STRUCTURES USED IN AUSTRALIA FOR PLANT PROPAGATION

IAN GORDON

Queensland Agricultural College
Lawes, Queensland, 4343
Australia

INTRODUCTION

The size and climatic diversity of Australia are frequently misunderstood. A comparison of size shows that Australia has a land mass of 2.9 million square miles and the continental United States has 3 million square miles. The two countries are comparable in size.

A study of the latitudes of the major cities of Australia will help to understand the climatic diversity. A comparison with northern hemisphere cities on similar latitudes is given in Table 1.

Table 1. A comparison of latitudes of southern and northern hemisphere cities.

Latitude	Temperature	Southern Hemisphere	Northern Hemisphere
12°	(24–32°C)	Darwin, Northern Territory	Grenada
17°	(20–29°C)	Cairns, Queensland	Kingston, Jamaica
23°	(18–29°C)	Rockhampton, Queensland	Havana, Cuba
27°	(16–26°C)	Brisbane, Queensland	Tampa, Florida
32°	(13–23°C)	Perth, Western Australia	Savannah, Georgia
34°	(14–22°C)	Sydney, N.S.W.	Atlanta, Georgia
37°	(10–20°C)	Melbourne, Victoria	Norfolk, Virginia
43°	(8–17°C)	Hobart, Tasmamia	Detroit, Michigan

*Temperatures supplied by the Australian Bureau of Meteorology.

Most major Australian cities are located on the coasts, which means that the maritime influence has a major effect on temperatures and prevents the extremes experienced inland.

The subtropical areas of Queensland and Northern New South Wales are the major production centers of foliage plants in Australia. Frost incidence is not a serious production problem, although some winter heating is necessary. Rainfall occurs primarily in summer. Light intensity is not a limiting factor to winter growth.

Southern New South Wales, Victoria, and South Australia are the major centers for temperate plant production. The area has relatively hot, dry summers and cool, wet winters. The low winter angle of elevation of the sun is a limiting factor to growth in southern areas in winter.

The area around Perth in Western Australia has a very well-developed nursery industry, producing most types of stock. However, the small domestic population of Western Australia and its isolation create natural restrictions on the growth of the industry in that state.

By U.S. nursery standards the average Australian nursery is small and relatively unsophisticated. Capital investment is usually rather small and the range of production facilities is often a limiting factor in production.

TREMENDOUS DIVERSITY OF CLIMATE

Design of greenhouse structures. The history of greenhouse design in Australia parallels design styles of Britain and Holland. Glasshouses have been constructed using design styles that have evolved for cold winter climates with low winter light intensity. This is not the ideal design for Australia so in the last 10 years a number of different design styles more appropriate to the climate have been introduced. This has led to the establishment of a thriving local greenhouse construction industry.

The major environmental factors of light, temperature, humidity, and carbon dioxide must be taken into consideration in the design of a greenhouse.

Light. For propagation purposes light intensity must be closely controlled. Over most of Australia the natural light intensity is more than adequate, even in the middle of winter. For cutting propagation it is usually necessary to reduce the natural light intensity, either by shading or by the use of light-reducing greenhouse covers.

Horticultural glass is rarely used as a greenhouse covering material. The cost of conventional glasshouses is now so high that few nurserymen will consider their construction. Rigid plastic covering materials have been widely used. These rigid materials fall into two groups: 1) fiberglass sheeting (F.R.P.), and 2) polycarbonate structured sheets (P.C.S.S.).

Both of these products can be obtained as clear sheets or with white or tinted pigments incorporated for light reduction. In areas of high light intensity it has been common practice to select tinted sheets for propagation use. However, it appears that quality control standards within the plastics industry are very poor. Many nurseries have been supplied with rigid plastic sheeting of both types that degrade at an alarming rate.

As a result, the trend in the use of these materials is now towards clear-grade sheeting, which lasts considerably longer than tinted grades. For shading purposes shadecloth, paint-based shading, and internal screens are all commonly used. Although light intensity must be reduced, transmission through the tinted sheets may drop to 12 percent in three years, which, of course, is much too low.

The high natural light intensity has enabled greenhouse designers to change the basic shape of greenhouses. The high-pitch roof of the English glasshouse has been replaced by a much lower roof pitch in some conventional designs and by the semicircular roof profile in others.

The increasing trend towards the use of plastic film covers has enabled design changes to be made. A wide range of high and low density polyethylene film products are in use as greenhouse covers. Products such as Solarweave, Agphane 101, Infrasol 266, Thermofilm IR, and Ag-Tuff are available. In the majority of installations a single layer of film is used. However, some greenhouse manufacturers are now promoting the advantages of double-layer plastic covers in the control of the greenhouse environment so the use of double-layer polyethylene is now increasing (Figure 1). Improved film fastening techniques now make double-layer plastic covers safer to use.

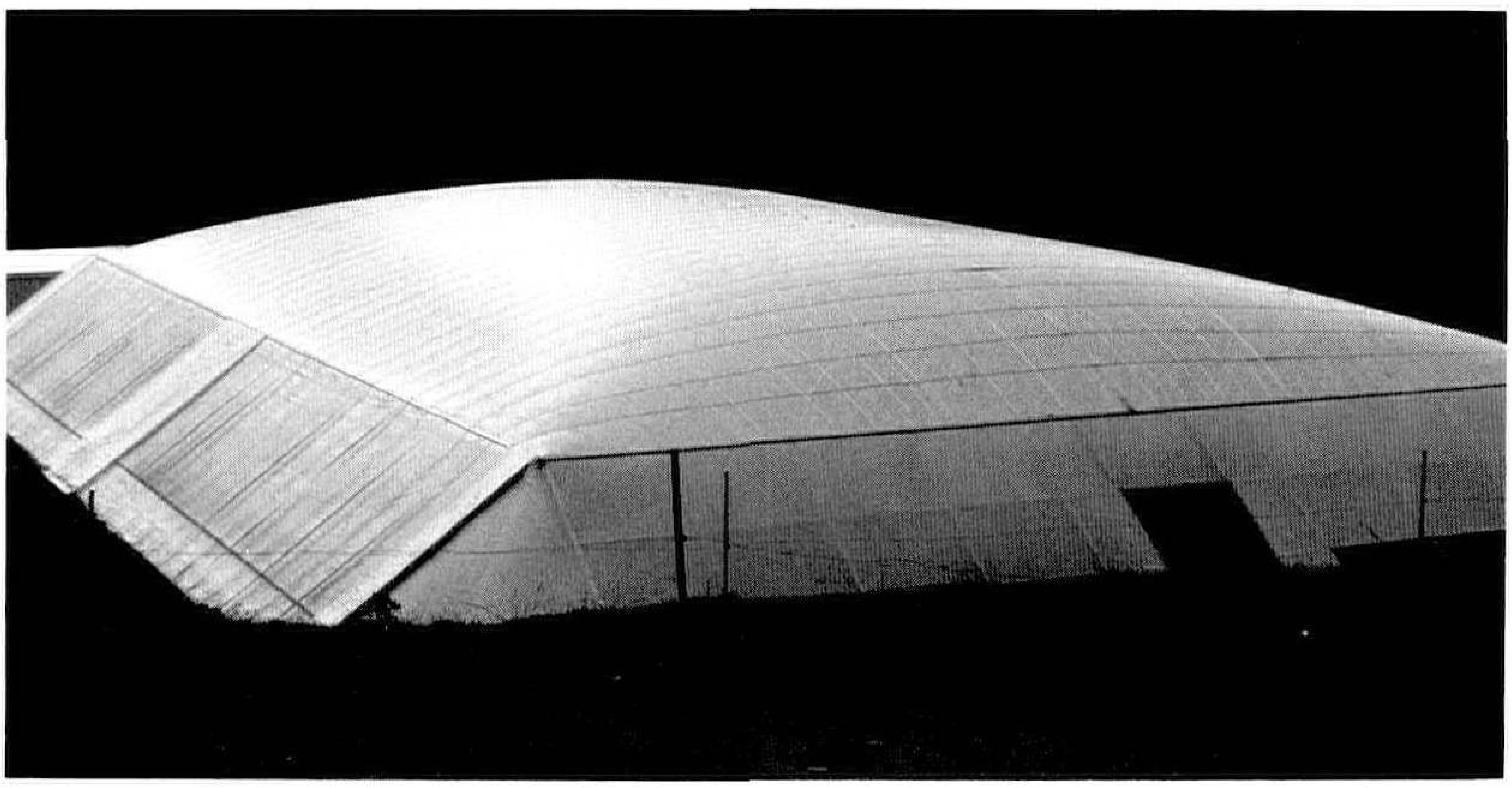

Figure 1. Inflated double-layer polyethylene covering is becoming popular in Australia.

The high ultraviolet light conditions of the Australia's East Coast cause rapid degradation of most plastic films. UV stabilized low density polyethylene film (L.D.P.E.) will only last for 18 months in the Brisbane region, whereas nurseries in Melbourne report a life expectancy of three years or more. Solarweave plastic, a toughened L.D.P.E. film has a life expectancy of four years in Brisbane.

Temperature management. Ventilation of greenhouses is an area of great importance. With single span structures it is still possible to rely on natural ventilation incorporated as part of the design. Hinged side walls that open to expose a large surface area of ventilator space and drop-down side walls are two widely used less conventional designs for natural ventilation.

In multispan structures natural ventilation alone is inadequate to cool the structures uniformly. Problems with natural ventilation

Figure 2. Roof-vented poly-covered quonset structure.

also occur in propagation structures where a high-humidity environment is maintained. In these situations a variety of fan ventilation systems are used. Double poly film is good for heat conservation but makes ventilation difficult. However, ways to ventilate through the roof are now being developed, as shown in Figure 2.

The use of perforated plastic ducts for the distribution of cool air uniformly through the greenhouse is common. The ducts may be connected directly to an inlet fan so that air at ambient outside air temperature is distributed through the greenhouse. Alternatively, the ducts may be connected to an evaporative cooling unit so that there is some actual cooling of the outside air prior to circulation. A large percentage of the nursery industry is located on the narrow coastal strip of eastern Australia. This region has a high summer relative humidity, which makes evaporative cooling of dubious value.

A further advantage of the use of plastic ducts is that they can be used for heating purposes in winter if required. Few nurseries north of Brisbane have the need to provide winter heating, but from Brisbane south there is a need for some winter heat. However, the actual heat requirement may be quite low and the duration of heating may only be for three months of the year.

The traditional practice of space heating is now losing favor so greater use is being made of root-zone warming, as shown in Figures 3 and 4. Both floor and bench-incorporated heating systems are

Figure 3. Bottom heat in the floor.

Figure 4. Heat lines are laid in a sand bed then covered with matting.

widely used. Mineral-insulated copper core cables (M.I.C.C.) are commonly used in both floor and bench systems. However, in the last few years warm-water heating systems have become popular.

Work carried out by Brian Hese of the South-East Queensland Electricity Board indicates that in a floor heating system with warm water circulated through 16mm polyethylene pipe, the water temperature need only be 40 to 50°C to maintain a pot-media temperature of 18°C, assuming an outside temperature of 7°C. This provides the opportunity for innovative approaches to reduce heating costs.

The use of Night Rate (Off-Peak) Tariff electric power for greenhouse heating is now widespread. This provides the ability to heat the greenhouse between 2300 and 0700 hours, the period when most heating is required. If heating is needed at other times, it will be necessary to install an insulated hot-water storage tank.

In the design of a greenhouse heating system it is important that excessive heat loss through the structure be avoided to minimize heating costs. Many Australian nurserymen have installed internal thermal screens as an additional measure to minimize heat input. Double-layer plastic film covers also play a major part in reducing heating costs. Work carried out by the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) at Griffith, New South Wales, indicates a 40% savings in energy costs with a double-layer plastic cover. In the Darwin area a shade house gives enough protection for foliage plants.

Other factors considered important in the minimization of heating requirements are:

1. Redesign of greenhouses to reduce the surface area of the structure.

2. Provision of windbreaks.

3. Correct placement and calibration of temperature-sensing equipment.

4. Development of new covering materials with improved thermal performance.

Solar heating. The natural climate of most of Australia lends itself to the development of greenhouse solar heating systems. The high winter sunshine hours provide the opportunity for large-scale solar heating designs.

Two approaches to solar heating are in use in Australia. The C.S.I.R.O. Low Energy Greenhouse Project involved the adaptation of a greenhouse to enable daytime solar heat gains to be collected and stored in an adjacent rockpile. When heating of the greenhouse is required, the collection cycle is reversed; and warm air from the rockpile is returned to the greenhouse. The rockpile is stored in a tall insulated chamber constructed on the end of the greenhouse structure (Figure 5, above).

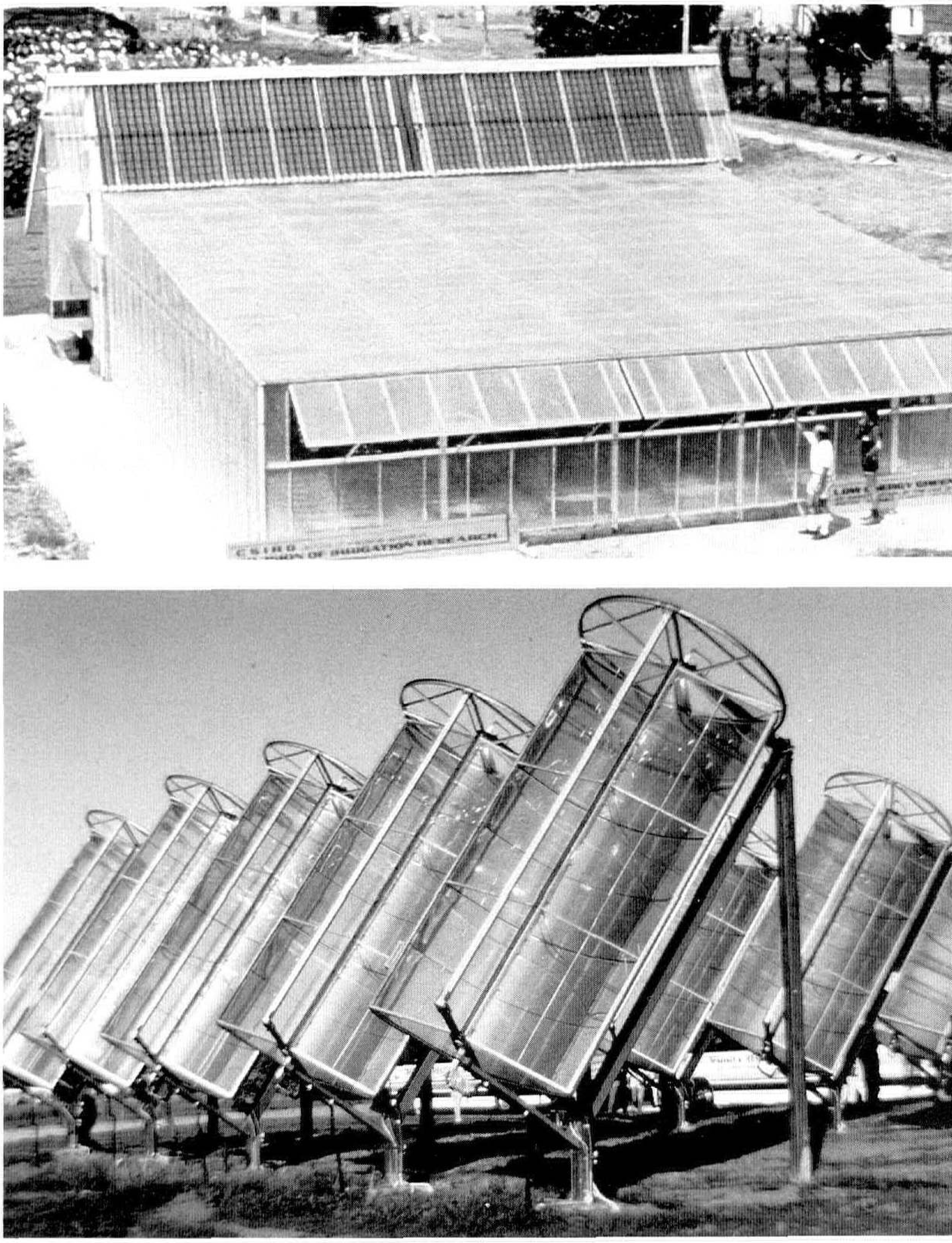

Figure 5. Examples of solar collectors currently being tried.

The ability for the greenhouse to collect sufficient energy to supply all heating requirements depends on the solar radiation levels outside the greenhouse. In southern areas of Australia, prolonged spells of cloudy weather can seriously reduce the efficiency of the system.

The C.S.I.R.O. has developed a solar air heating system that can be used to supplement the energy collected from within the greenhouse. This is a form of flat plate solar collector with a black painted metal absorber plate. This absorber plate is heated by absorption of the solar radiation. A layer of circulating air is passed through the collector, and this air absorbs heat from the absorber plate. The heat is stored in the greenhouse rockpile.

The second system of solar heating is the use of solar hot water heating. This concept of solar heating requires the installation of a large insulated hot water tank and the installation of a series of solar collectors with a sufficiently large surface area to heat the water to a suitable temperature (Figure 5, below).

The use of bench and underfloor heating systems utilizing water at temperatures between 40 and 50°C for circulation are tailor-made for solar hot-water heating, since even in the middle of winter it is possible to heat water to these required temperatures by solar means.

A number of large-scale experimental solar hot-water heating systems are in use, and to date their performance has been satisfactory. The major concern with all solar heating systems is the very high capital costs. This problem must be addressed by a search for lower-cost construction materials and techniques if solar heating is to become widespread in the nursery industry.

A NEW CONCEPT IN GREENHOUSE DESIGN

CARL E. WHITCOMB

Lacebark Research Farms
Route 5, Box 174
Stillwater, Oklahoma 74074

Classical greenhouse design consisted of vertical sides and sloping roof much like frame homes and other utility buildings, only covered with glass. Glass provided good light transmission but had many air leaks. With the development of fiberglass, many glass greenhouses were converted following hail or wind damage, but greenhouse design changed very little. In the 1960s double polyethylene film plastics with air blown between the layers provided the emphasis for change. The natural curvature of a quonset structure allowed the polyfilms to be used with a minimum of corners or edges where tearing could easily occur.

Both the classical and the quonset designs had a maximum exposure of the glass or plastic covering to the elements. As a result of the very low insulating values, heat loss was tremendous. Conventional design generally had the advantage of roof and side vents to provide natural convection cooling. On the other hand, double polyfilm quonset-style greenhouses could be very tight in terms of air infiltration and air loss but were difficult to ventilate and cool. Low-cost electricity and improved exhaust fans