

SOLAR GREENHOUSES

ASPI Technical Series

SOLAR GREENHOUSES

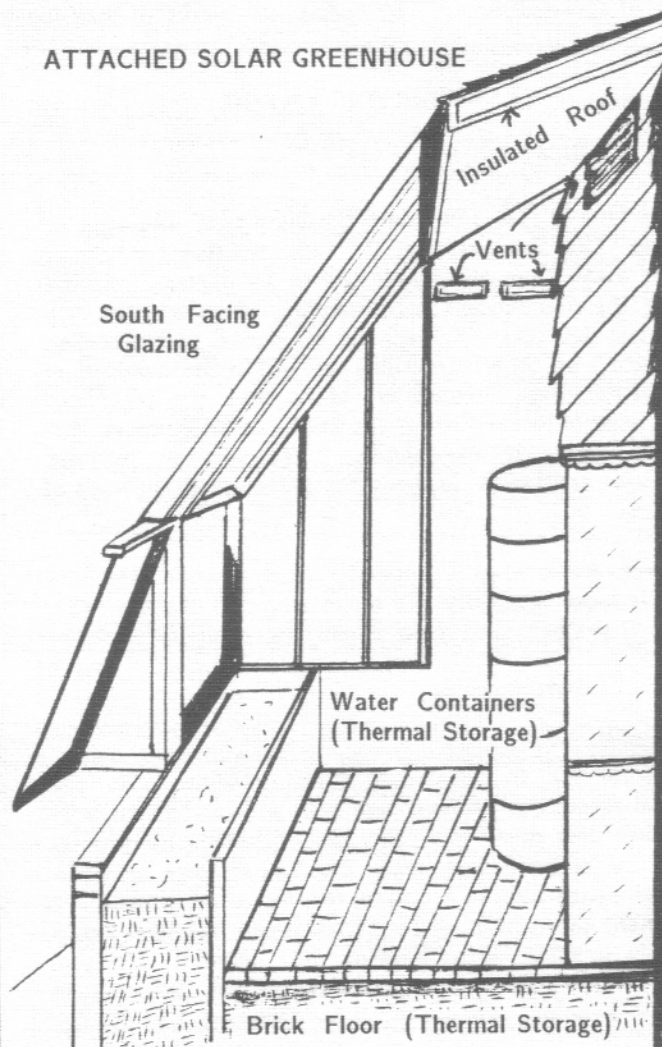
One of the best methods for providing fresh vegetables, berries and herbs in off-season months is by use of a solar greenhouse (SGH). We say "solar" because non-renewable resources (coal for electric and natural or bottled gas), the traditional greenhouse heating methods are becoming more expensive and deplete limited earth resources.

The SGH can provide low-cost nutritious food for families who cannot afford to buy imported vegetables and berries from distant outdoor year-round or extended growing zones.

You can have a solar greenhouse on your own property for a reasonably low cost, provided you are willing to do the work yourself or with volunteers, construct the SGH properly, grow organic foods, and maintain the structure in good operating condition.

The SGH works through three basic principles: collection, storage, and distribution of the sun's energy. Short wave solar radiation strikes the clear glazing of the greenhouse windows and is effectively captured using darkened surfaces. When the radiation strikes an object inside the SGH it is changed to heat which has longer wavelengths. In this form the energy cannot easily escape through the glazing and is trapped in the enclosed opening of the SGH. Reflective surfaces allow more of the radiation to be concentrated on the heat-retaining materials (stone, other solid building materials, or water). Plants set near the heat retaining systems will benefit and grow well even in colder climates.

ATTACHED SOLAR GREENHOUSE



ADVANTAGES

Besides providing needed green vegetables throughout the year at very low cost, here are some additional benefits of the solar greenhouse:

- * The SGH replaces a greenhouse heated through the burning of fossil fuel. There are no emissions of carbon dioxide and acid rain-producing gases, definitely an environmental benefit;

- * It provides a ready hobby and work place for those needing recreation during cooler times. When properly designed it is especially beneficial for those in wheelchairs or who have a desire to touch the soil but find it hard to leave a house.

- * It can furnish supplemental heat during cold days when the excess space heat can be channeled into the interior of the house. It can also serve as air space to cushion climate changes for the interior of the house;

- * An attached SGH provides sun space and extra living space for a home which needs room for dining, sitting and recreating.

- * An attached SGH is attractive and adds color in drab periods of the year, thus raising the spirits of occupants and visitors.

Some people prefer to order high-priced, ready-to-assemble solar greenhouses which are ultimately worth the price — but why go that route? Our work is devoted to low-cost appropriate technology programs most suited for lower income people. So we endorse work done using local labor and native building materials.

Programs for building attached or free-standing solar greenhouses are superb opportunities for teaching youth and others about environmental methods and construction skills. During reasonably short workshops, the participants can acquire a sense of accomplishment by seeing the works of their hands materialize. SGH projects yield benefits very quickly.

CONSTRUCTING AN SGH

1. Site Selection

Take time to plan and select the most ideal site on your property. For best results, it should be facing south or slightly away from the south (up to 15 degrees will not change the effectiveness significantly). Make sure the path of light is not severely hindered by dense undergrowth, evergreens or other structures or within the shadow of rather large trees. However, make sure the prevailing winter wind is blocked from the SGH. In the summer, the SGH is better in the shade. We suggest planting Jerusalem artichokes in a planter immediately in front of the SGH.

If you have several potential sites, choose the one which is most accessible to those who will use the SGH. Where is the best and most conducive place to work?

2. Plan the SGH

Determine the size that is optimal for your own needs, can fit well on the site, and meets building skills and financial resources. A floor size one-and-a-half to twice the length over depth is a good rule of thumb. Remember less space requires less heat. Don't have large amounts of upper space that is not used for the actual growing. It is too hard to warm in winter. Even if one has to stoop or fit snugly in some of the growing area, allow it. The goal is more growing space and less unused volume, so consider hanging containers. (See Diagram 1.)

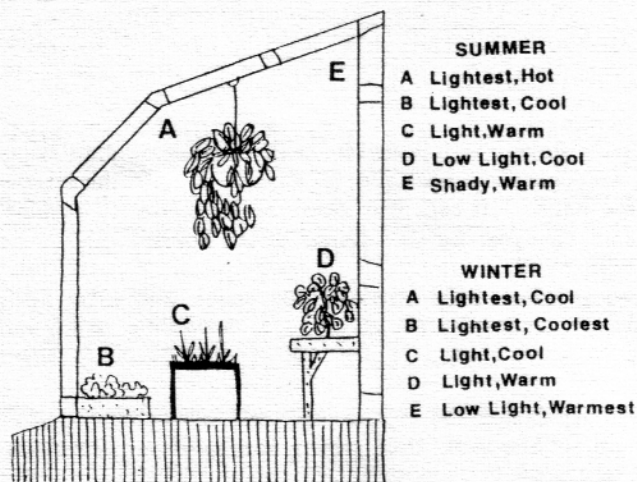


Diagram 1. GROWING SPACE

3. Glazing Materials

A major problem for solar greenhouses is the availability of proper glazing materials. While some would say that costs could be cut by recycling single pane glass windows, be careful, as such windows are inefficient. Some plastic could do but is often highly combustible and has a short lifetime. We recommend getting used glass from a dealer and assembling the double-glazed windows yourself using cedar stripping and proper weep holes for removal of moisture buildup between the panes. The double-glazing is good insulation and resists loss of heat from the SGH. (See Diagram 2.) (Check RESOURCES for information on glass and glazing supplies.)

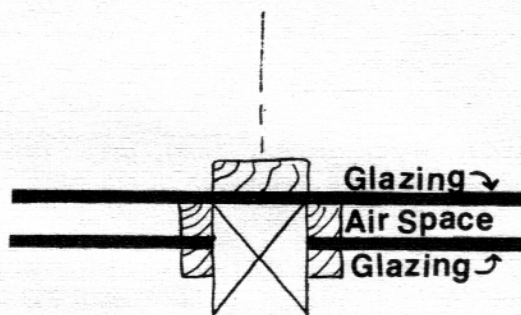


Diagram 2. DOUBLE GLAZING

The roof slope and the slope of the glazing will be important for the efficiency of the collecting structure. Angles of less than 40 degrees will cause excessive reflection of the winter sun. Don't permit too much dead space where the glazed surface connects with the wall of the major structure.

4. Heat-Retaining System

Stone or other masonry walls along with water contained in a variety of vessels are good heat-retaining systems. 55-gallon drums or 1-gallon milk jugs make good water containers for heat storage. We recommend that you DO NOT use glass bottles for storage. There is a strong possibility that the glass will break during severe winter freezes. An advantage to using a fish tank as a water container is that it can collect rain water and grow fish while doubling as a heat-retention system and source of water for SGH plants. Stone walls and rock should be properly insulated for the work at hand.

Some items such as glass, caulking materials and some insulating materials are not always manufactured locally, so materials transported from the outside are necessary. However, wood for siding, rock for heat storage and foundations, sand, dirt, and bamboo for interior trellises can often be locally obtained. Even cellulose from discarded newsprint can be used for insulation.

Workshops can be organized by planning, preparing needed tools, buying and delivering needed materials, assembling the work team, and having a leader conduct the workshop. Printed references and literature are helpful for participants.

5. Snug and Dry

Make sure no water gets into the building from leaking roofs, a failure to construct foundations properly or other reasons. The attached greenhouse itself should be built using standard building skills. Make sure soil is of a firm texture and the foundation is well built. Outer walls of the building and the foundation should be insulated to prevent interior heat loss at night. Use approved standards for the locality by asking authorities for information on the recommended R values for your location.

Insulating the windows should be the same as for double glazing protection for homes except on a larger scale. Ask advice on caulking and pane fitting from those selling and working with solar windows.

Adapt a proper roof slope and use shingles or other roof covering, making sure that the roof is tied in properly to the building itself.

6. Ventilation

Proper venting of overly moist or heated air is needed for a controlled greenhouse environment, along with mixing existing air and allowing for inflow of fresh air containing carbon dioxide. Generally relative humidity should stand in the 30 to 70 percent range. Higher humidity causes disease to spread and chills plants on cold winter nights.

Vents may be moveable and on the glazed front or sides or placed near the bottom and circulating out the top of the back wall. (See Diagram 3.) More sophisticated solar powered systems can also be used. A small exhaust fan and a vent placed in the opposite wall will force circulation of air through the SGH. Thermostats, which operate the fans only when needed, can also be installed.

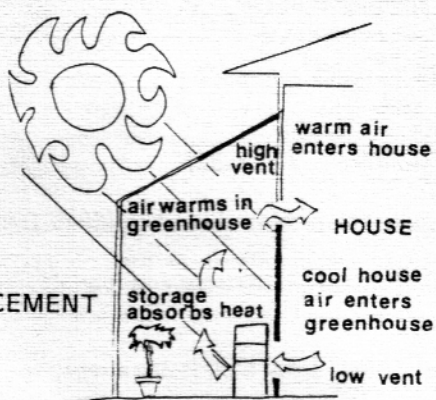


Diagram 3.
VENT PLACEMENT

7. Plant Arrangement

Expect that you are going to rearrange the planting after you acquire SGH experience. Allow for boxes near the window, others up higher and farther removed, and some hanging baskets or pots as well. Fill the space for efficiency and maximum use of air-heated space. Realize that warmer zones exist in the greenhouse and place plants accordingly. Also remember that vines and taller plants should not block smaller ones in the background. (See Diagram 1.)

Place plants needing more moisture in beds and those needing less in pots and individual containers.

SGH MAINTENANCE

The following are some helpful hints for maintaining the SGH in tip-top working order:

- * Keep doors closed as much as possible in cool weather. If necessary, build an air-locked compartment so that, when entering, less cold air comes into the growing areas;
- * Keep windows clean. Insulated shades should be pulled at night and open when the sun is shining;
- * Check for leaks in the system each autumn;
- * Remove and restore soil every year or two so that the biological organisms which keep soil fertile are present;
- * Discard weeds and vegetation in an exterior compost pile to prevent mold and harboring of harmful insects.
- * Don't use the SGH as a storage room and thus clutter up the growing space;
- * Refrain from using chemical pesticides within the SGH. Use biological and other controls if possible. (See RESOURCES.)
- * For plant protection try to keep praying mantises and ladybugs present, as well as flowers such as marigolds.
- * Watch for damp and moist areas which require wood protection. Remove all flat spaces such as wood ledges which could collect moisture and allow wood to rot. If necessary rot resistant treatments can be used on the plant boxes as well as on the SGH structure. These include linseed oil, Thompson's Water Seal brand Water Proofing Formula, and other approved wood treatments.

PLANT SELECTION

There is little use planting exotic vegetables or those requiring hot, humid climates or too much space. When one finds literature which advocates growing pumpkins or potatoes in an SGH, it is evident that the writer hasn't tried such an extravagance. Such plants require so much room or time to produce a single piece of produce that the space is essentially wasted. Select those using small amounts of space and/or growing time.

These authors have found that celery (a semi-tropical vegetable) can thrive in the SGH even with the temperature dipping below freezing for short lengths of time. The celery is highly affected by cold winds but not by the SGH's cool but protective enclosure.

We have selected 12 produce varieties which grow well in SGH's in Central Appalachia. (See Table 1). Plants not listed but which could grow in the SGH include such root vegetables as carrots (can be harvested in temperate zones in early fall and again in early spring), turnips (grow well outdoors in cooler climates), radishes which do the same, horse radish (can be collected through much of winter), and parsnips (can be harvested throughout the year due to slow growth rate). Brassicas, including cabbage, Brussel sprouts and kohlrabi take up much room, grow well out-of-doors in the spring and fall, and store well in cool places for further use.

Melons and many varieties of tomatoes can thrive only in warmer than most green houses provide. The same applies for sweet potatoes, okra and green beans. Peas are a borderline crop, many varieties of which grow well in the SGH if one so desires.

RESOURCES

Organic Gardening Supplies: NECESSARY TRADING COMPANY, New Castle, Virginia 24127.

Seed Source: JOHNNY'S SEEDS, Foss Hill Rd. Albion, ME 0490.

Organic Gardening Information: BIO-INTEGRAL RESOURCE CENTER, Box 7414 Berkeley, CA 44707 (415) 524-2567.

Glass and Glazing Supplies and Consulting: PAUL GALLIMORE, Long Branch Environmental Education Center, Rt. 2 Box 132 Leicester, NC 28748 (704) 683-3662.

TABLE 1

1. Kale (heartly in cool weather and highly nutritious)
2. Swiss Chard (grows well and is a good producer)
3. Celery (resists low temperatures, and its leafy tops provides flavoring for soup and other dishes)
4. Mustard (easily started from seed and can grow to great height during winter)
5. Herbs (oregano, dill, mint, parsley, and others do well in most SGHs)
6. Strawberries of hardier varieties
7. Broccoli (also cauliflower will grow and produce during cooler seasons)
8. Endive (grows well from seed and can produce all through the cool seasons)
9. Chives (other members of the onion family, such as garlic, also do well indoors)
10. Spinach (a favorite among salad lovers)
11. Lettuce of various types (near the bottom of the list because this plant needs looser soil than many greenhouses provide)
12. Cherry Tomatoes (hardier tomatoes are required due to the possibility of lower temperatures)

THINGS TO REMEMBER

- * Keep a log of planting times, growing conditions and amounts and time of yield;
- * Water only two days a week, rather than daily;
- * Cultivate ground in SGH because plants need air as much as they need water;
- * Allow enough growth space between plants or they will rot due to lack of a current of fresh air;
- * Don't leave wasted space. As winter vegetables are used, prepare for spring seedlings or flowers. Develop your own planting schedule, as time can slip up on you.

REFERENCES AND RESOURCES:

The Solar Greenhouse - Design, Construction, and Operation for Alabama Homeowners
Bruce J. Novell and Dr. Kenneth P. Lewis, Alabama Solar Energy Center, Huntsville, AL 35899.

East Tennessee Community Design Center, 1522 Highland Avenue, Knoxville, TN 37916 (615) 525-9945.

Low-Cost Passive Solar Greenhouses, Ron Alward and Andy Shapiro, 1980, National Center for Appropriate Technology, P.O. Box 3838, Butte, MT 59701 (406) 494-4572

The Food and Heat Producing Solar Greenhouse, Bill Yand and Rick Fischer 1980, John Muir Publications, Inc. P.O. Box 63, Santa Fe, NM 87501.