

RANGE OF FUNCTIONS OF TRADITIONAL STOVES.

Rural: the open fire

Most common is the 3-stone fireplace, although sometimes the stones are ridged clay mounds. Some places have instead metal triangles with legs, or iron bars held by four clay mounds (Gill 1982) to support the pot, or three legs on a cast iron pot. Sometimes the fire is sunken (Kapiyo 1982) and various other ways of shielding the fire and/or pot with mud have been developed in many traditions.

The open fire can:

- burn wood, dung, agricultural waste;
- provide light;
- accommodate different pot sizes and types of pots.

Also such a fire can be:

- portable;
- of little or no cost;
- used to dry wood stored overhead or alongside;
- used to preserve grain stored overhead with its smoke.

Finally,

- its heat output is easily variable and pots can be positioned around the fire to keep food warm;
- its smoke keeps away mosquitoes;
- most fires can cook many pots;
- and it is often a social or ritual focus.

Urban: Metal Charcoal Stoves

Small portable combustion devices for cooking are often made from scrap metals. They contain a grate for fuels that require it and are often found in rural homes (that can afford it) as a supplementary cooker. It is known as the Jiko in East Africa and the Fourneau Malgache in West Africa.

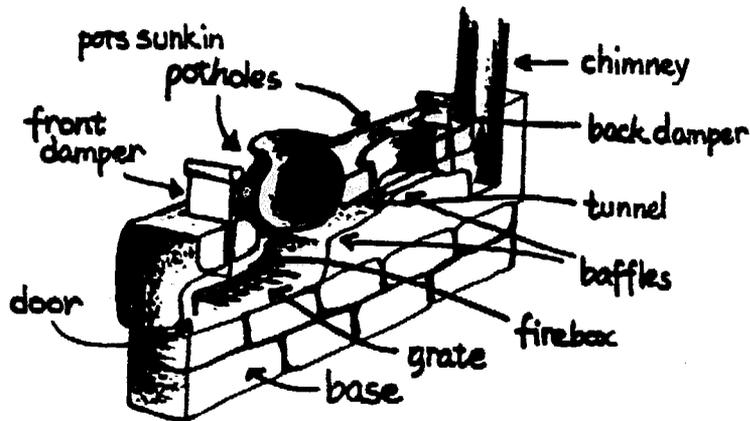
Some of these stoves were introduced only this century, but are widespread and ingrained enough in the cooking practices to warrant the status of tradition.

Characteristics: urns charcoal, maize cobs, coconut shell, wood, dung, briquettes;
portable: can be lit outside and brought inside when smoke has subsided (often done by children);
can be placed in different parts of the kitchen for safety or convenience;
requires less attention re-fuelling and controlling temperature than woodstoves;
provides warmth;
easily repaired or replaced (both inexpensive and higher quality are available);
can roast food.

Other stoves have been developed to burn specific fuels, such as sawdust, and many adapted for special purposes such as brewing beer, which requires a large volume to simmer for long periods of time.

DESIGN FEATURES OF NEW STOVES

To assess the suitability of a new stove or the functions and performance of an existing stove, it is helpful that a classification system be devised and utilized during assessment.



CUTAWAY VIEW INTO A COMPLEX 2-POT STOVE

Fig. 7.

Stoves and fireplaces come in many shapes and sizes. A range of materials and methods is used to make these stoves. Some stoves are purchased from artisans and some are made by members of the family. Some are fixed, some are portable. Stoves can have chimneys and grates in the fire box; others are little more than shields. Stoves and fireplaces can accommodate up to five pots of different sizes; some can only accommodate one pot. Some stoves have special devices (dampers) to control the flow of air - these can be placed at the entrance to the stove, between the pot-holes, or in the chimney. Some stoves have baffles to help increase heat transferred to the pot. Some stoves are specially designed to burn one fuel, others burn a range of fuels.

Two features that significantly affect the cost, acceptability, performance and method of dissemination of stoves are the number and type of pot seats used and whether or not a chimney is used. Key characteristics of stoves on the basis of these two variables are described below.

Single Pot Stoves

- a) Single Pot Chimneyless Stoves are known as shielded fires (de Lepelriere 1981).
i) Burning woody fuels

Shielded fires can either accommodate one size of pot or a range of pot sizes. They can be portable or fixed. A shield is placed around the pot to both direct hot gases up the pot sides and prevent heat escaping from the pot. Fuel savings are greatest on stoves that take one size of pot that sits right into the stove. It has been found that the fuel savings are largest when a grate is used. To reduce smoke it is necessary to determine accurately the number and position of air holes in and above the grate. Using a

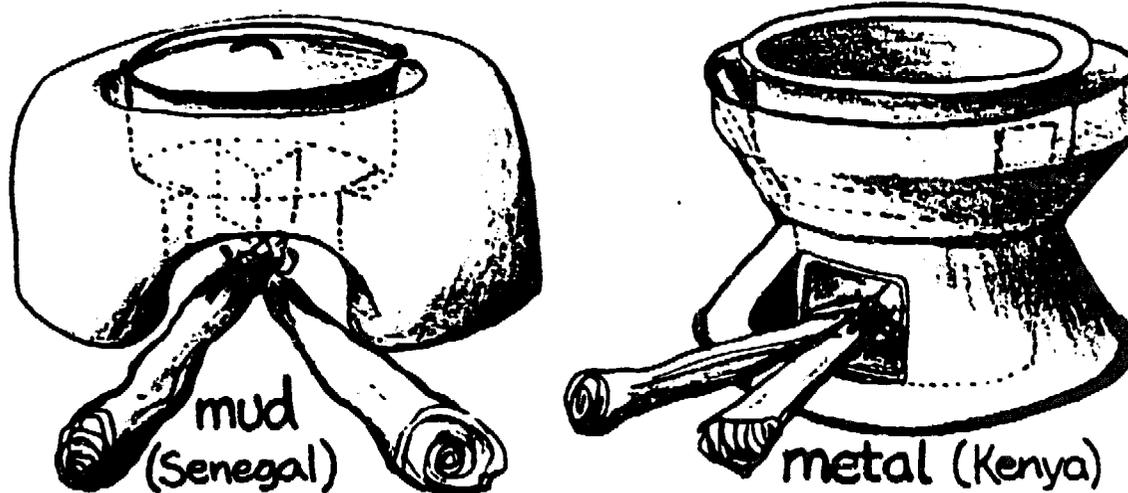


Fig. 8

grate reduces the amount of charcoal produced during cooking. It should be noted that the charcoal is often required for ironing and grilling or is used in the stove to simmer the food slowly. Thus stoves with grates may not be acceptable to some people. The performance of the stove does not seem to vary significantly if the distance between the pot and the shield and the grate and the pot is varied by 1 or 2 centi-

metres. These stoves can be used as ovens by placing an insulated lid on the top, and shutting the door. Stoves that accommodate a range of pot sizes can also fry as well as stew. The stoves can be constructed to provide light and allow the users to see the fire.

Simple mud or stone shielded fires can easily be made by the users, whereas metal or pottery must be made by artisans. Metal shields are made either by artisans or in small workshops. All these stoves are by far the cheapest to produce and appear to be more easily disseminated in large numbers in the African context (Madon, 1982; Thomas et al, 1983; Yameogo et al 1983). However, they are not smoke free (although often combustion is improved) and the portable stoves must be fixed if they are to be stable. Supporting pots that sit right into the stove is difficult, and it is necessary to have some type of fixture that wedges the pot in place for vigorous stirring. Single pot stoves are more appropriate when one dish is cooked at a time. If two or more dishes are to be cooked simultaneously it is necessary for the family to purchase two stoves. Metal stoves that are uninsulated can give considerable warmth to the room, where insulated stoves do not.

Shielded fires are most suitable when:

- people cook outside or in well ventilated kitchens
- more than one cooking area is used regularly;
- one dish is cooked;
- heating is required;
- mass dissemination/fuel conservation is the prime objective.

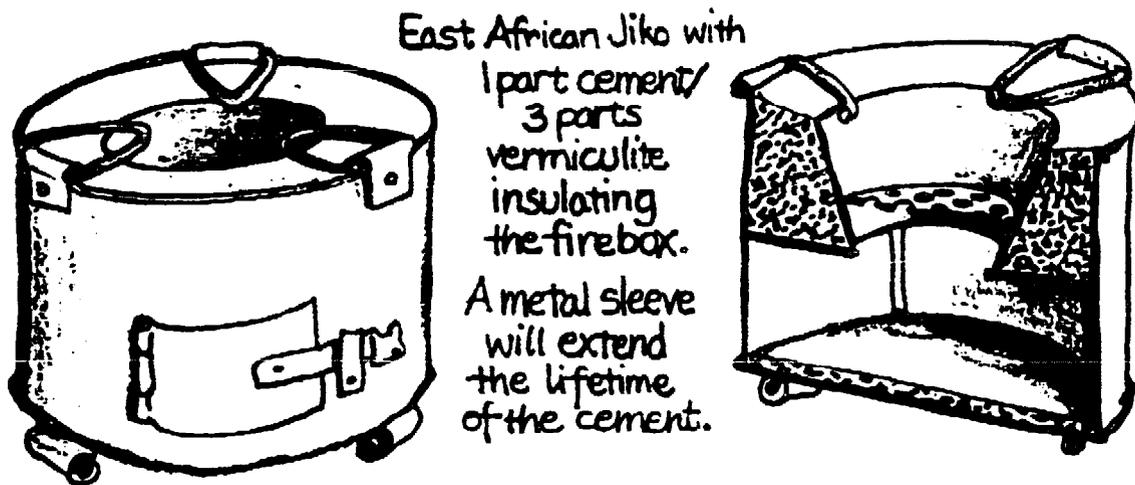


Fig. 9.

ii) Burning charcoal

Stoves that burn charcoal can be upgraded by placing either a metal, clay liner or cement and vermiculite liner inside. The pots can either be sunk inside the stove or sit on top of the stove. Sinking the pot inside the stove increases the fuel efficiency, but decreases the flexibility and ease of operation of the stove. Stoves that are insulated with clay, mud and cement and vermiculite do not radiate as much heat as those with only metal walls. However, a field survey of the Umeme stove carried out by the authors indicates that the heat retained by the stove with mud between the walls helps decrease fuel consumption for long periods of cooking. In Kenya, despite the fact that improvements on existing metal charcoal stoves double the cost, the payback period for a user (in terms of reduced expenditure) can be as little as two months.

b) Single Pot Chimney Stoves

These stoves usually accommodate one pot that is sunk into the stove. The pots usually have a diameter greater than 30 cm and thus are used by institutions and very large families (Micuta, 1983). If the pot is not sunk into the stove,

the fuel consumption and time to cook will be similar to a well tended open fire, that is shielded from the wind. The performance is similar to a shielded fire. However, they can accommodate much larger pots. These stoves can be portable or fixed depending on the material used and whether the chimney is fixed into the building. The stoves are very stable and if they are made with an insulating material are safe to use. The stoves must use a grate so that a range of fuels can be burnt. Careful control of the primary and secondary air can be achieved. These stoves can boil or fry (but only in the pot provided) and it is possible to bake inside the firebox.

Fig. 10



Single Pot with Chimney Community Stove

Bellerive Foundation



A long flame path is created by resting the pot on a semi-circle of bricks. The flame travels across the bottom, toward the front, and around the sides of the pot before reaching the chimney.

These stoves must be made by skilled artisans, as it is important that the internal sizes and position of the baffles be accurate. They will be considerably more expensive to produce than a shielded fire. These stoves take at least twelve hours to build.

If a chimney is to be installed in a house it will be necessary to have a trained person provide this service (chimneys are covered in detail in Joseph 1983c and Micuta 1981). The maintenance requirements are higher than those for the shielded fire especially if a chimney is used. It is probable that the performance of this stove will be more susceptible to poor construction and maintenance than the shielded fire.

They provide little light and if insulated provide little warmth.

Single pot chimney stoves are appropriate when:

- only one pot cooking is performed and the pots used are large;
- it is a priority to remove smoke;
- enterprises can be established or artisans trained to produce the stoves;
- a regular maintenance service can be established or sufficient resources are available to train owners;
- light and heating are not requirements.

Two-Pot Stoves

These stoves can be made from all types of materials, but experience has indicated that metal should be used in conjunction with other materials and not used alone.



Fig. 11.

a) Two pot chimneyless stoves

At present all stoves that have proven acceptable have pot seats that take a range of pot sizes. The two pots are usually sunk into the stove and the exhaust gas flows around them.

The stoves can be fixed. They are carved or moulded in situ (usually from mud) or pottery components are acquired, placed in the desired position, and surrounded by mud. Portable ceramic stoves of this design have proven popular in Indonesia (Kaufman 1983). These stoves do not need a grate but require a number of secondary air holes in the firebox. It is extremely important to construct these stoves accurately if optimum performance is required. The fuel consumption of these stoves is higher than the single pot stoves (where the pot sits inside the stove) (Yameogo 1983). If only one pot is used on a two-pot stove, then the performance of the stove is similar to or less than the well tended open fire. These stoves can provide light and heat by building the stove with an open front, which does not significantly lower the performance. Because of better combustion and the rear exit passage, the smoke is often reduced and released away from the user. It can also be used to dry wood and crops, keep out mosquitoes, and provide some indirect room heat.

These stoves can be made from mud or from fired clay inserts surrounded by mud. If made of mud these stoves can be manufactured both by skilled artisans or well trained groups drawn from the local community. A skilled potter can make 100 insert sets per month using a pottery wheel or about 200-300 using moulds. Alternatively a small ceramics industry can turn out the stoves using either moulds or simple presses.

The mud stoves need frequent cleaning and repairing, and the pottery stoves frequent cleaning, if the performance is to be maintained. Two-pot stoves can produce significant amounts of carbon monoxide and therefore should not be used in a closed room.

These stoves are usually more expensive and take longer to build than the single pot chimneyless stove because they are much more complex.

Two-pot chimneyless mud stoves are most suitable when:

- people want to cook two dishes at once;
- smoke reduction is of some importance but where its use is also of importance;
- users have a tradition of regular repair and cleaning of stoves;
- alternative more long lasting materials are not available;
- resources are available to:
 - train and support artisans to build and regularly service the stove (and where people are willing to pay for their service
 - train users to clean and make minor repairs.

Two-pot chimneyless pottery stoves are most suitable when:

- mass dissemination/time savings/fuelwood

- savings are the principal objectives;
- pottery producers are highly skilled and available;
- people have the money to purchase (or subsidy is available);
- owners can be trained or encouraged to clean their stove.

Tungu Sae (Indonesia)

This pottery stove may be used as is, or encased in mud for better durability.

extra clay reinforces the door



Fig. 12

Two Pot Chimney Stoves

There are a large number of stoves that have been designed using this basic configuration. Pots, of a fixed size, can be sunk into the stove. The stove can be designed to take a range of pot sizes that sit on top, but the performance of this stove is considerably lower than the stove where pots are sunk into the stove, and than that of the two-pot chimneyless stoves. The stove can be transportable if made of metal, mud and metal (see the Pogbi Stove illustrated at the end of this section), cement sections or ceramics and the chimney is less than two metres high (although a donkey cart is usually required to move the Pogbi stove). The largest segment, the stove body, weighs 200 lbs. Some of these stove models use a grate. It would appear that Pogbi

type stoves have a higher performance, but they are more expensive and more difficult to maintain (cleaning the chimney is not easy). The amount of air entering the stove is often controlled either by a door at the front or by using a damper placed between the chimney and second pot seat. These dampers are usually made of mild steel sheet and are often lost or corrode very quickly. They are rarely effective. Baffles are usually placed under the second pot to increase the amount of heat transferred to the second pot.

The size of the internal flues and the distance between the baffle and the second pot will depend on the height of the chimney and the type of fuel, its size and moisture content. If the stove is not made accurately to a predetermined size the performance will be significantly lowered.

The stoves can boil, fry, and possibly bake in the firebox. The models where the pot sits closer to the top of the stove can be opened at the front to provide light. If the stove is made of metal and not thickly insulated, it can provide heat.

Depending on the material, these stoves can be made by artisans or in small industries. The stoves can be made by groups involved in community development (if they are well trained). The time taken to build these stoves depends on the material used and the height of the chimney (and whether it is fixed into the house). A portable metal stove can be built in 2-4 hours; a pottery insert stove can be built and installed in 8 hours; and a mud stove in 8-20 hours.

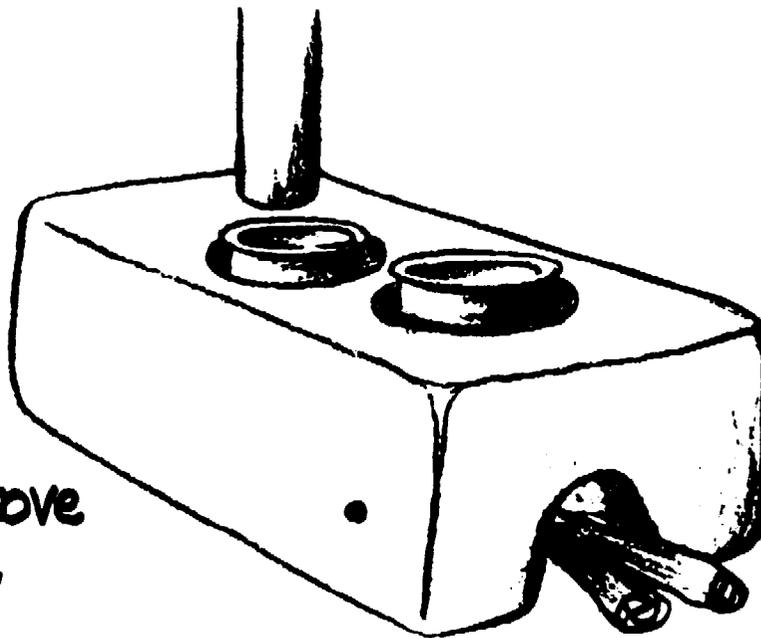
Both pot holes must be covered while in use

difficult to make and use the chimneyless stove. Insulated stoves will provide little heat. These stoves must be well maintained and cleaned if they are to give significant savings in fuel.

Two-pot chimney stoves are suitable when:

- two dishes are to be cooked simultaneously;
- smoke must be removed from the room;
- skilled artisans or small enterprises can manufacture and possibly install the stove;
- resources are available to train users or establish an enterprise to repair and maintain the stove;
- light and heating are not required.

Other design features that can be incorporated into a stove include raising the stove off the ground, ovens, and special racks for drying.



2-pot mud stove
with chimney

Fig. 13 .

MATERIALS

The overriding feature of a stove which affects

the cost, method of construction, the durability and, to some extent, the performance (and the change in performance as the stove ages), is the material or materials used to build the stove. The change in performance as the stove wears (and how this is affected by repair) is given in the first of the following charts. The effect of stove lifetime on the numbers of stoves distributed is given in the charts underneath (as calculated by K K Prasad, 1982).

The main materials that have been used in urban areas to manufacture stoves are steel, fired clay and cement. In rural areas the main materials have been stone, mud and fired clay.

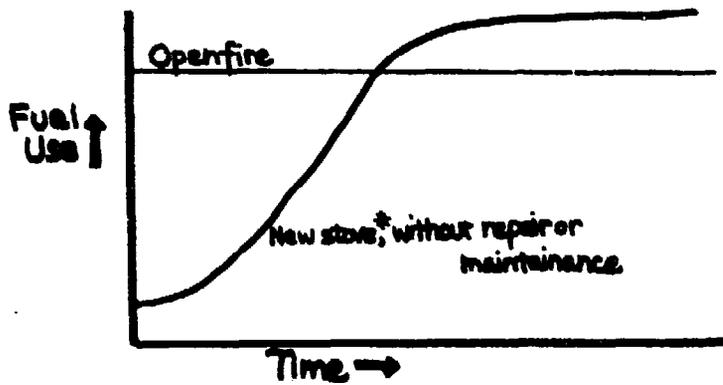
THE MOST ACCEPTABLE STOVES HAVE COMBINED THE BEST QUALITIES OF TWO OR MORE MATERIALS IN THE DESIGN.

The important aspects of choosing and working with each material are presented below.

Metal

Many of the urban wood and charcoal burning stoves in Eastern Africa are made from metal. The main supply of metal is scrap, the thicker gauges (1.5mm thick) are obtained from oil drums and the thinner from 'tin' boxes. The lifetime of a thicker gauge stove (in constant use) is 18 to 24 months. The thinner gauges have a much shorter lifetime.

Grates are normally made from thicker material than the stove body, and have a lifetime of six to nine months. In Sudan strip steel from packing cases (a very strong steel) is woven to provide a much more long-lasting grate (see Fig. 16).



*Actual curve depends on type of stove. Repairs will also significantly alter the curve. Based on information gained in Indonesia by ITDG.

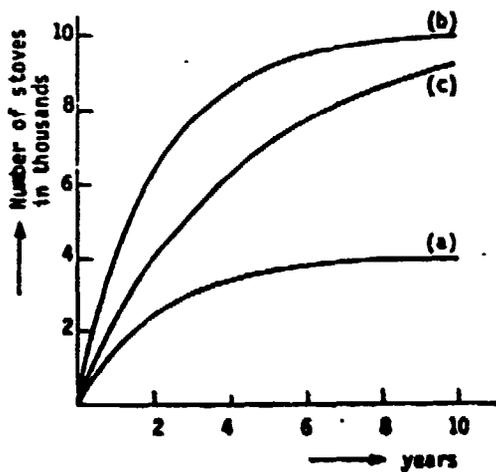


Fig.14 Operating stove population growth with time for a long-life stove design

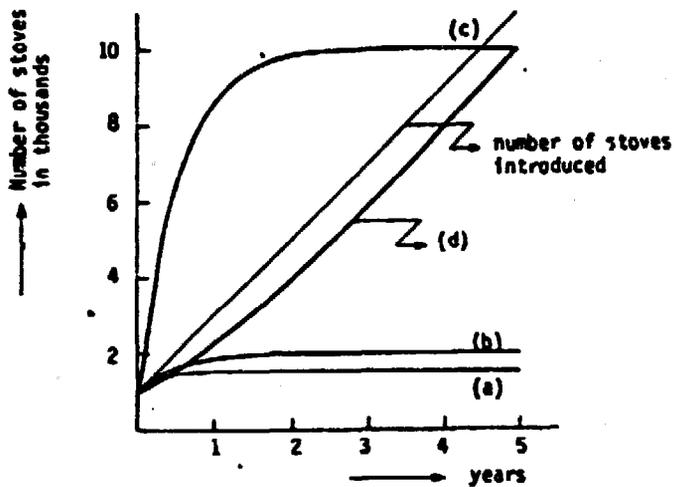
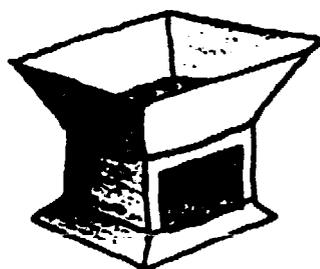


Fig.15 Operating stove population growth for a short-life stove design

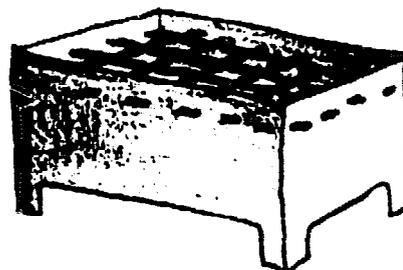
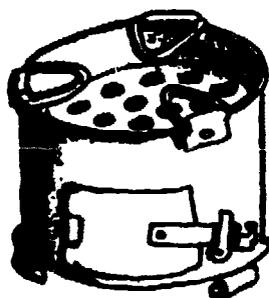
Fig. 16

TRADITIONAL CHARCOAL STOVES



West Africa
and Mexico

East Africa



Sudan

Stoves can be made from imported sheet steel at high prices (and probably with a shorter lifetime than those made from oil drum steel). The availability and cost of both imported and scrap steel depends on the level of manufacturing activity and government policy on importing materials. In Kenya, for example, the price of scrap and imported metal doubled in 1982-3.

Metal has the advantage of being easily shaped. Stoves can be produced in large numbers by the existing artisans working in the informal sector or by small or large engineering workshops. Experience in Kenya has indicated that stoves can be produced in the informal sector much more cheaply than in the formal sector. The investment required to produce a new stove is minimal and the time required to train skilled artisans to produce a new product can be less than one week. These people can make three to five stoves in a day. However, artisans will

often take short cuts and therefore not build the stove to the required degree of accuracy, thus tending to lower the performance of the stove.

Marketing a new product is a much more risky affair for the artisan than for a small industry, which has existing outlets. On the other hand, industry, small or large, may have to find considerable capital to retool or expand. The labour costs will often be greater and the actual market for the product may be smaller than for the artisans. The output from a small industry can be as high as fifteen stoves per day per person. Artisans operate in the rural sector whereas small engineering shops do not exist in many rural areas (and considerable effort is required to develop such industries). However, if small engineering enterprises are established, they may create employment and help produce other useful products.

Metal now has the advantage of providing area heat, though many children burn themselves on its hot surfaces. By adding an inner layer of fired clay (as in the Kenyan Ministry of Energy's stove), or by placing mud between two metal walls (as in UNICEF's Umeme stove), the same amount of heat will enter the room, but over a longer period of time, but will be much safer and more fuel-efficient. The techniques can be used for both charcoal and wood burning stoves, but may double or triple the cost. The addition of fired clay increases the complexity of the production process, but also extends considerably the lifetime of the metal cladding.

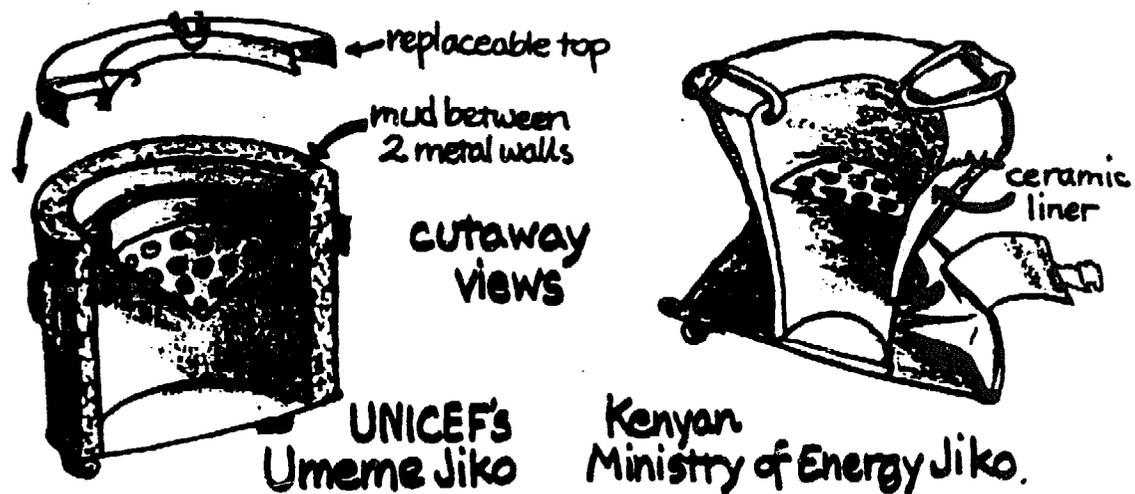


Fig. 17

Metal stoves can easily be lined with cement mixed with vermiculite or diatomite, or with soapstone or meerschaum (available in Somalia). This can be done by artisans or by semi-skilled workers who have received a short training course. The lining of charcoal stoves and wood burning single-pot shielded fires is relatively simple, but two-pot wood or charcoal stoves present greater problems. Repairs can be easily carried out by local artisans.

Pottery

Africa has a long tradition of producing fired clay ('pottery') pots, but there are few pottery stoves being produced. In most of Africa there are only a few areas where high quality clay is available for the manufacture of pottery stoves.

CLAY THAT IS SUITABLE FOR PRODUCING FIRED COOKING AND WATER POTS MAY NEED ADDITIONS TO PRODUCE LONG-LASTING POTTERY STOVES.

It is necessary to test the clay (see materials testing, Sec. 3.4). It may be necessary to mix clay from different deposits together, or to include additives such as sand, crushed fired clay, rice husk ash, soapstone, mica, dung or charcoal, in order to produce a satisfactory mixture. The mixture should be easy to form, should not shrink too quickly when wet, and should withstand repeated heating and cooling, and impact loads, when fired.

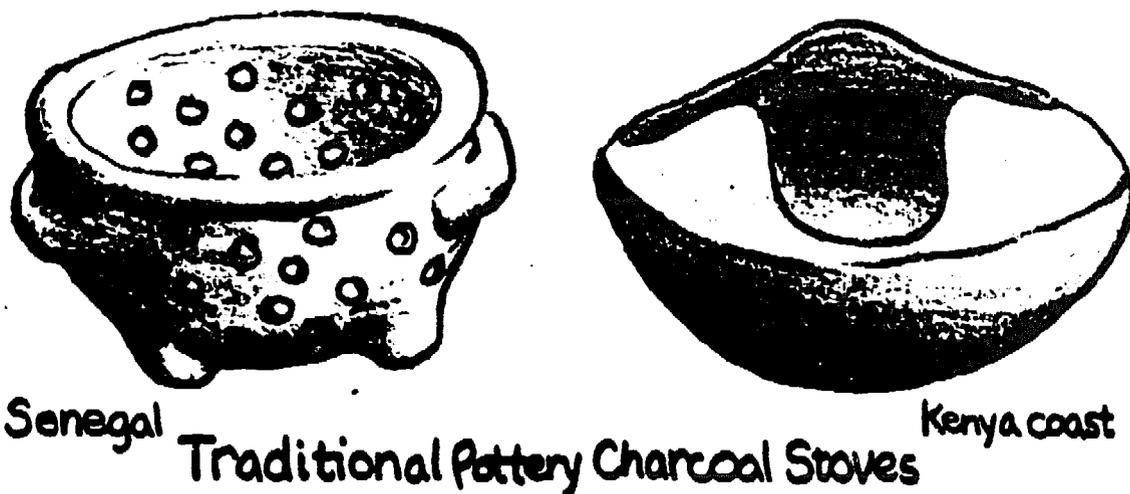


Fig. 13

Pottery stoves are easily mass produced in moulds or on a wheel, and are usually less expensive than metal stoves. They can be portable or fixed. The length of life depends on the quality of the clay, its preparation, the firing temperature, and the stove design. Pottery can be made by artisans, working part time at their homes, or in small ceramic industries. The cost of production in rural areas is much lower than in urban, but transportation of the stoves over long distances is often expensive and difficult.

In Kenya the pottery liners for charcoal jikos are often made by a separate pottery company, and the assembly is done in the informal sector. Alternatively, a pottery company has sometimes hired and managed skilled artisans to do the work on site. Experience has shown that it is much more difficult to train itinerant or part-time potters to make high quality stoves than it is to train metal-working artisans. Often these potters cannot produce stoves all the year round because of lack of fuel or the need to be involved in agricultural activity.

The extension costs of a pottery stove project can be greater than that of a metal stove project. (This applies especially to wood stoves.)

Either potters or extension workers may be required to install the stove, especially if the stove has a chimney. There has only been limited experience of people working with small pottery industries in Upper Volta (Baldwin, 1982) and Kenya, but it would appear that these enterprises can expand to produce a quality product at a lower cost than metal stoves. Training required to upgrade skills is minimal, but frequent follow up is necessary. Investment is usually required to upgrade the artisan or small industry's facility to produce a cost-effective high quality product. This could include improved kilns, clay-working machinery, moulds, or extra drying and working space.

Pottery stoves must be carefully designed so that concentrations of stress do not build up, in order to give a long lifetime (for more information see Joseph, 1983). It is desirable not to rest pots on pottery stoves, and this can be done by encasing the stove in mud or in the case of shielded fires to place an iron frame inside the stove. The lifetime of a pottery stove encased

in mud can be from 18 months to 4 years depending on the quality of the clay and the care taken in preparing the mix.

Pottery stoves can easily be repaired with mud, or a mixture of mud, ash and cement, if they were originally encased in mud. A mixture of 2 parts clay : 1 part cement : 1 part rice or millet husk ash, or a mixture of 1 part cement : 3 parts vermiculite can be used to repair portable stoves. The lifetime of pottery charcoal stoves is probably increased if a mixture of cement and ash is used on the internal surface.

Mud

In Africa, most of the wood stoves that have been introduced into rural areas have been made from mud (a mixture of sand and clay). Although mud is widely available and very cheap, it often does not withstand constant heating and cooling for long periods of time. Unless the clay is of high quality, and the walls are very thick, the fire-box will crumble when wood is continually struck against the sides, and cracks can occur adjoining pot-holes, and between wall and pot-hole, if heavy pots are continually dropped or placed heavily on the stove.

Mud stoves can be produced by artisans, extension workers, and by users. Quality tends to vary considerably with the skill and training of the builders. Stoves can be carved from a single block of mud (Fig. 19), made from ropes of clay/fibre (Fig. 20), or moulded (Fig. 21). A great deal of training and follow up is required if people are to carve mud stoves accurately. The stove can be produced in the home, or at a workshop, and then transported to the household. Small businesses making mud stoves have been established in Guatemala (Caceres, 1983), Senegal, and Kenya. The investment cost is low

and production can be intermittent.

'Methods of Manufacture of Mud Stoves'.

Fig. 19 Lorena (sand/clay) is compressed by layers into a solid block, and then carved with knives and spoons.



Fig. 20 'Ropes' of 50% clay/50% long fibres (either hay or raw sisal) are prepared, then interlocked and beaten into place around pots resting on three stones or bricks.

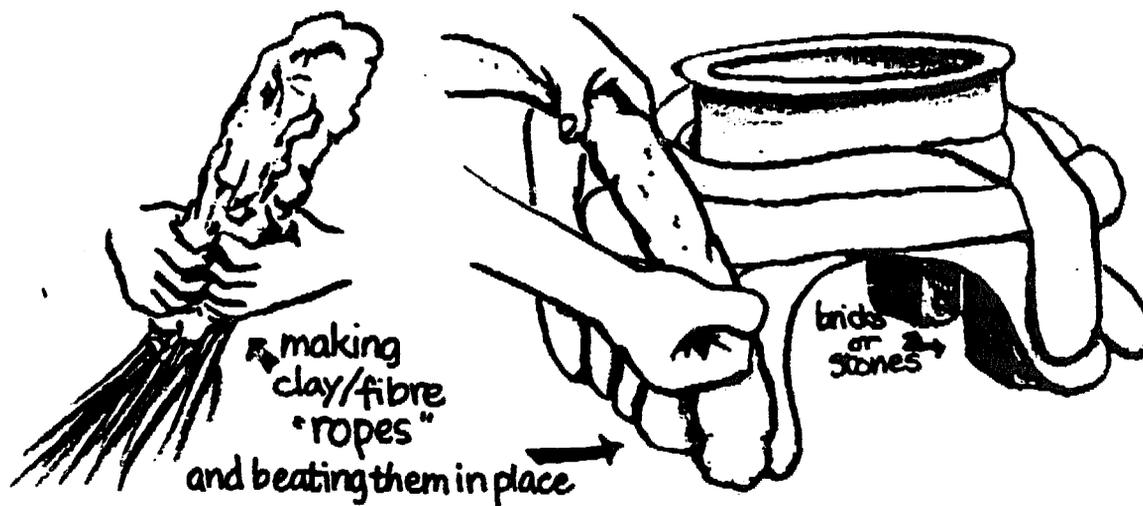
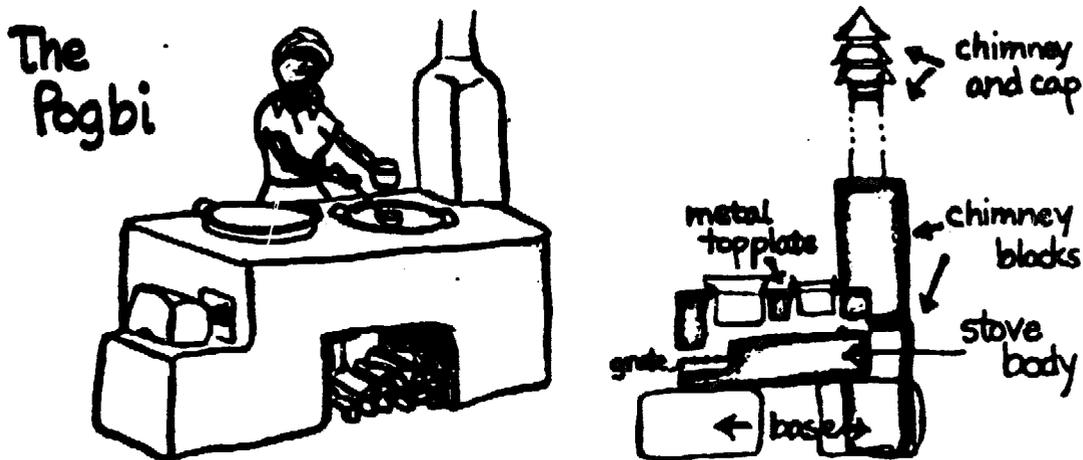


Fig. 21 Moulded stoves are (more often) accurately made, and can be transported if they have a significant fibre content.



Fig. 22 The Pogbi is made in a workshop by pounding clay/hay 'ropes' into wooden moulds. When dry, the body and chimney parts are transported and installed.



One person can produce a moulded stove in half a day, and a two pot-hole carved stove in one or two days. The total time taken depends on whether a chimney is installed and how much time

is spent collecting and preparing the material. A great deal of experimental work is often necessary to develop long-lasting mixes. Until recently mixes were developed by trial and error, but work at Kenyatta University College and at ITDG (UK) is starting to indicate how to speed up this process. Experience has indicated that termite mound is the best clay to make mud mixes. Clay should be crushed and sieved before use. It should be mixed with dung, ash and husks (the exact proportions must be found by experiment), mixed with water until damp, and allowed to stand before building. Some stove builders recommend mixing grass and crushed pottery with the clay although initial tests indicate that weak spots in the firebox are areas where grass has burnt away. The addition of fibres gives tensile strength to the block, reducing tendencies to crack. The properties of mud are possibly improved by the addition of 25% cement. A mixture of 2 parts mud : 1 part cement : 1 part rice husks, has been used to make bread ovens in Fiji (Petersham, 1982).

The lifetime of a mud stove can be as low as three months or as high as four years. Durability is considerably enhanced if the stove is constantly repaired. The extension cost of training and follow-up are considerably greater for a mud stove programme than for pottery or metal stoves.

Other Materials

Cement

West African cement stoves often have a lifetime of less than 18 months, are expensive, and difficult to repair. However, the lifetime of this stove could be increased by additions of vermiculite or diatomite to the cement that is being subjected to heat. Cement stoves can be moulded

in one piece or made in sections and can be made in the home by artisans or in a workshop. A man can make one to three woodburning stoves a day, depending on size, etc. The capital investment is relatively small.

Cement is quite good as a coating for mud stoves, making the surface impervious to water spills and strengthening against abrasion where pots are inserted into the stove.

Brick

Brick stoves have an extremely long lifetime - up to 20 years if good quality building bricks are used. The stove must be made in the household and usually takes at least one day to complete. To ensure proper construction these stove builders must be given extensive training and be provided with templates to fix the internal dimensions of a stove. The template can be made of metal, clay/fibre, banco or cement. Mortar between the bricks needs to be repaired occasionally.

Stone

Stoves can be formed from stone slabs or carved from soapstone, siltstone, or basalt. These are lifetime. Meerscham stoves are made in Somalia and siltstone and basalt stoves are common in Indonesia and have now been developed in Lesotho (ARD 1982). Stones can be joined together with cement/clay/husk mixtures to make a stove.

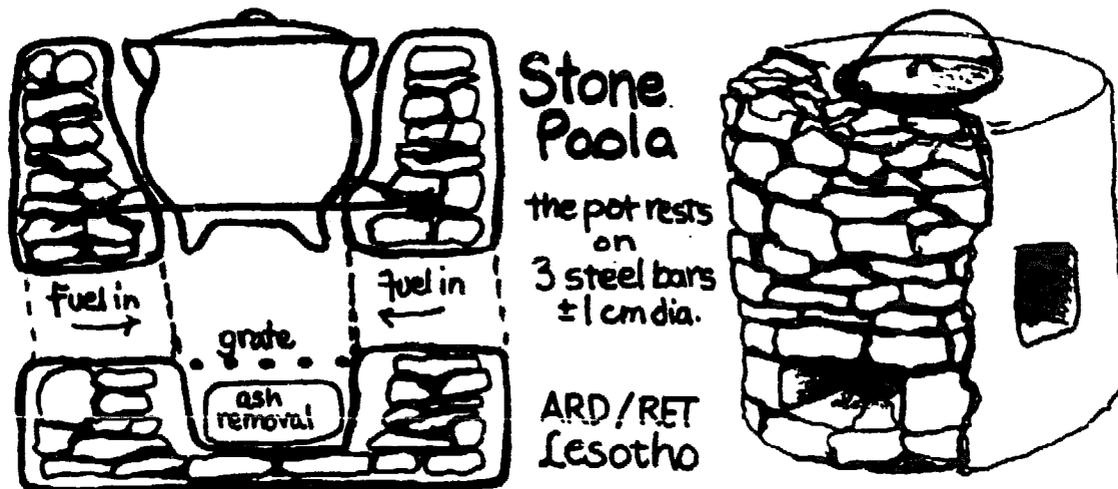


Fig.23

3.3 MATCHING TECHNOLOGY TO NEEDS AND RESOURCES

Having obtained the necessary information from the survey, and understanding the characteristics of different types of stoves, it is now essential to develop design criteria for stoves, and methods of promotion, manufacture, and distribution to meet the local needs and resources. This is presented here as a series of questions and possible answers.

1. What are user and implementing organization criteria for a stove?

NEEDS

POSSIBLE TECHNOLOGICAL

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Smokeless kitchens | <ol style="list-style-type: none"> 1. °Build a chimney stove
°Build exhaust vent or fireplace chimney |
|---|--|

- 2. Use of smoke
 - ° Increase ventilation in house
 - ° Optimize firebox for efficient combustion
- 3. Safety
 - 2. ° No chimney or short chimney
 - ° Build drying rack overhead
 - 3. ° Build stove too high off the ground for young children
 - ° Insert pots into the stove
 - ° Fully enclose firebox
 - ° Insulate stove
 - ° Use stable high-mass stove
- 4. Ease of maintenance
 - 4. ° Do not use chimney, or use a very short chimney that does not go through roof
 - ° Use pottery or cement and vermiculite inserts
 - ° Avoid more than two pot seats
- 5. Ease of operation
 - a) in cooking
 - 5. ° Interchangeable pots
 - ° Easily reached pots for stirring
 - ° Build stove high or low, for sitting or standing, as desired
 - ° Build stove on ground (no base) or with ample support in front of door for long sticks of wood
 - b) wood does not have to be chopped

- c) fire needs little tending
 - d) will ignite quickly
 - e) will ignite wet wood
 - f) able to raise and lower output of fire easily
- 6.
- a) Cooks faster
- 6. °Cook two pots at one time
 - °Pot inserted into the stove
 - °Pot lids (thick wood or metal)
 - °Increase fire output or heat transfer
- b) First and second pot come to boil at the same time
7. Save fuel
- 7. °Sink pots into stove
 - °Use single pot-shielded fire (multiple pot stoves have not been proven to save fuel in practice)

MOST IMPORTANT

- 8. Occasional baking
 - 9. Low cost
- 8. °Well designed
 - °Accurate construction
 - °Proper maintenance
 - 8. °Build firebox large enough to accommodate pans
 - 9. °Use locally available skills and resources
 - °Minimal cost of transport

- | | | |
|---------------------------------------|-----|---|
| | | <ul style="list-style-type: none"> °Develop method of mass production of the stove, or mass dissemination of skills |
| 10. Provides light | 10. | <ul style="list-style-type: none"> °Open up the front of the stove °Put many holes in the firebox (this will lower cooking efficiency) °Subsidize alternative liquid fuel for lamps |
| 11. Charcoal for ironing or other use | 11. | <ul style="list-style-type: none"> °No grate |
| 12. Provides space heat | 12. | <ul style="list-style-type: none"> °Use metal or thin-walled ceramics °Use high mass chimney stove with long tunnel °Lower draught into the kitchen |
| 13. Similar lifetime as three stones | 13. | <ul style="list-style-type: none"> °Use high quality refractory cement °Use cement (1 part) and vermiculite (3 parts) °Use cast-iron steel plate °Use dressed stones °Keep design simple |
| 14. Aesthetically pleasing | 14. | <ul style="list-style-type: none"> °Use high quality materials °designer or artist °Apply paint, diatomite, whitewash, varnish or tiles to final product |

- | | |
|---|---|
| 15. Can be made by local group | <ul style="list-style-type: none"> °Apply patterns to outside 15. °Mud or rock must be used as main material °Some parts purchased and encased in mud °Cement can be used, especially if a trained mason is part of the group |
| 16. Creates employment | <ul style="list-style-type: none"> 16. °Establish a stove-building enterprise °Ceramic and/or metal stove made by artisans °Establish a repair and maintenance enterprise |
| 17. Able to be produced in large numbers within a five year period (say 100,000 per year) | <ul style="list-style-type: none"> 17. °Made from metal or pottery or a combination °Portable °If mud, requires a large extension service using moulds |

It is possible that priority given to some criteria by users will be different to those of the implementing organizations (e.g. the implementers may want the stove to save wood primarily, whereas the users might want to save cooking time). Criteria may be conflicting (e.g. a stove that eliminates smoke will not be as easy to maintain). It is essential to resolve as many of these conflicts as possible before developing and testing stoves. Dialogue with users is the best method. Some of these conflicts will be resolved when other constraints on the designs are detailed. There is still scope for imaginative design

to meet conflicting criteria.

2. How do you adapt the design to fit the physical space available?

One way is to list the following:

- area occupied by existing stove (if it is to remain);
- area occupied by kitchen furniture;
- area required for preparation/consumption of food;
- area occupied/required for other items/activities.

Subtract the total of the above areas from the total floor area of the kitchen. This will then determine the maximum size of the stove, and possible position. Repeat this calculation for the range of kitchen sizes noted.

Another way is simply to place the pots on the floor where the stove is likely to be, taking account of where the air enters the room and arm movements in food preparation. Lines can then be drawn on the floor (for massive mud stoves).

Stoves are often tables in Guatemala, the large counter space being utilized for serving and sometimes eating (Aprovecho, 1980). Alternatively, the stove may need to be portable if the space is used for sleeping at night.

3. How does the height of ceiling, type of roofing, degree of ventilation and prevailing wind affect design and position of the stove?

1. 1.5 metre high chimneys can be placed inside if the roof or the ceiling is 3.5 metres above the floor and if the roofs are made of an inflammable material. If the height of the ceiling is less than 3.5 metres it is necessary to take the chimney directly through the wall or roof. If the roof is

flammable it is necessary to insulate the chimney when it passes through the roof. It is also necessary to have the chimney exit at least 1 metre away from the thatch. If a room is well ventilated it is possible not to use a chimney (a stove that operates properly does not produce smoke except when the fire is first lit).

It is possible to build a cowling to remove the smoke outside the room, in cases of portable or chimneyless stoves. A cowling may be built through the roof or into a window if the material surrounding it is non-flammable and if the cowling does not take away necessary light. Avoid placing the chimney close to an outside wall, especially if the wind hits this wall for a substantial proportion of the time.

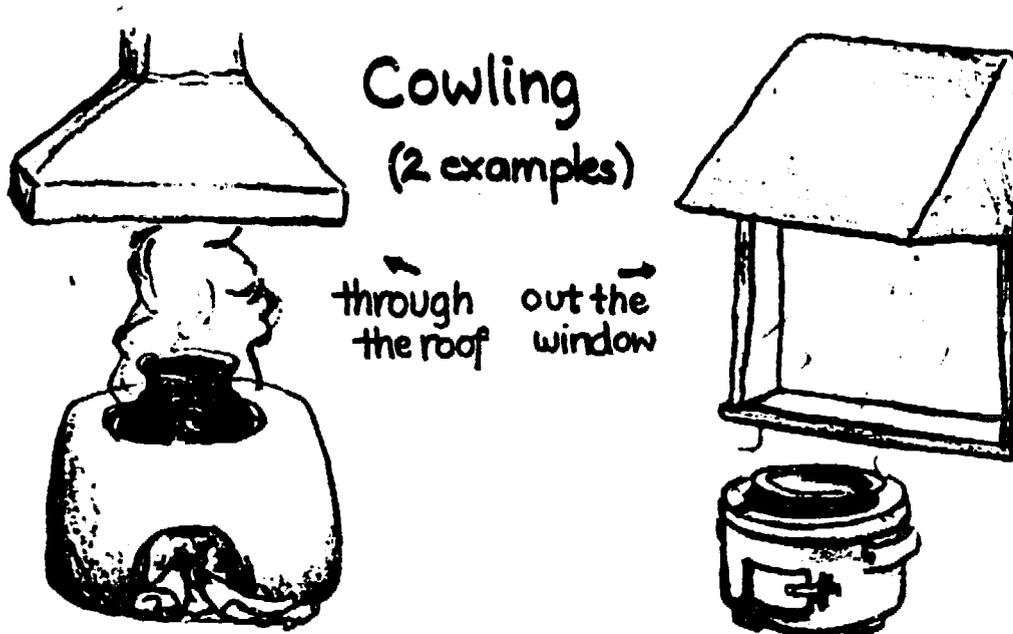


Fig. 24

4. What are implications on the design and the impact of the stove if people have more than one cooking place? or more than one stove?
- Design a portable stove
 - Design stoves that fulfil the same functions as the existing stoves
 - Be content, (if users are), that the stove can only fulfil some of their needs of fire and that the traditional stove will be used for some cooking and heating functions
 - Considerable wood savings will not be seen if a single fixed stove is used.
5. How does the type, number of, and size of pots regularly used affect the design?
- It is important that pot seats can accommodate all or at least the most frequently used pots.

Pot seats should fit the pots



Fig.25

- It is preferable to mould the pot seat to the contours of the pot (Evans and Boutette 1981). This will provide extra stability when cooking. It is important that the bottom of the pot does not hit the baffle.

- If people only use one or two pot sizes it is possible to build a very simple shielded fire or a single chimney stove that has two fire-boxes. The pots would sit inside the stove.
 - If people use small pots for brewing tea and large pots for cooking, it will be necessary either to make some type of ring or heavy wire screen on which to sit the small pot, or to provide a small stove for brewing teas. It is extremely important to determine whether people would restrict the range of pot sizes used if a stove with fixed pothole sizes were to be introduced (e.g. Pobgi Section 3.2). Pots of tea have to be modified or new pots purchased when 2-holed fixed pot size stoves are introduced.
 - Suspend the pot (like a tea kettle) above a bed of charcoal.
6. What is the significance of different pot sizes for the installation of an insert stove or the construction of a mud stove?
- It is important for the builders and installers to get the women to bring out all their pots and identify the use (and frequency of use) of each one. The distance between the 2 pot holes should be large enough to accommodate the two largest pots placed side by side.
 - It will then be necessary to determine the distance between pot seats and chimney, the inner and outer diameter of the pot seats, and the slope that will enable most of the pots to sit safely on the stove.
 - If large pots are used frequently to prepare beer or cattle feed it may be necessary to design a special stove (that is cheap but fuel efficient).

7. What are the implications of the diversity of existing stoves (and their different social and cultural significances) for the introduction of improved stoves?
- It is essential for the promoters to spend considerable effort to get households to explain all the functions of the old stoves. It will then be necessary to understand what functions the new stove can perform (and what are its advantages). It may also be necessary to determine if the household will still use their old stove for ritual, light, or other cooking purposes.
 - People who buy a stove may be more willing to purchase a new stove if the lifetime and cost are similar to the old stove. If people do not purchase their present stove they will have to be convinced that the benefits of the new stove outweigh the cost (in either money or labour).
 - It is much harder to train people to repair and maintain new stoves if they have not had to do this before. Introducing mud stoves to people who have never used mud before is also extremely difficult.
 - It will be necessary to monitor closely the response to the same stove by different ethnic groups living in the same village.
 - Since women usually make and use the traditional stove/fireplaces it will be very beneficial to involve them in the choice and/ or installation of the stove.
 - If the replacement stove has to be purchased (and the men make the decision on spending) they will need to be involved in the decision to adopt the stove and shown how it would benefit them (especially if they don't collect wood).