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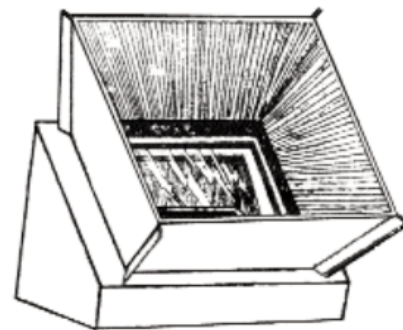
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ASPI TECHNICAL SERIES TP 67

The Lilongwe Solar Box Cooker A Construction Manual

Solar cookers are efficient and low-cost devices for preparing a variety of foods in many parts of the world. They use the energy from the sun rather than scarce wood or expensive non-renewable energy sources. The solar cooker is an answer for many of the people of the world who pay large portions of their meager incomes for cooking fuel — and it is a way to save our threatened forests as well.

The Lilongwe Solar Box Cooker is one of the easiest solar cookers to construct. It has been field tested by people who regularly use solar cookers for their food preparation needs and have worked on a number of solar cooker designs. Technical Paper 67 is a replacement for TP 1 “The Solar Box Cooker.” It is a way to cook relish (i.e. vegetables, fish, chicken, beef, potatoes, etc.) using only sunlight. There is no fire, no smoke, and no financial expenses as it cooks the food.



Materials and Tools. This solar cooker consists of two cardboard boxes, four large flat cardboard pieces, aluminum foil, dried bamboo leaves or grass (insulating material), and clear glass. The tools needed are similarly commonplace: a knife, scissors, white glue, string, a ruler, a piece of cloth, a tape measure, and a pen or pencil.

An example. Let us say there is an inner box 52 cm x 42 cm. The outer box, then, should be at least 66 cm x 56 cm. The inner box will be cut at the desired angle for the opening for the sun. The size of the glass can then be determined, since the angled opening will be bigger than the top view of the box.

The size of the inner box should be larger than 42 cm. x 42 cm. so that there is sufficient volume for the sun to heat. The size of the inner box will determine the sizes of the other parts of the solar cooker. The outer box, for example, will be at least 14 cm. wider and 14 cm. longer than the inner box. This allows space for the insulation when the inner box is placed in the outer box. The glass window overlaps the inner box and is 4 cm. larger than the inner box in each direction in order to cover the slanted opening for the sun.

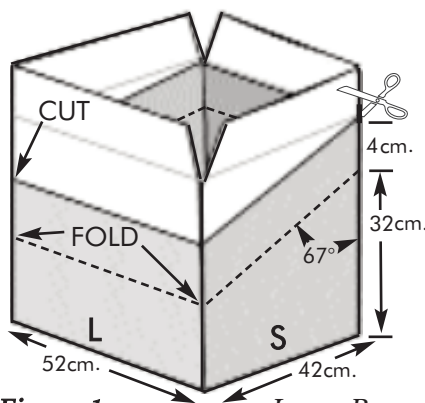


Figure 1

Inner Box

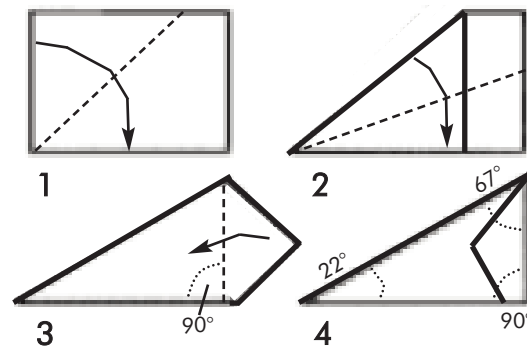


Figure 2 To Find 67° Angle

I. Construction — Inner Box

Begin with the inner cardboard box. If the box is rectangular, have one of the long sides (52 cm. from the example) facing the builder. This will be the lower side and the back the higher side of the angle cut (Figure 1). The lower side will be the one facing the sun. The two short sides, “S” (42 cm. from the example), will have the angle cut. These sides should not be more than 48-50 cm. The other side can be as long as is desired.

The inner box should be high enough to hold the pots that will be used. Keep in mind though, that two shallow pots will cook better than one deep one. For a box 52 cm. x 42 cm., as in our example, 32 cm. is a good height for the higher side, as long as the pots will fit in it. Fold a sheet of paper as indicated in *Figure 2* to find the 67 degree angle.

Mark the “S” sides of the inner box (*Figure 1*) with the 67 degree angle. This angle is placed at the high, or back side, of the box at 32 cm. (as from example) from the bottom. The front side will be shorter than this. This sloped line will be the fold-line; at 4 cm. above this line mark a second line to mark the cuts to be made to form the inner portion of the solar cooker. *Figure 3* illustrates the form of the inner box. The flaps will be needed later in securing the top. The width of the flaps equals the space between the inner box and the outer box (at least 3.5 cm.) minus 0.5 cm. so the flaps do not hit the sides of the outer box as they fold over.

Once the box is cut, then the aluminum foil can be applied to the interior wall of the box. Use white glue diluted with water and make sure the shiny side of the foil is facing toward the inside of the box. Lastly, make a tray (*Figure 3*) that will fit in the bottom of the inner box. The tray needs to be painted black. It can be either a piece of metal or cardboard lined with aluminum foil. A black bottom will convert sunlight to heat. A black paint can be made using a mixture of one part kitchen soot to one part white glue and a little water.

II. Construction — Outer Box and Top

The outer cardboard box (*Figure 4*) needs to be at least 14 cm. wider and 14 cm. longer than the inner box. To determine the heights of the sides of the outer box, set the completed inner box, with flaps folded down, inside the outer box and center it. Then place a straight edge like a ruler along one of the slanted sides of the inner box, observing both where it extends upward and where it extends downwards to touch the outer box. Mark these places on the outside of the outer box. For the heights of the sides of the outer box allow for 3-5 cm. of insulation under the inner box, so add 3-5 cm. to heights of all sides of the outer box. These marks determine the heights of the sides of the outer box, and one can proceed to mark the outer box as was done for the inner one. Now cut the top of these sides off to form the outer box.

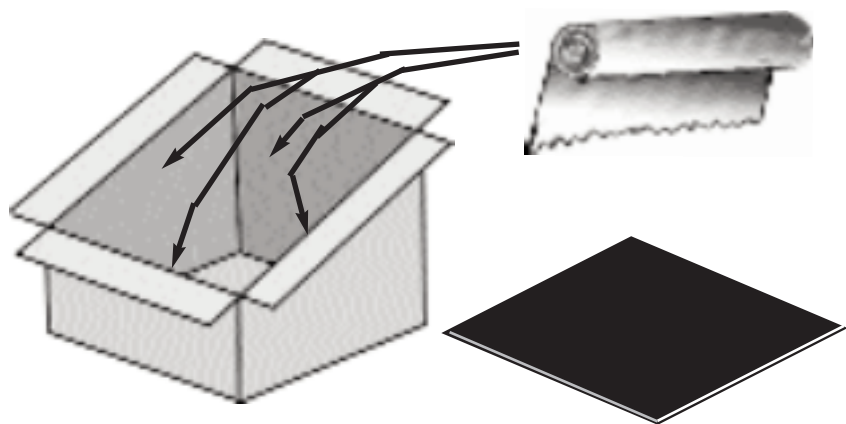


Figure 3 Inner Box, Aluminum Foil, Bottom Black Tray

These marks determine the heights of the sides of the outer box, and one can proceed to mark the outer box as was done for the inner one. Now cut the top of these sides off to form the outer box.

The top of the cooker is made from a large, flat and rigid piece of cardboard. The dimensions of the top can be determined by referring to *Figure 4* where “x” and “y” are measured on the outer box and these are the size of the top. (Note: If there is a tall outer box, one could simply fold down the top over the cut slanted sides instead of making the top separately.)

III. The Window

The glass needed will be 4 cm. wider and 4 cm. longer than the slanted opening of the inner box (*Figure 5*). Place the glass over the opening of the box, center it, and use a pen to mark around it. Next cut out eight strips of cardboard two centimeters wide. Cut the strips in such a way (either across the length or width of the cardboard piece) so there are no holes going straight through them where heat from the window could be lost. The lengths of the strips will depend on the size of the glass. Match these strips into four pairs, gluing each pair together so you have four thick strips. Now glue these four strips around the line made that marks where the glass will be, placing them 2 or 3 millimeters outside the line, so the window opens easily.

Next cut two more cardboard strips (about 20 cm. long) which will be glued together. Now glue to the bottom of the glass for a handle. Opening the glass from its low side reduces heat loss. The glass will fit inside the cardboard strip border, completing the window to the solar cooker.

IV. The Reflectors

The reflectors for the Lilongwe Solar Box Cooker are trapezoidal, with four panels joined together as one unit, fitting around the window of the cooker. The base of each reflector is determined by the size of the glass that is used. Two reflectors will have bases 4 cm. greater than the width of the glass and two reflectors will have bases 4 cm. greater than the length of the glass. If the glass is 50.5 x 56 cm., for example, the bases for the reflectors will be 54.5 cm. and 60 cm.

Figure 6 shows how to cut the reflectors out of a large, flat piece of cardboard. The 67 degree angle can be determined using the same folded paper that helped mark the inner and outer boxes. The 5 cm. flaps at each end will be used in joining the reflectors. The height of the reflectors, which is the same for each reflector, is about the same size as the length or width of the glass. For a glass size 50.5 cm. x 56 cm., for example, 50 cm. is a good height for the reflectors.

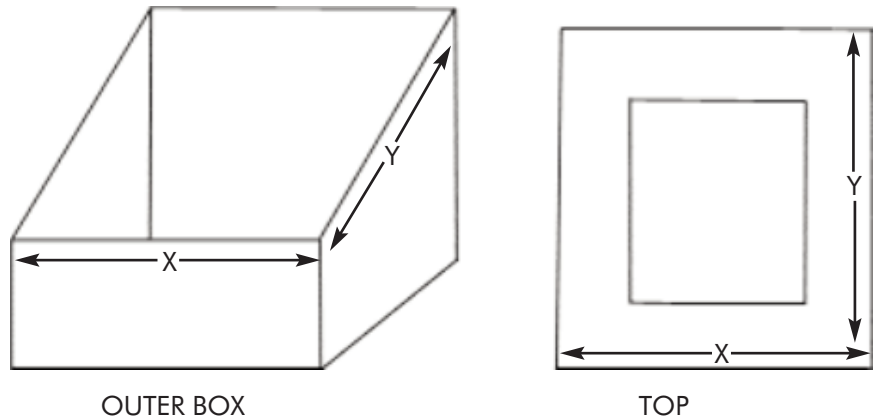


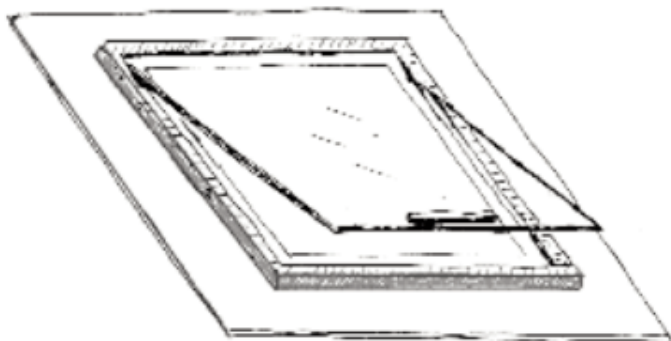
Figure 4

The dotted lines on the reflectors should be folded and the solid lines cut, as shown in Figure 6. Once the reflectors are cut out and the 5 cm. flaps are creased and folded, aluminum foil can be applied. Use a scissors to cut the aluminum foil after the measurement has been made. Spread white glue diluted with water on the dull side of the foil. Apply the foil to the reflector face, using a piece of cloth to smooth it to the cardboard. When the foil is on each reflector, the reflectors can be joined by sewing or gluing the flaps together. The large reflectors should be joined with the small ones so that the reflectors with the same size bases are facing each other.

V. Assembling the Cooker

The components are now ready to be assembled. First cut out cardboard pieces that will fit in the bottom of the box. The inner box needs to be raised 3 cm. to the same level as the outer box. The cardboard pieces will also act as insulation, preventing heat from leaving through the bottom of the box. One can tell when the inner box is at a proper level if there are no gaps between the inner box flaps and the top that goes over the two boxes.

Figure 5 Assembly of Top with Glass Window



Next, center the inner box inside the outer one. Fill the space between the inner box and the outer one with dried bamboo leaves, dried grass or loosely crumpled newspaper for insulation. When finished with the insulation, spread white glue along the inner box flaps and top edges of the outer box and place the top, holding it until it is secure. A weight can be put on the top of the cooker if its front edge is elevated by a brick. After the base of the cooker is finished, the last step is to place the reflectors around the window frame.

USE

The Lilongwe Solar Box Cooker only works if it is sunny or mostly sunny. Place it so it is facing the sun (if the shadows on either side of the cooker are an equal size, then the cooker is perfectly positioned). If the cook will be nearby, adjust the cooker a few times during the day. If the cook will be absent for an extended time, position the cooker so it will face where the sun will be at its highest point during the day — and upon returning the food will be cooked.

A number of things should be remembered in using a solar cooker. Foods take a little longer to cook, so one must start cooking earlier — put a lunch in after breakfast. It is no more work cooking with solar (in fact, solar cooking saves time and work). It is a *different* kind of cooking.

It is important to use black pots with tight fitting lids. There are differences in how food is cooked. Some foods — potatoes, sweet potatoes, beef, chicken, fish and some vegetables require no water. These foods cook in their own juices. There is no danger of burning. For rice, use less water. Put 1.5 cups of rice in 2.5 cups of cold water, and the rice will cook well. For other foods, like beans, cook the same way as you would over fire.

Figure 7
Assembling
the Cooker

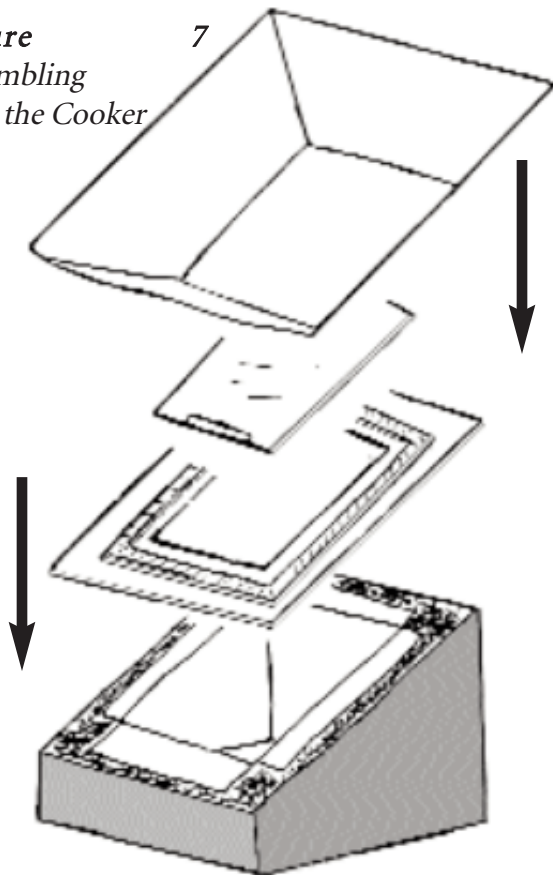
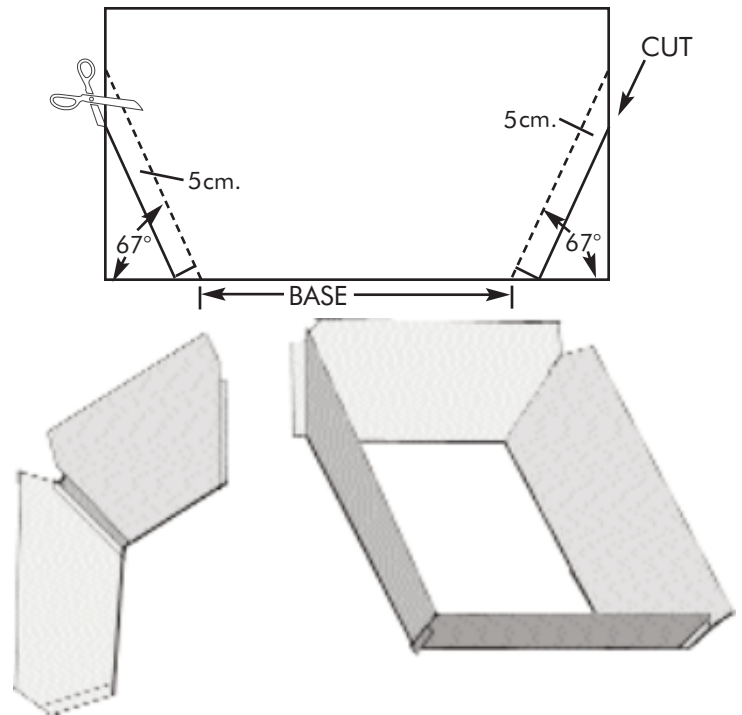


Figure 6 Making the Reflector Pieces & Reflector Assembly



Approximate Cooking Times

Beans	3 hours
Rice	1.5 hours
Vegetables	1 hour
Beef	2 hours
Fish	1.5-2 hours
Chicken	1.5-2 hours

These times are based on a fully sunny day — and also putting the food in an already heated oven.

This manual was developed by **Elesani Zakochera** (Managing Director of Zako Solar Cooker Industry, Lilongwe) and **Mark Schimmoeller** (a volunteer for Absenzi African Studies — Colorado, USA and Appalachia — Science in the Public Interest, Kentucky, USA as a result of the 1998 Malawi Solar Cooker Workshops, sponsored by the Malawi Ministry of Parks, Sports and Culture.