The use of greenhouse benches has several advantages over planting directly in the greenhouse soil or setting pots in the soil: 1) plants are at a more convenient height to work comfortably; 2) benches permit a more effective display of plants; 3) benches provide improved air circulation and environmental control around the plants; and 4) benches permit better disease and growth control.

Greenhouse benches elevate plants and flowers closer to eye level where they can be better observed and tended without the inconvenience of stooping or bending. This is especially important for many flower crops where plant height is not too great.

Air circulation is very important for good plant growth. Though plants might dry more rapidly when grown on benches than when placed on or in the ground, this is often an advantage due to the better control over watering which it permits. With control over watering, fertilizers can be properly applied with regard to both time and amount. Increased air circulation also helps to minimize root and foliar diseases since it causes the plant surfaces to dry more rapidly after watering instead of allowing moist areas where spores can germinate. Also due to air circulation under benches and around pots, the roots of plants on benches are warmer than the roots of those in the cooler soil of ground beds, resulting in a greater growth for the benched plants.

Plants grown in pots placed on the floor of a greenhouse also have a tendency to root through into the greenhouse floor soil unless a barrier is provided. And problems with diseases and insect pests are greater with such culture than when using benches.

Bench Size

Greenhouse benches should be customized for the individual operation. The best size depends on several factors, such as the height and reach of persons working around the benches, the type of plants grown on the benches, and aisle access to one or both sides of the benches. A tall person with correspondingly long reach could comfortably work with higher and wider benches than a short person. In commercial or other houses where several people are to be working with the plants, the benches should obviously be of a height and width suitable to an "average-sized" worker. This means, approximately, a 32- to 36-inch bench height.

As for width, benches generally should be 42- to 48 inches wide if they are to be worked from both sides, and 30- to 36-inches if they are accessible only from one side. Many establishments use benches wider than this, but difficulty may be encountered when plants are handled frequently.

Some exceptions do occur. For example, tall flowering plants should be grown in lower bench-beds so the stems and flowers will not be out of the reach of workers. Also, temporary benches for growing, bedding, or other small potted plants could be lower and wider where once-on and once-off handling is practiced. For example, temporary benches as wide as 5- to 6-feet and only 18- to 24-inches high are used successfully for bedding plants.

In instances where shade plants are to grow under the benches, bench heights as high as 48 inches have been used. With these
high benches, however, some difficulty in inspecting and handling plants on the bench is encountered and therefore such height should normally be avoided.

**Bench Arrangement**

The arrangement of benches within a greenhouse should depend on several factors, including 1) the dimensions of the house, and walkway location; 2) heating and air circulation patterns; and 3) materials handling into and out of the greenhouse.

In any arrangement, the bench-to-aisle space ratio should be considered. For efficient production houses, the aisles should be less than 1/4 to 1/3 the total house area. The types of equipment used will cause some exceptions. In houses for teaching and other educational uses, good aisle width for student movement is necessary; and, therefore, aisles could be as wide as benches, thus occupying 1/2 of the house space.

In commercial houses the standard arrangement is to run benches the length of the house, as shown in Figure 1.

This permits long continuous runs of watering lines, heating pipes, and/or plant support techniques. This arrangement often uses more floor space for aisles than shown.

Normally, benches should not be placed directly against exterior walls, since this interferes with maintenance of the house. Also, such benches will likely be cooler than benches elsewhere in the house and uneven plant growth will occur. Allowing a sidewall space of 6 to 12 inches permits better air circulation around and under the benches.

In hobby houses, where a great number of different plants having different temperature requirements are grown, the cooler outside bench may be utilized to obtain a desirable difference in environmental conditions for particular plants.

The "peninsular" type bench arrangement shown in Figure 2 gives the greatest amount of bench area per unit of aisle space and yet permits convenient access to all areas. In this arrangement there is a single, wide center aisle with narrow aisles branching from it. The center aisle is made

**NOTE:** BENCHES SHOULD BE PLACED AWAY FROM WALLS 6-12 INCHES FOR BETTER AIR CIRCULATION.
wide enough for all greenhouse equipment, while the side aisles are only wide enough to permit a person to enter. The center aisles would normally be 3 to 4 feet wide and the side aisles only 1 1/2 feet wide. With this arrangement it is allowable to have a considerable amount of bench area adjacent to the outside walls of the house. Where it is desired to have better air circulation, the benches would have to be moved in 6-12 inches from the walls to permit free movement of air between the walls and the benches as described above.

### Bench Design

Both the commercial and peninsular bench arrangements may be either flat or stepped. Flat benches are simply “tables” upon which plants are placed. Step benches are just what the name implies—“stair-steps.” The stepped arrangement permits a better display of plants for in-house sale and marketing. With wide or high-stepped benches, it will be necessary to work from one side. The step bench may be quite light in construction and can be built as a part of the greenhouse. It is possible with step benches to get a few more mature plants in the same bench area than with “tables.” One disadvantage of step benches is that plants on them get more light from one direction. This results in uneven plant growth unless they are rotated occasionally. Step benches can be built quite tall and, when so constructed, provide considerable area underneath for shade-cultured plants.

With stepped and flat benches, either a solid or open bottom can be provided. Slat and wire benches are two types of open benches. Open benches provide the maximum amount of air circulation among the plants. Insect and disease problems are also reduced. For example, with some wire benches it is almost impossible for slugs to travel from one pot to another. If wood is used, slat construction is generally more resistant to rotting than closed or solid-bottom construction due to better aeration and drying.

Open benches may or may not have sides. Where sides are used, they serve primarily to keep plants from being brushed off the benches. This is particularly necessary in commercial walk-in greenhouses.

Closed benches are used whenever a crop is to be planted directly in the soil contained on the bench. This system has been successfully used with a number of cut flower crops. Many growers also use flat benches containing a few inches of sand or gravel for pot plants. Since the sand or gravel provides a solid base in which the pot can be set, problems with tipping are minimized. The sides and solid bottom of such benches reduce air circulation to a large extent and thereby slow the drying of pots placed on them. Though this may be advantageous in some instances, disease organisms and insects harbored in this moist layer of gravel or sand generally are more serious than any drying problem.

Solid-bottom benches in which a layer of sand or gravel is to be placed must be strongly constructed in order to carry the weight of these materials. Closed-bottom benches with sides are not particularly suited to the step-type construction.

### Types of Bench Construction

#### Corrugated Asbestos-Cement Bench:

The major advantage of the corrugated asbestos-cement (“Transite”) bench is its excellent durability. It comes close to solid concrete in its permanence. The material is strong, though it will crack or break if abused. However, corrugated asbestos-cement will not rot or deteriorate. These benches are easily installed, with no special tools or skill required for fabrication. The material comes with corrugations every 4.2 or every 2 1/2 inches. The 2 1/2 inch material should be used when available since it is somewhat easier to work with.

For small pots it may be necessary to lay wire mesh over the corrugations before setting the pots. The wire mesh provides a reasonably flat surface upon which to set the plants yet permits good air circulation around the pots.

In some cases gravel is placed on corrugated benches to support the small pots, but this has the disadvantage of reducing air circulation and increasing the problem with disease and insects.

When sides are used, they are usually 6” to 8” high and normally made from flat cement-asbestos material. When this material is used, the sides have the same permanence as the bottoms. It is important that the sides be fastened to the bottom in such a way that a gap is left between the corrugated bottom and the sides. This gap is necessary to allow excess water to drain freely from the benches. Galvanized bolts and straps are normally used for attaching the sides. The bench is then filled with a suitable growth media, as required by the plants being grown. A gravel or coarse sand bottom layer is necessary to provide good drainage.

The major disadvantage of benches of this type is their comparatively high cost.

#### Other Corrugated Materials:

Other types of corrugated materials are sometimes used but generally do not prove as satisfactory. The corrugated plastics lack the strength of the cement-asbestos materials. Problems with deterioration of some materials are also experienced. Aluminum would have reasonably good permanence, but the normal roofing forms would be comparatively weak. If aluminum is used, one should choose the 0.024 inch thick aluminum in preference to the
more commonly available 0.019 or 0.0215 inch thick material. Galvanized steel, though available in sufficiently strong thicknesses, would be a poor choice for benches due to the rusting problem which will be encountered. The zinc-galvanized coating may also be toxic to plants in many situations.

**Flat Cement-Asbestos Board:**

Flat cement-asbestos board can also be used for constructing a bench. As with the corrugated form, the material should be 3/8" thick. Such benches do not have the strength of corrugated benches, but have the advantage that small pots will set on such benches without tipping. Flat cement asbestos board should not be used for benches which will be filled with soil.

Several different types of supporting frames can be used, as shown in Figures 3 and 4. For each type, the leg supports should be spaced four feet apart.
Wooden Benches:

Wood can be used for flat or step benches, but unless the wood is treated or is a very durable species, such benches can deteriorate rapidly and lack permanence. Some preservatives can damage the roots of plants that grow in contact with the wood. Thus, for good performance and permanence, use wood of the most decay resistant species or wood treated with water-borne, salt-type preservatives.

The most decay resistant species, in order of their decay resistance, are: a) Black Locust, b) Osage-Orange, c) Red Cedar, d) Redwood, e) White Oak, and f) Cypress. However, with the exception of the first two listed, none of the untreated wood species are as durable as preservative.
treated lumber. Also, due to the unavailability or premium costs of some species, preservative treated wood may be more economical. For greenhouse use, the treatment should be one of the commercial, water-borne, salt-type preservatives such as Chromated Copper Arsenate ("Osmose K-33", or "Green Salts"), Ammonical Copper Arsenite ("Chemonite"), or Fluoro Chrome Arsenate Phenol ("Tantalith", "Wolman Salt", or "Osmostals"). Wood properly treated with such material will last for 20-30 years or more in greenhouse use. (NOTE: Some of the above treatments are not rated for "ground contact" use.) Since fumes and vapors from wood treated with the more toxic oil-borne materials like penta or creosote can be damaging to plants, these preservatives are not recommended for greenhouse benches.

Wood treated with all of the water-borne, salt-type preservatives can be effectively painted once the wood has been redried. If possible, 6 months to 1 year weathering is recommended, since tests have indicated this period will eliminate any toxicity of these materials to plant roots. Information on preservative treatment of wood can be obtained from a separate Cooperative Extension Service publication, AEN-6, "Preservative Treatment of Greenhouse Wood." This publication is available at your local Extension office or by mail from the Bulletin Room, Experiment Station, University of Kentucky, Lexington, Ky. 40506.

Figure 5 shows a wooden bench with side boards. For flat-topped wood benches, a 1/8-inch to 1/4-inch crack...
should be left between the bottom and side boards to allow water to drain from the bench and to prevent damage to the bench if the wood swells due to moisture absorption. Cross supports should be spaced not more than 4 feet apart.

**Welded-Wire-Mesh Bench:**

Benchs of the wire-mesh type shown in Figure 6 are widely used in pot-plant culture. They give excellent air drainage and simplify insect control problems. The construction is simple. The framework can be made of 2" x 4" wood, species rot resistant or treated. Welded wire fabric is then stapled to this framework. The mesh should be one of the heavy wire types, since sagging is a problem with even the best materials. A 1" x 2" welded mesh, 12 1/2 or 14-gauge, has been used with good results. Staples should be 1 1/4- to 1 1/2-inch long. The use of galvanized wire and staples will delay the rusting problem and thus lengthen the life of the bench.

To minimize sagging, cross supports should be spaced 2 feet apart, though some sagging will eventually occur and the pots will not set evenly. However, the cost of such benches is generally low when compared to other types.

![Figure 6: Welded wire fabric bench with wooden framework and supports.](image)

**ALTERNATE CROSS BRACING METHOD**

1" x 2" x 14 GA. OR 2" x 4" x 12 1/2 GA.
GALV. WELDED WIRE FABRIC ATTACHED WITH 1" OR 1 1/4" GALV. STAPLES

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**WELDED WIRE FABRIC BENCH WITH WOODEN FRAMEWORK AND SUPPORTS**
Wood-Slat (Lathe-Fence) Bench:

When using small plants in pots and these pots in trays or flats, an economy bench top as shown in Figure 7 can be made of lathe-fencing placed on treated 2" x 4" supporting rails or pipe rails. The lathe-fence allows good air circulation around the pots. A problem would be encountered with pot tipping if small bedding-plant size pots were used alone on the fence. Wire mesh of 1" x 2" size should then be used over the slats to prevent pot tipping. Since the lathe-fencing is not generally preservative treated, the permanence of the bench top is not good in comparison to benches made completely with treated wood. The lathe fence is, however, easily replaced when deterioration requires its replacement. No practical method of providing side walls for lathe-fence benches now exists.

Figure 7: Economy lath-fence bench with pipe rail and concrete block supports for bedding plants in trays or flats.
Wooden Step Benches

Wooden step benches like the one shown in Figure 8 can be made any size, width, angle or height. The size of plants to be placed on the bench and the greenhouse size will largely dictate the specific dimensions of the bench. Slats are most commonly used and they should be treated with a wood preservative. Painting the slats will reduce toxicity problems and will also increase the light reflected below the bench. Step benches are usually built to face south so that they will receive maximum sunlight. If two-sided step benches are used, plants on the northern side will receive considerably less sun than those on the southern side. Thus, orientate the benches north-south so the morning and afternoon sun will shine on each side equally.

Step benches require more labor for construction than some of the other bench types, but this seldom is a factor in determining what type of bench to build. Shading problems, work efficiency, and space utilization should be the primary considerations. Remember, if you want to have uniform plants, pots on step benches will need to be turned occasionally when light intensity is higher on one side of the bench than the other.

Figure 8: Wooden step-bench.