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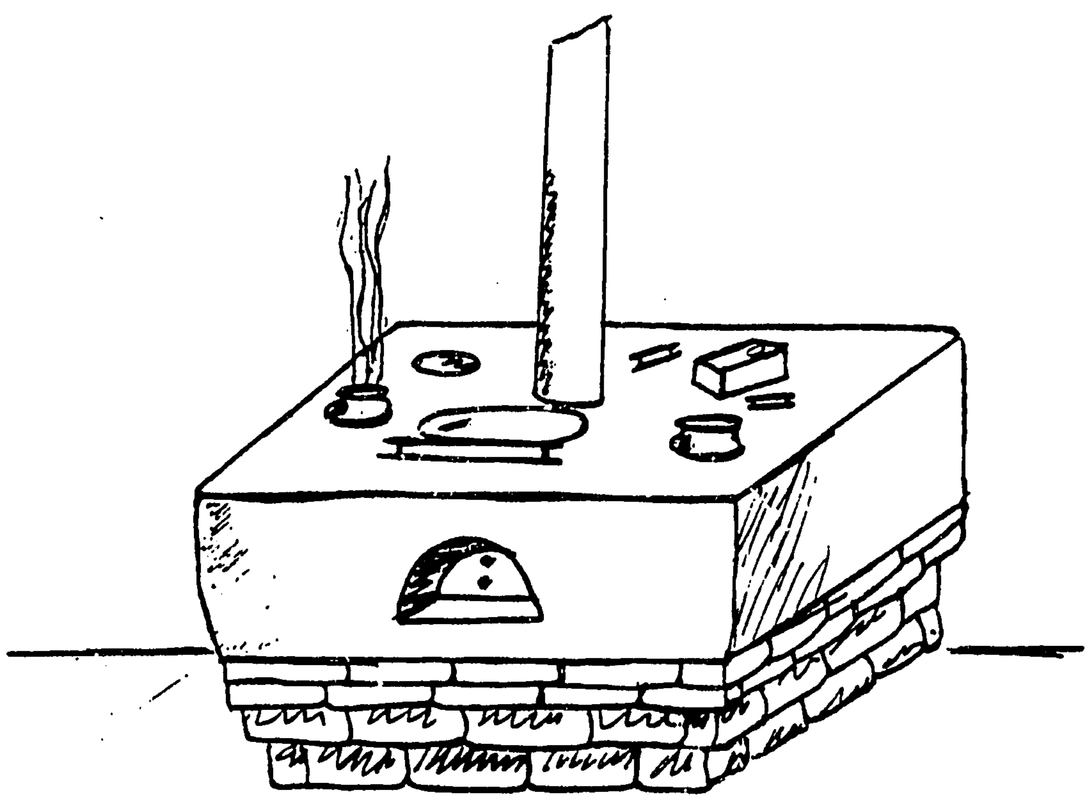
Wood Conserving Stoves: Two Stove Designs and Construction Techniques



a VITA publication

ACKNOWLEDGMENTS

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WOOD CONSERVING STOVE CONSIDERATIONS

APPLICATIONS:
HEATING AND COOKING
HOT WATER GENERATION

SKILLS/LABOR/TIME:

Construction time and labor resources required to complete this project will vary depending on several factors. For example, the project may in many circumstances be a secondary or after work project. This will of course increase the length of time necessary to complete the project. The construction times given here are estimations based on available information.

Skill divisions are given because some aspects of the project require someone with experience in metalworking and/or welding. Make sure adequate facilities are available before construction begins.

SKILLED LABOR -- 4 hours (Sawdust stove design)
UNSKILLED LABOR -- 30 hours (Lorena stove)
WELDING -- 1 hour

SPECIAL CONSIDERATIONS:

Advantages:

- Cuts traditional wood consumption by 20 to 40%.
- Uses sawdust and wood shavings.
- Smokeless.
- Easy to build and maintain.
- Minimum maintenance.

Disadvantages:

- Lorena stove construction may take several tries.
- All pot-holes must be covered for efficient operation.
- Sawdust stove will only operate with sawdust.

COST ESTIMATE:*
Lorena Stove -- $10 (US) including materials and labor.
Sawdust Stove -- $30 to $60 (US) including materials and labor.

*Cost estimates serve as a guide and will vary from country to country.

WOOD-CONSERVING STOVES

I. INTRODUCTION

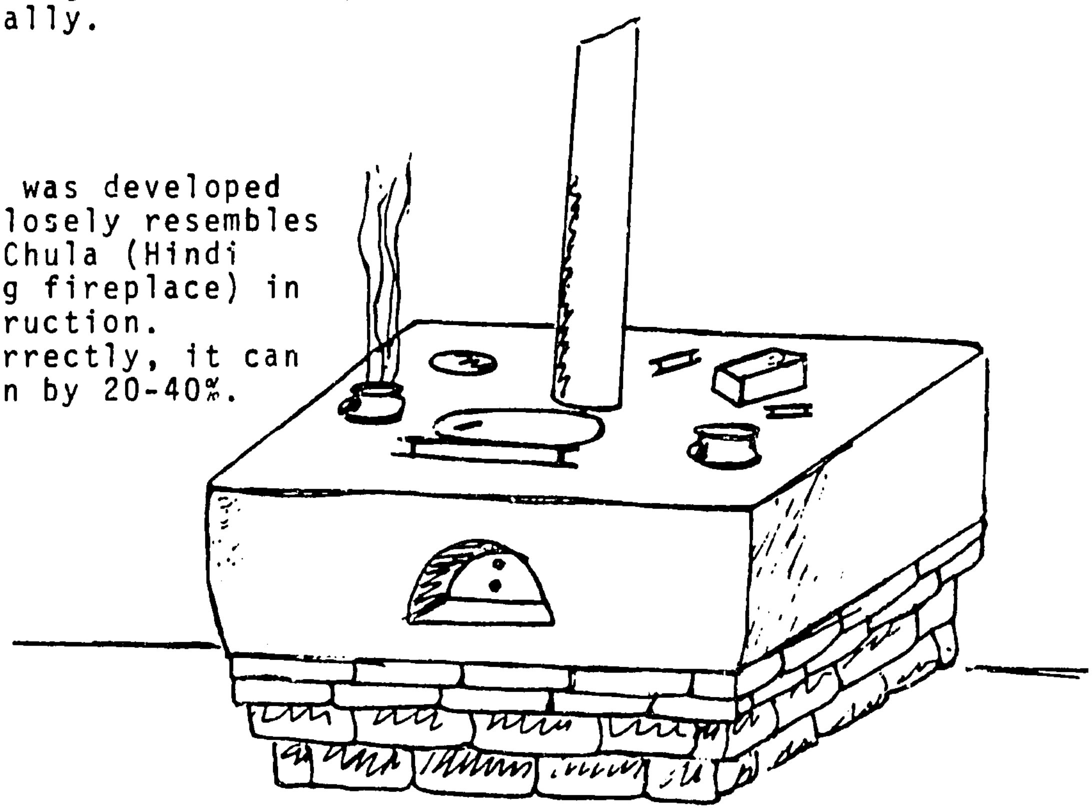
One of the most important steps toward preventing continued deforestation, depletion of forest resources, and loss of human energy and time spent cutting and carrying wood over long distances could be successful introduction of wood-conserving stoves.

At present, in many areas, much of the wood is used for cooking. Yet the cooking devices, often open fires, are inefficient; that is, it is necessary to burn a lot of wood to product enough heat for cooking.

In cooler climates, the cooking fire is also the only source of room heat. However, it creates a lot of smoke and, is responsible for many respiratory diseases. An even worse hazard is the danger from fire and personal injury, particularly to infants and small children.

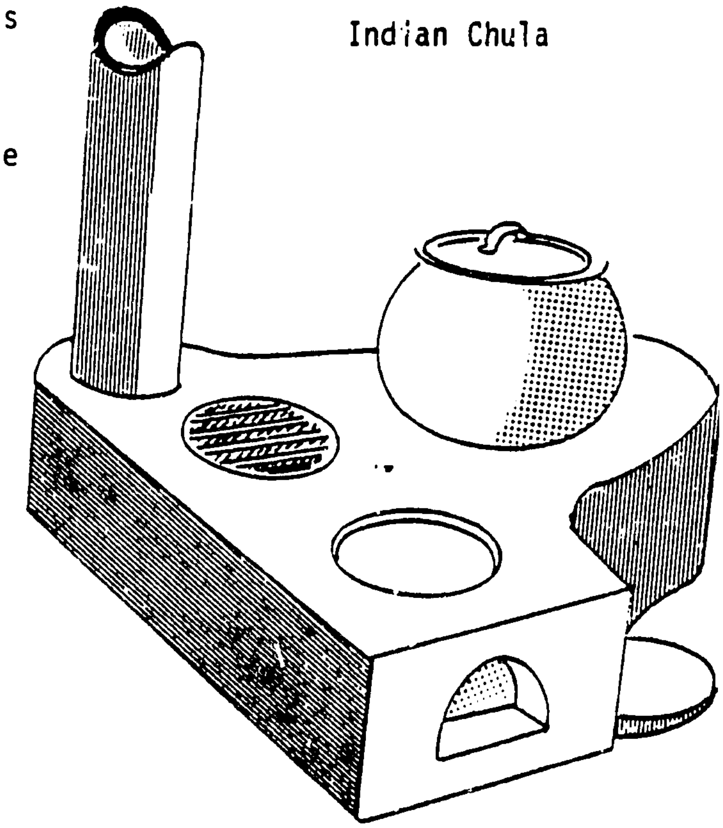
A number of stoves have been designed which present alternatives for cooking and heating. An efficient cooking stove intensifies heat and directs it to certain areas of its surface for cooking; an efficient heating stove radiates its warmth to a larger area. Therefore, it is generally better to have different stoves for each purpose. This booklet presents two devices, one for cooking and one for heating, which have potential for cutting wood consumption drastically.

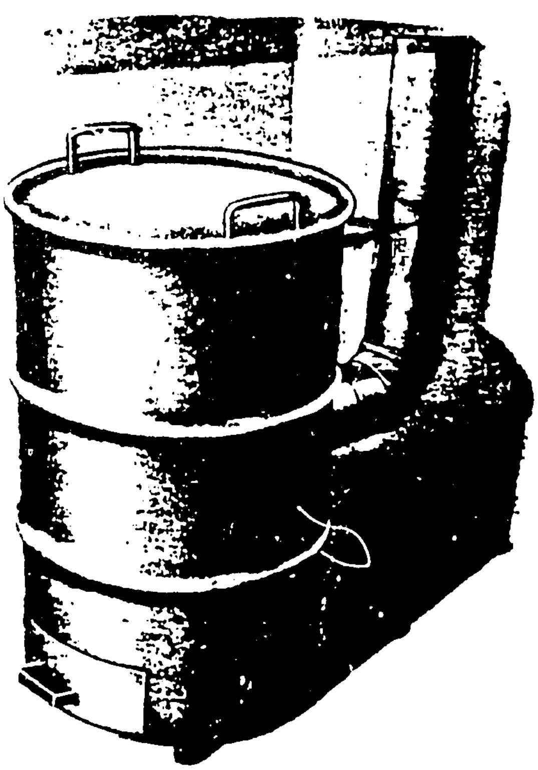
The lorena mudstove was developed in Guatemala. It closely resembles an improved Indian Chula (Hindi word meaning cooking fireplace) in principle and construction. When constructed correctly, it can cut wood consumption by 20-40%.



The lorena stove burns sawdust, woodshavings and grain stalks as well as wood. Because it can be built using local materials by unskilled workers and because it can be made larger or smaller depending upon the size of the family, it is gaining popularity rapidly. In Guatemala, there is an active program underway to insure that the construction design for the stove is made available as widely as possible, and small businesses are specializing in constructing such stoves for local families who do not wish to build their own.

Indian Chula





The Double-Drum Heating Stove burns sawdust, bark residue and wood shavings. Such stoves have been used in countries as widely separated as Chile, Afghanistan and England. The stove presented here is inexpensive to build; uses recycled parts, burns inexpensive fuel and heats for a long time without tending.

II. PRE-CONSTRUCTION CONSIDERATIONS - LORENA COOKSTOVE

The stove is build with a mixture of soil and sand called lorena from the Spanish words (lodo - mud and arena - sand). A solid base is first constructed and heaped with wet lorena to form a firm block. The chimney hole, pot holes, firebox and connecting tunnels are then excavated before the lorena fully hardens. The stove can be built any size or shape. The fire is kept enclosed in the body of the stove so no heat or smoke escapes. Smoke is carried away by the chimney. The stove can be build in about two weeks by a family member using simple materials and tools.

The uses and advantages of this stove should be clear without much further explanation. However, there are some points which should be considered before construction begins.

The stove can be located inside the house, or outside in a cooking area or shed. If the stove is inside, it will be necessary to make sure the chimney of the stove goes through the roof. Obviously this can be expensive and complicated, depending upon the roofing construction and materials.

The shape of the stove should be decided carefully beforehand. While the stove can be made in any shape, a round or square stove will burn better and be less likely to crack than a long rectangular one, for example. The shape may help determine where the stove is placed and vice versa. If the room is small, the only possible solution may be to construct a square stove against one wall.

When deciding shape and location, take daily household patterns into account. While the stove is smokeless and may be built inside a main living area, it may not be a good idea to make this move until the family has considered what changes that stove may or may not make in the living space or the household routine.

Consider the daily uses of the cooking fire and the types of pots used. With the lorena stove it is possible to shape the cooking holes using the same cooking utensils the family has always used. Use of the same utensils was found to be an important factor in terms of acceptance of the stove in Guatemala. In addition, one cooking hole on the stove can be made to hold several sizes of pots, and the layout of the stove can be adjusted to respond to the types of foods cooked by the family. If daily use indicates need for several pots which must cook food quickly at high heat, those are located near the fire source. Other foods which cook at low, slow heats for long periods of time are placed further away. For slow cooking, use of different fuels, such as sawdust, may be feasible.

Investigate fuel sources. The stove can use sawdust in those areas where slow steady fire is preferred. Grain stalks and wood chips and kindling can be used as well. There may be local businesses which have such by-products and which can be encouraged to make them available -- perhaps in return for cleaning up and getting them out of the way.

TESTING AND PREPARING SOIL

It is most important to use soil which contains sand and clay in the right proportions. Too much clay can cause shrinking and cracking as the stove dries. A soil which consists of too much sand will result in a stove which is too soft and, therefore, is likely to fall apart after only a short time.

Fortunately there is quite a wide range within which the clay/sand ratio in the soil is acceptable. For example, a soil which contains somewhat more sand than would be considered best may produce a stove which cracks somewhat, but experience in Guatemala has been that even with such cracks (within reason, of course), the stove can be far more efficient and conserving of wood than more traditional stoves.

In addition, if the soil in the area contains either too much clay or too much sand, the obvious answer is to make up for the overabundance or the lack by bringing sandy soil or clayey soil, as the case may be, from another location and mixing the soils until the mixture contains the right proportions.

One key source of information on soils is local brick or adobe makers: their experience working with local soil can be invaluable.

A good way to test a soil or soil mixture once the proportions of sand and clay seem correct is to build a small test stove before beginning the full-size one. Once built, the small stove is fired. If there are no cracks after a week's use, the mixture can be used to construct the full-sized stove with some degree of assurance that the resulting stove will be solid.

There are no easy formulas which can be set for determining, across the board, the right percentage of clay to sand. In one area, because of soil content, the right soil or mixture consists of one part clay soil to 4 parts sandy soil; in another a mixture may consist of one part clay soil and two parts sand. In fact, it is possible to find a situation where two layers of soil, directly on top of one another, have very different clay contents. In many cases, there will be the need to test the soil without benefit of complicated testing equipment. This section, therefore, provides assistance with guidelines for such testing.

TESTING FOR CLAY CONTENT IN SOILS

Method I:

Take a small handful of soil.
Add enough water to make a stiff mud.
Make a flat mud patty on the palm of the hand.
Close the hand; the mud should glisten and shine as your hand closes.
Open the hand. If the shine goes away when the hand is opened, the soil probably has a high proportion of sand or silt in it. If the shine remains, the soil has a high clay content.

Try the test several times to develop some points of comparison. Obviously the mixture needed for the Lorena is at neither one of these extremes. If the test shows that the soil is indeed an extreme in either direction, it is clear that mixing has to be done.

Method II:

Dampen a small amount of soil until it becomes stiff enough to roll into a rope about 15cm long and about the thickness of a pencil. (Use the palm of your hand to roll mud on a hard surfact).
Pick up the rolled mud at the center with your thumb and index finger.
Hold the mud roughly parallel to the ground. If the rope breaks, it contains a lot of sand or silt; if it bends or sags but doesn't break off, it contains a lot of clay.

TESTING FOR SAND CONTENT

Half-fill a transparent glass jar (at least ½ liter volume) with soil.
Add water until the jar is nearly full.
Cap tightly.
Shake the jar vigorously until the water and soil are thoroughly mixed.
Set jar on a flat surface where the soil can settle undisturbed.
The first soil to settle is sand (within 10 minutes).
The next soil to settle is clay (1 to 2 hours -- if none settles there is no clay in the mix).
The last soil to settle will be silt (1 to 2 days -- if everything settles in less than ½ a day, there is little or no silt in the soil).
Organic matter (straw, leaves, roots, etc.) will float on top for a long time.

Once all the soil has settled in the jar and the water has cleared, you' will be able to get a rough idea of how much sand, clay and silt there is by measuring the thicknesses of the different layers. It may be difficult to distinguish between the clay and silt layers, so measure the clay layer about an hour after the jar is set down to settle.

Almost any sand will work in the lorena mix, but coarse or rough sand works best. Beach sand should be washed with fresh water to remove salt. Extremely coarse sand or sand with gravel in it should be passed through a screen with 5 mm mesh.

Try to use soil that contains little or no organic material.

MIXING LORENA

An average-size, one-square meter top-surface requires about ½ cubic meter total of lorena mix. This amount of soil will require up to 200 liters of water if the material is dry when mixing begins. (An empty 55 gallon petrol drum holds about 200 liters of water). It does not matter if the water is murky, but it should not be salty. If the soil is dry and lumpy (clay often is), pass the soil through a 5mm or 6mm screen to remove the lumps.

TESTING THE MIX

When the ingredients have been prepared and mixed with water, take a handfull of the wet mix and form a flat patty with your hands. Clench the patty loosely in one hand and turn the hand palm down. Open the palms gradually. If the patty sticks, i.e., stays in the hand for a few seconds, or leaves a lot of mix behind, the mix contains too much clay. Add more sandy soil. If the mixture falls apart, it contains too much sand and clay soil must be added.

Repeat the test several times until the mud patty falls, as a patty, leaving the hand reasonable clean. When this happens, the mix is right for stove building.

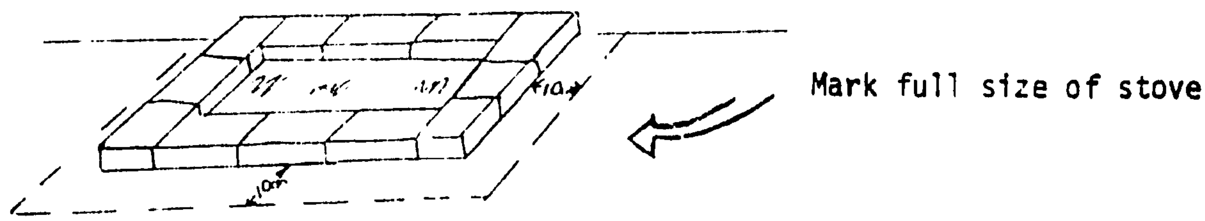
TOOLS AND MATERIALS

30 adobe rammed earth bricks. Large rocks can be used at least in part -- as long as the top surface is level. In fact, rocks or concrete blocks may be easier if a round stove is desired.
chimney pipe (10cm - 13cm diameter)
soil - 120 buckets (total for 1 square meter stove)
sand - 120 buckets
water
scrap sheet metal
sifting screen
shovel
large hoe
bucket
spoon
machete or similar tool

III. CONSTRUCTION OF LORENA STOVE

1. Make the Foundation

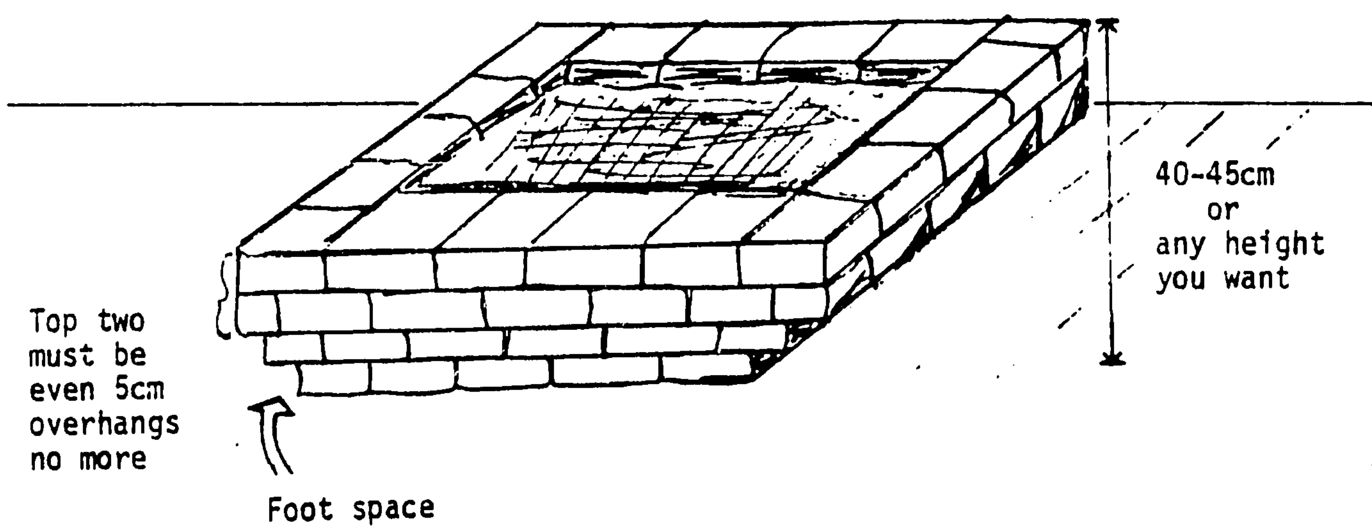
-- Mark the full size of the stove on the ground. Put the first layer of adobe blocks 10cm in from the mark on all sides. Leave the center empty. The foundation can be laid using any good cement or lorena mixture to hold the blocks together.



-- Add a second layer of blocks so that it sticks out 5cm further than the first layer -- this ensures there is foot space so that it is easy to work close to the stove.

-- Make the 3rd and 4th layers even. Add another layer if a higher stove is desired. 40-45cm is a good height for the stove's foundation.

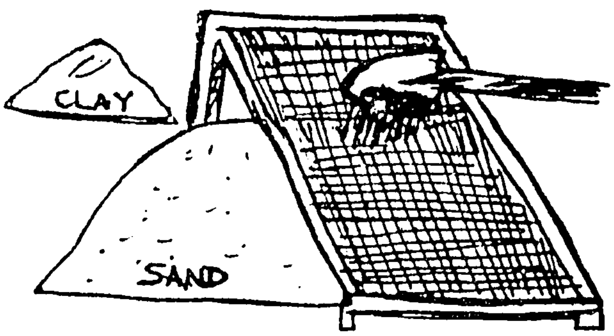
-- Fill in the center of the foundation with soil, rocks, broken adobe blocks or debris. Pack down and allow the foundation to dry overnight.

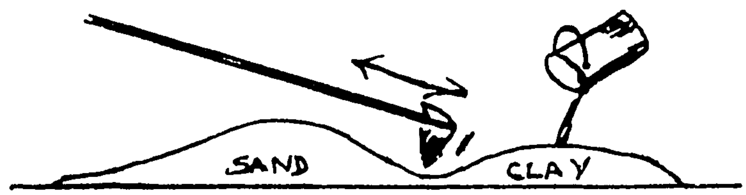


2. Make Lorena (or Soil Mixture) For Stove Body

-- Mix clay and sand soils together as necessary. Some soils will not make a good stove because the clay does not fire, causing the firebox to crumble. If it is a problem, the firebox can be lined with a thin layer of cement. If it seems the soil is exceptionally sandy, add clay.

-- Sift sand and soil to remove rocks. Use a screen with ½cm openings.

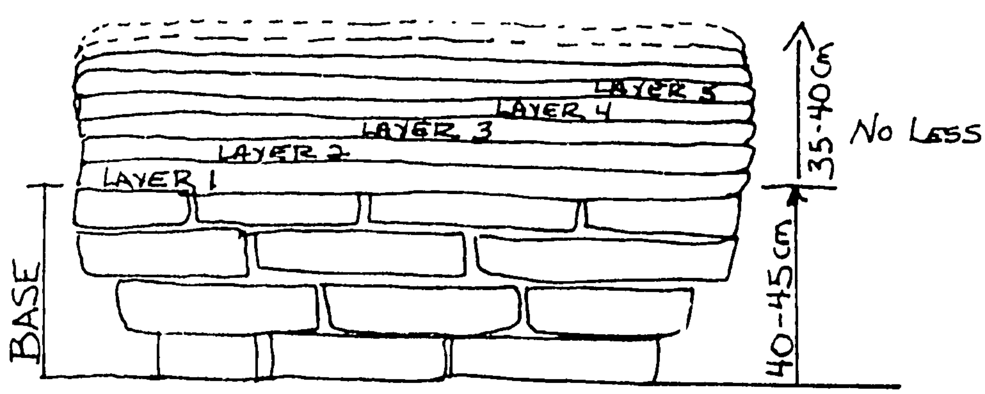




-- Mix 12-20 bucketfuls (6-10 each of soil and sand) at one time. This will make one layer. Do not add too much water. The mixture should hold together well without being runny. It must be of a consistency which can be spread easily but which holds its shape well.

3. Make Stove Body

-- Mix and lay one layer at a time.

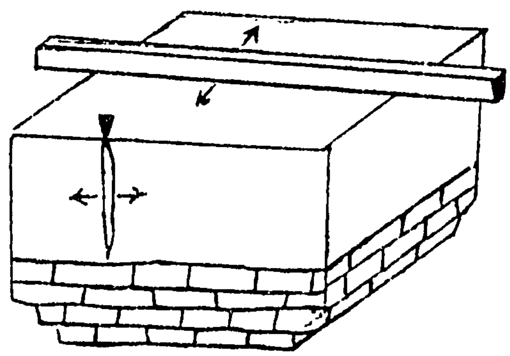


-- Add the layer working from the outside of the stove into the center.

-- Allow each layer to dry and firm until it no longer glistens before adding the next layer. It may take as long as one day per layer indoors.

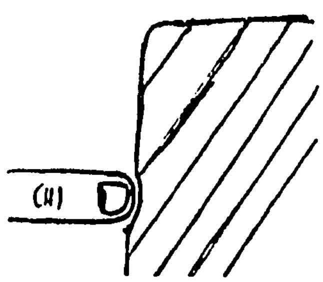
-- Watch each layer carefully. If cracks appear, add more sand to the next layer. Make sure to record any changes made.

-- Try to keep each layer level.



-- Work a board across the top of a completed stove to keep level. Use the machete to even and smooth the sides.

-- Allow the stovebody to dry until a finger pressed into the side leaves only a slight depression.



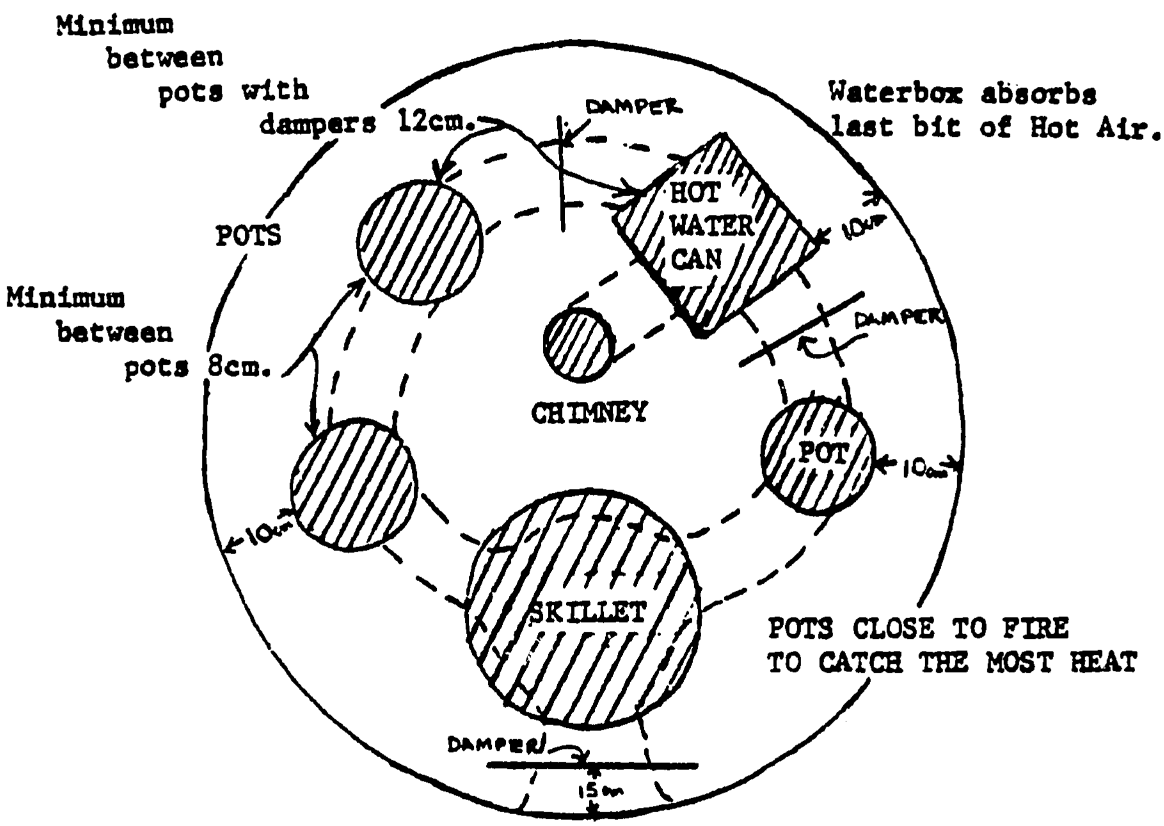
The Lorena may crack as potholes and tunnels are dug. These cracks can be filled in with wet Lorena. If cracks appear all the way across the top of the stove. demolish the stove. Break the Lorena up and start again.

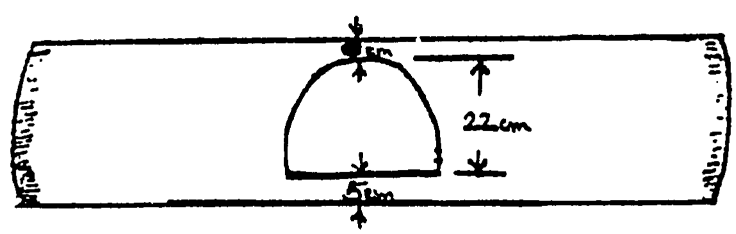
(Cracks are due to (1) overworking the lorena when the layers are applied, (2) cutting the tunnels when the layers are too wet, or (3) there is too much clay in the mix causing excessive shrinkage of the layers when they dry).

4. Mark Stove Layout

-- Draw the outline of the desired layout on the stove body. The following illustrations show two possible stove layouts.

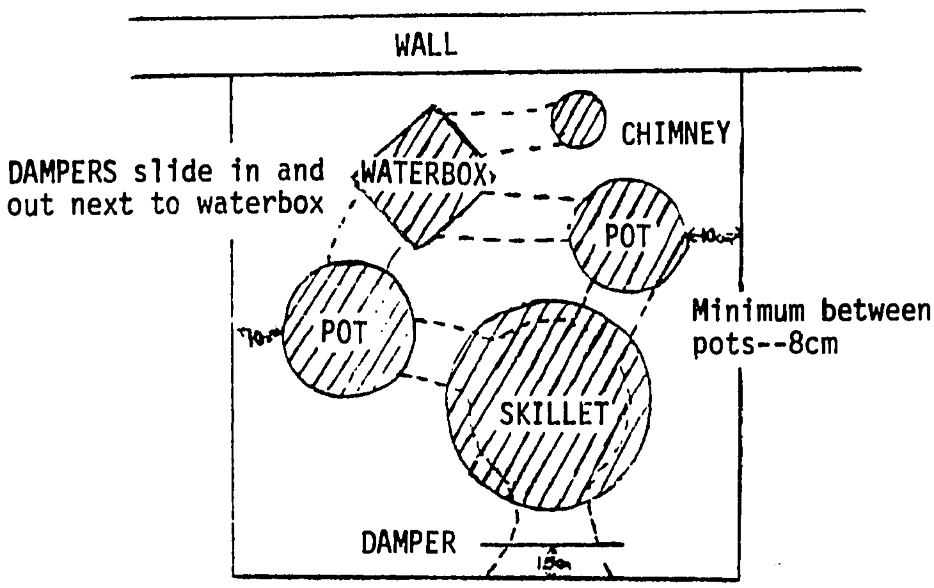
TOP VIEW





FRONT VIEW

Locate the firebox at the fron center of the stove. Arrange pots so that they are closest to the heat source. Diagrams show the positions of hot air tunnels and dampers; a cooking hole located near the chimney provides enough heat to keep water warm for washing.

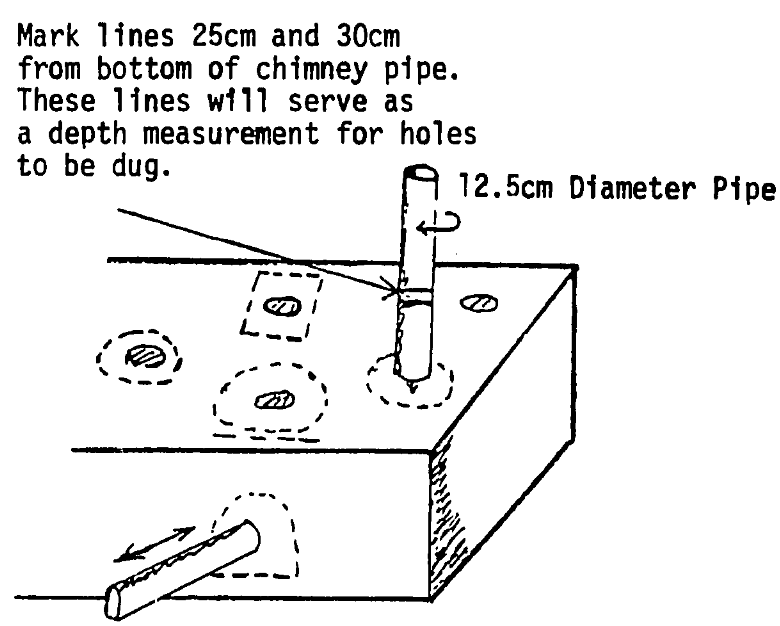


TOP VIEW

5. Excavate Stove Holes

-- Use a wet chimney pipe or similar tool as a digging implement.

-- Center the wet chimney pipe over a pot hold and press down. Twist the pipe clockwise while pushing it in. Remove the pipe by twisting in the opposite directions.



-- Core out the chimney hole to a depth of 30cm.

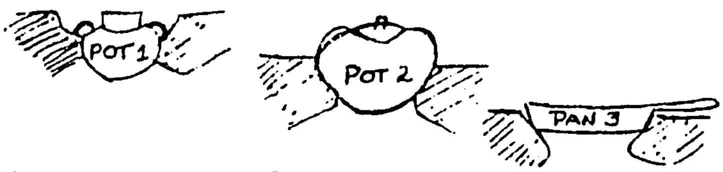
-- Core out the remaining holes to a depth of 25cm.

-- Wait a day for drying if working indoors; only an hour or two if outside.

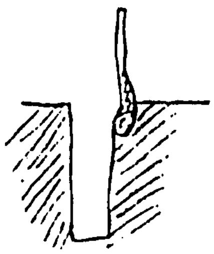
6. Complete Cooking Holes

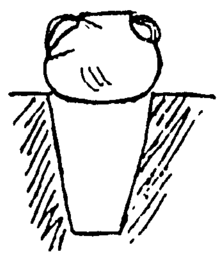
-- Plan carefully: one hole can be made so that several pots may be used in that place.

SIDE VIEW

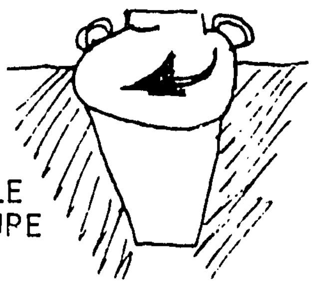


-- Use a spoon and the pots to enlarge and shape the hole. Work carefully. Begin with the spoon. Then wet the sides of the pot to be used on that hole, press downward -- but not too hard -- and twist back and forth.

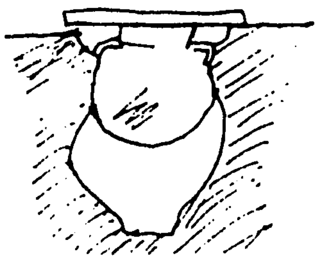




WET SIDES
AND TWIST
BACK AND FORTH
WITH VERY LITTLE
DOWNWARD PRESSURE



THE
FURTHER
DOWN THE
POT SITS
THE BETTER

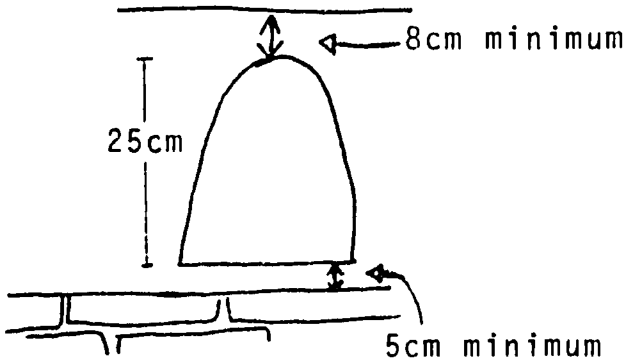


-- Arrange for the pot used to cook foods requiring highest heat to be over the firebox hole. In Guatemala, this is where the skillet, or comal, used in making tortillas fits.

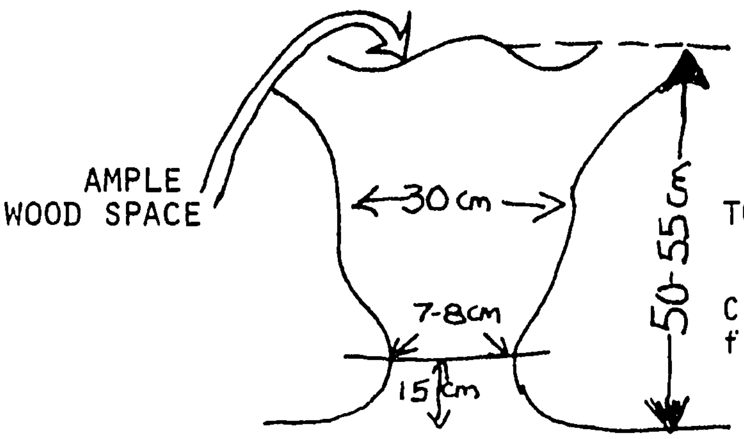
7. Complete Firebox

-- Shape the entrance in the form of an arch. The arch should be higher than it is wide.

FRONT VIEW



-- Widen entrance at top so that wood can be placed more easily.



TOP VIEW

Cutaway to show size of firebox inside stove.

8. Complete Waterbox Hole

-- Use a machete and an empty can to dig out the waterbox hole.

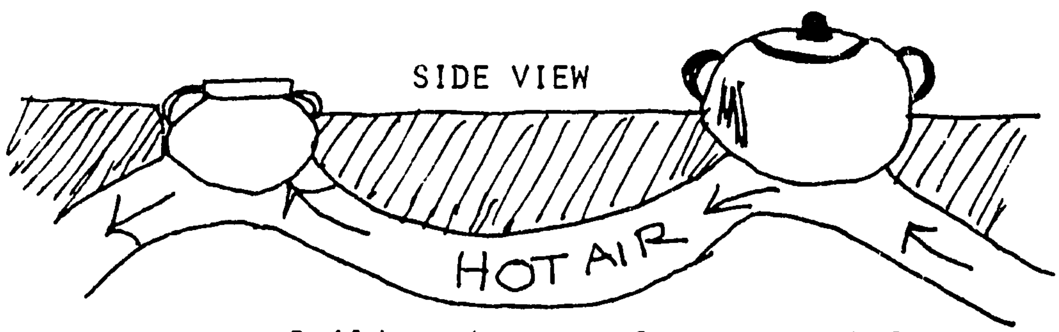
-- Dig the hole about the same height as the can.

9. Excavate Tunnels

-- Use the spoon to dig out tunnels connecting the firebox and the pots. The tunnels carry the hot air inside the stove. Hot air should circulate around as much as possible.

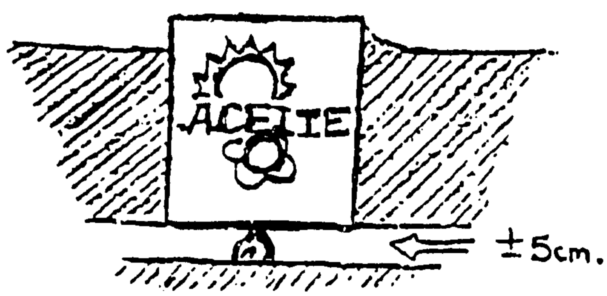
-- Make the tunnels just large enough for a hand holding three eggs to fit.

-- Leave the tunnel running below each pot hole wide enough for only three fingers between the pot and the tunnel floor. If there seems to be too much space build up the floor using dug out stove clay.



Build-up bottom of each pot hole leaving a three finger space.

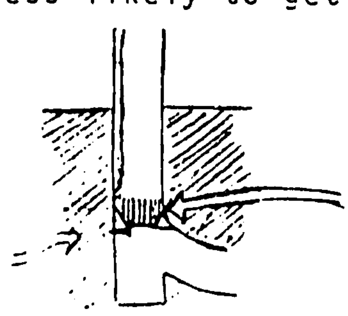
-- Place a rock 5cm in height in the bottom of the water-box hole. It will raise the box and allow air to circulate.



SIDE VIEW

10. Add Chimney

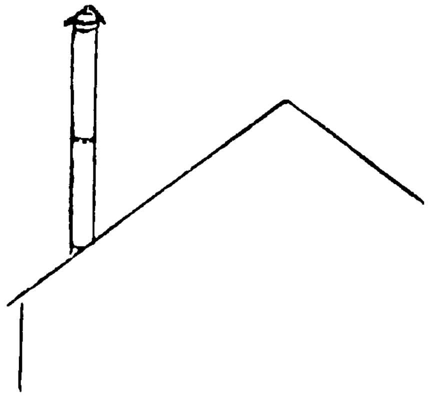
-- Make sure the hole for the chimney is deeper than the tunnel inside the stove. This gives added space so that the air passage is less likely to get clogged up with fallen debris.



-- Place a nail at the desired place for the chimney to rest inside the stove. If the chimney fits very tightly and remains steady, the nail may not be necessary.

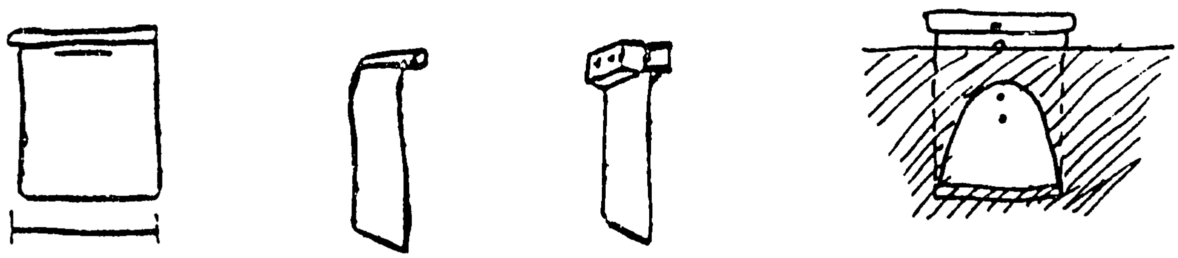
-- Add enough chimney pipe. The higher the pipe, the better it feeds air to the stove.

-- If the stove is constructed inside a building, the chimney should be higher than the roof to insure good draft.



11. Make the Dampers

-- Use scrap sheet metal and make three dampers as shown. Each damper should be a little wider than the tunnel so that it can be used to control the flow of air through the tunnel.



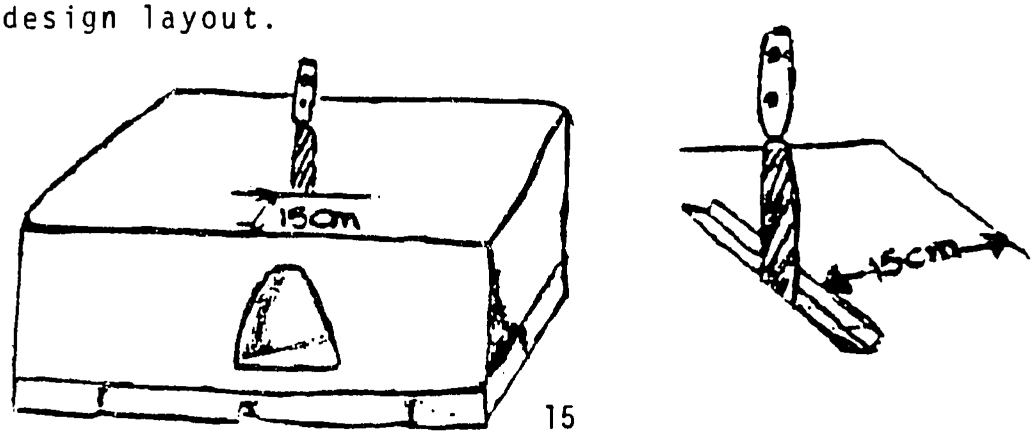
A little wider than the tunnels

Doubled over or with two pieces of wood

A nail and holes through the firebox damper make it adjustable.

-- Rounding off the bottom edges of the dampers will allow easier movement of the dampers in the stove.

-- Use a wet machete to carve slots for the dampers. One damper is located 15cm behind the firebox door. Others are located on either side of the waterbox hole. See design layout.



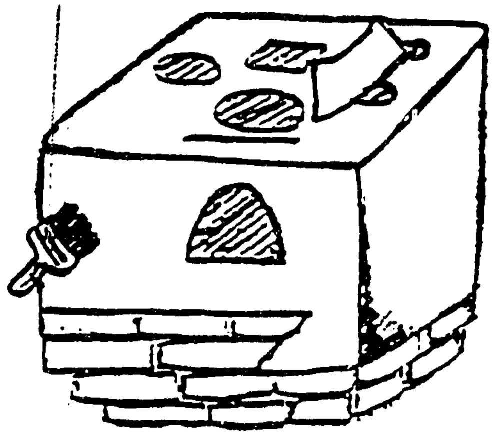
12. Finishing Touches

-- Complete the body of the stove by lightly splashing water on the sides and top and running the machete or scrap metal over the surfaces until they are smooth.

-- Dry

-- Apply whitewash, plaster, or varnish.

-- Fill adobe cracks with lorena.



Once stove has dried, whitewash, plaster, or varnish can be applied

Adobe cracks can be filled with lorena.

IV. OPERATION AND MAINTENANCE OF THE LORENA STOVE

To Use The New Stove:

1. Put pots in place. Make sure all the pot holes are covered and waterbox is in place.
2. Open damper doors.
3. Place kindling just inside the firebox damper door and light.
4. Close firebox damper and adjust waterbox dampers for draft. The stove is now ready for cooking.
5. Slow fire down and conserve heat by lowering damper doors.

Slow Cooking:

1. Pull coals forward and add a large piece of firewood.
2. Pour in a bucketful of sawdust.
3. Close damper doors and cook breakfast overnight.

The lorena stove is easy to maintain. If the stove stops drawing, the tunnels or chimney pipes need to be cleaned.

V. PRE-CONSTRUCTION CONSIDERATIONS - SAWDUST HEATING STOVE

Sawdust in several forms is burned to produce heat. It is often compressed into logs or briquettes but can also be used in loose form. The sawdust heating stove presented here burns loose sawdust; it is used in Afghanistan where it is produced by tinsmiths. Sawdust stoves will burn for a long time on a single filling -- perhaps as long as eight hours depending on the size of the stove and the moisture content of the sawdust. Because it burns slowly, sawdust delivers a relatively small amount of heat bur works well in small rooms or rooms with little heat loss through windows and cracks.

The sawdust stove is made from discarded 55 gallon and 30 gallon petrol containers. Sheet metal is used for the chimney. Metal shop facilities should be available for welding and working with the sheet metal. A local blacksmith might be able to help. The stove is essentially a cylindrical stove with an inner container which can be removed for filling with sawdust.

MATERIALS

1 - 55 gallon drum with lid (stove body)
1 - 30 gallon drum, with lid removed (fuel cannister)
2 - 13cm diameter steel rods 60cm long
1 - 14cm x 23cm peice of 14 gauge steel (Draft door)
2 - 3cm x 25cm peice of gauge steel (Draft door slide guides)
1 - 80cm x 9cm diameter wood post (wooden inserts for filling fuel cannister)
1 - Damper control for 16cm diameter stovepipe
1 - 20 gauge sheet metal for stovepipe

TOOLS

tin smith tools (metal saw and blades, tin snips, drill, etc.)

welding equipment

hammer

pliers

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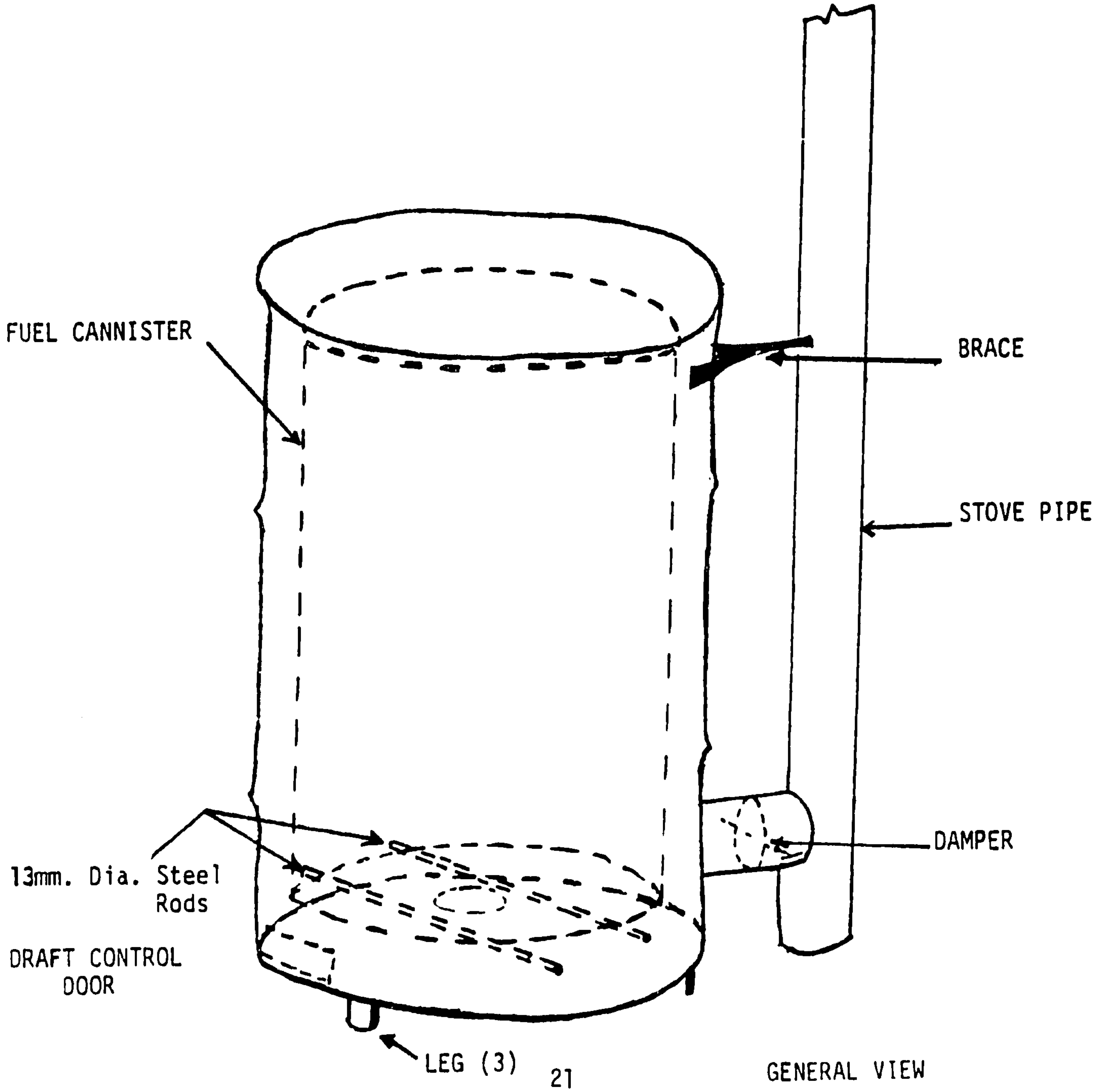
VI. CONSTRUCTION OF SAWDUST HEATING STOVE

The stove is constructed of a 55 gallon drum with a 30 gallon drum. A False floor separates the two drums at the base.

1. Drill holes into both sides of the outer barrel, 13cm from barrel bottom. Insert steel rods to support fuel canister.

2. Cut an air opening (12cm x 21cm) below the steel rods as shown to provide draft. This area fills with ash which can be swept out from time to time.

3. Cut 8cm diameter hole in the center fuel cannister bottom. This hole lets air pass up to the fuel and lets ashes fall into the bottom.



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4. Make sure the outer barrel has a tightly fitted lid.

5. Leave 8cm between this lid and the top of the inner barrel.

6. Cut a hole for 16cm diameter stovepipe to the outer barrel. This chimney will allow smoke to escape.

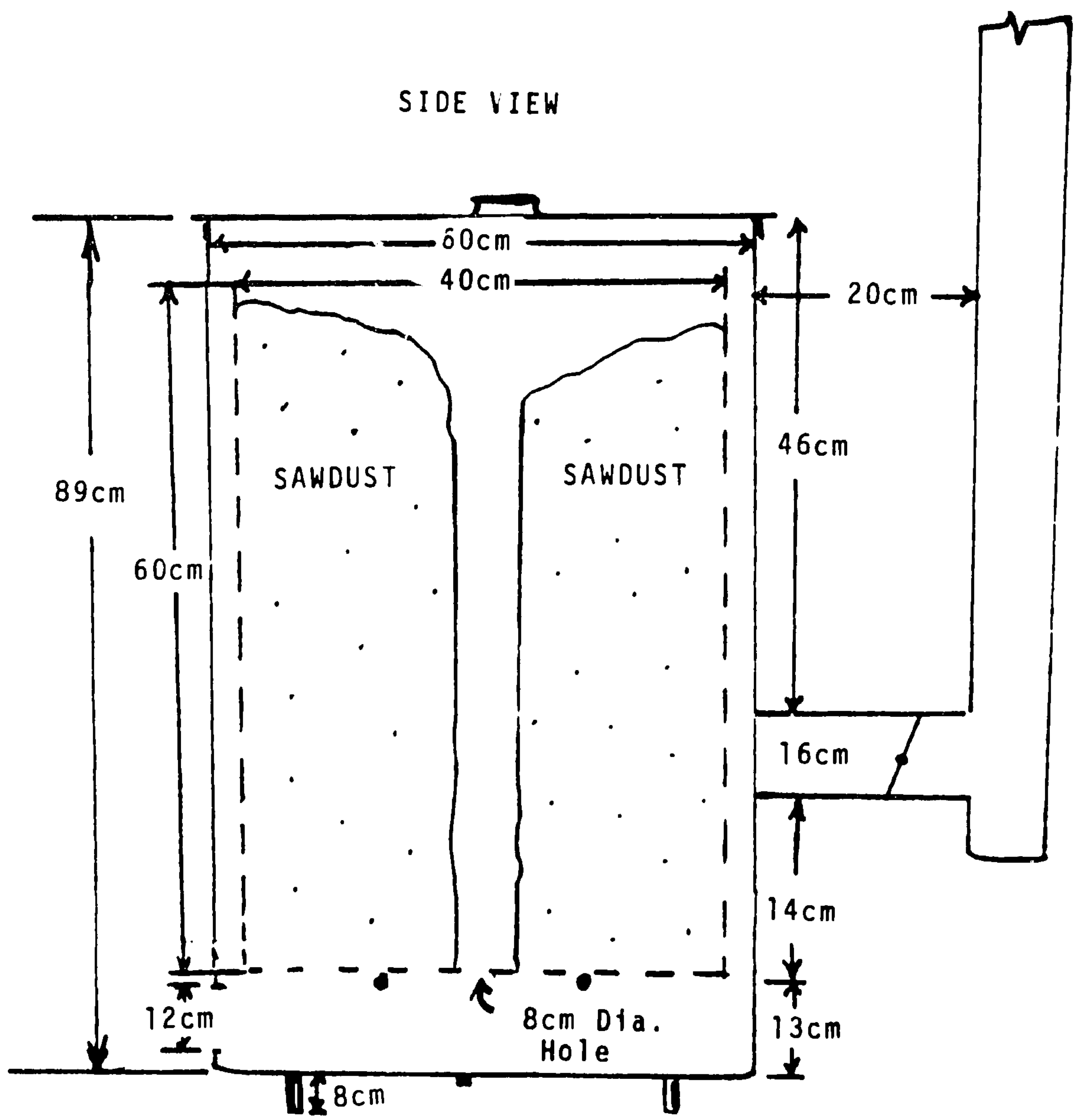
7. Support outer barrel on three legs, 8cm high, to keep excess heat from the floor and to prevent rocking.

8. Make handles for the lid and for the draft door from 13cm steel rod, bent to shape and welded.

9. Fit this horizontal pipe with a damper.

10. Weld 20cm long steel rod (brace) to barrel and chimney for support.

SIDE VIEW



Installation

Place the stove at least 60cm away from any combustible wall or floor material. Make sure it is set on a fireproof floor pad (rock or slate) that extends at least 50cm in front of the draft door opening. A triple wall pipe or clay pipe 16.5cm diameter should be used where the pipe goes through the wall or ceiling and the roof.

NOTE: Keep the horizontal sections of pipe short -- gas from the sawdust tends to condense and will leak at the pipe joints and corrode the stove pipe.

VII. OPERATION AND MAINTENANCE OF THE SAWDUST HEATING STOVE

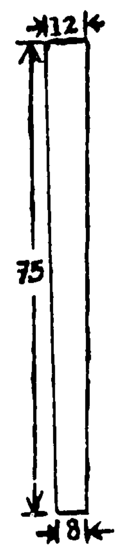
A round cylindrical piece of wood 75cm long, tapering from 12cm to 8cm is used to shape the fuel change.

To Fuel The Stove

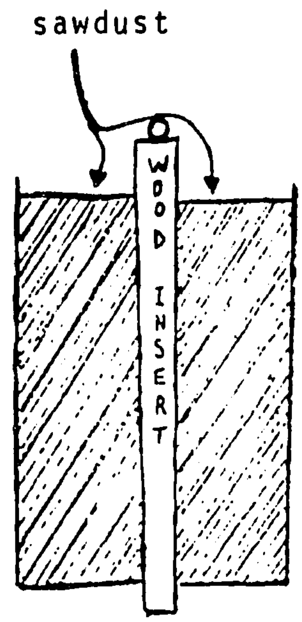
-- Remove the smaller, 30 gallon barrel from the stove.

-- Place the small end (8cm) of the wooden shaft in the hole at the bottom of the barrel

-- Add sawdust and tamp around the wooden insert until the fuel barrel is full. Wet fuel should not be tamped as much as dry fuel.



Wooden Insert
for filling
Sawdust Container



Loading Fuel

-- Place fuel barrel into larger barrel carefully. Make sure that the bottom hole of the fuel barrel is aligned over the hole in the bottom.

-- Remove the wood insert carefully, leaving a vertical hole in the center of the fuel barrel.

-- Open the draft opening in the outer drum and the damper before lighting the fire.

To Burn

-- Crumple and light a piece of paper, and drop it down the hole in the fuel. (May take several tries before sawdust catches fire).

-- Place the lid on the outer drum.

-- Adjust the draft opening and damper to obtain the desired rate of burning and output of heat once the fuel is burning. Thus, more heat is transferred to the room and less is lost through the stove pipes.

CAUTION: Opening the lid of the outer drum while fuel is burning may cause a flare-up and could cause a fire hazard.

Notes

With dry sawdust and a good draft, one charge of sawdust will heat a 200 foot square room for 6 to 8 hours with no tending. Fuel with a higher moisture content heats less but lasts longer. As an added bonus, during the first 2 hours of burning, there is enough heat in the center of the outer drum lid to boil water or cook with. As burning progresses, heat on the lid is distributed more towards the outer rim of the drum.

This stove is virtually maintenance free. Ashes falling into the bottom of the outer barrel will have to be cleaned on a regular basis for efficient fuel burning. Other than this and the precaution given in the construction process, this stove should give years of trouble-free service.

In addition to sawdust, bark residue from saw mills and planer shavings from carpentry shops can be burned in the stove. The limiting factor for fuels is their moisture content. Although fuel having a very high moisture content will burn, most of the heat generated is used in evaporating fuel moisture. Fuel below 60 percent moisture content works well. Fresh sawdust, shavings, and bark have moisture values anywhere from 50 to 100 percent. The best source of fuel is sawdust or shavings from dried timber. Fuel can be stored in a bin or in plastic bags.

CONVERSION TABLES

Units of Length

1 Mile	= 1760 Yards	= 5280 Feet
1 Kilometer	= 1000 Meters	= 0.6214 Mile
1 Mile	= 1.607 Kilometers	
1 Foot	= 0.3048 Meter	
1 Meter	= 3.2808 Feet	= 39.37 Inches
1 Inch	= 2.54 Centimeters	
1 Centimeter	= 0.3937	

Units of Area

1 Square Mile	= 640 Acres	= 2.5899 Square Kilometers
1 Square Kilometer	= 1,000,000 Sq. Meters	= 0.3861 Square Mile
1 Acre	= 43,560 Square Feet	
1 Square Foot	= 144 Square Inches	= 0.0929 Square Meter
1 Square Inch	= 6.452 Square Centimeters	
1 Square Meter	= 10.764 Square Feet	
1 Square Centimeter	= 0.155 Square Inch	

Units of Volume

1.0 Cubic Foot	= 1728 Cubic Inches	= 7.48 U.S. Gallons
1.0 British Imperial Gallon	= 1.2 U.S. Gallons	
1.0 Cubic Meter	= 35.314 Cubic Feet	= 264.2 U.S. Gallons
1.0 Liter	= 1000 Cubic Centimeters	= 0.2642 U.S. Gallons

Units of Weight

1.0 Metric Ton	= 1000 Kilograms	= 2204.6 Pounds
1.0 Kilogram	= 1000 Grams	= 2.2046 Pounds
1.0 Short Ton	= 2000 Pounds	

CONVERSION TABLES

Units of Pressure

1.0 Pound per square inch	= 144 Pound per square foot
1.0 Pound per square inch	= 27.7 Inches of Water*
1.0 Pound per square inch	= 2.31 Feet of Water*
1.0 Pound per square inch	= 2.042 Inches of Mercury*
1.0 Atmosphere	= 14.7 Pounds per square inch (PSI)
1.0 Atmosphere	= 33.95 Feet of Water*
1.0 Foot of Water = 0.433 PSI	= 62.355 Pounds per square foot
1.0 Kilogram per square centimeter	= 14.223 Pounds per square inch
1.0 Pound per square inch	= 0.0703 kilogram per square centimeter

* at 62 degrees Fahrenheit (16.6 degrees Celsius)

Units of Power

1.0 Horsepower (English)	= 746 Watt = 0.746 Kilowatt (KW)
1.0 Horsepower (English)	= 550 Foot pounds per second
1.0 Horsepower (English)	= 33,000 Foot pounds per minute
1.0 Kilowatt (KW) = 1000 Watt	= 1.34 Horsepower (HP) English
1.0 Horsepower (English)	= 1.0139 Metric Horsepower (cheval-vapeur)
1.0 Metric Horsepower	= 75 Meter X Kilogram/Second
1.0 Metric Horsepower	= 0.736 Kilowatt = 736 Watt

WOODBURNING STOVES/OVENS

1. OUTDOOR OVEN: VITA, Village Technology Handbook - p. 339

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3. DOUBLE-DRUM SAWDUST STOVES, VITA, Technical Bulletin # 29

4. LORENA MUDSTOVE, Choqui Experiment Station, Guatemala

5. RICE HULL STOVE, Volunteers in Asia, A.T. Sourcebook

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