

Hobby Greenhouse Design Notes

Hobby greenhouses provide year-round enjoyment for many gardeners and can be a useful investment for families that wish to raise their own flowers, ornamentals or garden vegetables. Plans are available for greenhouses of various styles, shapes, sizes and degrees of durability. The design chosen by the individual homeowner is usually influenced by location, space, budget and intended use. In addition to consultation with zoning, building code and tax assessor personnel, the following factors should be carefully considered:

- location
- style of greenhouse
- type of construction
- heating and ventilating system

Location should allow maximum use of sunlight—a southerly exposure since a *greenhouse is a collector of solar heat*. The site should be as far from trees as practical, well-drained and convenient to water, fuel for heating and electric service.

Styles of various kinds are available to suit almost any need. There is an extensive variety of sizes, shapes and designs ranging from window box attachments to lean-to annexes to free-standing greenhouses. Gothic arch, rigid frame, air-supported, shed roof and conventional pitched roof are just a few of the available shapes. A greenhouse that fits both existing landscape and personal preference dictates the choice. Greenhouses are framed with wood, steel or aluminum and covered with glass, fiberglass, polyethylene or vinyl.

Glass-type houses are very attractive, permanent and expensive. These houses should be built by a greenhouse manufacturer or purchased in a ready-to-assemble package since they are rather difficult to construct. Suppliers are listed in gardening magazines or the yellow pages under "greenhouses."

Fiberglass-covered houses are durable, attractive and moderately priced. They are commercially available or can be built from available plans. Only transparent or translucent fiberglass weighing 4 to 5 ounces per square foot should be used. Fiberglass-reinforced plastic or acrylic in flat or corrugated sheets, manufactured specifically for greenhouses with life expectancy of 10 to 20 years, is commercially available.

Plastic film-covered greenhouses are inexpensive and temporary. They are less attractive and require more maintenance than other styles. Clear polyethylene, 4 or 6 mils (0.004 to 0.006 inch) thick, is most commonly used as it is inexpensive and readily available. Polyethylene lasts only from 3 to 8 months because it is rapidly broken down by ultraviolet radiation from the sun. Polyethylene treated with an ultraviolet (UV) inhibitor is slightly more expensive and will last 3 to 6 months longer than regular polyethylene.

Two layers of plastic can be installed to reduce heat loss as much as 40% and reduce condensation. An inside layer of plastic 2 to 4 mils thick is spaced

not less than 1 inch or more than 4 inches from outside layer to create a dead airspace. Although two layers are difficult to install, they are well worth the trouble. Typically, both layers can be installed on the outside of the framework with a 2 x 2 spacer placed between the layers where they are fastened to the rafters. One sheet is held by the 2 x 2 nailed just to hold it in place. The second sheet can then be held with batten strip and nails driven through the 2 x 2 and an inch or more into the rafter. In small greenhouses, the inner layer of plastic can be fastened to the inside framework with staples driven over a string. Simply pulling the string removes the staples.

Greenhouse Construction requires seasoned, construction-grade lumber for framing. Redwood, Douglas-fir or cedar are best. Paint the framework with a white oil-base exterior paint to improve appearance and reflect more light. Posts and wood that touch the ground should be treated with copper naphthenate preservative. Do not use creosote and pentachlorophenol preservatives because they release toxic vapors harmful to plants.

Heating the greenhouse is a must for winter use. Many types of heating systems are available. Most plants are classed in two greenhouse temperature categories—warm or cool. Also, most plants do better when night temperatures are about 10°F lower than day temperatures. A greenhouse temperature program of 56-57°F for nights and 65-70°F for days allows the greenhouse enthusiast to successfully grow both cool and warm temperature plants.

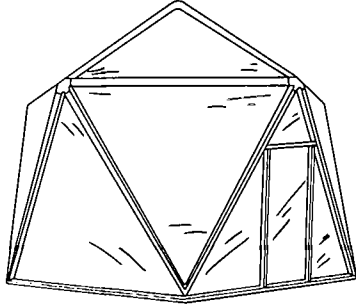
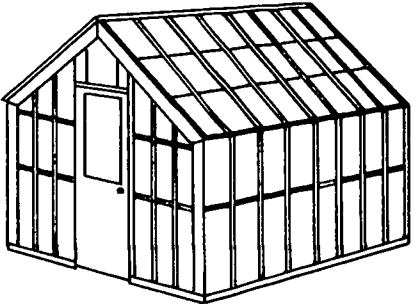
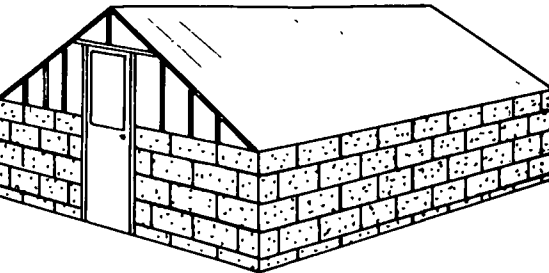
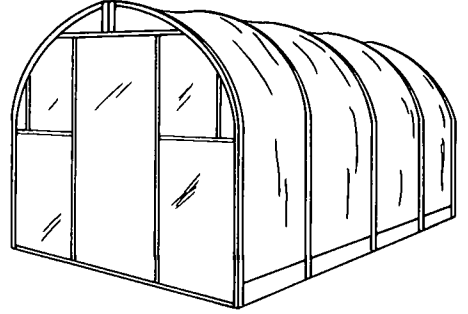
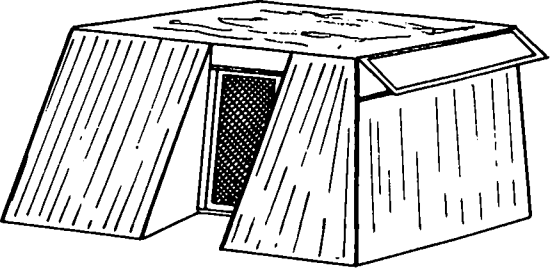
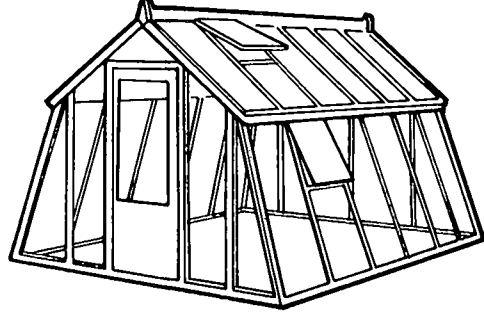
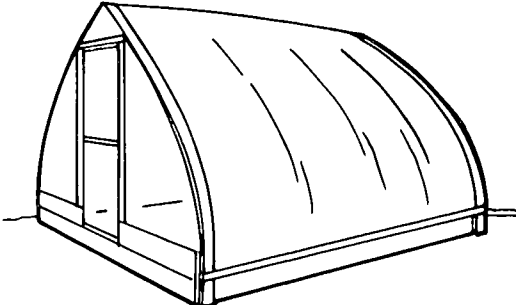
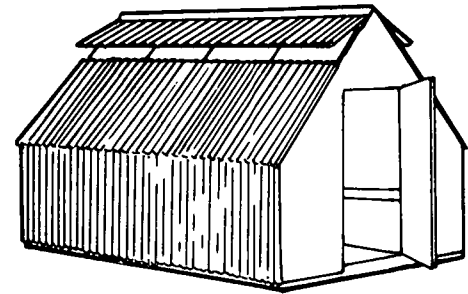
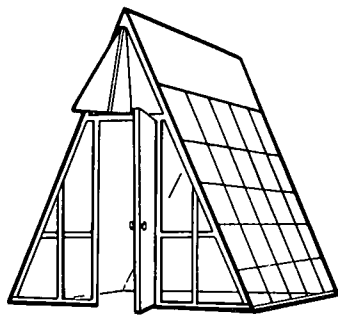
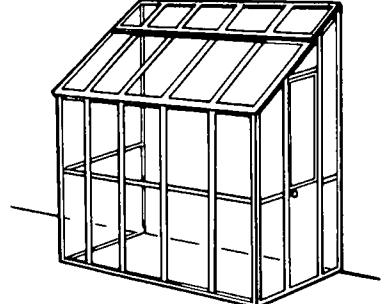
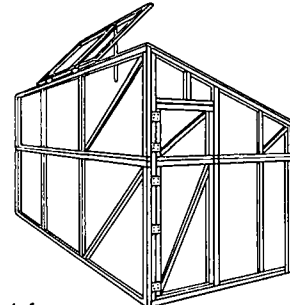
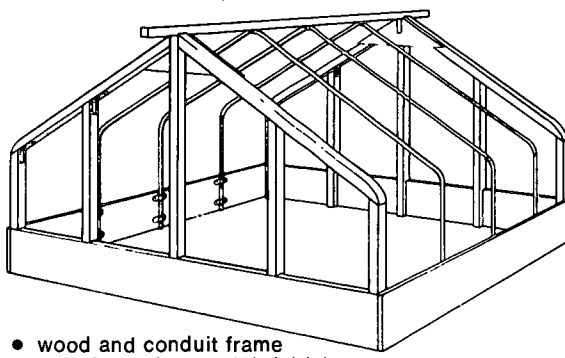
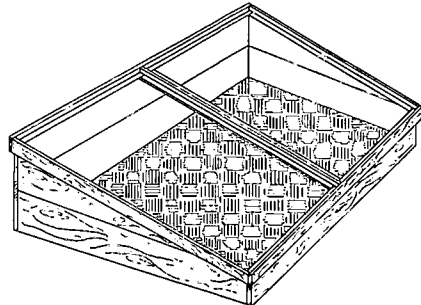
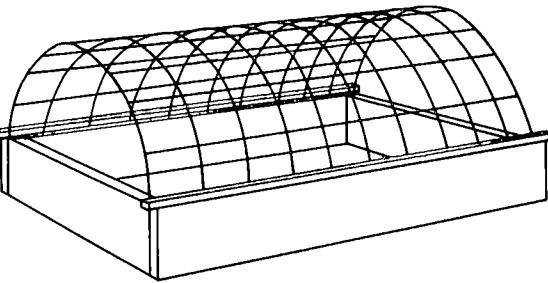
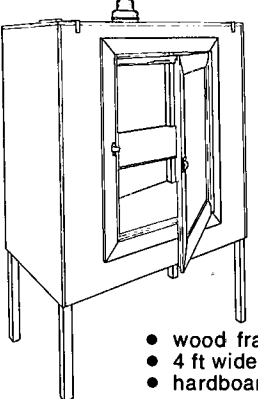
- **Home Heat Systems**, if of adequate capacity, may be extended to a small window-box or lean-to greenhouse. However, the heat demand for a greenhouse is different than that of the home so a separate thermostat and control system is required. A heating contractor normally will be needed for installation.

- **Space-Heaters**—either electric, gas, or oil—are often used to heat small greenhouses. Heated air is circulated by a fan in the heater. Space-heaters without a fan are rather uneven and ineffective. Depending on the size of unit, space-heaters should not be more than 10 to 30 feet apart to produce uniform heating. Oil or gas space heaters must be vented to the outside since the products of combustion are toxic to plants. Electric heaters are easy to install and more convenient.

- **Space-Heaters With Ducts** distribute heat more uniformly throughout the greenhouse. A space-heater with a fan built for moving air in ducts is attached to a clear 12- to 24-inch diameter polyethylene tube hung overhead. The tube has 2- to 3-inch holes spaced every 2 or 3 feet. Warm air is blown into the tube and distributed out the small holes to provide uniform heating.

- **Home Forced-Air Furnaces and Ducts** are used to heat large houses. Clear polyethylene tubes, such as used with the space-heaters and ducts, can be at-



<p>Tri-Penta Greenhouse 6097—3 sheets, \$6.00</p>  <ul style="list-style-type: none"> • wood frame • 216 sq ft floor area, 13¾ ft peak, 8½ ft wall • plastic film cover 	<p>Plastic Greenhouse 6251—2 sheets, \$4.00</p>  <ul style="list-style-type: none"> • wood and conduit frame • 12 ft wide, 16 ft long, 9 ft high • plastic film cover 	<p>Sash Greenhouse 5189—1 sheet, \$2.00</p>  <ul style="list-style-type: none"> • concrete block and wood frame • 10 ft wide, 18 ft long, 6 ft high • glass sash cover 	<p>Economy Greenhouse WRAES 1017—1 sheet, \$2.00</p>  <ul style="list-style-type: none"> • plastic pipe frame • 10 ft wide, 16 ft long, 8 ft high • plastic film cover 	<p>Greenhouse & Storage Building 6288—1 sheet, \$2.00</p>  <ul style="list-style-type: none"> • wood frame • 10 ft wide, 14 ft long, 8 ft high • plywood and plastic film cover
<p>Home Greenhouse 6181—2 sheets, \$4.00</p>  <ul style="list-style-type: none"> • wood and plywood frame • 10 ft wide, 12 ft long, 8 ft high • corrugated fiberglass cover 	<p>Portable Plastic Greenhouse 5946—1 sheet, \$2.00</p>  <ul style="list-style-type: none"> • wood frame • 8½ ft, 12 ft long, 7 ft high • plastic film cover 	<p>Fiberglass Greenhouse WRAES 1016—2 sheets, \$4.00</p>  <ul style="list-style-type: none"> • wood frame • 8 ft wide, 12½ ft long, 7 ft high • fiberglass cover 	<p>"A" Frame Greenhouse WRAES 1015—1 sheet, \$2.00</p>  <ul style="list-style-type: none"> • wood and plywood frame • 10 ft wide, 10 ft long, 8 ft high • plastic film cover 	<p>Lean-To Greenhouse WRAES 1014—1 sheet, \$2.00</p>  <ul style="list-style-type: none"> • wood frame • 8 ft wide, 12 ft long, 9 to 5 ft high • plastic film or fiberglass cover
<p>Plastic-Covered Greenhouse/Coldframe 5941—2 sheets, \$4.00</p>  <ul style="list-style-type: none"> • wood frame • 5 ft wide, 8 ft long, 7½/5½ ft high • plastic film cover—roof removable for use as coldframe 	<p>Hotbed & Propagating Frame 5971—1 sheet, \$2.00</p>  <ul style="list-style-type: none"> • wood and conduit frame • 6 ft wide, 6 ft long, 3½ ft high • plastic film cover 	<p>Hotbed 6206—2 sheets, \$4.00</p>  <ul style="list-style-type: none"> • wood frame • 6 ft wide, 3 or 6 ft long • glass or plastic cover 	<p>Mini Hotbed & Propagating Frame 6080—1 sheet, \$2.00</p>  <ul style="list-style-type: none"> • wood and woven wire mesh frame • 3½ ft wide, 5 ft long, 2 ft high • plastic film cover 	<p>Plant Growth Chamber Roomette 5980—2 sheets, \$4.00</p>  <ul style="list-style-type: none"> • wood frame • 4 ft wide, 2 ft deep, 5½ feet high • hardboard or plywood cover

Plastic-Covered Greenhouse
6094—4 sheets, \$8.00

- wood and plywood frame
- 16 or 26 ft wide, optional length in 4 ft segments
- heating and ventilating design
- plastic film cover

Greenhouse Frame
6029—2 sheets, \$4.00

- wood and plywood frame
- 23 ft wide, 48 or 96 ft long, 12 ft high
- optional cover choice

Greenhouse Benches
6163—1 sheet, \$2.00

- plans for six greenhouse benches

Plastic Greenhouse
6217—2 sheets, \$4.00

- wood and conduit frame
- 20 ft wide, 80 ft long, 8½ ft high
- fiberglass or polyethylene cover

Note: suitable only for areas with no snow load

Greenhouse, Pipe Frame
6222—3 sheets, \$6.00

- steel pipe frame
- 25½ ft wide, 16 ft bay segments
- plastic film cover

Greenhouse Heating & Ventilating Systems
6197—3 sheets, \$6.00

- specifies fans, heaters, air ducts, controls, flues, wiring

Greenhouse, 28 foot wide
6185—3 sheets, \$6.00

- wood or steel pipe roof truss and frame
- 28 ft wide, 96 ft long, 7 ft high to truss
- plastic film cover
- excellent construction details

Propagation Unit for Plants
6101—3 sheets, \$6.00

- wood frame
- 6 ft long, 3 ft wide
- details for ventilation, watering

Soil Treating System
6198—3 sheets, \$6.00

- 4 ft wide, 10 ft long, 2½ ft high
- requires steam supply

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tached to the furnace and hung overhead for distributing heat. These furnaces must be vented.

- **Amount of Heat** required for a greenhouse depends on the size, minimum outside temperature, minimum temperature required inside, amount of wind, quality or tightness of construction, nearness to heated buildings, height of sidewalls, etc. For most construction, each square foot of exterior surface loses 1.2 Btu of heat per hour for each degree (F) of temperature difference between outside and inside conditions. The following tables may be used as guides to size heating systems for free-standing gable roof greenhouses.

Heater Sizes Single layer covered greenhouses

Floor Dimensions, ft x ft	Uninsulated Wall Height, ft	Surface Area, sq ft	Temperature Difference, °F				
			30°	40°	50°	60°	80°
Heater Capacity, Btu/hr ^a							
6x 8	5.5	242	8,700	11,600	14,500	17,400	23,200
8x10	6.0	338	12,200	16,200	20,300	24,300	32,500
10x12	6.5	452	16,300	21,700	27,100	32,600	43,400
12x16	6.5	615	22,100	29,500	36,900	44,300	59,000

^a To convert to kilowatts, divide heater capacities by 3400

Heater Sizes Double layer covered greenhouses

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6x 8	5.5	242	5,800	7,700	9,700	11,600	15,500
8x10	6.0	338	8,100	10,800	13,500	16,200	21,700
10x12	6.5	452	10,900	14,500	18,100	21,700	28,900
12x16	6.5	615	14,700	19,700	24,600	29,500	39,300

^a To convert to kilowatts, divide heater capacities by 3400

Ventilation and/or cooling is needed to provide fresh air to plants and to regulate temperature. In winter, air movement is needed to reduce excess humidity, condensation and dripping of moisture from the roof. Either fans or vents can be used.

- **Ridge Vents** at top or roof of greenhouse combined with side vents give the most effective natural ventilation. For small greenhouses, a 1- to 2-foot wide vent is adequate. In larger greenhouses, a ridge vent 1/8 the width of the house should be used. Side vents should be used in houses over 15 feet long to allow enough air to enter on hot days. Small ridge vents, open doors or end vents provide adequate ventilation for small houses. Ridge vents should be opened slightly in cold weather to allow some moisture-laden air to escape. Without ventilation, humidity becomes too high and condensation, drip and disease become problems.

- **Circulating Fans** are often used to circulate air within the greenhouse to eliminate stagnant air pockets caused by a poorly-designed heating and ventilating system. In small greenhouses or those with good heating/ventilation systems, they are unnecessary.

- **Cooling Fans** provide positive air control when greenhouse is used in summer. Fans will ventilate even on

calm, hot summer days and are easier to control automatically than vents. Fans exhaust air from house and during warm weather should provide one air change every minute.

- **Evaporative Cooling Units** using wetted aspen-fiber pads can be placed at one end and fans at the other to provide cooling. As air is drawn through the wet pad it is cooled by evaporation—as much as 30°F on hot, dry days. Packaged evaporative cooler units are available for small greenhouses. The unit can be mounted to blow cool air into the house at one end with opposite end door opened to exhaust air. Coolers should change air once per minute.

- **Shading**, besides reducing light, reduces heat load in greenhouses. Shading compounds are available to spray or paint on greenhouse coverings and aluminum, fiberglass, plastic or wooden screens and panels are available. Partial shading does not normally reduce summer light enough to reduce growth, but does reduce heat load.

- **Humidification** is often needed on hot days to prevent dehydration of plants. Some tropical foliage plants and orchids grow best in high humidities. The least expensive way to increase humidity is to frequently water the gravel under benches and in walkways. Water nozzles that periodically spray a fine mist are also very effective humidifiers. The nozzles can be automated with a timer and electric valve. A time cycle of 1 minute on and 5 to 10 minutes off is common. Commercial greenhouse humidifier units can also be used.

Automation of watering, heating, cooling, fertilizing and humidifying are all feasible and practical. Only the budget limits how many chores are automated. Some people prefer to control all operations themselves. However, some jobs are better handled by automatic controls. All automation is nice to have but heating and ventilation should be automated first, using appropriate thermostat controls.

Information on local greenhouse structural requirements, heating, cooling, ventilating, lighting and plant culture should be obtained by contacting your local cooperative extension service office or your state's land grant university. Additional literature is available from numerous sources. Some are listed below.

Greenhouse Reference Publications

Building Hobby Greenhouses—PNW 171, February 1978, 12 pages, free from Extension Services in Idaho, Oregon and Washington.

Building Hobby Greenhouses—Ag Info Bul No 357, USDA, January 1975, 20 pages, from local Extension Services or 35 cents per copy (minimum charge of \$1.00) from Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402.

Small Plastic Greenhouses—Leaflet 2387, August 1975, 16 pages, from Division of Agricultural Sciences, University of California, Davis, CA 95616.

Hobby Greenhouses and Other Gardening Structures—NE77, October 1976, 68 pages, \$2.00, and **Energy Conservation & Solar Heating for Greenhouses**—NRAES 3, 1978, 48 pages, \$1.50 from NRAES, Riley-Robb, Cornell University, Ithaca, NY 14853.

Greenhouses in Alaska—Ext. Pub. No. 51, May 1977, 46 pages, from Cooperative Extension Service, University of Alaska, Fairbanks, AK 99701.

Electric Gardening—1971, 56 pages, 60¢ from Food & Energy Council, 909 University Avenue, Columbia, MO 65201.