



# PROJECT FOCUS # 5

Small Farm Energy Project

## The Solar Food Dryer & Window Box Collector

July, 1979

"Project Focus" is part of a primer on energy alternatives that would help lower the high costs of energy inputs on small farms. The examples are drawn from innovations built by north-east Nebraska farmers who are participants in the Small Farm Energy Project, a special 3-year research effort sponsored by the Center for Rural Affairs of Walthill, Nebraska and based in Hartington, Nebraska. The aim of Project Focus is to help small farmers discover and develop viable alternatives for their own farms.

The solar food dryer and solar window box collector are practical items demonstrating the principles of solar energy use. Either of these solar innovations can be constructed during a single-day workshop or for a school shop project, making for an excellent educational opportunity. These two projects complement each other well. The window box collector provides supplemental heat to the home in winter and can contribute to food drying in the summer. The food dryer can also double as a cold frame for starting plants in the spring.

As a creative use of new or recycled materials, the solar food dryer and window box are good introductory projects for the "beginner" of solar energy innovations.

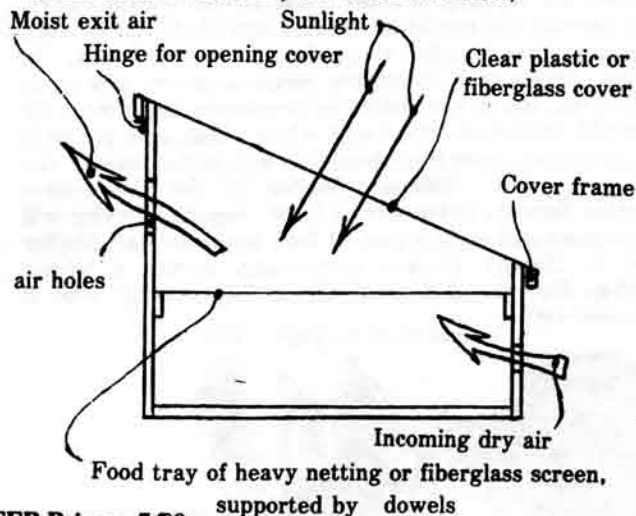
### The Solar Food Dryer

#### A Food Preservation Method

Seven cooperating families of the Energy Project have utilized solar food dryers as a new means of food preservation. Actually, the art of drying fruits and vegetables in the sun is probably as old as the earliest of history, but in recent times lost its appeal to the process of canning and freezing of foods. However, people have become more interested in solar drying due to the benefits of energy savings, improved taste and other features. An improvement over the old methods of drying food is that the solar food dryer is enclosed to lower problems with air borne dust and insects.

Theodora Wuebben, a Project cooperator, has used the solar food dryer for several years. Her husband, Edgar, was the first cooperator of the Energy Project to build such a solar collector, a 2 ft. x 6 ft. wooden box with a glazed surface on the top. The dryer is a simple device with holes drilled and cut into the sides to allow ventilation air to remove moist air from the food and the box. The food itself acts like a solar collector, absorbing the sun's heat, which in turn aids the evaporation of the moisture from the food.

#### SOLAR FOOD DRYER (Cross-section View)



#### Construction & Cost

Construction of the food dryer requires some basic carpentry skills. The solar food drier used by cooperators of the Energy Project is made primarily of 1/2" plywood with 2 x 2's as the framing structure. The ventilation holes at the front and back of the drier are drilled through the plywood, with more holes in the upper rear side for moisture removal. The front holes are drilled below the food trays to allow dry air to enter the system. As the air in the collector is warmed, it rises by convection carrying moisture with it.

Mosquito netting or window screen is used to cover the ventilation holes to keep insects out of the food dryer. Nylon or fiberglass screen can also be used for the food trays. Wood dowels help to support the screen on the collector frame. A small soldering iron or woodburner can be used to wrap and bond the screen in a loop around the dowels at the tray ends. Cheese cloth has also been used for trays, but fibers often stick to the food. Galvanized screen should not be used for the food trays, since the galvanized material often can leave toxic substances on the food. The trays can be removed from the interior of the dryer. Vegetable trays used for such foods as onions should be kept separate from those used for fruit to avoid the taste on fruit. Or onions can be dried over wax paper on the screen, but will restrict the air flow somewhat.

The interior of the drier box can be painted black to improve the heat absorption of the collector box. For light colored food, it has been suggested that a dark colored gauze will also improve the heat absorption, but it is unnecessary. It is also not necessary to insulate the food dryer.

The cover of the drier is hinged on the taller north side of the drier, for opening. Glazing is used in the cover. An old storm window might be used for this purpose. "Sun-Lite" fiberglass, .025 inch thick, has been used and is available from Kalwall Corp., 1111 Candia Rd., Manchester, NH 03103. Filon flat fiberglass is also available from many lumber yards. Light vinyl plastic can also be used, but may have a lower life.

The cost of the dryer as used by Energy Project cooperators is near \$40 for new materials, but many recycled materials can be used to lower the cost.

## Using the Food Dryer

Each of the farm women using the food drier last summer and fall tried something different and most of the ideas worked well. The most popular foods dried were apples and onions. Apples are plentiful and can be easily reconstituted. Onions are used extensively and keep much better dried than the whole onions which can rot in the winter.

**DRIED BEEF.** Andrea Sudbeck made excellent beef jerky from brisket this summer. She injected a sugar cure solution into the meat and soaked it in brine for one day. The meat was thinly sliced (1/8" thick) and dried for one day in the solar food drier. Jerky from a three pound chuck disappeared within two days, so it must have been good.

**FRUIT.** Andrea also dried Italian plumbs in three days with good results. The pits were removed prior to drying.

Theodora Wuebben's garden produces a lot of strawberries so she used the food drier to make strawberry preserves. For each quart of berries, she cooked one cup of water, one quart of sugar and one tablespoon of corn syrup 'til it reached 230°F (she could spin a thread with it), then the berries were added and allowed to boil for ten minutes. This mixture was poured into pyrex containers in the food drier for two to three days. Theodora also dried apricots last year and was satisfied with the taste but disappointed that they turned dark. This year she may be trying an ascorbic acid treatment (1 1/2t/cup of water, according to a flier of the Colorado State University Extension) before drying.

Linda Kleinschmit kept track of the apples she dried. Six loads (the drier measures 2' x 4') filled one gallon jar with as many apples as it would take to make ten quarts of frozen apples, Linda reports. In addition to the freezer space she is saving, Linda is pleased her children have something besides candy to snack on in afternoons and on trips.



—Edmund and Andrea Sudbeck and children inspect food being dried on their solar drier. The Sudbecks have used the drier successfully to dry beef, a tasty treat for all.

**VEGETABLES.** When their solar grain dryer was going up last fall, all the help was treated to Ruth Ellen Truby's food drying handiwork. Zucchini chips and a sour cream dip were the big hit at lunch time. Ruth Ellen is also pleased with dried tomato slices she uses in soups. She says they dry down to flakes but keep the good flavor.

Linda Kleinschmit tried drying green beans but found they turn hard and brown and do not reconstitute well.

Though Delores Young is not ready to report on results, she is looking forward to making cottage cheese in her food dryer. Her recipe calls for 3 qt. of milk combined with 1/2 cup of good buttermilk in a covered pan. She will let it stand in the food dryer at 90° to 110°F for 12 to 24 hours or until a firm curd forms. "After lining a collander with nylon organdy and setting it over a large pan, pour carefully (so the curd doesn't break and

go through the collander). Let the whey drain overnight, then pick up edges and twist gently to allow drainage for a few more hours," says Delores' recipe.

Delores agrees that dried onions are well worth the effort. She places the 1/8" thick crescent shaped onion pieces on cellophane over the nylon screens to prevent the screens from taking on an onion flavor.

## Other Drying Considerations

It is recommended that some foods be dried in the "dark" without direct sunlight, in order to preserve the special nutrients of those foods. In such a case, the solar window box collector can provide heat for the solar food dryer which is covered. It is recommended that carrots, herbs and grains, such as corn, be dried in dark conditions. Most fruit and onions can be dried in light conditions.

Foods can be "re-hydrated" by soaking in water for preparation or cooking.

Not too high a temperature should be used for drying of foods. 110-120 degrees seems to be an appropriate temperature for drying most foods. Excess temperatures can cause nutrient or vitamin losses, like "volatile" vitamin C. Also "case hardening" can occur at higher temperatures above 130 degrees, which prevents the inner portion from drying properly. Often suggested preparation of fruits and vegetables includes the use of sulfur and salt, primarily to preserve the food's color and some vitamins. However this is questionable and probably unnecessary. There appears to be a difference of opinion with regard to the necessity of blanching foods, particularly vegetables. Some experts encourage the use of natural unpeeled, untreated food for the best food drying results.

## Benefits of Food Drying

The food dryer can become an energy saver in the home. In replacing canning or freezing of vegetables and fruits, much of the energy of preparation and preservation of the foods is avoided. It therefore makes the home-maker less dependent on outside energy sources for food preservation. It has been suggested that the shelf life of foods can also be increased by food drying.

Space savings can also be realized by food drying, as less bulk must be stored. Vegetables are often dried to 5% of the original moisture content and fruits to 15-20% of initial moisture. By weighing foods before and after drying, one can calculate the moisture content, if the original moisture is known. Storage should be in a cool, dark place. Glass jars are usually recommended as the best storage containers.

The taste of foods can be enhanced by food drying. "Dehydrating enhances and draws out new flavors and sweetness," reports Arnold and Maria Veldez in their book, *A Cookbook for Building A Solar Food Dryer*. "Dried onions, celery, carrots, and zucchini can be used instead of chips for dips, or powered in a blender to produce a vegetable salt." In addition, "fruits such as apples, peaches, pears, pineapple, bananas, etc., are an alternative to sweeteners, and a must for travel with little ones. Mixed with whole wheat, oats, pumpkin seeds and honey, dried fruits become a high protein snack," the Veldezes report. Theresa Shaffer of the Cooperative Extension Service, University of Nebr., reports, "Drying will become more and more a part of food preservation." Shaffer talked to Energy Project cooperators during a winter workshop. She labeled the method as a "high quality" type of food preservation.

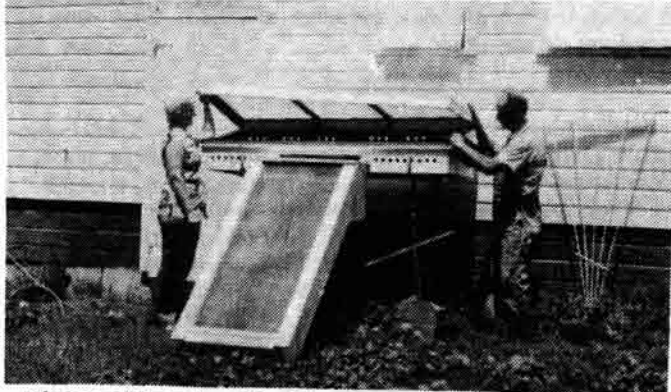
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## Variations in Dryer Use

Most of the cooperators of the Energy Project have chosen the 2 ft. x 4 ft. dimension for food drying, compared to the original 2 ft. x 6 ft. size used by the Wuebbens. Other sizes can be used, although similar width to length ratios are suggested. A corrugated cardboard box can be used for the frame of the food dryer for lower cost. A variety of plans are available for food dryers with various shapes and sizes, so the end product can be the result of the imagination of the builder.

Not only does the food dryer help after the harvest of gardens and orchards; it can also be used as a cold frame for



—Edgar and Theodora Wuebben inspect food in their solar food drier. The drier can be used alone or with the solar window box collector, shown attached to the drier. The window box improves the efficiency of the system, especially during the fall months. In some cases, where "dark" drying is required, the window box provides all the heat for drying, while the drier itself is shaded.

starting young early plants. Theodora Wuebben has used the device for starting tomatoes and cabbage in the spring.

There are other methods of drying food. A solar greenhouse might provide the atmosphere for simple food drying. A pilot light of the gas oven provides adequate heat for drying of fruits and vegetables. Solar food drying requires sunshine for the final result, but if there is no sun for a day, food often can be left on the dryer, awaiting sun a day later.

A solar window box collector is used by Theodora Wuebben during cooler fall months when the sun is lower in the southern skies to improve the efficiency of solar drying during these months. The top end of the window box attaches to the front of the food drier, where the extra heat is received. □



—Edgar Wuebben checks on plant boxes in the solar food dryer which doubles as a cold frame during the early spring.

## The Solar Window Box Collector

### A Passive Solar Heater

The solar window box collector is essentially an insulated box with a glazing material over a suspended black-painted metal collector plate. The black plate absorbs energy from the sun, warming the air above it. This causes warm air to flow up and out of the collector by convection and into the room behind the collector. As the warm air rises, cool air from the room flows into the area beneath the collector plate.

The window box functions as an extension of a window, and it can provide supplemental heat to a room on a clear, wintry day. Since the collector requires no fan to operate, it is classified as a "passive" solar collector, a simple device.

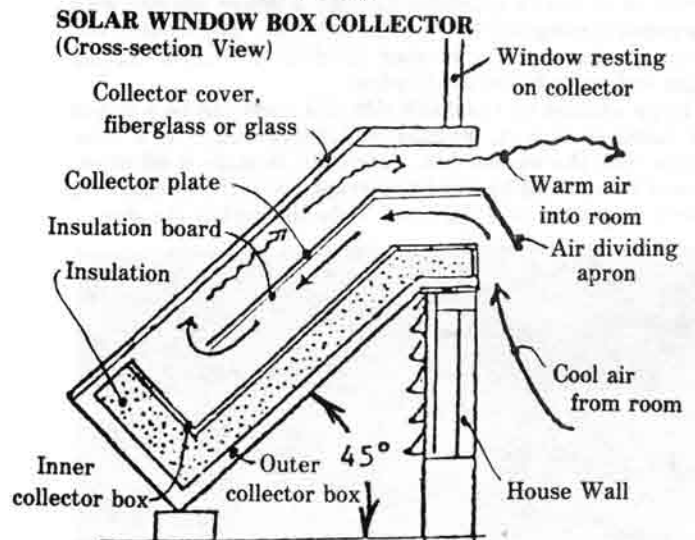
A variety of sizes and shapes are possible options for the builder of the window box collector. The window box should be well insulated on the sides and bottom. During construction of the collector, an inner "box" is built to provide support for the collector plate and a liner for the air flow. A larger box is built to enclose the inner box, with insulation installed between the two. The fiberglass glazing or glass cover is placed onto the top side. Caulking is essential to make an air-tight collector.

### A Low-Cost Collector

Rick Pinkelman was the first cooperator of the Energy Project to use the window box collector. He built the collector for \$10, using mostly materials from around the farm. Encouraged by the results, he and his wife, Mary, went on to build a large solar collector on their farrowing barn, and they also built a 290 sq. ft. vertical wall collector on their home. The window box collector, for them, represented a valuable learning experience on the assets of solar energy, before proceeding to uses of larger collectors.

A construction workshop was held for cooperators of the Energy Project two years ago. Fourteen window box collectors were constructed. The workshop used mostly new materials, SFEP Primer, 7/80

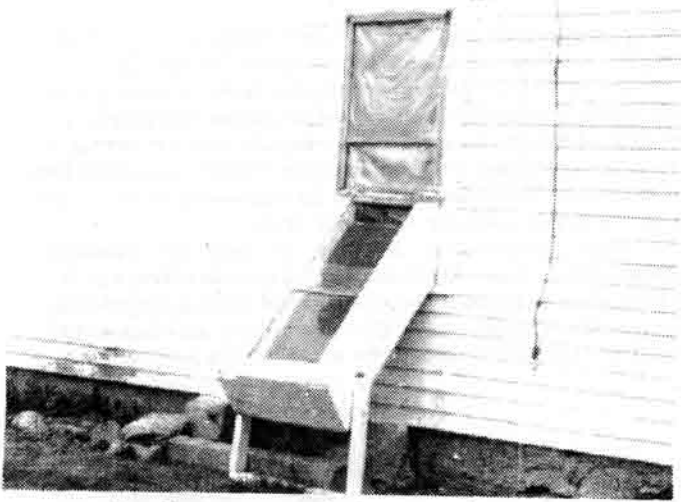
giving a cost of about \$40 per unit. However used materials would lower the cost. A used storm window, for example, can be used for the collector glazing.



### Uses of the Window Box

The window box collector can be installed into a window for the winter months, similar to the installation of an air conditioner. As a portable collector, it is usually removed during the summer months and placed in storage. However, for more permanent installations, the collector can be covered with a sheet of plywood or over covering to restrict sunlight from striking the collector surface, and heating the room.

The window box collector is effective in improving the efficiency of the solar food dryer, especially during fall months. It is simply attached to the front of the food dryer.



### Performance of the Window Box

The window box collectors used at the Energy Project utilize about 10 sq. ft. of collector surface, although these collectors can be built considerably larger.

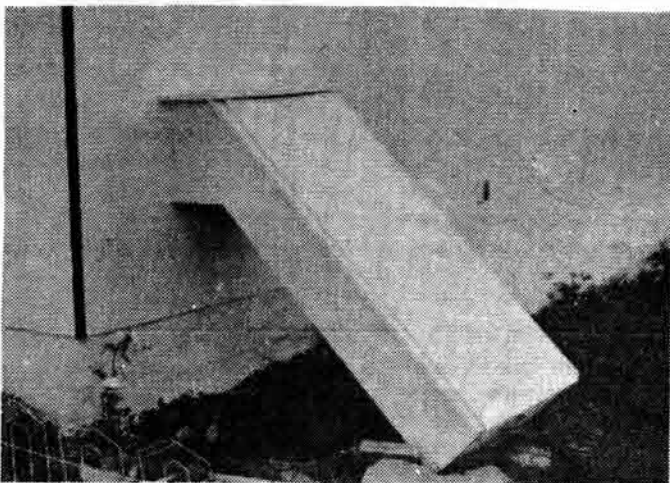
The amount of heat the modest window box collector can produce may be surprising—often enough to keep a room warm during calm, clear wintry days. In late winter (April 1) of 1978, one window box gave a 23°F temperature rise and moved air at a rate of 38 cubic feet per minute (cfm). This was at 4:00 in the afternoon. Later that spring (May 10), a similar window box installed on a dairy barn gave a 55°F temperature rise although the air flow rate was 29 cfm at 2:00 p.m., more than enough to take the chill out of the milking parlor, where it was used.

### Special Precautions

The solar window box must be well caulked and well insulated for satisfactory performance. When mounted to the window, it should be weatherstripped to avoid air leaks into the home.

The window box can be mounted to the exterior frame of the window, or it can be extended through a larger window with the window resting on the top of the collector. The window box will not perform properly when used in a window having heating radiators below the window.

A large window on the south side of a room can be a larger solar collector as it is, perhaps performing better as a solar collector than the window box. However, to make it effective, it should be covered by insulated drapes at night to conserve the energy gained as a "passive" collector during the day.



—The window box collector on the home of George and Janet Hamilton of Hartington. This is a permanent installation, therefore it is covered during summer months. Janet is office manager at the Energy Project.

—The first window box, left, in Cedar Co. was constructed by Rick Pinkelman early in 1977. The success of the device led to the organizing of a workshop where 14 systems were built. The window box represents an educational tool for learning about solar energy. Rick and Mary Pinkelman went on to build large solar collectors on their farrowing barn and home.

## More Information

A variety of plans and books are available for constructing and using the window box collector and solar food dryer. Several are listed below.

### References

"Solar Food Dehydrator Plans," Domestic Technology Institute, 12520 West Cedar Dr., Lakewood, CO 80215, \$8.50. Contains five 18" x 24" blue-prints for constructing a 2 ft. x 6 ft. food dryer. The plans include details on making a small dryer unit from a corrugated cardboard box and information for building a window box collector. Also includes suggestions for food drying considerations, such as "dark" drying.

**A Cookbook for Building A Food Dryer**, San Luis Valley Solar Energy Assn., P.O. Box 1284, Alamosa, CO 81101, 16 pages, \$3.50. Includes introduction to drying, design and variations of dryer and window box collector with many illustrations and a bibliography. Excellent.

**Dry It, You'll Like It**, by Gen MacManiman, Living Food Dehydrators, P.O. Box 546, Fall City, WA 98025, 1974, \$3.95. Instructions for drying fruit, herbs, meats and other foods, includes solar dryer plans. Highly recommended.

"Solar Energized Food Dehydrator-Plans", Solar Survival, Cherry Hill Road, Harrisville, N.H. 03450, \$6. Five 18" x 24" blueprints indicate the construction of a food dryer using a 50 gal. drum for use of solar energy in "dark" drying. Includes suggestions for the drying process and other uses of the system.

"Solar Window Box Plans", Small Farm Energy Project, P.O. Box 736, Hartington, Nebr., 68739, \$2.50. Includes one 18" x 24" blueprint and details for construction of a window size solar heater. Plans were developed for workshop construction of over a dozen window boxes, but are helpful for single collectors also.

"Food Dryer Bibliography", Teresa Shaffer, Extension Specialist in Food And Nutrition, U. of Nebr., Lincoln, NE 68583. Local extension services also have information on drying fruits and vegetables and making leathers and jerkies.

**Dry and Save: A Complete Guide To Food Drying at Home. . . With Recipes**, by Dora D. Flack, Woodbridge Press Publishing Co., P.O. Box 6189, Santa Barbara, CA 93111, 118 pages, \$2.95. A discussion of the reason for food drying, methods used, pretreatment, storage, food leathers, and various recipes. A good resource, covering many aspects.

**The Solar Food Dryer Book**, by Stella Andrassy, Morgan and Morgan, 145 Palisade St., Dobbs Ferry, N.Y. 10522, 127 pages, \$3.95. Includes instructions for making the "sunhood" dryer, basic information for food drying, recipes for dried food use, and a reading list.

**The Solar Cookbook**, by S. Andrassy, Morgan & Morgan, 145 Palisade Str., Dobbs Ferry, N.Y. 10522, 128 pages, \$3.95. Includes 100 recipes, and information on the portable sun oven, weighing 35 pounds. □

