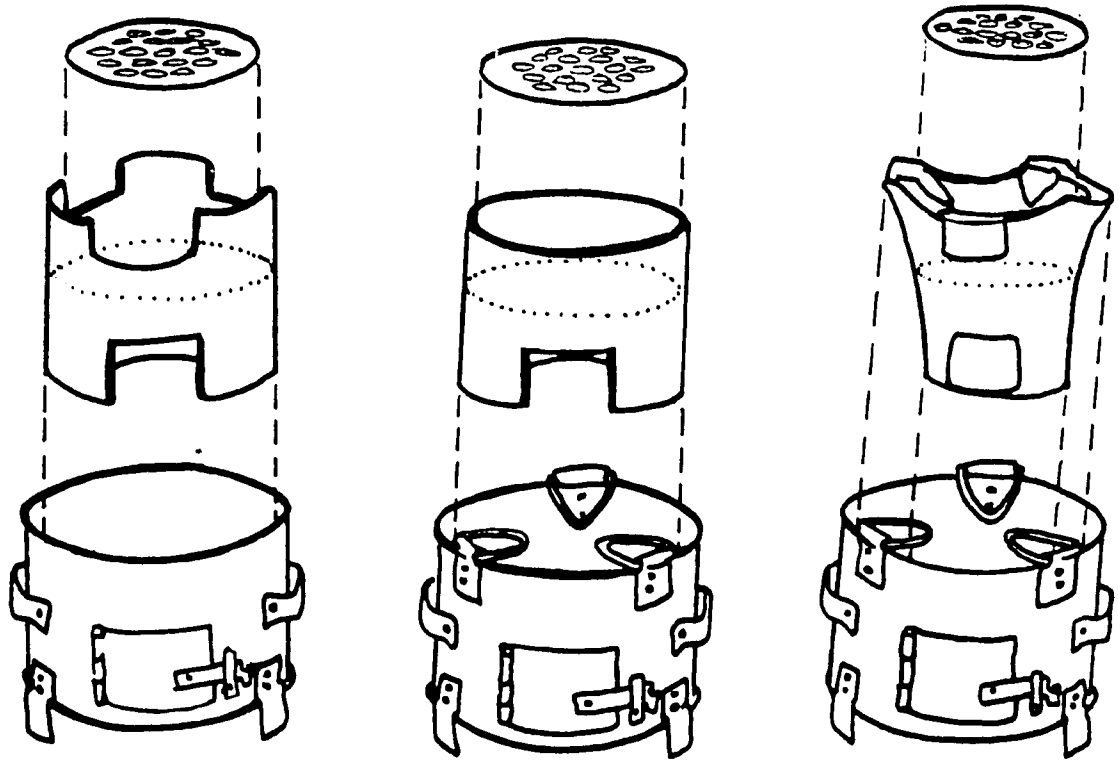
Sub-activities will consist of:

- Collecting data on the field performance of the Kunimbili Jiko;

- Collecting information on production, sales and utilization of the Kenya Ceramic Jiko; and

- Analysis of field data and assessment of the social, economic and ecological impact of the stove program.

ANNEX 1: Evolution of the Kenyan Ceramic Jiko

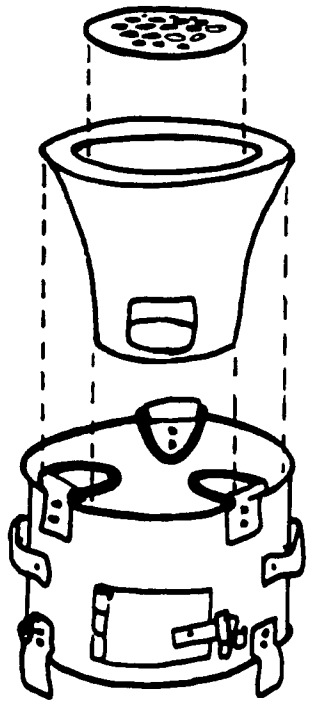


a b c

(a) and (b) The Pipeliner. Regular traditional metal stove lined with an extruded fired clay pipe. In model (a) the liner also acts as a pot rest and is quite liable to breakage. Metal pot rests are affixed in model (b) to protect the liner. Problems were experienced in holding the grate in place and also the liner cracked excessively after use for only a short time.

(c) The initial Kenyan version of the Thai Bucket. Again, a regular traditional metal stove lined with a bucket-shaped fired liner. Problem of grate rest eliminated. Hardships in anchoring the liner inside the metal casing. Excessive weight. Liner has pot rest and wood post.

ANNEX 1 (continued): Evolution of the Kenyan Ceramic Jiko



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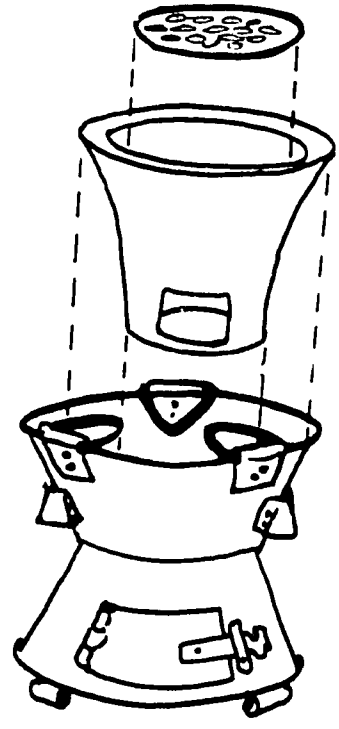

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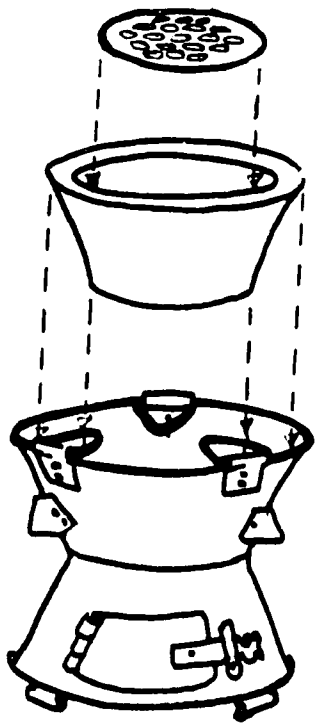
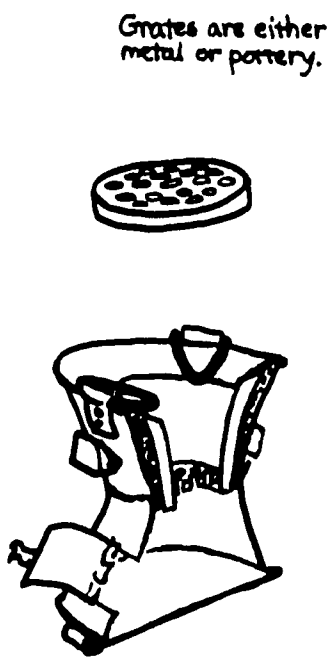
(d) Pot rests removed on ceramic liner and the wood port dispensed with. Metal pot rests were better for liner's durability and stove strength. The same metal shell was retained.

(e) The metal casing is now altered so that it conformed more to the shape of the liner. This allowed firmer assembly and reduced the stove weight by 25%.

ANNEX 1 (continued): Evolution of the Kenyan Ceramic Jiko



(f) The Kenya Ceramic Jiko. The ceramic liner was altered to line only the top half of the stove. This reduced the weight of the stove considerably, simplified construction technique (thus reducing construction costs), and provided more space in the ash chamber which also improved the ignition time.



(g) Cutaway section

FOOTNOTES

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