6

CO_2 Neutral Energy

42 • Introduction - Energy

There is a lack of firewood and charcoal around many towns in Southern Africa. This means that the price of wood and charcoal go up because they must be transported over long distances. Highly deforested areas are subject to erosion and, at some places, even desertification.

On a global scale, this also affects the amount of carbon dioxide (CO2) emitted into the atmosphere. When plants grow and create organic matter, they absorb CO2. During combustion, organic matter is transformed into CO2. In areas where trees are cut down for energy purposes, more CO2 is emitted during combustion than the amount absorbed by new trees and plants during their growth. This results in increased amounts of CO2 in the atmosphere, which leads to the greenhouse effect, increasing the average global temperatures.

This stove uses 30% less energy than a conventional 3-stone fire

One way to reduce the problem of deforestation is by cultivating a mixture of plants that also produce firewood. This can be done by improved fallowing, where the production of firewood is combined with the cultivation of one's own fertilizer (see section 21).

Another way to reduce carbon emissions is to choose alternatives that reduce the use of firewood. Among these are for example:

- constructing firewood-saving stoves
- producing and using briquettes made from available organic matter
- using biogas systems, which produce cooking gas from manure and organic waste
- using solar stoves, in which the food is prepared using solar energy

There are other renewable energy systems that require more technological knowledge. Some of these can, however, also be used to supply energy to rural communities in Africa while simultaneously reducing carbon dioxide emissions.

For example:

- producing jatropha oil and using it as lamp oil, as biofuel in stationary diesel engines or in adapted diesel engines or - after transformation - as biodiesel
- utilising solar panel systems to produce electrical energy
- utilising residues from agricultural industries for producing energy - such as sugar cane bagasse or coconut shells for the production of "charcoal" briquettes
- utilising "biomass" - from trees with high energy values or agricultural residues - in gasification systems, where the gas produced may be used mixed with diesel on a conventional generator. These systems are marketed in India and used, for example, to generate electricity from rice husk. There are also small-scale gasification systems - for example to supply energy to irrigation pumps.

43 • Firewood-Saving Stove

Advantages of this stove

- A well-built stove can use as little as half the firewood used by a traditional 3-stone fire.
- By using a firewood-saving stove, people who usually purchase firewood will save money, while people who usually collect firewood will save time.
- This stove has positive environmental impacts, by protecting trees and saving wood.
- This stove reduces the amount of smoke in the kitchen, and thus improves the health of the people who cook. Inhaling smoke from a stove is as unhealthy as smoking cigarettes.
- This stove reduces the likelihood that children and others will burn themselves.
- This stove improves hygiene in the kitchen. Pots used on the stove are easier to clean than those used on an open fire.
- This stove is easy to build, and it is made from material available anywhere.

How to make a firewood-saving stove

Step 1 - Collect the material

- You need clay, sand, seven large bricks and water.
- The best clay to use is that from small anthills found in wet areas (dambos). Clay from termite hills can also be used.
- Where anthill clay is not available, it may be necessary to dig deeper to find good clay.
- Remove stones, sticks, and other foreign material from the clay and sand.

Use clay from anthills

Step 2 - Prepare the material

- Crush the clay into dust.
- Soak it in water overnight.
- Mix the sand and clay together using a ratio of one quantity of sand to two quantities of clay.
- Add water until the mixture is easy to work with. To check if the mixture is good, make a ball and drop it on the ground. If it splashes out, the mixture is too wet, if it falls to pieces, it is too dry.

Mix sand and clay - 1:2

Step 3 - Foundation

- Decide where to place the stove. If it is placed in an indoor kitchen, it must face the door in order to get enough air for appropriate combustion. If the stove is placed outside, the opening must face the direction from which the wind usually blows.
- Position 4 large (15 cm x 20 cm) clay bricks so that they form a square.
- Fill the hole in the middle halfway up with clay and plaster the bricks outside and on top with clay/sand mixture.

4 bricks form the foundation

Step 4 - Heat insulation

Place ash to a depth of 5 cm into the hole between the bricks and cover it with the clay mixture. The ash acts as a heat insulator so that heat from the fire

does not penetrate into the ground.

Step 5 - Construction

• Use a 5 litre paint or oil tin - or a cooking pot - as a mould. The tin should be 17-20 cm in diameter. Place the tin in the middle of the constructed foundation, on top of the ash insulation layer.

• Place the clay-sand mixture around the tin until it is 4 cm from the top of the tin. This should make the firebox 19 - 20 cm high. It is important not to make the walls too thick. Otherwise, they absorb too much heat.

Step 6 - Make the firewood rest

• Lay three bricks as a foundation, as shown in the photo.

• Plaster the bricks with the clay-sand mixture.

• Leave the stove to rest overnight.

Step 7 - Shape the stove

• Remove the tin.

• Shape the outside of the stove using a knife or construction trowel.

• Make the stove smooth using water.

Step 8 - Carve out the firewood opening

• Carve out an opening for the firewood using a knife or building trowel. The size should be about 12 x 17 cm. Do not make it too small, otherwise you will need to chop the firewood too much.

• Make sure the stove wall above the hole is not too narrow. It should be 5 cm high or more in order not to break easily.

Step 9 - Carve the edge

- Carve the edge of the top opening to an angle of 45° with a knife. This will make it possible to place pot-rests and use pots of different sizes (see the photo showing pot rests).

Step 10 - The pot rest

- Use some clay to make a pot-rest. It should be about three fingers wide and one finger thick (5 cm x 1 cm). It is important not to place a pot-rest on top of the firewood opening.
- Make small cuts on the pot-rest and on the part of the stove where it is to be placed (so that they fit together firmly).
- Add some water to both surfaces
- Press the pot rest firmly against the stove and shape it nicely. See next photo showing pot rests.

Step 11 - Place the pot rests

- Place three pot-rests on the stove, as shown in the photo. (It is important to have three of them - not any other number).
- The pot-rests allow smoke to come out, and enable the use of pots of different diameter.

Note: If the pot rests later fall off, you must replace them. Without them the stove will not function well.

Step 12 - Let the stove dry

- Let the stove dry completely before using it. Drying can take 2 to 3 weeks depending on the weather.
- Some cracks will appear while the stove dries. Repair these with some of the surplus clay-sand mixture. It is recommended that you keep a bit of the original mixture for this purpose.
- Cracks might keep on appearing. These must be repaired in the same way.

How the stove works

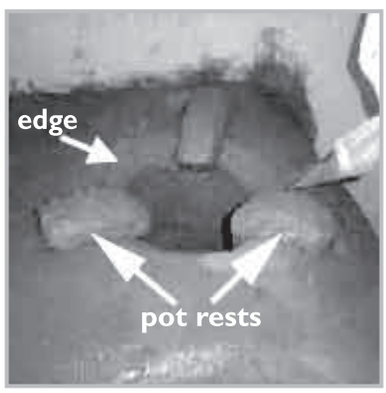
A fire can burn at different temperatures. The more oxygen a fire receives, the hotter it gets. A hot fire uses the firewood completely, which means it is very efficient.
A cool fire releases more smoke due to gasses which are not fully burned. If you look at a 3-stone fire, you might notice that the fire at the edges releases more smoke - because it is cooler at the edges and hotter towards the centre.
This stove promotes a small, hot fire - which releases less smoke, and which uses the firewood more efficiently.

Most common mistakes

1. Making the stove very big or too small. It is very important for the stove to be the right size. If the distance from the firewood to the pot is too great, some heat will be lost before it reaches the pot. If the stove is too small, the firewood must be chopped into very small pieces, which makes the stove less user-friendly.

2. ***Making the pot rests too thin or too thick***. If they are too thin, they will not effectively let the smoke escape from the stove. If they are too thick, they will allow too much heat to escape and the stove will be less efficient.

3. ***Correct clay-sand mixture***. Make sure the mixture is not too wet or too dry. Using the right amount of water in the initial mixture will make a stronger stove and there will be fewer cracks during drying.



It is important to have 3 pot rests in the right position

Other types of firewood saving stoves

There are many types of firewood saving stoves. Some have two pot holes and a chimney. The chimney ensures that there is no smoke in the kitchen, but it uses more firewood and is more difficult to make. The one-pot stove can be placed in the middle of the kitchen, so that the family can sit around it in the evenings, or it can be placed in a corner in the kitchen. Which stove will be appropriate depends on the family's needs and wishes.

Photos and text by: Development Aid from People to People, Child Aid and Environment, Monze, Zambia

44 • Jatropha for Fences and Oil

Jatropha

Jatrophas can form a closed fence within 2 years

Jatropha curcas is a small tree or large shrub which can grow to a height of up to 5 metres and live for more than 50 years. It is a drought-resistant species widely cultivated in the tropics as a hedge to protect fields and gardens, since animals do not eat it. The leaves and seeds are toxic to humans and many animals.

Propagation from seeds

Jatropha fruits. Seeds contain up to 35% oil

The best time for direct seeding is the beginning of the rainy season. After the first rains, when the soil is wet, the seeds are sown to a depth of 2-3 cm. The seeds sprout faster if the part from where the roots will emerge (indicated by small spots on the seed) faces downwards. After 2 years, or 3 rainy seasons, the jatropha plant will start to produce seeds.

Propagation by cuttings

Jatropha is easily propagated from cuttings. These should be more than one year old, "lignified" (this means the cuttings should be woody, not green branches) and about 60-120 cm long. The best planting time is 1-2 months before the beginning of the rainy season. For hedging, the cuttings can be planted alongside one another, like a regular wooden fence. The cuttings should be placed 20 cm into the soil, and held in place with horizontal branches on top. They will thus function as fencing immediately. Within a few weeks, the cuttings will start to grow. Cuttings can easily be kept in a shaded place for a few weeks, without drying out.

To get an efficient live fence that protects gardens against animals, the distance between the plants should be 5 cm. Dead plants should be replaced by new cuttings or seeds.

It is also possible to make a double row, with 20 cm distance between the two rows. The distance between each plant in the row should be 10-15 cm. Since the young plants have not developed their repellent odour, they are at risk of being eaten by animals. Therefore, they must be protected with some tree branches during the first year. After the rainy season, the plants will be large enough to function as a protective fence. If well maintained, this kind of hedge can even keep chickens out of gardens.

Possible uses of jatropha

- The plant is often used, in small quantities, as a plant medicine.
- It is used to mark boundaries and as live fencing.
- The fences are useful against erosion - especially if combined with vetiver contours or stone "bunds" - lines of stones running along contours.

- Oil which can be used for making soap or lamp fuel can be pressed from the seeds, or the seeds can be sold directly for industrial uses.

Jatropha for oil production

The suitability of jatropha for oil production varies according to the variety of jatropha being used, and ranges from 300 g to 9 kg per tree per year. This corresponds to ½ - 2 tons of oil per hectare.
The seeds contain about one-third oil. With a manual press, around two-thirds of this oil can be extracted (5 kg of seeds give about one litre of oil).
Jatropha press cake (the material that is left after pressing the oil) is valuable as an organic manure. It is comparable to chicken manure in terms of its effectiveness. One ton of jatropha press cake corresponds to 200 kg of chemical fertiliser.
Because the press cake still contains some oil, it also has pesticidal properties, and may reduce the amount of nematodes (a common pest) in the soil.
The most interesting and economically viable use of the jatropha oil is for soap production.
Jatropha gives a good quality, glycerine-rich soap which has positive effects on the skin.
Jatropha oil can be used as lamp oil, although a kerosene lamp requires conversion to burn jatropha, because jatropha oil is heavier than kerosene). A floating wick in a glass with oil can also be used, as developed by Binga Trees Trust. The use of jatropha oil as a lamp oil is explained further below.

Oil extraction

Seed preparation
Seeds for oil extraction should be dried in sunlight on top of a black plastic sheet for several hours, or in a roasting pan for 10 minutes. It is important that the seeds are heated, but not burnt. This process breaks down the cells that contain the oil, allowing the oil to flow out more easily. Heat also thins the oil, which improves the extraction process.

Manual press to produce oil from seeds

The manual press
Many villages have manual presses for the production of sunflower or sesame oil. These can also be used to press jatropha seeds. In such presses, a piston creates pressure to force the oil out of the press cake. Sometimes the piston gets stuck and is difficult to move. Then the press has to be taken apart and the piston and its cylinder need to be cleaned thoroughly. It is possible to regulate the outlet of the manual press. The more closed it is, the more difficult it becomes to press the cake through the gap. Thus, more oil is extracted (a higher extraction rate). The outlet should be regulated in such a way that one person can push down the lever without forcing too much (no "hanging" on the lever).

Oil purification

- ***Sedimentation***

Letting the sediments settle at the bottom is the easiest way to obtain a clear oil. It is best to use several containers, so that the clear oil is siphoned from one container to the next. After 24 hours this process is repeated at least one more time to get a batch of clear oil.

The oil left in the containers with the sediments (remains of seed shells, etc.) will eventually also separate.

- ***Boiling with water***

The purification process can be greatly accelerated by boiling oil and water together in a ratio of four parts oil to one part water. The boiling should continue until the water has evaporated (there are no bubbles of water vapour anymore). After a few hours, the oil becomes clear.

- ***Filtering***

Passing the raw oil through a filter is a very slow process and has no advantage in terms of sedimentation. Therefore, it is not recommended.

Cleaning the press

Because jatropha oil is not suitable for consumption, the manual press must be cleaned thoroughly after being used to press jatropha and before it is used to extract cooking oil. At least one kg of edible seeds must be pressed, and the oil thrown away or used as biofuel. before the press can be used for edible oils again.

The Binga Lamp

Lamp oil

Lighting is a basic need and kerosene is not always available in rural areas. Many people then use diesel instead. This creates much smoke, has a disagreeable smell and is unhealthy.

Two lamp designs using jatropha oil have been developed.

Adapted kerosene lamp

To use a kerosene lamp for burning jatropha oil, the body the lamp is modified so that the mechanism for moving the wick is turned around to reduce the height between the surface of the oil and the flame. This is necessary because jatropha oil is heavier than kerosene. This design is promoted by Africare in Lusaka.

Binga Oil Lamp

A very simple and suitable design for a jatropha oil lamp was developed by the Binga Trees Trust, at Kariba Lake in Zimbabwe. This model works very well and can easily be assembled.

It uses a small glass filled with oil up to 3 - 5 cm below the rim. A small cork disc (or a disc of a maize cob) floats on top of the oil, wrapped in aluminium foil to prevent it from burning. A hole in the centre of the disc contains a cotton wick. The floating wick holder is centred using match sticks. Thus, the flame of the oil lamp is only some 1 or 2 mm above the surface of the oil and gives a quiet and steady light. There is some evidence that the smell of this light also repels mosquitoes.

Information from the manual "The Jatropha System " published by GTZ. More information at: www.jatropha.de

45 • Fuel Briquettes

Introduction

A briquette is a block of compressed materials suitable for burning. Briquettes can be made from materials that cost little or no money to obtain, such as old newspaper or partially decomposed plant waste. They can be used as fuel instead of charcoal, firewood or mineral coal, and may cost less. Depending on which materials were used to make the briquettes, they may burn cleaner than charcoal. Finally, turning waste materials into a fuel source is attractive because it reduces waste as well as reducing the demand for non-renewable fuel resources. Many different methods and technologies exist for pressing briquettes. Each has its own unique advantages and disadvantages. This document describes two designs for briquette presses that are used by the organisations ECHO and WWF-Malawi.

Materials used for briquettes

One of the most commonly used materials for making briquettes is shredded newspaper. Small woodchips and sawdust also work well. Plant waste can make good briquettes, but it is best to compost the plant waste for a while (two or three weeks) so that it will stick together when it is pressed. Adding a small amount of wood ash to the mix makes briquettes harder and makes them burn longer. The addition of manure can achieve the same effect.

Testing materials for briquettes

To test a material to see whether it will make good briquettes, first soak the material in water.
Take a handful of material and press it into a ball. If the ball retains its shape and does not fall apart, it will most likely press into a good, solid briquette. If the ball falls apart, you should add materials that increase the binding capacity of the mixture.

Binding materials

Examples of good binding materials are fish waste, molasses, wood ash, manure, maize or wheat flour. If the press functions well, most mixtures for briquettes will not need binding materials.

Recipe for a good briquette

A good briquette is one that burns for a long time. Make mixtures with locally available materials, and experiment with the proportions in order to come up with a good briquette recipe. For example, although it is possible to make briquettes with only shredded newspaper, they will burn better if you add some small woodchips or a very small amount of charcoal dust.
After the briquettes are pressed, they will still be moist. It is important to dry them fully before using them as fuel. Drying for a few days in the sun should be enough. Before using them as fuel, the briquettes should be broken into smaller pieces in order to increase the surface area, which will make them burn more efficiently.

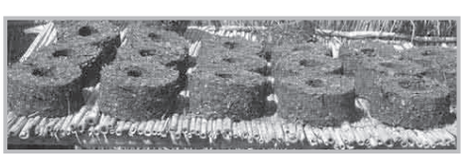
Briquettes from WWF in Malawi

Pressing briquettes. Notice the briquettes drying at the top.

WWF Finland is supporting a project in Chembe, Malawi, where groups of women are trained and assisted in making fuel briquettes from plant residues. The women use maize stalks gathered from the fields after harvest, herbs, and leaves from trees. Sometimes animal manure or sawdust is added to the mixture.

Production begins by transforming the collected organic material into a pulpy mass. Maize stalks, herbs and leaves are soaked in water for about a week in an air-tight container, where fermentation takes place. The plant material is then taken out and pounded with a pestle in the traditional African wooden mortar. This working method is familiar to the women, since they use the same kind of mortars for grinding maize into flour.

The pulpy mass is then placed into a metal cylindrical mould, which makes the briquettes into a circular shape. A simple, inexpensive wooden pole or metal rod is used to compress the material, in order to expel excess water through the holes in the base of the mould. The briquettes are then placed on a drying rack and left in the sun. It takes about a week for them to dry out and be ready for household use.



Briquettes drying in the sun

The production of briquettes presents an opportunity to generate income. By reducing the need to collect firewood - often considered to be their most strenuous household activity - the use of briquettes can reduce rural women's workloads.

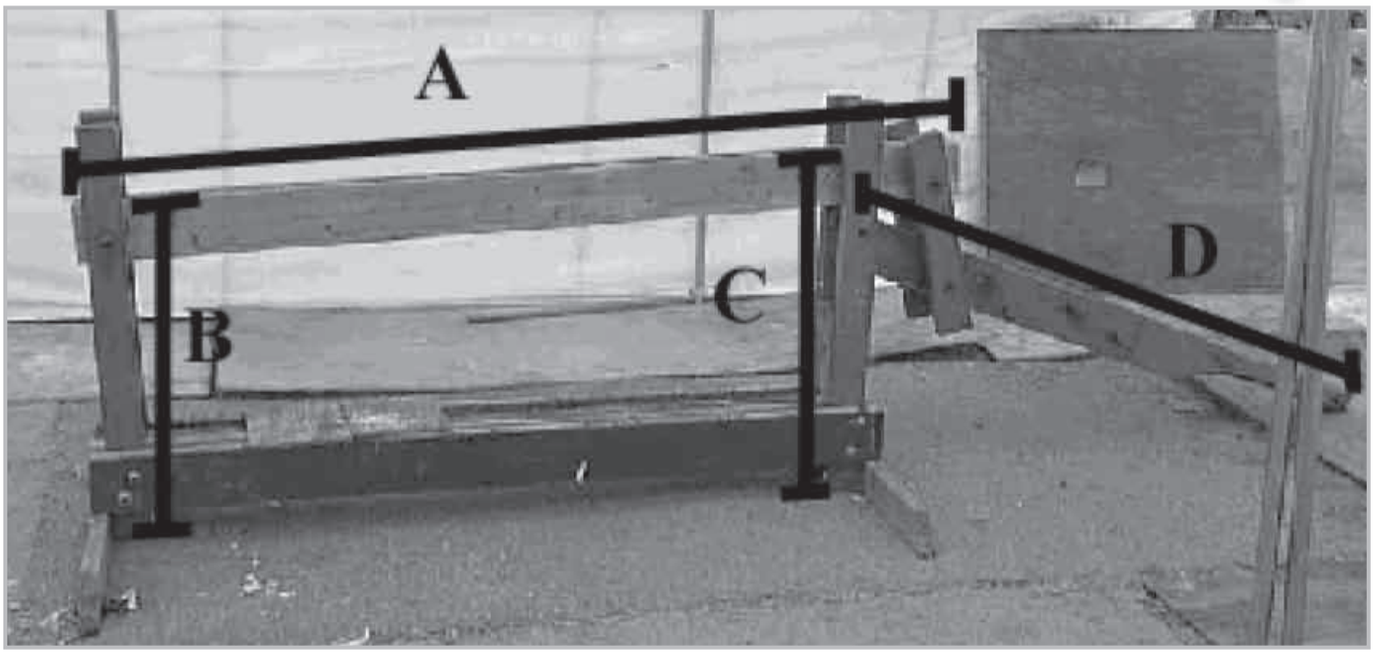
Improving the system

It is important that the briquette generates a proper flame and not too much smoke. Further research has shown that briquettes made from maize stalks produce less smoke than those made from leaves, and that a porous briquette burns faster than one that is denser and heavier.

The following organic-waste briquettes follow the model developed by PAMET (Paper Making Education Trust) model:

The briquettes have a circular shape, with a diameter of approximately 20 centimetres (8 inches), and a hole in the middle that helps to maintain enough airflow to allow combustion. However, further research is required to increase efficiency and to minimize the cost and work involved in the production process.

In Chembe, briquettes are sold at 2,5 Malawian kwacha (about 0,02 EUR or USD) each. It takes two briquettes to cook a meal of nsima, or maize porridge, the staple food of Malawian rural families. It is possible to conclude that producing fuel briquettes from plant residues is a good option in areas with few trees and where women and children walk long distances to collect firewood.



Wooden press. Details of the pressure-generating mechanism below

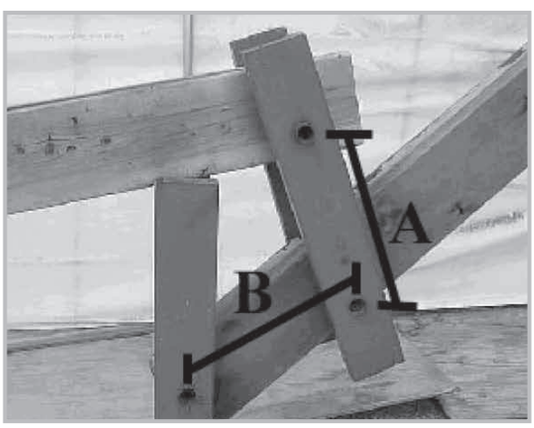
Wooden briquette press

This press is primarily made of wood and materials that are easy to find. Pressure is achieved through a simple lever mechanism. Two people are needed for the press to work efficiently.

Press dimensions (see large photo):
A: 215 cm (86 inches)
B: 80 cm (32 inches)
C: 85 cm (34 inches)
D: 180 cm (72 inches)

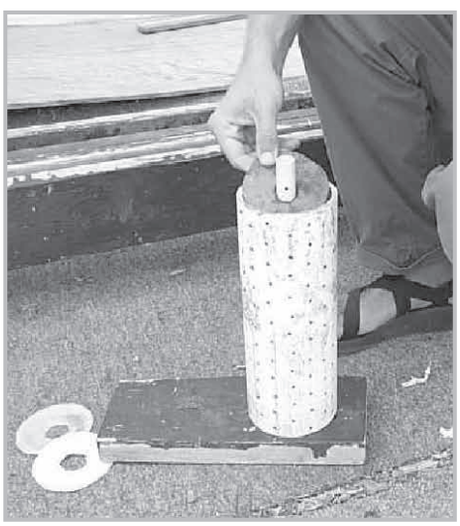
Details of the pressure-generating mechanism
A: 30 cm (12 inches)
B: 30 cm (12 inches)

The mould for the briquettes is made from a piece of PVC pipe 40 cm (16 in) long with a 7.5 cm (3 in) diameter. Holes should be drilled all around the pipe, so that water can escape when the briquette is pressed.
Use a sturdy, flat piece of wood as a support against which the mould will be pressed (see illustration). On top of the support, place a wooden disc about 3 cm in height with a diameter slightly smaller than the diameter of the PVC pipe. Screw it down onto the flat wooden base. The PVC pipe can then be placed on the wooden disc and will not slide when pressure is applied from the press.
Another piece of PVC pipe with a smaller diameter can be used to form a hole in the centre of the briquette (see illustra-



tion). To place the new pipe in the right position, partially drill a hole into the base board with the same diameter as the small pipe so that it can be inserted into the hole. This will help keep it in the middle of the mould when you fill it with your briquette material. Though this hole is not needed, it has been found that briquettes dry faster when there is a central hole.

Ready to press some briquettes



PVC pipe with holes that allow the water to escape

Briquette extraction

Briquette removal may be aided by a small wooden frame which is built and designed so that the briquette mould rests on its edges. The structure is pressed once more to force the briquettes out through the bottom of the mould.

Information and photos of the wooden press from publication "Briquettes Presses" by J. Dahlman and C. Frost at the ECHO website: www. echonet.org
Information and photos of the Malawian production from the WWF website: www.panda.org

A wooden structure facilitates briquette extraction

46 • Solar Cooking Panel

"Cookit" - The foldable family panel

The "foldable family cooking panel" is neither a "solar oven" or a "curved concentrator" but a great hybrid. Its utter simplicity belies its powerful cooking power. Its low cost means it is possible to give large numbers of people access to solar cooking. It can be used for cooking food, baking bread, pasteurizing water and teaching the basics of solar energy.
The developers of "Cookit" are Roger Bernard (France) and Barbara Kerr (the USA), who also worked with Edwin Pejack, Jay Campbell, and Bev Blum from Solar Cookers International. Extensive field tests in the USA, as well as those with refugees in Kenya confirm its performance, convenience, low cost, acceptance and adaptability to diverse needs.

Construction drafts:

Start with a big piece of cardboard about 1m x 1.33m (3'x 4'). Cut and fold as shown. The angles and folds shown are best, but small variations can be made. Hint: To make clean straight folds in cardboard, first make a crease along the line with a blunt edge such as a spoon handle, then fold against a firm straight edge. Make the slots a little too small and narrow so that they fit snugly to hold up the front panel. Glue aluminium foil on the side that will form the inside surfaces when the oven is set up for cooking. To set up, lay panel flat with shiny side up. Fold up front and back parts and fit back corners into the slots in front. You're ready to cook! Put your food into a dark-coloured pot.

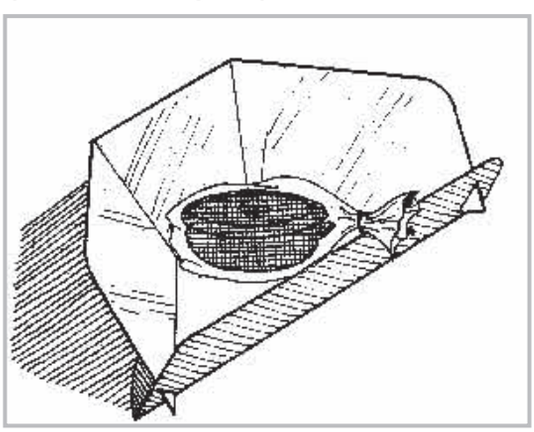
Then place the pot inside a plastic bag (Oven cooking bags of special plastic will withstand the heat best. A normal clear bag can also be used but will not last long). Close the open end of the bag and place pot and bag into the centre of the solar cooker.

Solar cardboard cooker in Zimbabwe

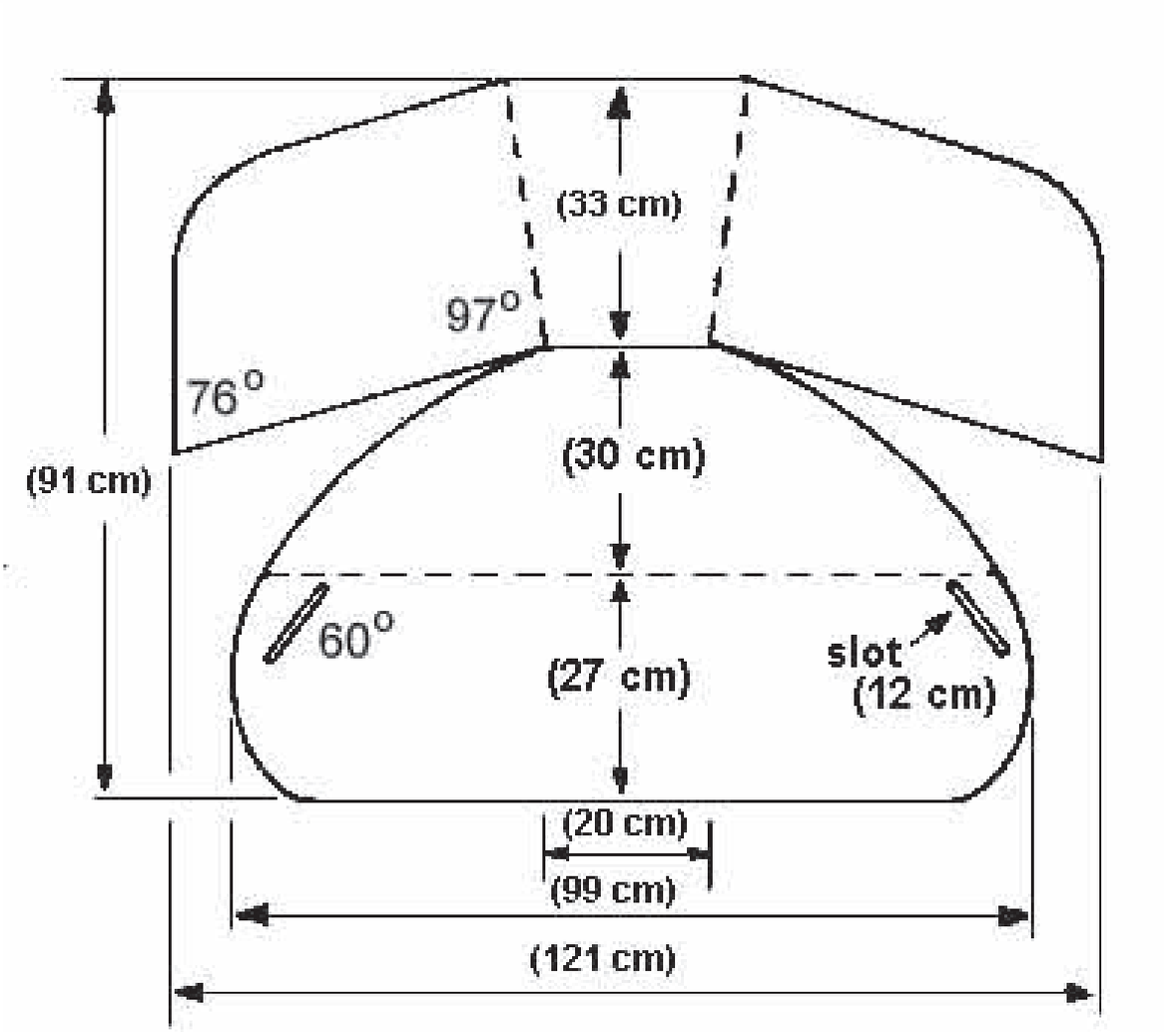
You will have to experience to find out how long time is needed to cook the food. The cooker works best in direct sunlight, and should be turned at least every hour to catch as much heat as possible.

Hints

Dr. Steven Jones found that raising the pot on a wire frame improved cooking in a panel cooker.



Information and drawings by Solar Cookers International, www.solarcooking.org/cookit.htm



Solar panel dimensions. It can be assembled from several pieces of cardboard