

SOLAR FOOD DRYER
 ASPI Technical Series

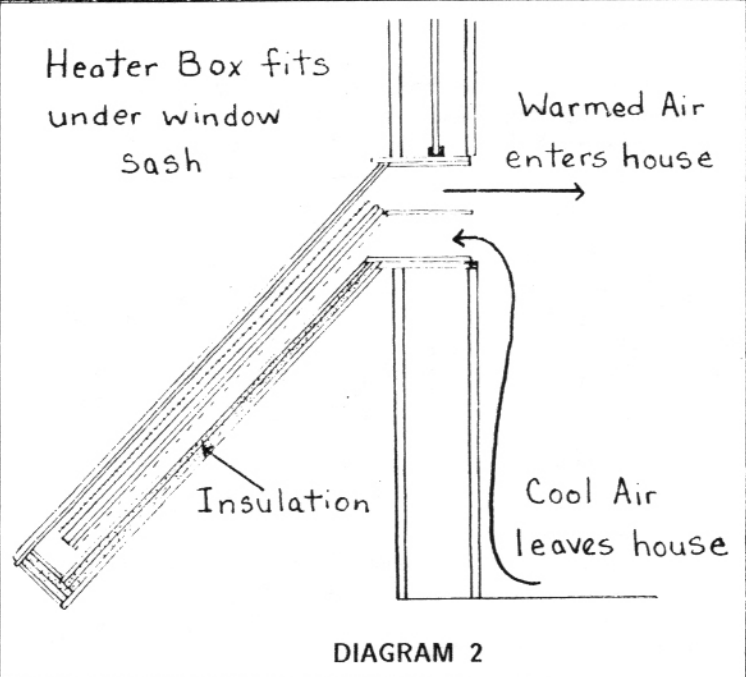
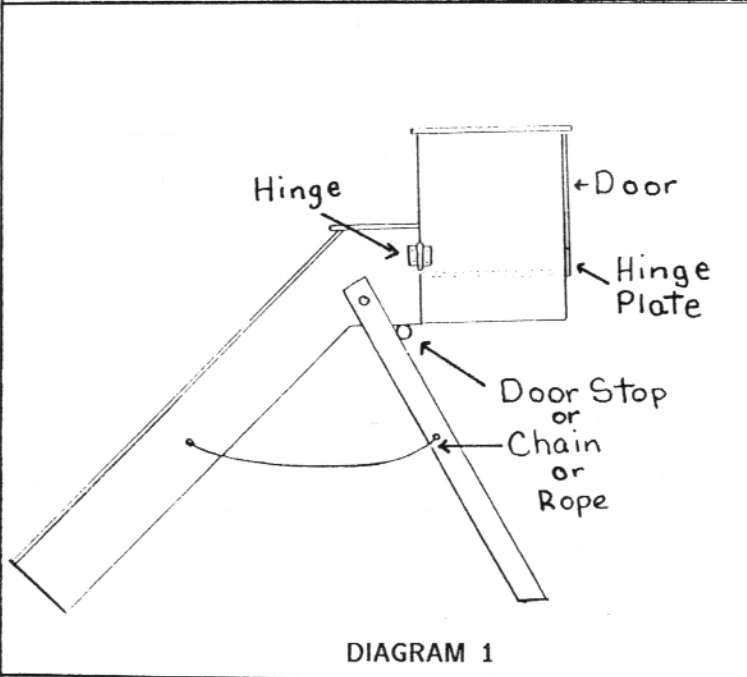
INTRODUCTION

Solar food drying is one of the oldest methods of preserving food for long term storage. Ancient peoples, particularly those in nomadic cultures knew the value of drying food for consumption between harvests or on the trail. This survival method appears to have been practiced globally. Just as early Egyptians placed dried food in the tombs of their dead, evidence of the same has been found in Latin American burial grounds a half a world away. For centuries North American natives dried a variety of foods for use during the winter or on the long journey between hunting grounds.

In recent United States' history food drying served an important function during both World Wars. This method of preservation allowed large quantities of food to be shipped in small spaces. Dried foods have a weight 1/4 that of fresh foods and require only 1/3 to 1/6 the storage space. Following World War II food drying lost much of its popularity. This was due mainly to advances in canning and freezing methods and the convenience of pre-packaged foods.

Today, with more people concerned about the potentially dangerous chemical additives in many commercially prepared foods, home gardening and food preservation are once again becoming popular. In this time of rapidly decreasing stores of fossil fuels and rising levels of air pollution, the ecologically sound, energy-conserving practice of solar food drying has definite appeal over other methods.

The added advantage of using the sun is that with careful temperature monitoring much of the nutrient content and flavor lost in other high-energy methods of drying (as well as canning and freezing) can be maintained. No chemicals or processed sugars are added and almost any type of fresh food can be dried. (See the insert for methods and recipes).



THE SOLAR FOOD DRYER

The Appalachian Solar Food Dryer (Diagram 1) incorporates a food dryer into a window box heating system. The window-box heater was designed for providing solar heat through the window during the cold months. Air, from the room, is heated by the sun and circulated back into the room (Diagram 2). By attaching a food dryer to the outlet, the warm air passes over the food. This system can be placed outside in the summer, installed as an indoor dryer in the fall, or used as a heater in the winter.

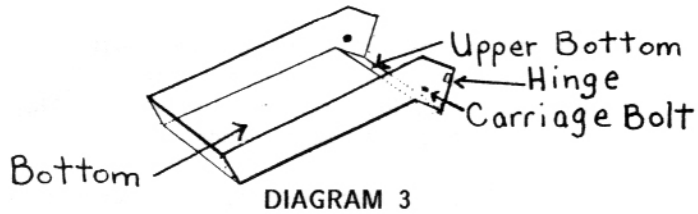
The cost of this food dryer/heater system should be under \$120 (U.S.) and will be even less if on-hand materials can be substituted for some of the purchased items.

NOTE: Before beginning construction measure the window. These instructions are for a heater measuring 27 inches (68.6 cm) wide. If your window is smaller you will need to adjust your measurements. If it is larger seal around it with plywood, insulation and caulk to avoid heat loss.

THE HEATER BOX

1. Cut out plywood pieces according to Diagram 14 (on the back page). Drill 1/2 in. holes in parts as indicated. Assemble the outer sides, bottom, lower end and upper bottom. Apply glue and clamp pieces together. Drive screws into the joints (See Diagram 3).

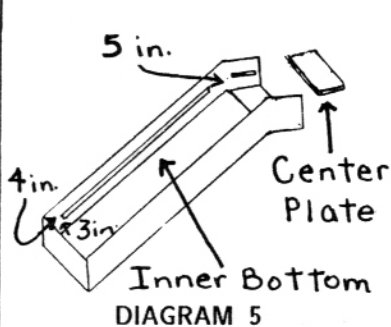
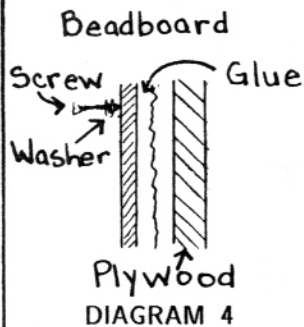
2. Insert 2 1/2 in. carriage bolts in the holes. Measure down 2 in. from the top and secure hinges with 1/4 in. x 1 in. machine bolts and nuts. (Diagram 3).



3. Insulate the box with 2 layers of 3/4 in. styrofoam. (See OTHER CUTS). The pieces will have to be trimmed to fit.

4. Assemble the pieces of the inner box (sides, lower end, bottom and upper bottom) using glue and wood screws. (The same as the outer box.) Note: When attaching polystyrene beadboard to plywood, use washers on the screws. (Diagram 4)

This completes the inner box. It should fit snugly into the insulated outer box. Caulk all of the joints of the inner box. The inner box is not very sturdy, so BE CAREFUL!



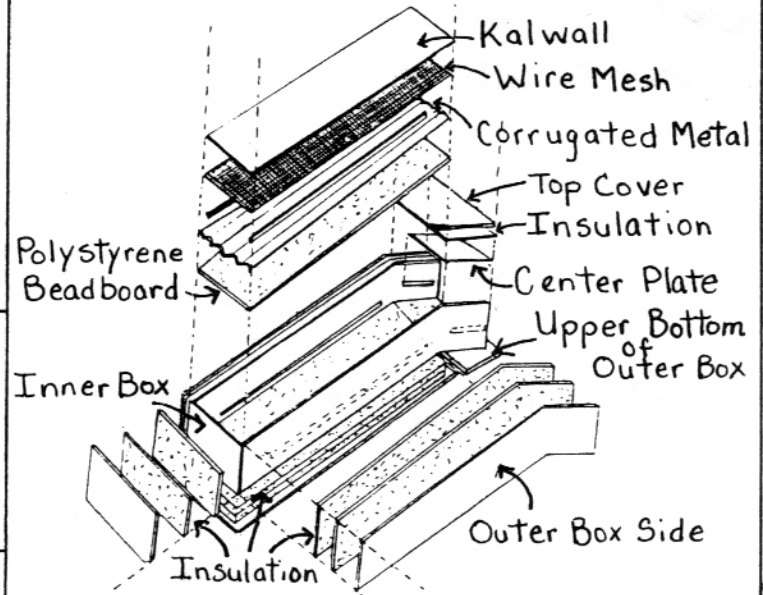
5. Measure 3 in. along the sides from the bottom. Now, measure 4 in. up from the lower end (Diagram 5). Nail stripping (1 in. x 1 in. wood strips 4 ft. in length) along both sides of the inner box.

6. Place the center insulation (beadboard) and corrugated metal together. Drill holes at 12 in. intervals down the center of the metal and beadboard. Secure the pieces with 8.32 in. x 1 in. machine screws, washers and nuts. Place this on the wood strips secured to the inner box sides, drill holes and secure with No.8 1 1/4 in. metal screws.

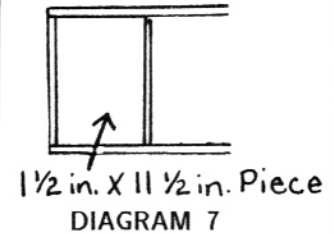
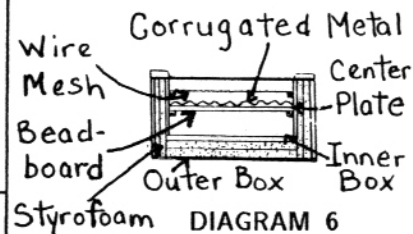
7. Measure 5 in. up from the upper bottom and secure wood strips (1 in. x 1 in. x 9 1/4 in.) on each side (Diagram 5). Fit the center plate in and secure with 1 1/4 in. wood screws. (The measurements of this step are critical if the dryer is to fit the heater box properly.)

8. In a well-ventilated area paint the interior flat black. Let it dry.

EXPLODED VIEW OF THE HEATER BOX

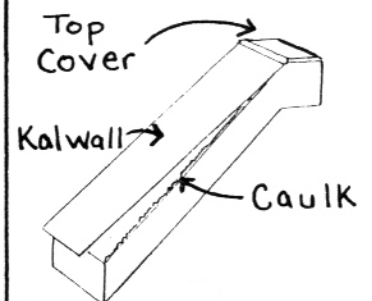
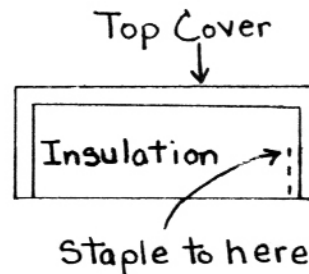


9. Directly above the corrugated metal, secure strips (2 in. x 1 in. x 1 in. wood strips 4 ft. in length) and staple the wire mesh to them. (Diagram 6)



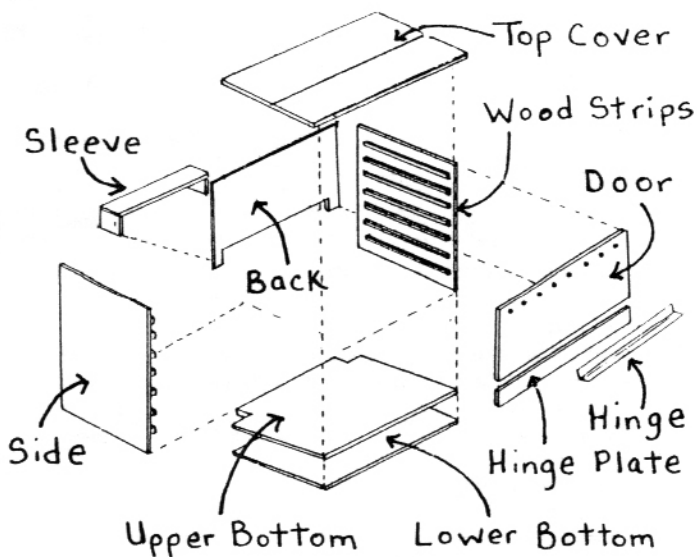
10. Notice that the styrofoam is still exposed at the top front. Cut pieces of AC plywood 1 1/2 in. x 11 1/2 in. Cut the styrofoam back 1/2 in. on both sides. Secure these pieces from the sides (Diagram 7).

11. Staple the fiberboard insulation to top cover, centered on the sides and front. Staple no more than half the way back. (Diagram 8)



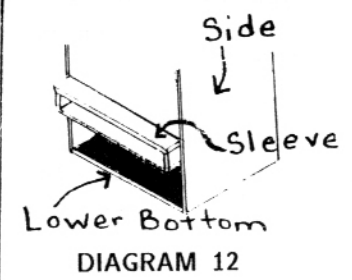
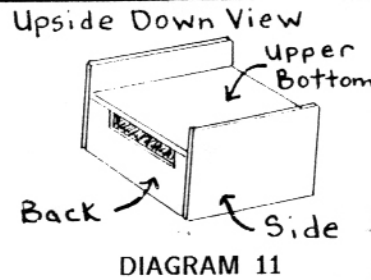
12. Slide one end of the Kalwall (fiberglass sheeting) between the cover insulation and the shelving top (the unstapled part). Drape it down the entire length of the box. Secure the top cover in position (flush with the front). Adjust the Kalwall to 1/4 in. past the end of the box. Center it from the sides. Lift the Kalwall and run a bead of caulk around the edge of the inner box. Replace the Kalwall. (Diagram 9) Nail or screw the front edge.

EXPLODED VIEW OF THE DRYER BOX



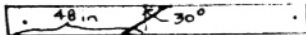
Secure the sides, back, upper bottom and the hinge plate. Use the door to mark where the hinge plate goes (Diagram 10 will help in this step). The door will be flush with the top so measure down the width of the door to place the hinge plate.

16. Secure the lower bottom to the box. Complete the sleeve on the back of the box. (Make sure the outside sleeve matches the opening of the heater.) Diagram 11.



13. Run trim around the face of the box (two 1 in. x 3 in. x 60 in. pieces and one 1 in. x 3 in. x 27 in. piece). (See NOTES ON CUTTING TRIM) On the lower edge chisel channels to let water run off. After securing trim, run a bead of caulk around the inner edge for weather-proofing.

14. Cut the 8 ft. two-by-four in half at a 30° angle. (Measure 48 in. and make the angle pass 1/2 way through the line, thus both pieces are of equal length).



Measure down 1 3/4 in. and drill a 1/2 in. hole in the center. Place legs on the carriage bolts. Secure with washers and nuts. Place door stops on so the legs rest against them when the upper top and bottom of the heater box are level. (NOTE: Chains or ropes secured to the legs and sides of the heater box can be substituted for the doorstops. See Diagram 1). Take them off again until you paint it. (Do this when the dryer box is finished).

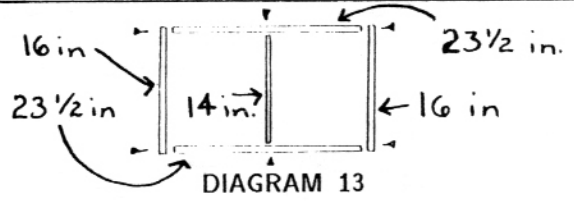
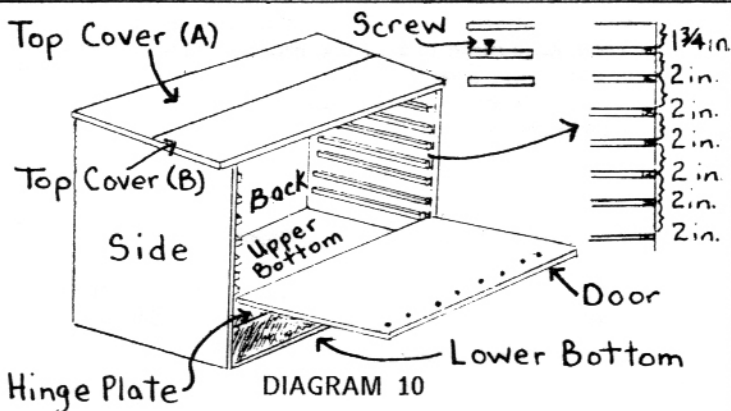
17. Measure 1 in. down from the top of the door and using the 1/2 in. bit drill holes at 3 in. intervals across the width of the door (8 holes). Using a continuous hinge or 3 small hinges secure the door to the hinge plate making sure the door is flush with the sides and top of the box.

18. Put the dryer and heater together. Mark where the hinges go on the dryer (mark the screw holes) (See Diagram 1). Take apart and drill the holes. Remove the pins from the hinges and secure the loose plate to the box with 1/4"x1" machine bolts, nuts and washers.

19. Glue the parts of the top cover (A and B) together. Center the cover and secure to the top of the box.

20. Cut fine screen for the openings (the sleeve and the vent holes in the top of the door). Staple these pieces on the inside of the openings to keep bugs from entering. Place the wood strips together to make the dryer rack. (See Diagram 13)

21. Staple fiberglass screen, stainless steel screen or cotton weave to the bottom of each rack. (Other screen materials may affect the taste and color of the dried foods.) NOTE: Fiberglass screen is the best choice as the cotton will have to be replaced frequently due to sticking and possible rotting. Stainless steel screen works well but is expensive.



The Dryer Box

15. On the dryer box sides, using measurements in Diagram 10, secure 14 wood strips (1 in. x 3/4 in. x 17 in.) to inside walls (7 each side) with glue and 1 1/4 in. wood screws. On the second fourth and sixth strips from the bottom place a screw 1 in. from the back to allow the shelves to be staggered for better air circulation.

22. Apply Thompson's Water Seal brand water proofing formula to the outer box of the window box heater. Paint the heater and dryer with an exterior paint. Do not paint the racks or interior.

23. Secure the hasp to the top and front. Whittle a little pin to hold the door shut. Put the legs back on the indow box heater. Put the two parts together.

SOLAR FOOD DRYING

GENERAL INFORMATION

In comparison with other methods of food preservation (canning and freezing) solar food drying has definite advantages. It requires no energy other than that of the sun, uses no chemicals or preservatives and retains much of the flavor and nutritive value of the foods.

Proper food drying should accomplish two goals:

1. Remove 75-90% of moisture from the food which prevents most bacterial growth.
2. Cause enzymes to become inactive which halts the ripening process.

To accomplish these goals there are three factors to be considered:

1. **HEAT RANGE:** The temperature should reach 100-160°F to kill bacteria and inactivate enzymes.
2. **AIR FLOW:** A steady flow of air out of the dryer carries moisture away from the drying food.
3. **LOW HUMIDITY:** This allows the moving air to carry away more moisture.

WHAT FOODS CAN BE DRIED?

Almost any food can be dried with good results. The only limits are experience and imagination. The methods given in this paper are suitable for most fruits and vegetables. Some sources give instructions for drying meat and fish, and yes, it can be done successfully. However, we strongly caution the novice not to experiment with this unless instructed by someone with practical experience in the techniques. Any mistakes when drying such perishable foods may result in food poisoning, a very serious condition which can be fatal.

TEMPERATURE CONTROL

A fairly constant temperature of 95-100°F is desirable for drying food quickly. If possible the temperature should not exceed 110°F. Higher temperatures will cook the food, rather than dry it. A thermometer will be helpful until you develop a feel for the characteristics of your individual dryer. If you find that the temperature is rising too high (on a particularly sunny day) a white sheet can be draped over the heater box to cool it down.

The amount of time it takes to dry food depends on the season, climate, and particular characteristics of the food. Most foods will dry in 1-3 sunny days, unless the humidity is high. Check the food for dryness by feel. If the texture is leathery (most fruits) or hard (most vegetables), you can be reasonably confident that the drying is complete. True, this is not always an accurate test but as you gain experience, your ability to discern drying time will improve.

ROTATING THE RACKS

As the food dries, don't forget to rotate the racks. Keep the racks with the food that seems drier on the bottom. This helps equalize moisture and speed up drying time by preventing the almost dry food from absorbing moisture from the air above the food that is less dry.

CARE OF THE DRYING RACKS

Do not overload the drying racks. Place food in a single layer with space between the pieces to allow for proper air flow. Most foods will be dried directly on the racks so it is very important to clean them after each drying. Residue from previously dried foods can give unpleasant flavors or odors to your product. Strong smelling foods, such as onions or garlic should not be placed directly on the racks. Instead, dry them on plastic wrap or baker's parchment paper with alternate sides of the racks uncovered for ventilation. This method is also necessary when drying juicy or pureed foods (as when making leathers).

With proper care, the racks of your solar food dryer should give you many seasons of successful drying. After food is removed the racks should be wiped with a damp cloth. If necessary they can be washed and scrubbed with a brush, then rinsed and towel dried. After washing replace the racks in your dryer and allow them to dry.

PRETREATMENT

Various sources suggest that some foods require pre-treatment before drying to maintain the flavor and texture of the fresh food. These methods include blanching (boiling or steaming), treating with ascorbic acid (Vitamin C) or sulfuring. However, other experienced dryers have excellent results without this. It is never a good idea to add unnecessary chemicals to food and blanching can remove vital nutrients. While dried foods may vary somewhat from fresh (in color and texture) the taste is often just as good. If you feel some sort of pre-treatment is necessary, a mixture of 2 tablespoons of honey and the juice of one lemon can be used. Pineapple juice is also effective in retaining the color of some fruits. Drying this dipped fruit is sticky but it has a good flavor.

BASIC DRYING PROCEDURE

1. Wash fresh, fully ripe fruits or vegetables. If you are drying purchased produce, be sure to wash it thoroughly. Drying increases the percentage of chemical residues in proportion to drying time. Use organically grown fruits and vegetables if possible. Cut into desired sizes. The pieces should be small and uniform in size. Small pieces speed up the drying time which results in a higher quality product.

2. Place the food on the racks, remembering not to overload the racks. Leave enough room between the pieces for air circulation.

3. Occasionally, (once or twice each day) open the dryer and rearrange the pieces on the racks. If necessary, rotate the racks as well.

4. Check for completeness. Depending on the weather, the drying should be complete in 1-3 days.

NOTE: Vegetables will need to be dried harder than fruits due to the lack of natural sugars in the juice. The concentration of sugars in dried fruits allows for preservation with a higher moisture content.

5. Cool and store.

STORAGE

The main problem associated with storing dried foods is damage from humidity. If food has not been dried completely any moisture will cause it to mold. In some areas insects and mice may also cause problems. There are three things to remember about storing dried food: NO AIR, NO LIGHT, and NO MOISTURE. Food should be placed in clean, air-tight containers and stored in a cool dark space. Glass or plastic containers work well, as do metal cans with tight fitting lids. Plastic bags can also be used but these must be placed in other containers, such as paper bags or glass jars. Try to store food in portions that are appropriate to your family's size and eating habits. This will help avoid contaminating large quantities of food when removing small amounts. Check occasionally for signs of mold or insect infestation. If mold is present remove the damaged pieces and heat the rest in the oven at 165-175 F for 30 minutes. Use this food as soon as possible.

NOTE: Never place warm food in storage containers. Allow it to cool completely before storing.

It is wise to label everything. Many dried foods are similar in color and texture. Remembering exactly what you have dried may be difficult. Make it a practice to label and date containers as you fill them.

It is probably unwise to store dried food for longer than a year (unless in a freezer). Some sources do report good results with longer storage, however, so use your own judgement.

EQUALIZING MOISTURE

Food can often appear dry, with hard brittle edges and yet have moisture pockets still present. If stored in this condition the moist areas can develop mold. To prevent this, place a quart or two of the dried food in a large paper sack, making sure that it doesn't pack down. Pin this to a clothesline or in another convenient place. Occasionally, give the bag a "pop" on the bottom to redistribute the food. Gradually the hard areas will absorb the moisture from the pockets and in 2 or 3 days the moisture will be equalized.

USING DRIED FOODS

Dried fruits and vegetables can be used in many ways to provide variety and nutrition to your menu.

Many fruits are excellent in their dried forms; grapes, apricots, bananas, apples, etc. With juicy fruits it is often best to preserve them as leathers - scrolls of dried pureéd fruit. Berries taste great when mixed with other fruits (apples for instance) in leathers. They can also be dried whole, if handled carefully so that no juice is lost. These dried berries can be reconstituted with water and sweetened with honey to make jams and spreads

Dried vegetables are best when reconstituted or used in soups and stews. They can also be ground into powders and used as instant soups or as flavor enhancers for other dishes. Tomatoes can be dried in small pieces or pureéd and dried as tomato sauce.

Remember that herbs can also be dried in a food dryer. After drying the leaves can be crumbled and stored in small jars for tea or spices. Mushrooms grains and seeds can be dried as well.

RECONSTITUTING DRIED FOODS

Cover the dried food with cold water. Let this stand until the fruit or vegetable has gained most of its original size. Do not drain vegetables but add water for cooking if necessary.

As a special treat, reconstitute bananas in milk and serve this sweet mixture warm or cold, as a pudding.

REFERENCES

DRY IT YOU'LL LIKE IT, Gen McManiman, 1974
Published by Living Foods Dehydrators, P.O. Box 546, Fall City, WA 98024.

THE SOLAR FOOD DRYER BOOK, Stella Andrassy, 1978, Earth Books, Morgan & Morgan, Inc. 145 Palisade Street, Dobbs Ferry, NY 10522

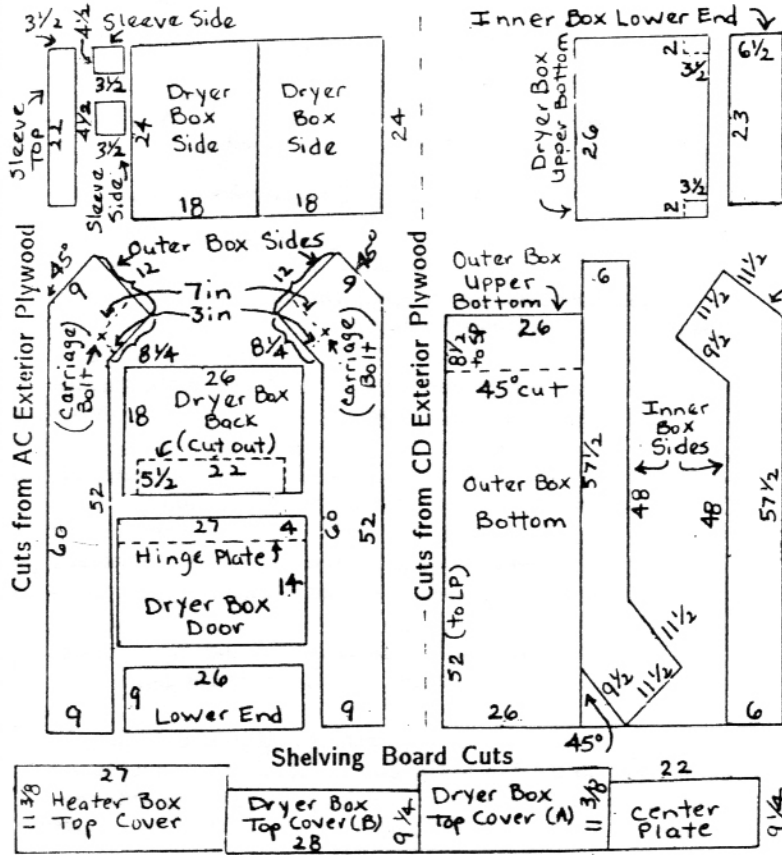
DRY AND SAVE, Dora D. Flack, 1977, Woodbridge Press Publishing Co., P.O. Box 6189, Santa Barbara, CA 93111

WEATHERIZATION

As the solar food dryer/heater is to be used outside in varying weather conditions, care must be taken to protect the wood from water damage. One expert suggests adding rot proof wooden feet to the parts of the heater box that are in contact with the ground. A more convenient alternative would be to place a rubber or plastic mat beneath the heater box edge and the legs. As a further precaution treated wood can be used for the legs.

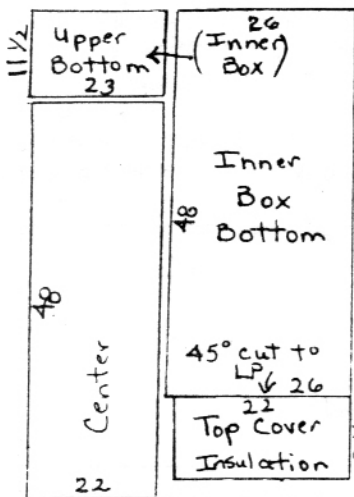
NOTE: The long point (LP) and short point (SP) of an angular cut refer to the distance from the end to the point of cut.

DIAGRAM 14 MEASUREMENTS ARE GIVEN IN INCHES



Cuts from Polystyrene Beadboard

NOT TO SCALE



OTHER CUTS: Using the patterns for the outer box (sides, bottom and end) cut 2 of each from the styrofoam. This will be insulation around the inner box.

Using scraps of shelving board or wood of similar weight, cut strips of the following sizes:

- 1 in. x 3/4 in. x 17 in. (cut 14)
- 1 in. x 3/4 in. x 23 1/2 in. (cut 14)
- 1 in. x 3/4 in. x 16 in. (cut 14)

NOTES ON CUTTING TRIM: Cut two 1 x 3 in. strips 60 in. long. Cut the top at a 45° angle to long point.

Cut one 1 x 3 in. strip 27 in. long. Both ends cut at 45° to long point.

MATERIALS

DESCRIPTION	SIZE	AMOUNT
AC plywood*	4 ft. x 8 ft. x 1/2 in.	1 sheet
CD plywood*	4 ft. x 8 ft. x 1/2 in.	1 sheet
styrofoam insulation	4 ft. x 8 ft. x 3/4 in.	2 sheets
polystyrene beadboard	1/2 in. thick	1 sheet
(or fiberboard)		
2 x 4 (not a stud)	8 ft.	1
fiberglass sheeting (Kalwall)#	62 in. x 24 in.	1 strip
corrugated metal+	48 in. x 22 in.	1 sheet
wire mesh (plaster lathe)	48 in. x 22 in.	1 sheet
shelving board	8 ft.	1 piece
wood strips	1 in. x 3 in. x 12 ft.	1 piece
continuous hinge	4 ft.	1
(or 4 small hinges)		
fine screen	12 in. x 12 in.	1
fiberglass screen		1 roll
(or stainless steel mesh or cotton screen)		
carriage bolts with washers and nuts	2 1/2 in.	2
machine bolts with washers and nuts	1/4 in. x 1 in.	12
No. 6 wood screws	1 in.	150
No. 6 wood screws	1 1/2 in.	100
No. 8 metal screws	1 1/4 in.	10
No. 6 washers		50
No. 6 nuts and bolts		8
waterproof caulk		1 tube
Elmer's Wood Glue or P1-200 by Goodrich		1 bottle
door stops		2
hasp set		1
door hinges with removable pins		2 sets
exterior house or porch paint		2 quarts
heat resistant flat black house paint		1 can
Thompson's Water Seal brand water proofing formula		
scraps of wood (shelving board or similar weight) at least 17 inches in length		

* You may want to use 2 sheets of AC or 2 sheets of CD plywood, depending on the amount you wish to spend.
+ Try to get a friend to build one because these will come in sizes twice what is needed.

Kalwall reference: Solar Components, P.O. Box 237, Manchester, NH 03103

TOOLS

Skill Saw or Table Saw	Hammer
Saber Saw	Level
Drill	Staple Gun and Staples
with 3/32 in., 1/4 in., and 1/2 in. bits	Combination Square
Pipe Clamps	Tin Snips
(also called Pony Clamps)	Paint Brush
Screw Driver	and Cleaning Fluid
3/4 in. Wrench	Hack Saw

REFERENCES AND RESOURCES

PLANS FOR AN APPALACHIAN SOLAR FOOD DRYER, Wayne A. Clark, 1980 ASPI Publications

A COOKBOOK FOR BUILDING A SOLAR FOOD DRYER, Arnie and Maria Valdez, 1977 Printed by Sangre de Cristo Printing, 924 Main Street, Alamosa, CO 81101