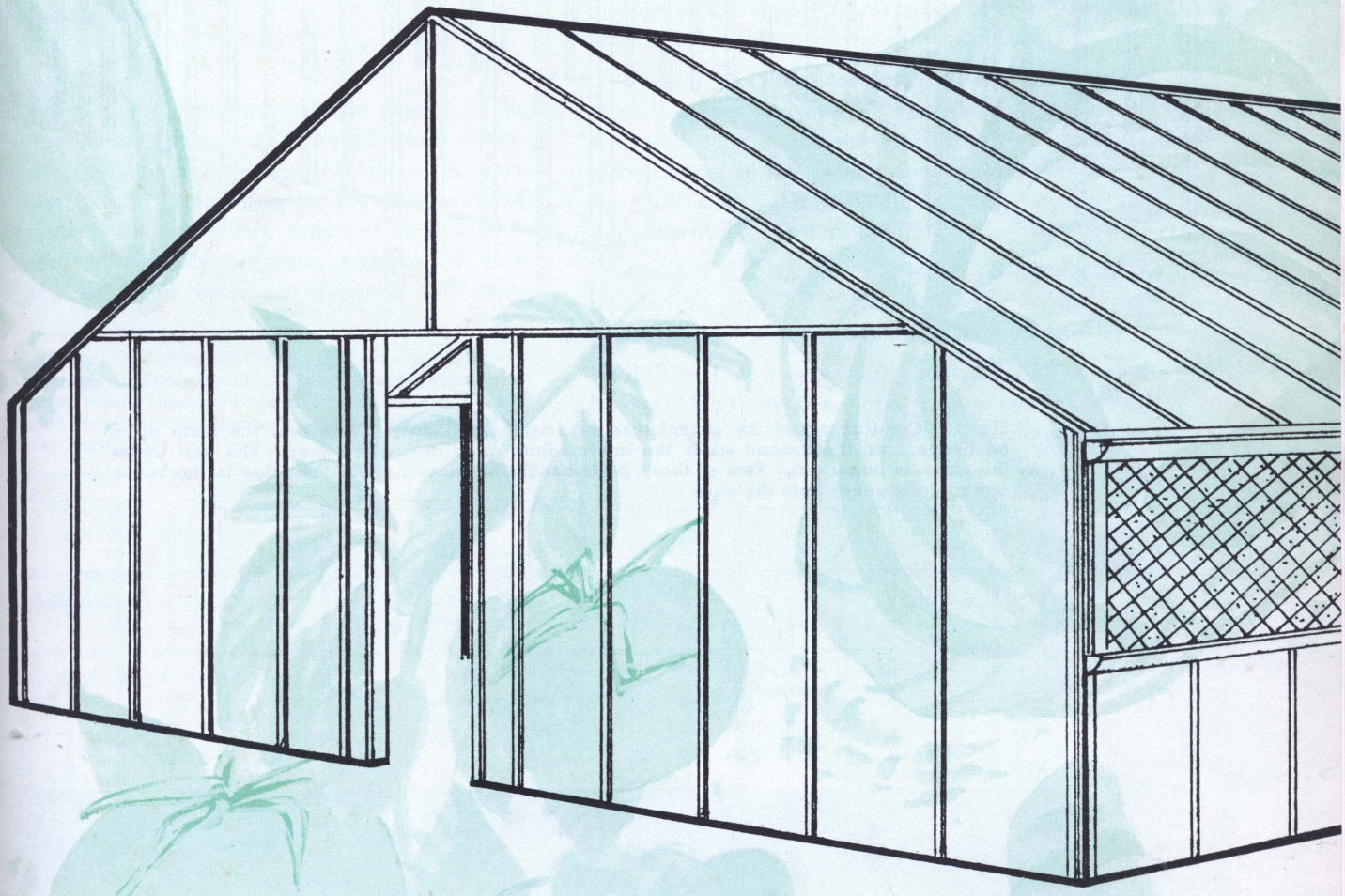
MP-341

Plastic Greenhouses for Growing Vegetables



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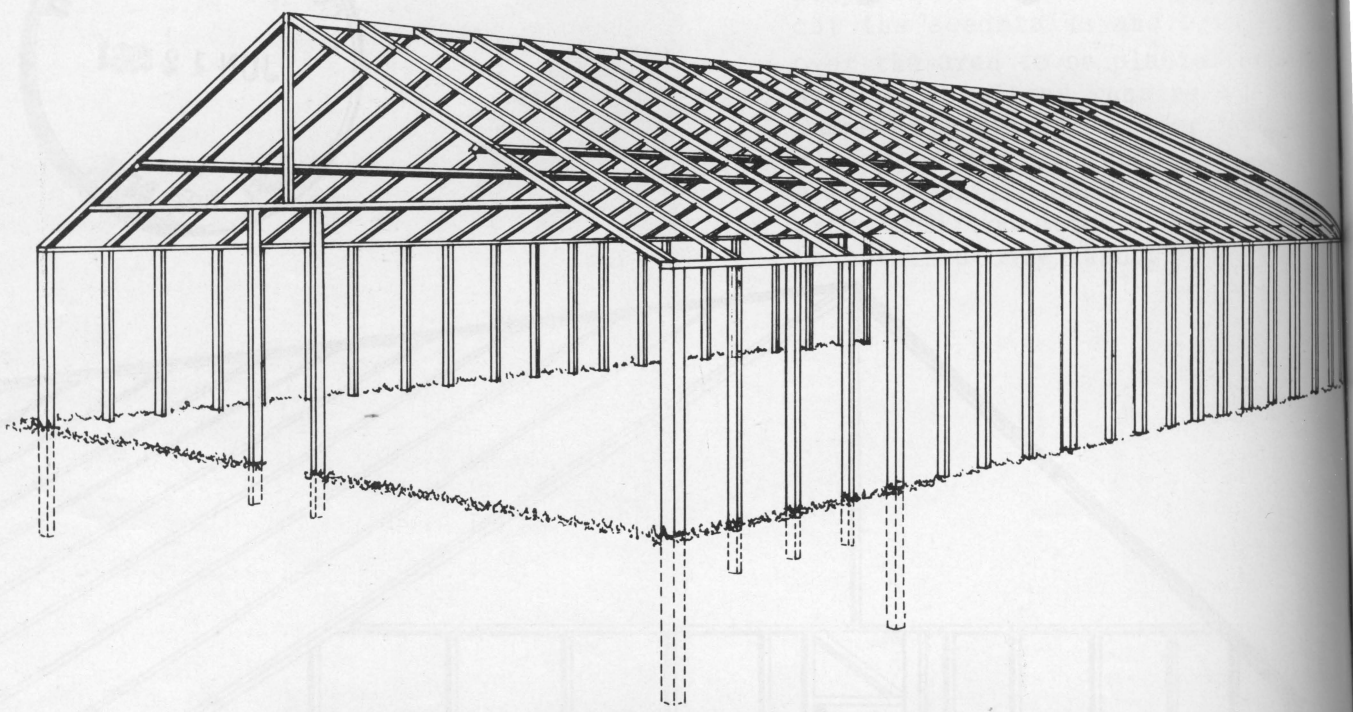

Fig. 1. The framing of the greenhouse is simple and sturdy. Note how the main posts go deeper into the ground while the intermediate posts are not so deep. The post under the ridge is important. Two of these posts should be placed under the ridge in the house at equal distances from the ends.

Plastic Greenhouses For Growing Vegetables

D. R. PATERSON, A. L. HARRISON, W. S. ALLEN AND C. C. SINGLETARY*

THE USE OF PLASTIC as a substitute for glass in greenhouse construction has caught the interest of farmers, particularly the smaller, intensive operators, who grow vegetable transplants and produce tomatoes out of season. With the relative low-cost plastic structure, the season of growing vegetables can be extended into the winter months. The price level and demand for out-of-season vegetables generally is good.

This publication presents ideas in the construction, heating and cooling of plastic greenhouses, based on recent research.

Construction

Size

The size of the greenhouse should depend on its use and ease of management. Several years of experimental tests in Texas show that it is necessary to air-cool plastic greenhouses for top production of good plants. Use of exhaust fans and cooling pads has worked successfully and many greenhouses, both glass and plastic, in Texas are air-cooled with some variation of the system shown in Figure 6. A plastic greenhouse cannot be cooled sufficiently with ventilators during bright sunny days in the winter and early spring.

The greenhouses described in this publication will be in units of 1,000 square feet since standard-size fans can be fitted easily to this size unit. Since wide greenhouses are preferred, a width of 25 feet and a length of 40 feet, is suggested for each unit.

Frame

The frame is a simple wood structure composed of posts, plates, rafters, ridgepole and ends with door entrances. The frame structure requires strengthening by middle supports, guy wires or 1″x4″ diagonal braces and rafter purlines and cross braces.

Posts: 4″x4″ posts are placed 3 feet in the ground at each corner and every 8 feet along the side, with a smooth edge to the outside. The 2″x2″ posts are placed 1 foot in the ground and every 2 feet between the 4″x4″ studs. Posts should be preservative-treated to reduce decay and termite injury.

Plates: A 2″x4″ plate is nailed to the top of the foundation posts. The plates should be level and at a height of about 5 feet above ground level.

Rafters: The rafters are shown as 2″x2″ lumber; however, 2″x4″ lumber makes a more substantial rafter. A spacing between rafters is generally 2 feet

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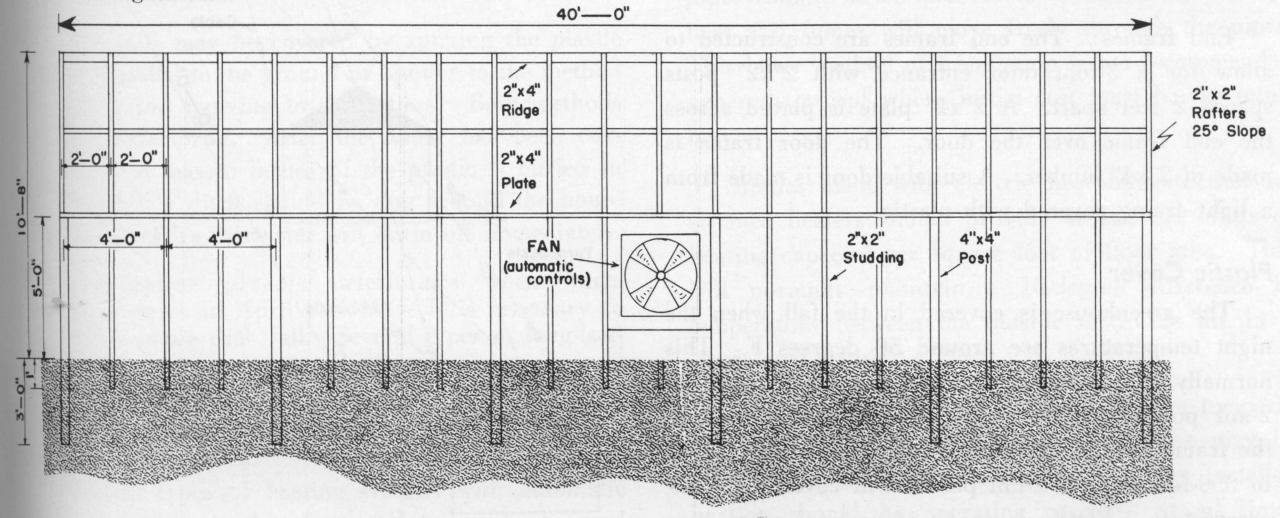
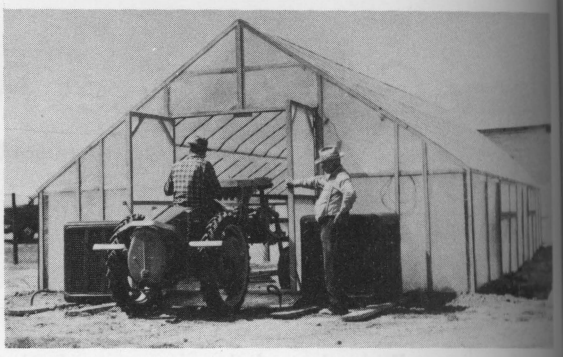


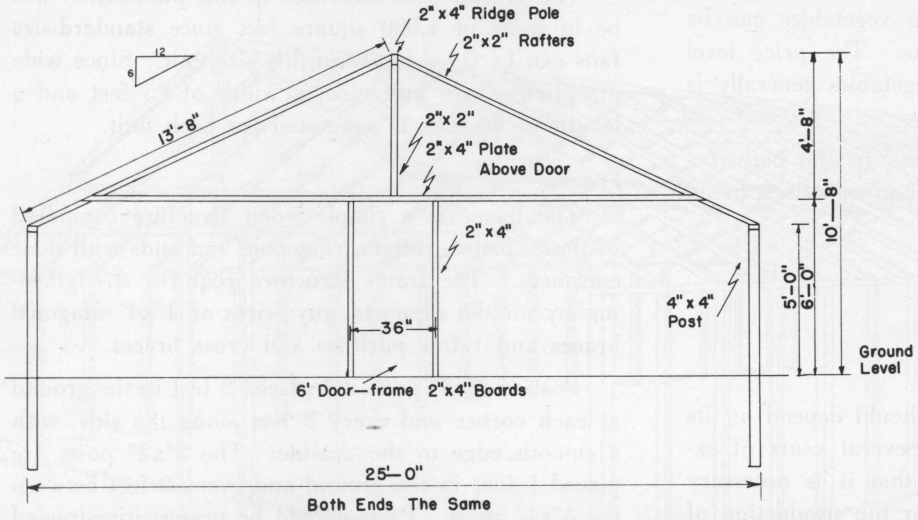
Fig. 2. A side view showing the framing and fan installation. A satisfactory method of cooling is essential to successful production during hot weather.

when using plastic 52 inches wide. A narrower spacing may be required for plastic only 50 inches wide.

Ridgepole supports: These supports keep the ridgepole from becoming weak. These supports should be made so that they can be removed when the soil is being prepared for planting. Two ridgepole supports, equal distance apart from either end are required in a 40-foot house. (See Figure 3.)

Guy wires or diagonal braces: These wires or braces give increased strength and rigidity to the house frame. The diagonal braces may be made from 1"x4" lumber, television guy line or No. 11 wire. Turn buckles are needed to keep the guy wires tight. (See Figure 4.)





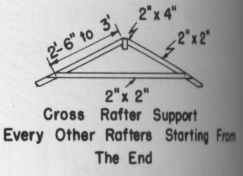


Fig. 3. The cross section showing framing and bracing details. Have large doors in one end to move heavy equipment and supplies in and out of the house. Two ridgepole supports, equal distance apart from either end are required on a 40-foot house.
The large doors are shown in the photograph above.

End frames: The end frames are constructed to allow for a 3-foot door entrance with 2"x2" posts spaced 2 feet apart. A 2"x4" plate is placed across the end frame over the door. The door frame is made of 2"x4" lumber. A suitable door is made from a light frame covered with plastic.

Plastic Cover

The greenhouse is covered in the fall when the night temperatures are around 50 degrees F. This normally is about mid-October. A single layer of 2-mil polyethylene plastic, nailed to the outside of the frame, is used for most Texas conditions. A 500 to 550-foot roll of 2-mil plastic will cover a 25'x40' greenhouse. Plastic is more economical when purchased in large rolls.

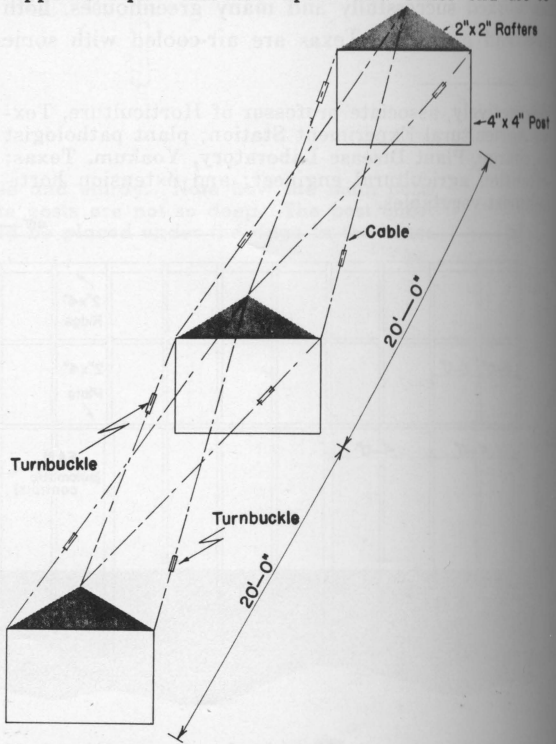


Fig. 4. A diagram of the turnbuckle and cables used to brace the framework of the house.

The frame of the house is covered by stretching the plastic from the plate on one side over the rafters to the plate on the other side. When the ground is uneven and the foundation studs on either side are not the same height, the plastic often is stretched from the ground on one side over the rafters to the ground on the other side. A width of plastic which will reach across three rafters and allow for lapping over them should be purchased. When the width of plastic is 54 inches, the spacing of rafters may be 24 inches with a spacing of 22 inches between rafters for 50-inch wide plastic. The plastic should be rolled into lengths to reach over the house for easy covering.

The plastic is nailed to the rafters with lath or screen moldings. The lath is placed over the plastic and nailed to the outside rafter with small galvanized nails. The other edge of the plastic is pulled over the third rafter and tacked to the inside with large-headed nails. A second sheet of plastic is lapped to the third rafter over the first sheet and nailed into place. The lap should be great enough so that the plastic may be folded back over the lath and cleated to the rafter by an additional lath. This prevents the wind from getting under the laps at the rafters. Continue this procedure from rafter to rafter until the entire top is covered.

Cover the sides by running the plastic parallel to the plates and ground. The side cover should be placed about 6 inches in the soil to prevent ground water from entering the house and to provide for additional insulation. Two widths of plastic, either 50 or 54 inches wide are required where the height of the studs are 5 feet or more. These widths should be lapped at least 6 inches and nailed into place at each stud with lath.

The ends may be covered by running the plastic widths parallel to the ground or similar to the method described for applying to the rafters. Both methods work satisfactorily. After the house has been covered and at least 6 inches of the plastic is buried in the ground, a ditch should be dug around the house so that excessive rainwater will drain off immediately.

Polyethylene plastic deteriorates when warm weather begins in April and May. It is necessary to cover the house each fall. Several types of long-lasting plastics are being tested.

Heating

Several types of heating systems with automatic controls which circulate heat uniformly may be used in plastic greenhouses. Electric resistance heaters, LP or natural gas heaters and steam or hot water heat can be used. Steam or hot water boilers and heating systems normally are not used in these low-cost plastic structures because of the high installation costs.

A gas heating unit for a 25'x40' plastic house should have an output of at least 60,000 B.t.u.'s. One system tested by the Texas Agricultural Experiment Station is a propane or propane-butane heater with automatic controls, an automatic fan blower and at least 200 feet of 6-inch radiation pipe. (See Figure 5.)

The heater is placed in a corner at one end of the house. The blower is attached to the heater. The pipe, connected to the blower, extends along the studs around the house. It is necessary to run the pipe around the house twice in a 25'x40' house so that the heat is radiated before the fumes are exhausted to the outside. *Any system that produces toxic gases should be installed so as to discharge these toxic combustion fumes outside of the house, since they can injure plants.* There should be no leaks where joints of pipe are fastened together. Your county agent can provide the names and addresses of manufacturers of the heating systems.

A simple but less effective heating system can be provided by using the heater without the blower, allowing the heat to radiate through 3-inch galvanized pipe by gravity. The heater may be placed in the middle of the house with 3-inch pipes running to the ends in opposite directions. These pipes extend to the outside to exhaust combustion fumes. The pipes should be elevated from the stove so that the heat and fumes will move freely through the pipes. This latter method of installation is not recommended generally except where initial cost must be the minimum.

Studies made with electric heat indicate that resistance heaters should provide at least 10 watts of heating capacity per square foot of floor area. This will normally maintain a 10-degree difference in temperature between the outside or inside air in a single wall house.

On still, clear, cold nights in Texas the temperature inside a non-heated plastic greenhouse may be lower than the outside temperature. Any installed heating should be operating properly at all times during the winter to avoid damage to plants.

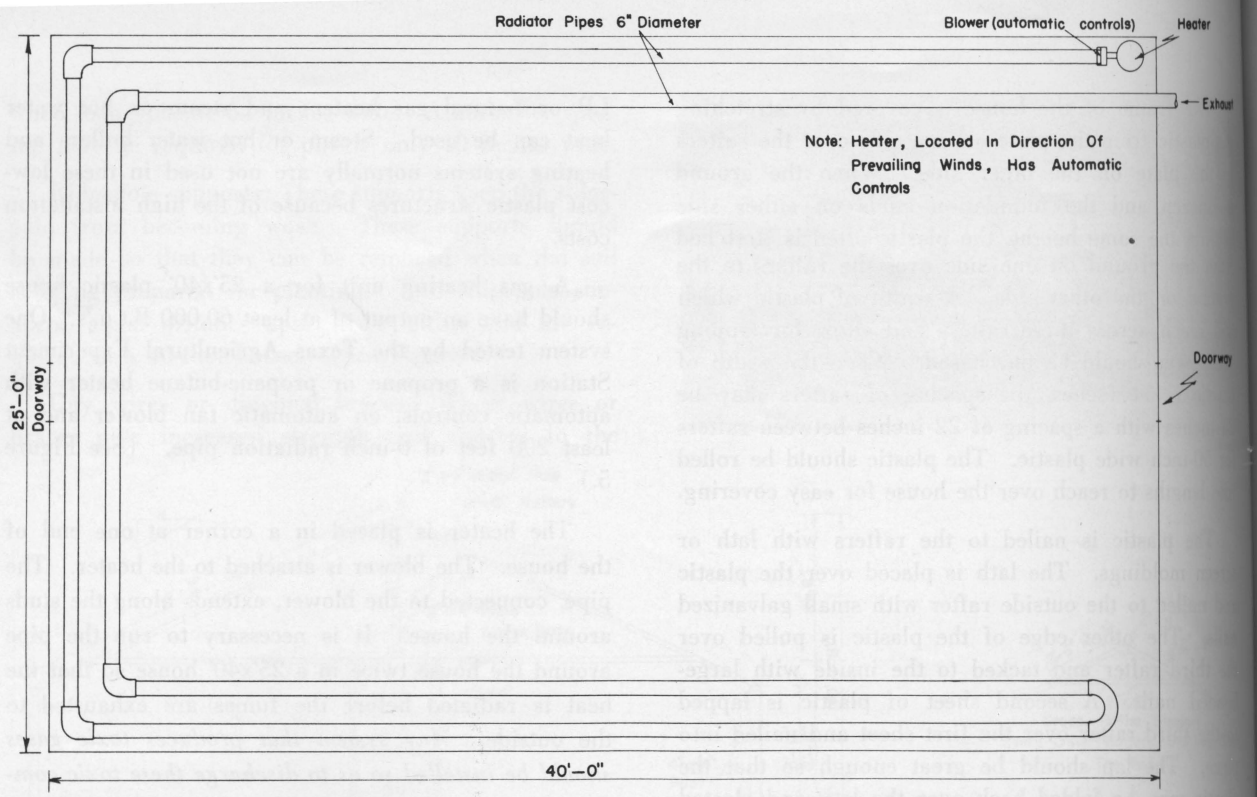


Fig. 5. A typical heating layout showing the closed air ducts. Fumes should be exhausted and not allowed to become a part of the air in the greenhouse.

Cooling

Cooling is necessary for good production of vegetable plants and tomatoes in plastic greenhouses. The method described in MP-163, "Greenhouse Cooling," available from your county agent or the Agricultural Information Office, College Station, should be followed in constructing the cooling system. Your county agent can advise where the exhaust fan, cooling pad and recirculating pump may be purchased. (See Figure 6.)

Diagrams show the placement of fan· cooling pad and pump in the greenhouse. They also show how the inside of the pad may be covered with plastic strips to prevent cold air from entering the house when the fan is not running, and how the cover will open to let in air when the fan is exhausting. These flaps prevent loss of heat during cold days and nights. The exhaust fan and recirculating pump should operate together on the same control.

Approximately 7 c.f.m. of air should be exhausted for each square foot of floor area. Normally, a 30-inch fan, capable of delivering 7000 c.f.m at .1-inch of static pressure of water will handle the 25'x40' unit described in this publication. Should variations in size be more desirable for your installation, consult your county agent, power supplier or an engineer concerning the size and specifications of fans needed to cool the house.

The padding (of aspen wood, excelsior or similar material) is installed, where possible, on the side or end of the house opposite the prevailing wind. The fans can be located on either the side wall or gable end, but usually are easier to install on the side wall of plastic greenhouses. All ventilation including the doors should be closed during operations. The amount of air to be exhausted is expressed in cubic feet per minute. Approximately 7 cubic feet of air per minute should be exhausted for each square foot of floor space.

Fans are normally rated by the amount of air they will move against certain static pressures (measured in inches of water). A 30 inch diameter fan capable of delivering 7000 c.f.m. at .1-inch of static pressure will handle the 25'x40' greenhouse unit described in this publication.

The air should move through the pad at a velocity of 150 feet per minute to provide a sufficient amount of pad area for effective cooling. One square foot of pad area should be provided for each 150 c.f.m. The amount of pad area for this house would be 7000 c.f.m. $\div$ 150 $=$ 47 sq. ft. For even distribution of of this air, the pad area should be continuous along the entire side of the house.

Should variations in size be required for your installation, consult your county agent, power supplier or an engineer concerning the size and specifications of fans needed to cool the house.

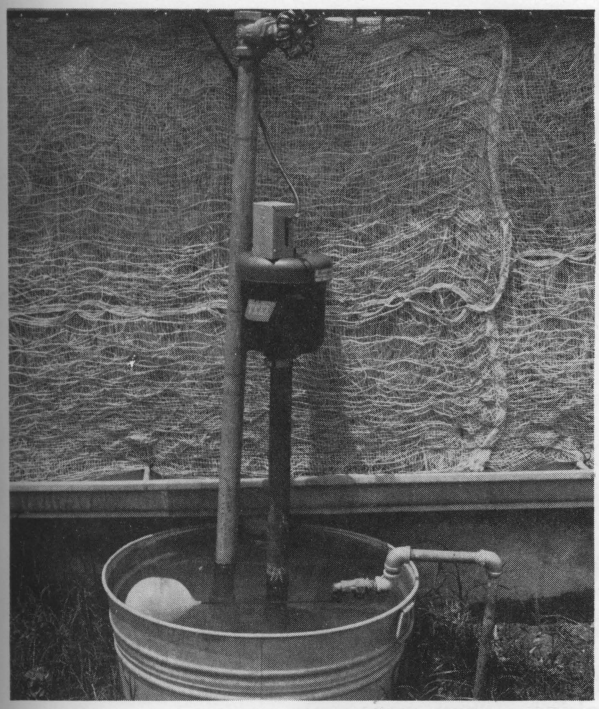
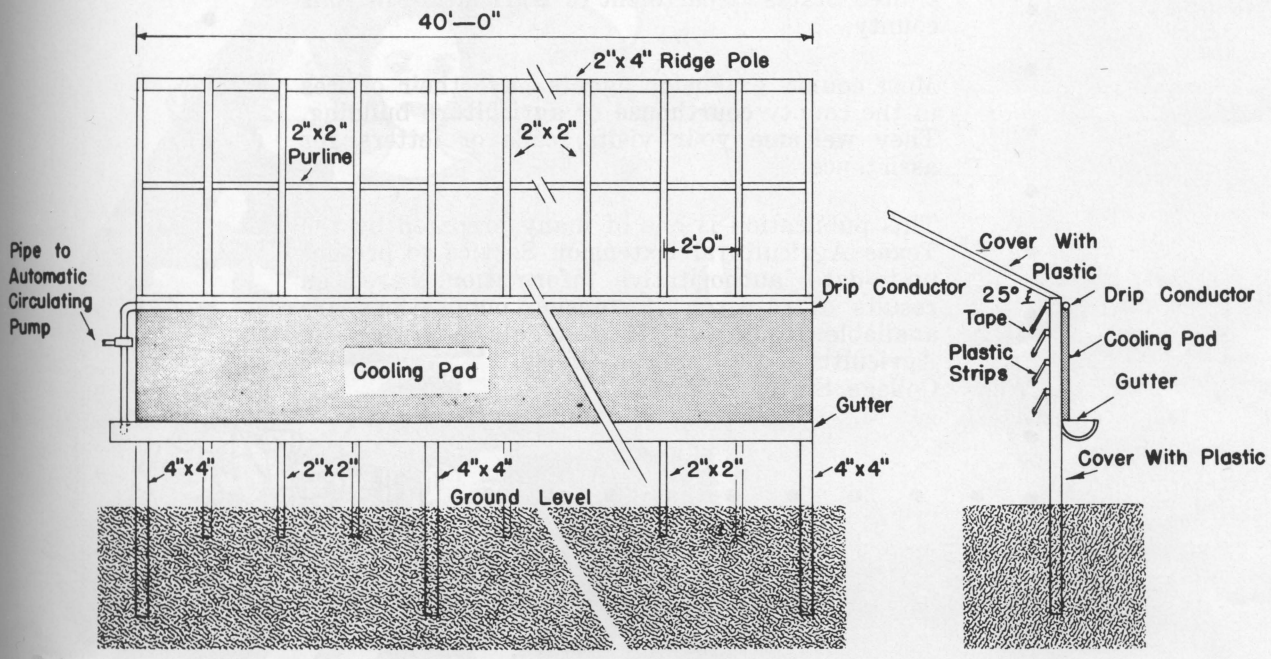


Fig. 6. A diagram showing the installation of the cooling pad. Note the gutter collector to reduce waste water problems. The plastic strips allow air to enter when the fans are operating, yet close when the house requires no cooling system. Note the purline supports across the rafters.

The photograph shows a typical pump installation for supplying water to the pad used for cooling the house during bright, sunny days.



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