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The Complete Guide to DIY GREENHOUSES

Updated 3rd Edition

Build Your Own Greenhouses, Hoophouses, Cold Frames & Greenhouse Accessories

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Featuring key updates for:
- How to choose the right greenhouse
- Sunrooms
- Workbenches and storage
- And all-new designs for hardworking cold frames!

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GREENHOUSES

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COOL SPRINGS PRESS

Contents

Introduction

Home greenhouse gardening could not be better suited to our tumultuous times. Never has there been a greater assortment of greenhouse and cold frame options available to the home gardener, and never has home gardening been more important on both the personal and global levels.

Start with the personal. A global pandemic has taught us that the food chain is a fragile thing. Food prices climb ever higher and eating organic and healthy is harder day by day. But not if you grow what you eat. A greenhouse can be your way to have a bumper crop of your favorite edibles, even in the depths of winter.

It's not all about food, though. You can just as easily grow work-of-art flowers like orchids that might not otherwise survive in your garden. There is a place in every life and every home for beautiful blooms and foliage. Those, too, enrich our lives. The right greenhouse can help you cultivate your favorite flowers, regardless of how exotic they may be.

Beyond the practical, greenhouse gardening is just plain relaxing and rejuvenating. It's an enjoyable way to get outside, get a little exercise, do something entirely productive and positive, and unplug for awhile from our hectic, fast-paced, tech-driven world. There is also that incredibly rewarding satisfaction of eating something you grew with your own two hands and the sweat of your effort. There is no price tag for that particular feeling.

That's a lot of upside, but the many benefits of home-based greenhouse gardening do not stop at the boundaries of your backyard. As climate change accelerates and wreaks havoc across the country and around the globe, individuals often feel powerless to have any kind of impact. They are not. Growing food in a greenhouse is something any homeowner can do to help the environment. That's food that won't use fossil fuels to find its way to your kitchen table. Greenhouse gardeners can also turn kitchen scraps into precious compost, keeping that waste out of landfills.

The biggest challenge? Simply getting started. Fortunately, that's where this book shines. You'll find all the information you need to decide on a size and type of greenhouse that will be best for you, your yard, and your life. The chapters that follow sort out whether you should choose plastic or glass, the frame material that will serve your situation and needs, and the type of tech that will best accommodate your particular style of gardening.

Sifting through the choices is key, and you'll find a wealth of advice here to help you do just that. As fun and rewarding as greenhouse gardening can be, it has to fit into your household budget. So, while we cover the amazing new tech in greenhouse gardening—such as smart phone–connected hygrometers, thermometers, and heaters—we'll also help you make the hard decisions about which are most affordable and useful for your needs.

Greenhouses

It’s the golden age of hobby greenhouse gardening. The good news? You’ll enjoy an incredible diversity of structural, equipment, and add-on options. The bad news? You’re faced with an incredible diversity of structural, equipment, and add-on options. Sifting through all the variables can be daunting. For what is in theory a fairly simple structure, the reality is anything but.

You can have a heated glass greenhouse, a plastic-draped three-season hoophouse, or something completely different. You might go with a concrete foundation, a brick floor, no foundation at all, or something else entirely. Perhaps you need to create a humid environment to coddle exotic flowers or are better served with diffused light and UV protection to create an ideal growing environment for seedlings and young tender plants.

It’s an awful lot to consider, but there is no need to feel overwhelmed. This detailed chapter is meant to set you up with all the basic knowledge any home gardener needs to purchase, erect, and make the most of a hobby greenhouse. You’ll find guidance on what equipment you need, and what you don’t. You’ll learn all about proper positioning of a backyard greenhouse to take advantage of the growing day. There’s in-depth information about how local climate can affect the choices you make in setting up your greenhouse. All in all, it’s safe to say that this chapter provides just about all the information you could need or want to ensure gardening success.

In this chapter:

Choosing a Greenhouse

There are so many hobby (or "starter") greenhouse options, even beyond the available selection of sizes and shape, that it is quite easy to feel daunted at the prospect of starting to shop for your own backyard grow structure. Take a step back, breathe, and consider a few key questions. The answers will give you clear direction on your final selection.

1. Plants. What will you grow in your greenhouse? Will you just harden off seedlings or extend the season for a few vegetables? A small, unheated PVC structure might serve your needs. Starts and seedlings require different lighting and conditions than established, mature plants. Are you hoping to create a cornucopia of blooms by growing flowers? Or do you want to save some money by growing your own produce. How big will the plants get? What are their special needs? All of those factors may lead you to a more permanent structure with a sturdier frame and glass panels.

2. Budget. How much are you ready to invest—in both money and time—into your greenhouse gardening adventure? Keep in mind that some types of greenhouse plants, like fruits and vegetables, can pay you back handsomely in savings on your grocery bill. Ultimately, the money you're willing to spend will narrow the size and type options from which you can select.

3. Local climate. This factor, in combination with the plants you hope to grow, will have the most significant impact on your final choice of greenhouse. If you're simply looking to extend the growing season at both ends, and your local climate is relatively mild, a basic unit will serve your needs. If, however, you want to do more extensive four-season gardening, or your local area is subject to temperature extremes, expect to pay more for the structure and equipment that works best under those conditions.

4. Style, size, and shape. The actual size of greenhouse that suits you best and the type that appeals to you will lead you to particular units. Are you okay with the informal look of a hoophouse, or would you prefer a more fully featured Victorian? That decision may also be driven to some degree by the look you want for your landscaping. Are you hoping the greenhouse will be a stunning decorative feature in its own right, or are you focused on practicality and function?

The majority of greenhouses are simple rectangles (except for the rare octagonal model or geodesic dome), but they come in a long list of widths and lengths. Measure the space you have available and note the sun exposure. Consider how tall your plants will be and how much room you want to move around inside. Understand that most hobby greenhouse gardeners regret buying too small, not too large. You'll likely put any extra space in the greenhouse to good use.

5. Heat, water, and ventilation. Unheated greenhouses are usually used just to extend the growing season for hardy and half-hardy plants. The greenhouse may offer some frost protection, but will be used only in spring, summer, and fall. A heater makes any greenhouse more versatile, increasing the growing period to four seasons and expanding the variety of plants you can grow. You'll also need to determine if you want water run to the greenhouse by way of a hose, or if you want to actually plumb the structure. Misters and grow lights are additional features that can increase greenhouse usability.

THE COST QUESTION

Greenhouse prices vary to extremes. You can spend around $100 for a simple, portable zip-up greenhouse, or splurge on a full-size, well-outfitted, custom glass Victorian with bespoke foundation, as a package running as much as $25,000. Your budget, however, is particular to you. Here are what you can expect to find at different levels of expense:

$ ($60-$500)

- 5-foot-square mini "pop-up" greenhouse.
- 6 × 8 basic greenhouse with polycarbonate panels.
- 6½ × 6½ prefab hoophouse with flap or roll-up door.

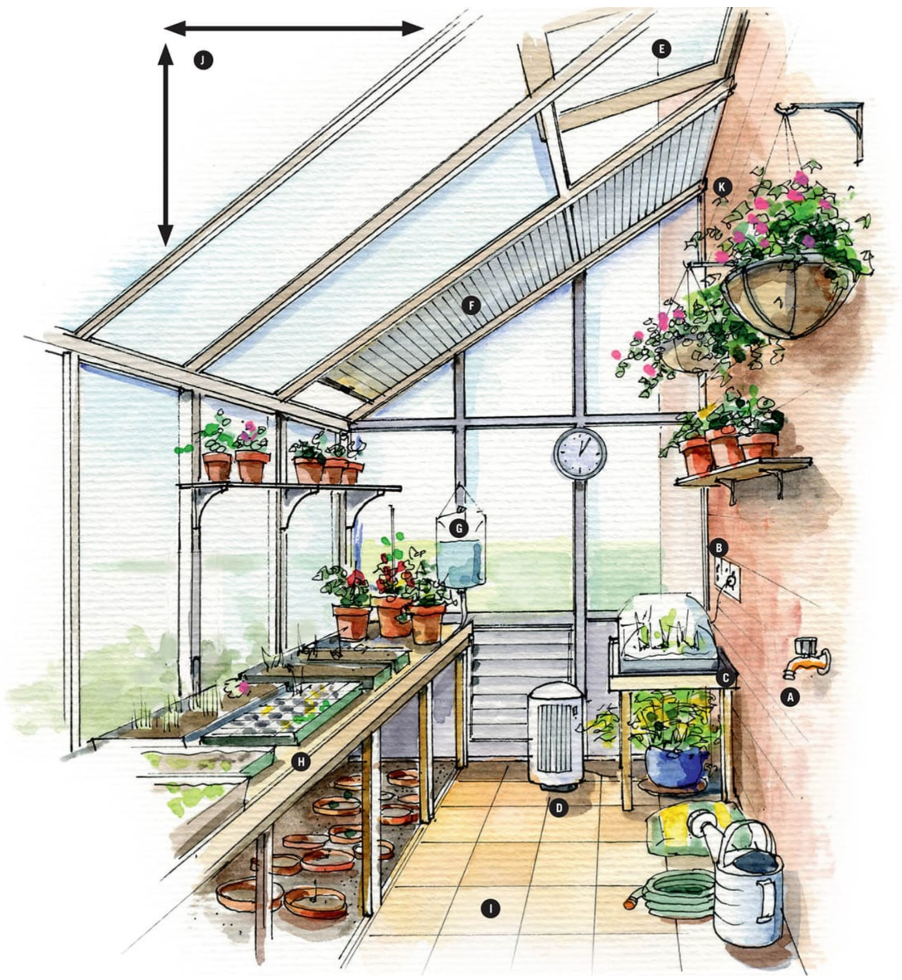
$$ ($500-$2,500)

- 8 × 4 attached aluminum-frame lean-to with polystyrene panels and an operable door.
- 16 × 20 hoophouse kit with PVC tubing and frame door.
- 8 × 12 basic aluminum frame hobby greenhouse with polycarbonate panels and a framed door.

% ($2,500+)

- 8 × 10 Victorian greenhouse with tempered glass, aluminum frame, automatic openers, and multilevel adjustable shelves.
- 8 × 12 farmhouse style greenhouse with louvered windows, auto-opening vents and double doors.
- 10 × 26 bell-shaped tunnel, with two doors and vents.

This large Victorian-style glass greenhouse features a “drop” door—a door that extends down below the original threshold of the greenhouse to accommodate the height of a foundation wall. The steep roof pitch and distinctive top crest create an eyecatching formal visual with plenty of space inside for growing a variety of plants or just relaxing in the warmth of the sun.



Attached to the exterior wall of the house, this lean-to-style greenhouse has all the features for complete growing success: running water (A); electrical service (B); a heated plant-propagation table (C); a heater (D) for maintaining temperatures on cold nights; ventilating windows (E) and sunshades (F) for reducing temperatures on hot days; drip irrigation system (G) for maintaining potted plants; a full-length potting bench (H) with storage space beneath; paved flooring (I) to retain solar heat. It also has the steep roof pitch (J) (expressed as the drop per foot, or 5/12 in this case), and permanent wall attachment (K).

Lean-to or Freestanding?

Hobby greenhouses can be divided into two basic categories: lean-tos and freestanding. Lean-to greenhouses are attached or butted to a wall of the house, while freestanding models can be placed anywhere in the yard that receives the appropriate sun exposure.

• **Lean-tos.** Inexpensive lean-tos are simply butted against a flat, plumb wall surface. Slightly more expensive attached versions are physically fastened to the wall and the seams sealed to prevent heat loss. Both are normally positioned on an unshaded south-facing wall. The wall can be part of a shed, an outbuilding, or the main house.

Although they typically have less floor space inside and less headroom because of a sharply pitched roof, lean-tos can take advantage of close proximity to the home's plumbing and electrical connections. The lean-to can also benefit from the home's heating. This type of greenhouse comes in several variations to suit location. Most are specifically meant to be connected to a side wall, while some are designed for gable-end wall placement. They can be simple plastic-covered, three-season enclosures, or can come equipped with glass or polycarbonate panels, vents, misters, fans, heaters and other accessories.

Lean-tos are dependent on the construction and siting of the host building. Highly textured or irregular walls do not provide a good seal for lean-to mating surfaces. In cold climates, they must be protected from heavy snow sliding from the house roof. The space inside a lean-to is by nature smaller than the potential space inside a freestanding greenhouse. Lean-tos are also prone to overheating when not properly vented.

• **Freestanding.** Freestanding greenhouses can be portable or permanent, and come in a much wider range of sizes than lean-tos do. Portable freestanding greenhouses offer the potential to move when the homeowner does, or to be positioned differently if plants are not doing as well as they should. The more important advantage of this type over lean-tos is that four sides of glazing translates to much greater sun exposure.

However, a freestanding greenhouse is usually more expensive to build, and certainly more expensive to heat or plumb. Depending on the size, a freestanding unit may require a foundation be laid. These are also more exposed to the elements and subject to wind damage.

HEATED GREENHOUSE ENVIRONMENTS

Heated greenhouses are cool, warm, or hot. Each of these environments supports different plants and gardening activities.

Cool: Minimum Nighttime Temperature 45°F (7°C)

In a cool environment, you can start seeds and propagate cuttings early in the year so they will be ready for planting in garden beds at the beginning of summer. Unless your climate is mild, however, you'll probably need a propagator to provide a little extra warmth for starting seeds. Vegetables and hardy and half-hardy plants do well in this type of greenhouse. Although the temperature in a cool greenhouse is suitable for protecting frost-tender plants, their growth during winter is minimal.

Warm: Minimum Nighttime Temperature 55°F (13°C)

A warm greenhouse is suitable for propagating plants, raising seedlings, and growing a wide range of plants, including flowers, fruits, houseplants, and vegetables, even during the coldest months. You can sow tomato seeds in January and harvest the ripe fruits in June. Though this type of greenhouse provides a highly desirable environment for plants, heating it can be extremely costly, especially if you live in an area with long, cold winters.

Hot: Minimum Nighttime Temperature 65°F (18°C)

Only a few serious gardeners will invest in a hot greenhouse because it is prohibitively expensive to heat. This type of environment is ideal for growing exotic tropical plants, such as orchids, bromeliads, and ferns.

How Big?

In all likelihood, you'll shop for a greenhouse that fits the "hobby" category. Larger, estate greenhouses are categorized as "conservatories," while much smaller greenhouses, which are usually portable, are labeled "mini."

Some experts recommend buying the largest greenhouse you can afford, but this isn't always the best advice. You don't want to invest in a large greenhouse only to discover that you're not up to the work it involves.

Of course, buying a greenhouse that is too small can lead to frustration if your plant collection outgrows the space. It is also much more difficult to control the temperature. One compromise is to buy a greenhouse that's one size larger than you originally planned, or better yet, to invest in an expandable structure. Many models are available as modules that allow additions as your enthusiasm grows.

When choosing a greenhouse, take into account the size of your property. How much space will the structure consume? Most of the expense comes from operating the greenhouse, especially during winter. The larger the structure, the more expensive it is to heat.

Be sure the greenhouse has enough room for you to work. Allow space for benches, shelves, tools, pots, watering cans, soil, hoses, sinks, and a pathway through the plants. If you want benches on both sides, choose a greenhouse that is at least 8 feet wide by 10 feet long. Give yourself enough headroom, and allow extra height if you are growing tall plants or plan to hang baskets.

How Much Can I Afford to Spend?

Your budget will influence the type of structure you choose. A simple hoop greenhouse with a plastic cover is inexpensive and easy to build. If you're handy with tools, you can save money by buying a kit, but if the greenhouse is large, requires a concrete foundation, or is built from scratch, you may need to hire a contractor, which will add to the cost.

Location is important. If you live in a windy area, you'll need a sturdy structure. Buying a cheaply made greenhouse will not save you money if it fails to protect your plants or blows away in a storm. And cutting costs by using inefficient glazing will backfire because you'll wind up paying more for heating.

BUILDING DEPARTMENT QUESTIONS

Local building codes vary from region to region, but many dictate the type, size, and location of any greenhouse that may be placed on your property. Codes may also require a certain type of glazing—for instance, they may mandate that in a structure with glass panes, only tempered glass be used. That's why it's essential to do a little homework before you commit to buying or building your dream greenhouse. Here are a few basic questions every homeowner should ask the local building department:

- What type of foundation is required for a freestanding greenhouse? If compacted gravel is allowed as a foundation, how deep must the foundation go?
- Is there a minimum wind load required? Are anchors required? (Anchors are necessary for lighter greenhouses in areas that are commonly affected by high winds or extreme weather events.)
- What is the snow load per square foot or dead load required on the greenhouse?
- Does the structure need to be code compliant with the International Building Code (IBC) or Universal Building Code (UBC)? Which year?
- Do the building plans have to be site specific?
- Does the greenhouse have to be Americans with Disabilities Act (ADA) compliant?

How Much Time am I Prepared to Invest?

You may have big dreams, but do you have the commitment to match? Maintaining a successful greenhouse requires work. It’s not hard labor, but your plants depend on you for survival. Although technology offers many time savers, such as automated watering and ventilation systems, there’s no point in owning a greenhouse if you don’t have time to spend there. Carefully assess your time and energy before you build.

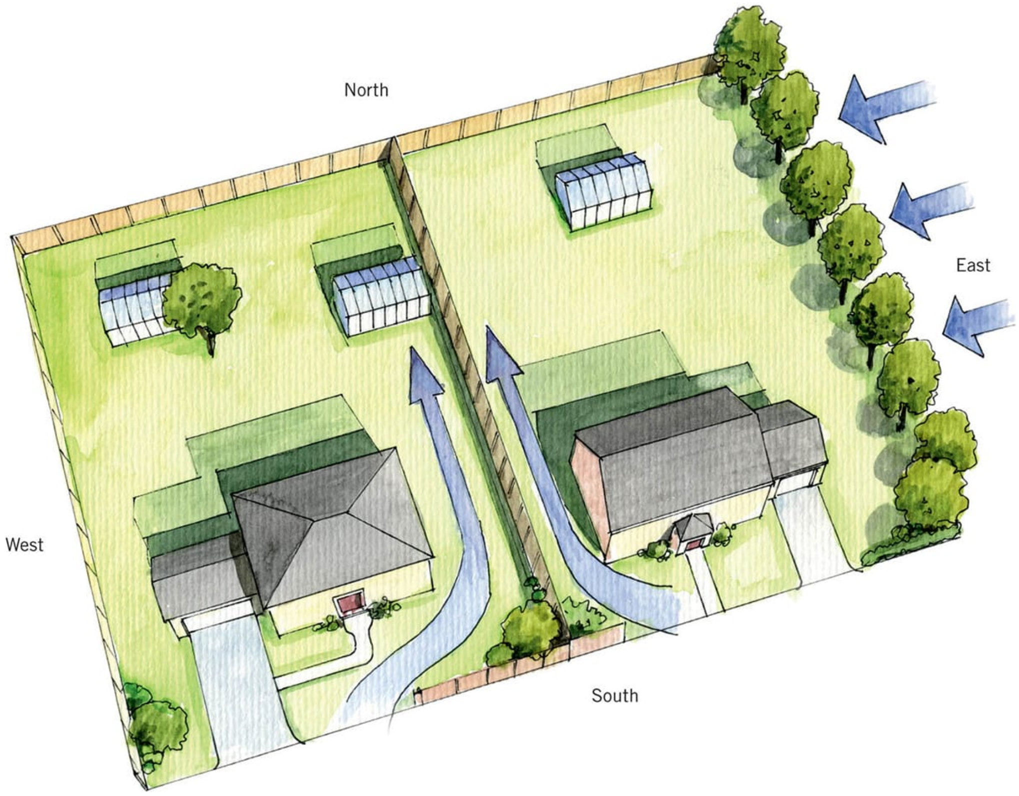
You might save money by choosing a smaller greenhouse, but if you don't have usable room to grow everything you want to grow, you aren't getting real value out of the structure. This beautiful redwood-framed, prefab unit may be a little pricey, but it offers abundant counter, shelf, and work-surface space as well as quality construction and glazing meant to last decades.

Siting Your Greenhouse

When the first orangeries were built, heat was thought to be the most important element for successfully growing plants indoors. Most orangeries had solid roofs and walls with large windows. Once designers realized that light was more important than heat for plant growth, they began to build greenhouses from glass.

All plants need at least 6 (and preferably 12) hours of light a day year-round, so when choosing a site for a greenhouse, you need to consider a number of variables. Be sure that it is clear of shadows cast by trees, hedges, fences, your house, and other buildings. Don’t forget that the shade cast by obstacles changes throughout the year. Take note of the sun’s position at various times of the year: A site that receives full sun in the spring and summer can be shaded by nearby trees when the sun is low in winter. Winter shadows are longer than those cast by the high summer sun, and during winter, sunlight is particularly important for keeping the greenhouse warm. If you are not familiar with the year-round sunlight patterns on your property, you may have to do a little geometry to figure out where shadows will fall. Your latitude will also have a bearing on the amount of sunlight available; greenhouses at northern latitudes receive fewer hours of winter sunlight than those located farther south. You may have to supplement natural light with interior lighting. For an easier, quicker, and more exacting solution, you can turn to one of the many sun-mapping apps available for smart phones and tablets. Simply plug in your latitude and longitude, or other location indicators, and the app calculates sun exposure for your property, over time and through the seasons.

To gain the most sun exposure, the greenhouse should be oriented so that its ridge runs east to west (see illustration, below), with the long sides facing north and south. A slightly southwest or southeast exposure is also acceptable, but avoid a northern exposure if you're planning an attached greenhouse; only shade-lovers will grow there.



The ideal greenhouse location is well away from trees but protected from prevailing winds, usually by another structure, a fence, or a wall.

Siting Factors

Several factors influence the decision of where to build your greenhouse. Some pertain to your property, some to the structure, and some to your tastes.

Climate, Shelter + Soil Stability

Your local climate and geography have an impact on the location of your greenhouse. Choose a site that is sheltered from high winds and far enough away from trees that roots and falling branches are not a threat. (Try to position the greenhouse away from areas in which children play, too.) If you live in a windy area, consider planting a hedge or building a fence to provide a windbreak, but be careful that it doesn't cast shade on the greenhouse. Avoid low-lying areas, which are prone to trapping cold, humid air.

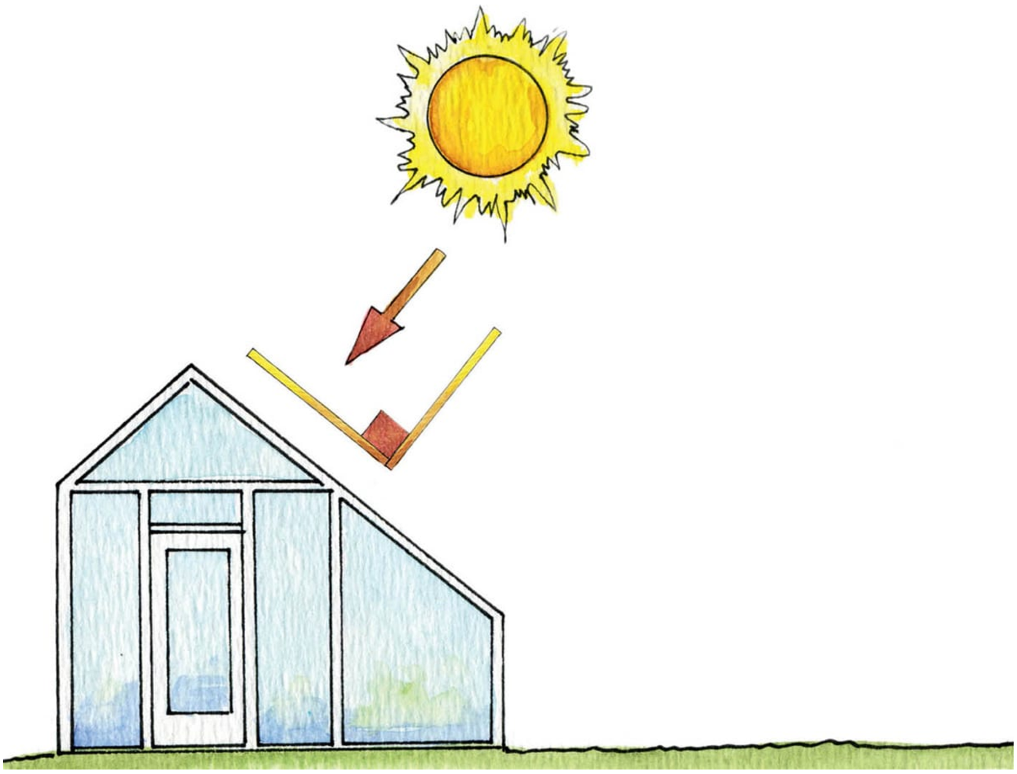
The site should be level and the soil stable, with good drainage. This is especially important if heavy rains are common in your climate. You might need to hire a contractor to grade your site.

Access

Try to locate your greenhouse as close to the house as possible. Connecting to utilities will be easier, and you'll be glad when you're carrying bags of soil and supplies from the car. Furthermore, a shorter walk will make checking on plants less of a chore when the weather turns ugly.

Aesthetics

Although you want to ensure that plants have the perfect growing environment, don't ignore aesthetics. The greenhouse should look good in your yard. Ask yourself whether you want it to be a focal point—to draw the eye and make a statement—or to blend in with the garden. Either way, try to suit the design and the materials to your home. Keep space in mind, too, if you think you might eventually expand the greenhouse.



For maximum heat gain, orient your greenhouse so the roof or wall with the most surface area is as close to perpendicular to the sunrays as it can be.

Greenhouse Elements

At first glance, a greenhouse seems like a very simple structure: some basic framing, a good amount of glass or plastic, and voilà—a greenhouse. But actually, there is much more to this garden addition than meets the eye.

In addition to being thoughtfully situated to take advantage of the sun throughout the day and the seasons, any greenhouse must be carefully built to last while still providing an optimal environment for the plants you want to grow. That starts with choosing the right foundation and making sure the greenhouse has an appropriate floor. Not only is the base of a greenhouse important for its support, but the right floor can also serve as a heat sink, absorbing heat during the day and releasing it at night.

In addition, you'll need to put a lot of thought into your greenhouse's covering. Glass is traditional, but fragile and expensive. Plastic panels and sheeting are easier to work with, but you must choose the right type to create the ideal microclimate for your plants.

Any plant needs water, and depending on how large your greenhouse is, you may decide to automate the watering of your plants or to use misters to create the proper humidity. You'll also need to figure out how to moderate the heat inside, because the temperature in a greenhouse can swing by as much as 50 degrees Fahrenheit over the course of any given day. Ventilation goes hand in glove with heat, and, of course, you'll probably want some form of lighting so that you can check on or work with your plants after dark.

These are just some of the factors any greenhouse owner needs to consider and resolve. The purpose of this section is to help you make informed choices from among the great many options available in order to create the ideal space for whatever it is you hope to grow—not to mention yourself.

A greenhouse is composed of several major systems that perform important functions. When planning your greenhouse, you'll need to make choices about each system, which include the foundation, floor, frame, glazing, ventilation, watering, heat, storage, and more.

Foundations

Some portable starter freestanding greenhouses, and a few inexpensive lean-tos, require no foundation whatsoever. They can just be staked in place or, where there is little wind, simply stood on a flat, level area of ground. In most cases, however, a greenhouse benefits from some sort of foundation, whether it be a compacted soil or gravel base, or something more substantial. Larger, heavier structures will most likely require a more significant foundation to prevent movement in the underlying soil from damaging the framing or glazing. A foundation should also keep any wood or metal parts off the ground to prevent premature rot or corrosion.

If you've purchased a kit greenhouse, the manufacturer will likely recommend appropriate foundation options. Regardless of what you're building, you should consult your local building department to determine the codes that dictate the foundation you need to use and whether you need a permit for the foundation, the whole greenhouse, or both.

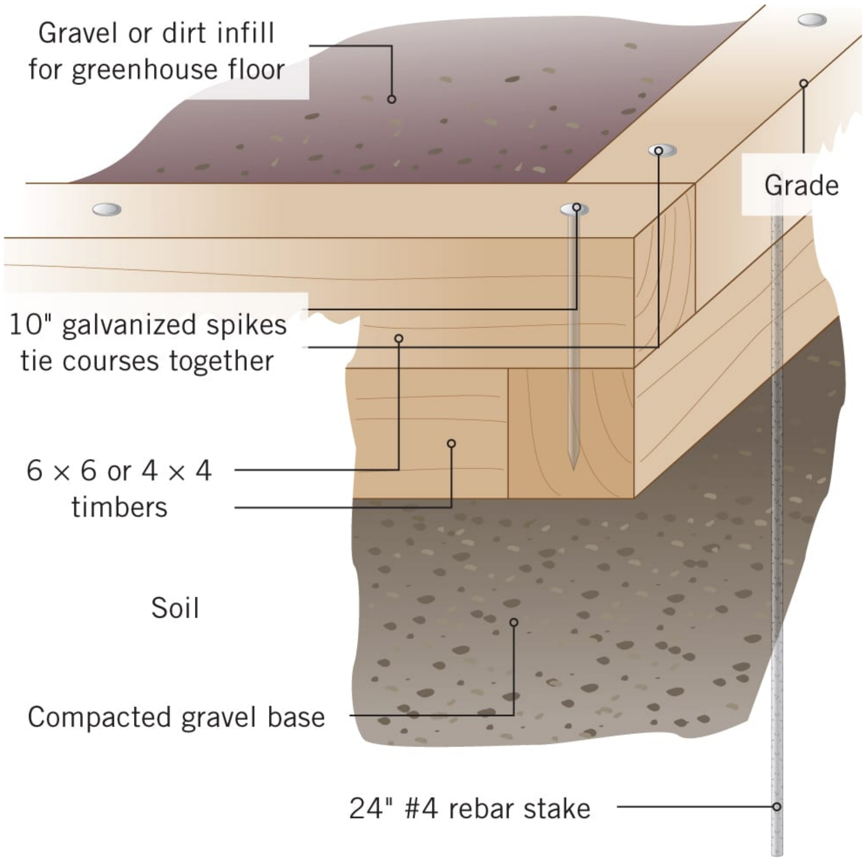
Whether you're working from codes or simply following best building practices, the foundation needs to match the greenhouse. A kit greenhouse may come with its own metal or fabric base. For many types of prefab structures, a crushed gravel base 4 inches deep or more will serve the purpose. Other cases may call for a base of landscape timbers, concrete footings or piers, or a concrete slab. More traditional, substantial, and permanent greenhouses are often built on a kneewall of wood, brick, or stone. This is an option for most types of greenhouses, but the work and expense mean that kneewalls are rarely used with hobby greenhouses.

KNEEWALLS

Kneewalls, sometimes called pony walls, are low walls to which a greenhouse frame can be attached. They can raise a greenhouse to maximize headroom and can help to retain heat. However, they also eliminate growing space behind the walls and below the benches. If you only plan to grow potted plants on the benches, this may not be a problem—you can use the area underneath the benches for storage.

Kneewalls can be built with concrete blocks on a concrete footing, but a more attractive option is to use stone or brick and mortar. To help integrate the greenhouse with your home, build the kneewall from materials that complement the exterior of the house.

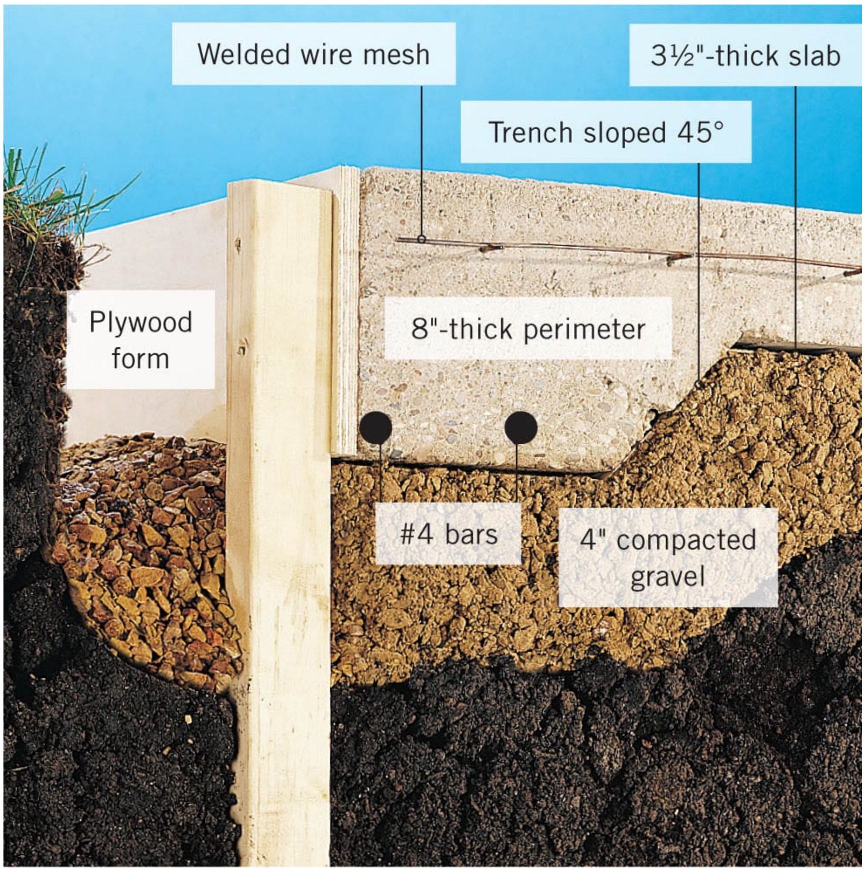
Earth anchors, or anchor stakes, are often used to tie down very lightweight greenhouses and crop covers to prevent them from blowing away. A typical anchor is a long metal rod with a screw-like auger end that is driven into the ground. An eye at the top end is used for securing a cable or other type of tether attached to the greenhouse.



Timber foundations are simple frames made with 4 × 4, 6 × 6, or larger landscape timbers. The timber frame is laid over a leveled and compacted gravel base (which can also double as the floor or floor subbase for the greenhouse interior) and pinned to the ground with rebar stakes. One level, or course, of timbers is suitable for small greenhouses, while two courses or more are recommended for larger structures.

A concrete footing provides a structural base for a large greenhouse or a masonry kneewall. Standard footings are continuous and run along the perimeter of the structure. They must extend below the frost line (the depth to which the ground can freeze in winter; varies by climate) to prevent frost heave and should be at least twice as wide as the greenhouse walls they support.

Pier footings are structural concrete columns poured in tube forms set below the frost line—the same foundation used to support deck posts. Pier foundations are appropriate for some kit and custom greenhouses and are often used on large commercial hoop-style houses. Anchor bolts embedded in the wet concrete provide fastening points for the greenhouse base or wall members.



Concrete slabs make great foundations and a nice, cleanable floor surface but are overkill for most hobby greenhouses. In some areas, it may be permissible to use a "floating" footing that combines a floor slab with a deep footing edge (shown here). Otherwise, slabs must be poured inside of a perimeter frost footing, as with garage or basement construction. To prevent water from pooling inside the greenhouse, concrete slabs must slope toward a central floor drain—a job for a concrete pro, not to mention a plumber to install the drain and underground piping.

Floors

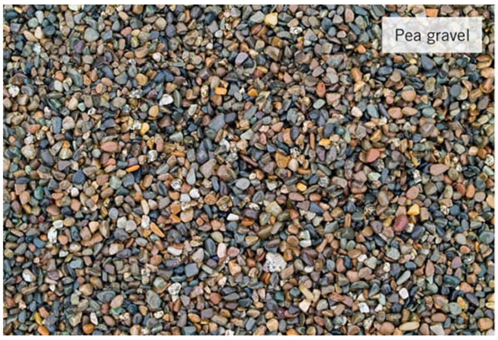
Even if your greenhouse is small or temporary, a dirt floor is often a bad idea. Watering of plants and even condensation can lead to a muddy mess that invites weeds, disease, and pests. There are plenty of inexpensive options for greenhouse floors, all of which are easy to install yourself. In general, any water-permeable surface that works for a patio or walkway will make a good floor for a greenhouse.

For long-term stability, improved drainage, and a level floor surface, it's wise to support any greenhouse floor with a 4- to 6-inch subbase of compacted gravel. Cover the subbase with commercial-quality landscape fabric (not plastic; the fabric must be water-permeable) to inhibit weed growth and to separate the gravel base from the upper layers. From there, the simplest floors can be made with any type of suitable gravel, such as pea gravel or trap rock.

Brick and concrete patio pavers are other great options and offer a more finished look and feel over gravel floors. Pavers are laid over a 1- to 2-inch layer of sand and should be surrounded by a border (foundation timbers or patio edging will suffice) to keep them from drifting. Once the pavers are set, you can sweep sand over the surface to fill the cracks and lock the units in place. Another floor option—flagstone—is installed in much the same way. Keep in mind that any stone or concrete surface will also serve as a heat sink. This, alone, can be a good reason to add a stone floor to your greenhouse.

A poured concrete floor is stable and washable, and requires no routine maintenance.

Concrete pavers set in sand offer a long-lasting, stable floor covering that breathes and allows for good drainage.



Pathway gravel is the easiest and cheapest flooring to install. Pea gravel, trap rock, and some river stones are good for both drainage and cleanliness. Highly compactible materials, such as decomposed granite, remain solid and level underfoot but leave a lot of grit on your shoes. In any case, choose a material that's comfortable to walk on; loose or large gravel or stones can be unstable.

Framing Materials

Wood and aluminum remain the most popular framing materials for hobby greenhouses, but they are far from the only options. Steel is popular for larger, more complex structures, and PVC is commonly used for more simple and portable greenhouses and hoophouses.

Every framing option has advantages and disadvantages, which is why it's essential that you choose the best framing material for your needs both now and in the future. The key is to balance durability, weight, expense, and, of course, appearance to find just the right framing. Looking at the tradeoffs entails considering local weather conditions (do you need a high snow or wind load tolerance?), the gardening you intend on doing (do want to hang baskets in the greenhouse?), and the look that most appeals to you (do you want the greenhouse to blend in or stand out?).

Wood

Advantages: Wood is often selected for custom greenhouse framing because of the many beautiful species available. The bonus with a wood frame is that it won't conduct heat as quickly as metal or plastic and will be less likely to shed potentially harmful condensation. It is also long lasting and durable. These qualities come at a higher cost than that of other materials, but the price tag also buys an extremely beautiful greenhouse structure. Some of the best woods for greenhouses are cedar and redwood, because both are naturally resistant to rot and insects and age well, whether finished or unfinished. Hardwoods also offer these benefits, but the cost is usually prohibitive for a hobby greenhouse. The practical choice for a utilitarian greenhouse is pressure-treated wood. In either case, wood is a wise choice if you are planning on hanging baskets or accessories from the framing, or if you intend to put up shelving.

Disadvantages: Wood framing is heavy and usually requires regular maintenance. Because it's necessarily bulkier than other options, wood also casts more of a shadow on greenhouse plants. Rot is a potential problem, especially as the wood ages, and many types of woods will ultimately be attacked by insects—something that is never a problem with plastic or metal. You'll also pay a higher cost for the frame than you would if you had used other materials, especially if you choose the beauty of redwood.

A pine frame with plastic glazing. This is a good option for a lightweight and inexpensive greenhouse that will be used for two or three seasons.

Choose redwood for a greenhouse frame that will last years and provide an incomparable appearance to the structure.

Aluminum

Advantages: The foremost advantage of aluminum is that it is low maintenance. It is also strong and lightweight, lasts longer than wood, and can easily accommodate different glazing systems and connectors. Aluminum is used in many greenhouse kits and can be powder-coated or anodized in various colors (although the most common are white, black, and green). Aluminum greenhouse kits are typically easy to assemble and come with predrilled holes for attachments, connections, and fixtures. Some manufacturers offer “thermally broken” aluminum frames, which are made by sandwiching a thermal barrier between two layers of extruded aluminum to decrease heat loss through the frame.

This simple kit greenhouse includes a basic aluminum frame with durable polycarbonate glazing.

Disadvantages: Because aluminum loses heat more rapidly than wood does, this type of greenhouse is more expensive to heat. In addition, cheaper aluminum frames can be too flimsy to withstand high winds or heavy snow loads. The material can also exacerbate condensation problems inside the greenhouse.

PVC (Polyvinyl Chloride)

Advantages: PVC tubes are used in less expensive kits for hoophouses and greenhouses. The tubes make for a very low-cost frame that is durable and lightweight. The material does not rot and is entirely resistant to insects. It is also easy to clean, and although not distinctive in appearance, it looks neat and tidy. PVC frames are usually used in greenhouses meant to be portable and for beginner or intermediate gardeners.

Disadvantages: High winds, heavy snow loads, and other extreme weather can damage PVC frames. Bright sun also takes its toll, making PVC framing brittle over time. It cannot be used with glass—the frames are restricted to bendable polycarbonate panels or plastic sheeting.

An upscale example of a handsome prefab, aluminum-framed greenhouse. Used with rubber gaskets and glass panels, this construction can easily withstand even high wind loads. The crest and finial are finished in long-lasting baked enamel. A crest like this, as well as adding flair to the greenhouse's look, also keeps birds from perching on the ridge—which in turn keeps the panels cleaner.

A simple hoophouse frame like this is easy to assemble and doesn't require a serious investment in money or expertise.

Greenhouse Glazing Materials

There are two types of greenhouse glazing: glass and plastic. Ideally, whatever glazing you choose should let in maximum light, and let out minimum heat. The other distinctions are between opaque and translucent glazing. Tender plants may burn with overexposure and will benefit from opaque panels. Mature plants do better in the stronger light through clear glazing. Different glazing materials have different lifespans. The warranty is an excellent indicator of how long the glazing will last.

Glass

Advantages: Glass is the traditional glazing material and remains popular today. Undamaged, the material will last forever. It offers some of the best light transmission among glazing materials, doesn't degrade under long exposure to UV radiation, and is easy to clean. It boasts surprising tensile strength—in a frame, it can hold up to a lot of stress and wind load. Although single-pane glazing has poor insulating properties, the R-value can easily be raised by purchasing double- or even triple-pane glazing.

Disadvantages: Uninsulated single-pane glass is inefficient at retaining heat. Glass is also extremely breakable—children, tree branches, and hail are all threats. For safety, tempered glass should be used for greenhouses because it shatters when broken, creating small, rounded fragments, rather than sharp, jagged shards. Glass is also heavy, requiring a strong supporting framework. Direct sunlight passing through glass is so strong it may burn some plants. Lastly, unlike some synthetic materials, glass panes cannot bend to accommodate curved shapes.

Fiberglass

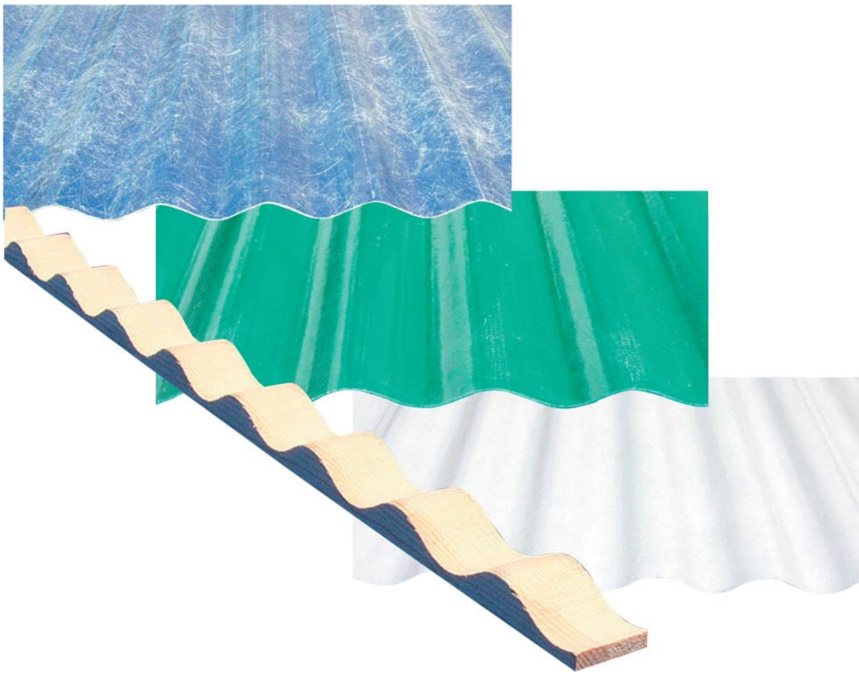
Advantages: Modern fiberglass panels are UV resistant and formulated to resist yellowing under prolonged sun exposure—a key problem in early panels. This material transmits almost as much light as glass does, but also diffuses that light. Fiberglass also provides much better heat retention than glass. The best panels now come with 15- or 20-year warranties.

Disadvantages: The surface of fiberglass panels is rough and captures dirt, requiring more frequent cleanings than other types of glazing. Fiberglass panels can also, under certain circumstances, experience excess condensation that can lead to plant disease and overwatering. Dirt and debris can collect in the valleys of panel ridges. Inexpensive fiberglass panels will degrade and deteriorate much more quickly than high-quality versions do.

Polycarbonate

Advantages: Polycarbonate panels are light, strong, and shatter resistant. Multiwall versions retain heat far better than glass does. Corrugated panels are the least expensive, but most used today are multiwalled. Manufacturers offer panels with between two and five walls. The more walls, the greater the heat retention and the lower the light transmission. Panels can be clear or white, to diffuse light. Warranties typically run 10 to 15 years.

This stunning redwood greenhouse combines the best of both worlds—the beauty and view through clear glass windows on all walls and frosted polycarbonate panels on the roof to diffuse light.



Fiberglass panels
come in clear, white, and colored varieties, such as the green shown here. The ridged panels can be challenging to install, so manufacturers supply wavy nailing strips (called “closure strips”) that make installation as easy as nailing flat panels.

Disadvantages: Although polycarbonate scratches easily, the main drawback is the high price. They are hard to clean, because mass-market glass cleaners may damage the material.

Polyethylene + PVC

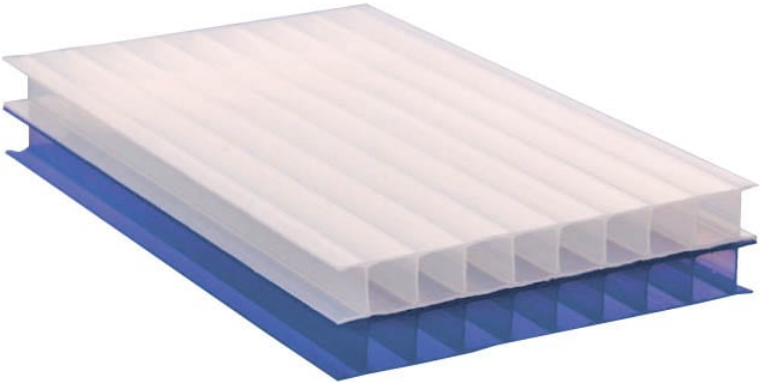
Advantages: Greenhouse sheet coverings—primarily polyethylene plastic, but also including some PVC products—are inexpensive, easy to work with, incredibly lightweight, and adaptable to unusual shapes. They come in different thicknesses. Thicker sheet products retain heat better without much loss in light transmission. These products usually come in white (although you can buy clear), which ensures that transmitted light is diffused and won't burn plant leaves. The sheeting can be doubled up, which cuts down significantly on light transmission, or layers can be attached to both the outside and the inside of a structure, for improved heat retention.

Disadvantages: Polyethylene sheeting does not retain heat well and will deteriorate under prolonged sun exposure. The material is prone to rips during installation and can become brittle and yellowed in as little as two years.

UV protection is a consideration in any greenhouse glazing. Panels can be treated or formulated to filter UV rays, which can protect tender plants, and the skin of a gardener spending significant time in the greenhouse. However, growth won't be as robust when UV rays are filtered out.

Lastly, be aware that although plexiglass panels are available in some places, they are rarely used for hobby greenhouses because polycarbonate and PVC products are superior for the application.

Double-wall
clear polycarbonate.



Double-wall
white polycarbonate.

Triple-wall
polycarbonate.

GREENHOUSE GLAZING CHARACTERISTICS*

GLAZING	LIGHT TRANSMISSION**	R-VALUE	STRUCTURAL STRENGTH
Single-Pane Glass	±95%	.9	High
Double-Pane Glass	±90%	2	High
Double Pane Low E Glass	±70%	3.3	High
Polyethylene Film (6-mil)	±85%	.87	Low
Fiberglass panel	±92%	.9	Medium
Polycarbonate 2-wall (6-mil)	±82%	1.6	Medium
Polycarbonate 3-wall (8-mil)	±76%	2	Medium
Polycarbonate 4-wall (6-mil)	±76%	1.8	Medium
Polycarbonate 5-wall	±62%	3	Medium

**It's important to note that between different manufacturers the same products will vary in light transmission and R-value. The numbers here should be considered for comparison purposes.*

***Light transmission will be lower in colored or white panels or film. The variation can be from 90% for clear down to 60% for green in the same material.*

Water

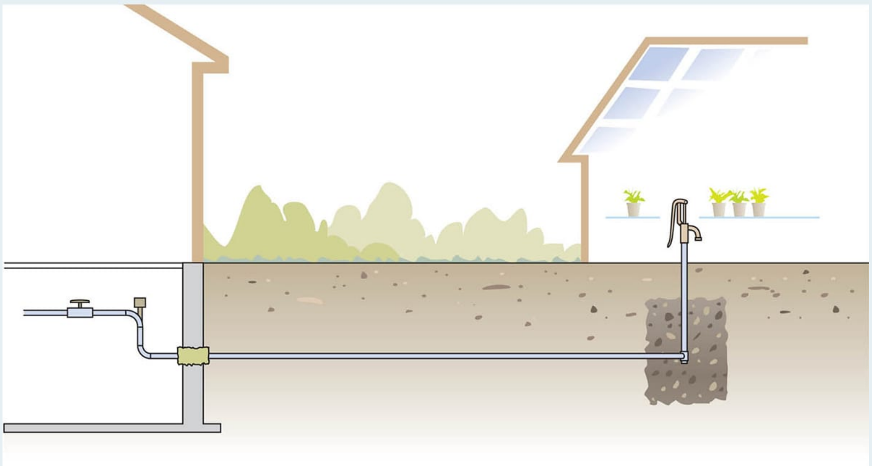
All greenhouses need some kind of water supply system. This can be as simple as a hose connected to the nearest outdoor spigot or as complex as a frost-proof underground line extending from your basement to a special spigot in the greenhouse. The latter is obviously more convenient, and the system can operate year-round. It’s also a big job that usually requires a plumber to make the final connections. A somewhat easier alternative is to install a shallow underground water line that you drain at the end of the growing season, similar to the supply line for a sprinkler system. Or, if your water demands are not too great and your greenhouse is located near your house, maintain a rain barrel nearby.

A rain barrel can provide a ready supply of water for your greenhouse. It’s an easy water supply option, but it lacks the convenience of linking the greenhouse to your house’s water supply system.

AN ALL-SEASON WATER SUPPLY

A dedicated all-season water line is the ultimate setup for any freestanding greenhouse. To prevent the line from freezing during winter, the entire buried portion of the water line must be laid 6” below the frost line in your area. In the greenhouse, the water comes up through a freeze-proof yard hydrant (commonly used on farms), which drains itself of residual water each time it is shut off. The water drains into a gravel pit (installed per local code and the hydrant manufacturer).

In a typical installation, the supply line connects to a cold-water pipe in the house and includes a shutoff valve and backflow preventer (vacuum breaker). The line passes through the foundation wall (where it’s protected by a sleeve of rigid pipe) at the burial depth, then runs underground to the hydrant. For most applications, flexible PE (polyethylene) tubing is the best all-around option for the buried portion of the supply line. As always, all connections and devices must follow local code requirements.



A seasonal water supply line is similar to an all-season setup but somewhat easier to install and is just as convenient for everyday use. The supply line connects to a cold-water pipe inside the house and runs through an exterior wall above the foundation, then down into a trench (left photo). At the house-end of the trench, the initial supply run connects to the underground line (typically PE tubing) inside a valve box. The box provides easy access to a T-fitting necessary for freeze-proofing the line each fall. The supply run is buried in a 10"-deep trench (or per local code) and connects to copper tubing and a standard garden spigot inside the greenhouse.

Winterize a seasonal supply line using a shutoff valve with an air nipple. With the valve closed and the greenhouse spigot open, blow compressed air (50 psi max.) into the line to remove any water in the tubing. Then, remove the plug from the T-fitting inside the valve box (photo top right) and store it for the winter.

A greenhouse with a water supply of any sort should also have a drain. A dry well can be made with an old trash can or other container perforated with holes and filled with coarse rock. The well sits in a pit about 2’ in diameter by about 3’ deep and is covered with landscape fabric and soil. Dry wells are for draining graywater only—no animal waste, food scraps, or hazardous materials.

Watering + Misting Systems

If your greenhouse is fairly small and you enjoy tending plants daily, you might enjoy watering by hand, either with a watering can or with a wand attachment on a hose. Hand-watering helps you to pay close attention to plants and cater to their individual needs. You'll quickly notice signs of over- or under-watering and can adjust accordingly.

However, hand-watering isn't always practical. That's why many greenhouse gardeners use an automatic system such as overhead sprinkling and drip irrigation. This approach is convenient, especially when you're not at home. Greenhouse suppliers sell kits as well as individual parts for automated watering systems. Be sure your system includes a timer that can be set to deliver water at specific times of the day, for a set duration, and on specific days of the week. You can also incorporate water heaters and fertilizer injectors into your system.

Overhead-sprinkler systems are attached to the main water supply and use sprinkler nozzles connected to PVC pipes installed above the benches. The system usually includes a water filter, which prevents the nozzles from clogging, and a pressure regulator. Set the system to water in the morning and during the hottest part of the day. Avoid watering late in the day so the plants will be dry before nightfall, when the temperature drops and dampness can cause disease.

Drip-irrigation systems use drip emitters to water plants a drop at a time, when moisture is needed. Each plant has an emitter attached to feeder lines that connect to a drip line of PVC tubing or pipe. Unlike overhead sprinklers, drip irrigation ensures that the plant leaves stay dry. It also helps to conserve water.

If you prefer to water plants from underneath, consider capillary mats. These feltlike mats are placed on top of the bench (which is first lined with plastic) and under the plants, with one end of the mat set into a reservoir attached to the bench. The reservoir ensures that the mat is constantly moist. Moisture from the mat is drawn up into the soil and to the plant roots when the soil is drying out. Unlike drip irrigation and overhead sprinkling, capillary-mat watering systems do not require electricity, pipes, or tubing. However, unless they are treated, the mats will need regular cleaning to prevent mildew and bacteria buildup. To ensure that the system works properly, it’s important that the bench be level.

This automatic drip-watering system is fed by a garden hose that connects to the mixing tank. In the tank, water and fertilizer are blended to a custom ratio and then distributed to plants at an adjustable rate via a network of hoses, drip pins, and Y-connectors.

NOTE: The spiral trellis supports hanging from the greenhouse roof are not part of the watering system.

You can simplify greenhouse maintenance and monitoring—and your life—with a smart sensor like this one. Humidity levels, temperature, and more are available to check any time through a smart phone app connected to the sensor.

Misting is a very gentle method of providing moisture to plants and maintaining greenhouse humidity. Misting heads mounted on spray poles (inset) can be controlled manually or automatically. In addition to maintaining a constant state of moistness for plants, a misting system will give your greenhouse a tropical environment that many gardeners enjoy.

Regardless of the watering system you choose, use lukewarm water. Cold water can shock the roots, especially if the soil is warm. If you're hand-watering, let the water sit in the greenhouse so it warms up to ambient temperature. (Keep it out of the sun, though—you don't want it to get too hot). Wand watering and automatic systems can benefit from an installed water heater.

Misting

When the temperature inside the greenhouse rises and the vents open, they release humidity. Misting increases humidity, which most plants love—levels of about 50 percent to 65 percent are ideal—and dramatically decreases the temperature by as much as 20°F. Misting systems are available through greenhouse suppliers. You can buy a complete system, which may include nozzles, tubing, PVC pipe, a humidistat, and sometimes a hard-water filter and a pressure gauge. Or you can buy the parts separately to create a customized system. The size of the greenhouse will determine the size of the system. Larger greenhouses need more nozzles and in turn more tubing and pipe.

Humidistats can automatically turn on misters and humidifiers when the humidity drops below a set level. You might also want to invest in a device to boost the water pressure. Higher pressure produces a finer mist, which cools more quickly. Suppliers recommend placing the nozzles about 2 feet apart around the perimeter of the greenhouse, between the wall and the benches. Place the nozzles underneath the benches so the mist doesn’t drench the plants. As with watering, avoid misting late in the day. Wet leaves and cold, humid air can encourage disease.

Lighting

The most basic greenhouses use only the sunlight nature provides to grow plants in a warmer environment than the plants would experience outdoors, but a greenhouse can be much more than that. If you're willing and able to run power to the structure—or if it's connected to your home—you can add lights that will not only extend growing days and growing seasons but will also allow you to care for your plants after dark. In fact, supplemental artificial lighting is key to turning a two- or three-season greenhouse into a four-season garden structure.

Supplementing natural light with artificial light can be tricky. Natural light is made up of a spectrum of colors that you can see (the red, orange, yellow, green, blue, indigo, and violet colors of the rainbow) and those you can't see (infrared and ultraviolet). Plants absorb light from the red and blue ends of the spectrum—blue light promotes plant growth; light from the red end of the spectrum encourages flowering and budding. The red-blue light combination is easily achieved when the source is the sun but a little more difficult when you're using artificial lighting. Intensity is also important: Lights that are set too far away or that don't provide enough brightness (measured in lumens or foot-candles) will produce weak, spindly plants.

The three types of light bulbs used in greenhouses are incandescent bulbs, fluorescent tubes, and high-intensity discharge (HID) lights, which include metal halide (MH) or high-pressure sodium (HPS). Each has advantages and disadvantages, which is why greenhouse gardeners often use a combination of two or more types to achieve light that is as close to natural as possible.

Incandescent

Ordinary tungsten incandescent bulbs are inexpensive, readily available, and a good source of red rays, but they are deficient in blue light. They can be useful for extending daylight for some plants and for supplementing low light levels, but they are not an efficient primary source of light. Incandescent lights produce a lot of heat—hanging them too close to plants can burn foliage, but if you hang them at a safe distance, they don't provide enough intensity for plant growth. The average life span of an incandescent bulb is about 1,000 hours.

Fluorescent

Fluorescent tubes are more expensive than incandescent bulbs, but the higher cost is amply offset by their longevity and efficiency: bulb life for fluorescents is about 10,000 hours, and they provide the same amount of light as incandescents with only one-quarter to one-third the amount of energy. They also produce much less heat than incandescent bulbs.

The right lighting in a greenhouse increases the number of hours you can work in the structure each day and expands the growing season and growing hours of plants.

Fluorescent is a better source of growth-stimulating light for your greenhouse. It must, however, be hung relatively close to plants in order to spur growth.

Fluorescent bulbs (or “lamps,” as they’re called by the lighting industry) come in a variety of colors and temperature ranges, including full-spectrum light. Cool white lamps, which produce orange, yellow-green, blue, and a little red light, are the most popular choice. To provide seedlings and plants with a nearly full spectrum of light, many growers combine one cool white lamp and one soft (or warm) white lamp in the same fixture.

Due to their energy efficiency and low heat output, fluorescent-tube fixtures are a great all-around choice for starting seedlings and growing small plants.

The downside to using fluorescents as grow lights is that they must be hung very close to the plant—from 2 to 8 inches, depending on the plant—to be effective. This makes them most useful for propagation and low-growing plants.

HID

High-intensity discharge (HID) lights work by sending an electrical charge through a pressurized gas tube. There are two types: high-pressure sodium (HPS), which produces light in a narrow yellow-orange-red band, and metal halide (MH), which produces a broader range of light waves but tends to be more toward the white-blue-violet end of the spectrum.

Novice growers tend to use metal halide lights if they’re using grow lights at all. But more experienced greenhouse gardeners, and those who grow throughout the year, may use a combination: MH lights to start plants off and encourage early growth and bushiness, then switching to HPS as the plants mature, because HPS light encourages flowering and fruiting.

Ordinary incandescent lights aren't particulary good sources of growth-promoting light, but they can help heat a greenhouse. And their attractive warm light also turns a greenhouse into a nighttime landscape design feature.

In fact, although most fixtures do not allow for bulbs to be interchanged, convertible fixtures are available that do allow the gardener to switch between bulbs.

HID lights of both types are very expensive, but they last a long, long time. A standard 400-watt HID bulb can provide 20,000 hours of lighting. These bulbs also light a large area: that single bulb will provide enough light for 16 square feet of plants. HID lights do, however, produce a significant amount of heat. Hang them high in the greenhouse, and provide plenty of ventilation in warmer months.

LED Grow Lights

As lighting technology continues to evolve, light-emitting diodes (LEDs) are growing in popularity and use. Manufacturers have developed special LED grow lights that include both blue and red light waves, effectively serving all the needs of plants—from initial growth through mature budding, flowering, and fruiting. The big bonus of these bulbs is that they last almost as long as HID lights do but cost a fraction of the price. The lights can be used with conventional fixtures and provide wide, diffuse illumination that prevents the light from ever burning plant leaves.

Heating

Novice greenhouse gardeners can gain knowledge and extend their growing season with a basic lean-to or tiny kit greenhouse. But if you're going to take advantage of the full potential inherent in greenhouse gardening, you'll need to heat the greenhouse. There are several ways to do that. Some techniques, such as using a heat sink, are usually meant as a complement to a main heat source. In any case, the most common and simplest way to heat your greenhouse is with a heater. The two main types are electric and fuel fired (gas, propane, kerosene, or oil).

Electric heaters are inexpensive and easy to install. They provide adequate heat for a small greenhouse in a temperate climate and are useful for three-season greenhouses. However, they are expensive to operate (although relative costs are constantly changing). Electric units can also distribute heat unevenly, making it too warm in some areas of the greenhouse and too cold in others. Placing a heater at each end of the greenhouse can help. If you use an electric heater, be sure the fan doesn't blow warm air directly on the plant leaves; they may scorch.

Gas heaters usually cost more than electric and most areas require that a licensed professional hook them up, but heating bills will be lower than if you use an electric heater. Gas heaters operate much like a furnace: a thermostat turns on the heat when the temperature drops below its setting. You can help to distribute the heat by using a fan with the heater. If you plan to use a gas heater, install the gas line when you're building the foundation. It is also important to ensure that the heater is vented to the outside and that fresh air is available for combustion. Poor ventilation can cause dangerous carbon-monoxide buildup.

Propane, oil, and kerosene heaters also need to be vented, and if you're using kerosene, be sure it's high-grade. Another option is hot-water heating, in which the water circulates through pipes set around the perimeter of the greenhouse under the benches. You can also consider overhead infrared heat lamps and soil-heating cables as sources of heat.

In most climates, an electric heater with an automatic thermostat will be sufficient to protect tender plants on cold nights. Electricity is an expensive heating option, however, so it's best reserved for moderate heating needs.

HEATING REQUIREMENTS

- Heaters must be equipped with an automatic shut-off switch.
- Position more than one thermometer at bench level throughout the greenhouse so you can check that heat is evenly distributed.
- Do not place thermometers or thermostats in direct sunlight.
- Install an alarm or set a smart phone alert to warn you if the temperature drops dangerously low. Set the temperature warning high enough to give you time to remedy the problem before plants die.

THE RADIANT HEATING OPTION

Heat rises. That simple fact is the principle behind an in-floor greenhouse radiant heating system. Piping in the floor radiates heat upward. Although home radiant-floor heating systems use electrical mats, those would be impractical in a greenhouse, because they would be expensive to run and prone to shorts. That's why radiant heating systems in greenhouses are plumbed; hot water flows through pipes, heating the air above. A boiler heats water on demand, as needed.

The system is set with a thermostat that turns it on when the temperature drops below a preset level. The advantage of this type of system is even, uniform heating. It's also efficient.

However, a radiant greenhouse heating system does require upfront planning and expense. The pipes are run in a gravel bed below the greenhouse floor. They can be run in a concrete slab or beneath a tile or paver surface. The thinner the floor, the more efficient the heating. PEX tubing makes this a much simpler project than was once the case with rigid plumbing lines. However, the major expense remains the boiler that heats the water.

Calculating Heat Needs

Heat is measured in British thermal units (Btu), the amount of heat required to raise one pound of water 1 degree Fahrenheit. To determine how many Btu of heat output are required for your greenhouse, use the following formula.

Area (the total square footage of the greenhouse panels) × difference (the difference between the coldest nighttime temperature in your area and the minimum nighttime temperature required by your plants) × 1.1 (the heat-loss factor of the glazing; 1.1 is an average) equals Btu.

Calculate the area by multiplying the length by the height of each wall and roof panel in the greenhouse and adding up the totals. Here's an example, using 380 square feet for the greenhouse area and 45 degrees Fahrenheit as the difference between the coldest nighttime temperature (10 degrees Fahrenheit) and the desired nighttime greenhouse temperature (55 degrees Fahrenheit). 380 square feet × 45 × 1.1 = 18,810 Btu.

If the greenhouse is insulated or uses double-glazed glass or twin-wall polycarbonate, you can deduct 30 percent from the total Btu required; if it's triple-glazed, deduct 50 percent. You can deduct as much as 60 percent if the greenhouse is double-glazed and attached to a house wall.

A portable space heater may be all the supplemental heat your greenhouse requires. Use it with caution, and make sure yours shuts off automatically if it overheats or is knocked over.

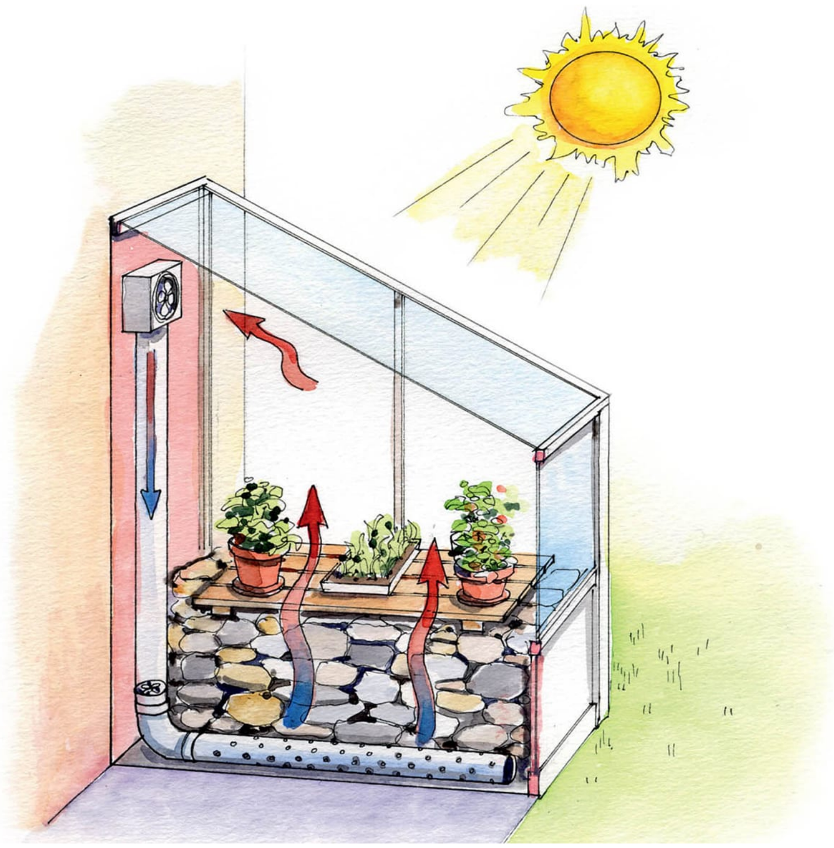
Conserving Heat

On cold, cloudy days and at night, solar heat is lost. Even if you have supplemental heating, holding onto that heat is essential to maintaining an optimal climate. Insulating the greenhouse and making use of heat sinks are the most effective means of conserving heat, but don’t overlook heat thieves such as cracks and gaps. Be sure the glazing is tight, and seal any opening that lets in cold air.

If you built a concrete foundation, it may have polystyrene board installed between the concrete and the soil. Concrete rapidly loses heat if the ground around it is cold, and polystyrene insulation helps to reduce this heat loss. You can use polystyrene board or bubble insulation (similar to bubble wrap used for shipping) to temporarily insulate the walls of the greenhouse. Simply attach the material to the greenhouse frame beneath the benches before winter and remove it in the summer. You can also insulate the greenhouse from the outside. Plant low-growing plants around the foundation, or prop hay bales or burlap bags filled with dry leaves against the walls.

Heat Sinks

Heat sinks absorb solar energy during the day and radiate it back into the greenhouse at night. Stone, tile, and brick floors and walls are good collectors of heat, but to be really effective, they should be insulated from underneath. Piles of rocks can act as heat sink, but the best option is a blue- or black-painted barrel or drum full of water. Place a few of them around the greenhouse. If you have an attached greenhouse, painting the house wall a dark color can cause it to radiate solar heat back into the greenhouse at night. A light-colored wall, on the other hand, can help reflect heat and light back into the greenhouse during the day.



This heat sink system uses solar energy to heat the greenhouse. Air heated by the sun is drawn in by the fan and blown into the rock pile, which also absorbs solar heat. Heat is radiated back into the greenhouse after the sun goes down.

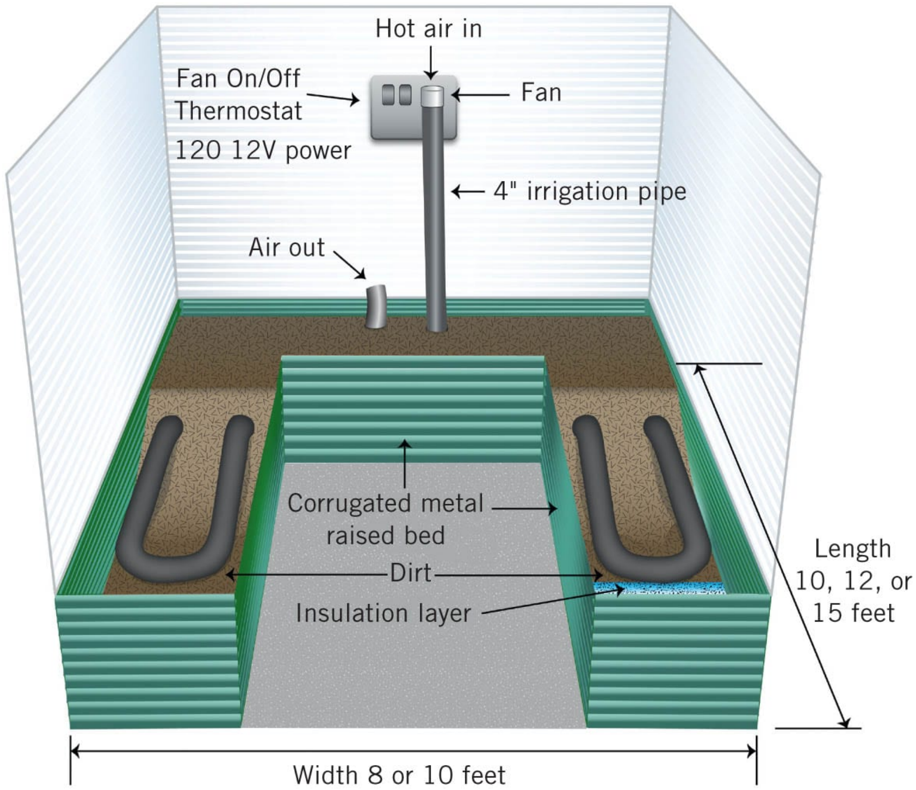
SMART HEAT CONSERVATION

- Reduce the temperature by 5°F. Growth may be slowed, but plants will survive.
- Make sure the greenhouse is as airtight as possible.
- To prevent drafts, add a storm door.
- Mulch the soil in raised benches to insulate it during cool seasons. Consider watering tropical foliage plants and other warm-season plants with water warmed to 65°F.
- Insulate all water- or steam-heating supply lines.
- At night, hang black cloth horizontally from the greenhouse ceiling as close to the plants and benches as possible to prevent the warm air from escaping through the roof.
- If the greenhouse uses automatic vents that are controlled by a separate thermostat, set that thermostat 5° or 10° higher than the heater thermostat to keep the vents from opening when the heat is on.
- Install an alarm system or smart phone alert that will go off when the temperature ranges above or below the safe limits or when there is a power failure.
- Make use of the heat exhausted by your clothes dryer by running the vent into your greenhouse.
- Plant a “shelter belt” of evergreens on the windward side of the greenhouse to reduce heating costs. (But be sure it is far enough away that it doesn’t cast shade on the greenhouse.)

MICROCLIMATES

Any yard and garden will most likely have microclimates. A sunny sheltered corner. A cool shady spot beneath old-growth trees. Those vary significantly from the general temperature and conditions of your landscape at large. Your greenhouse, too, has microclimates. For instance, most greenhouses are warmer near the roof and cooler at floor level. Some areas may be shaded for all or part of the day, while others receive strong, direct light. Like the plants in a garden, greenhouse plants have differing light, heat, soil, and moisture requirements. Before you place them in the greenhouse, take stock of the microclimates, and group plants according to their needs.

A heating and cooling thermostat is perhaps the most important greenhouse control device. The thermostat will control heat sources and automatic vent controls to cool the greenhouse when temperatures climb into the danger zone for overheating plants.



Products like this propriety soil-warming system are helping home gardeners use simple science to conserve heat and lower greenhouse heating bills.

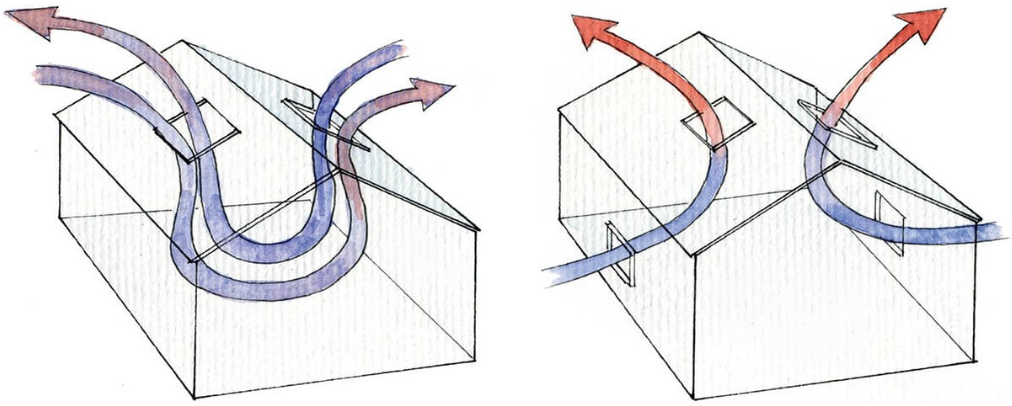
Ventilation

Whether your plants thrive depends on how well you control their environment. Adequate sunlight is a good start, but ventilation is just as important. It expels hot air, reduces humidity, and provides air circulation, which is essential even during winter to move cold, stagnant air around, keep diseases at bay, and avoid condensation problems. You have two main options for greenhouse ventilation: vents and fans.

Because hot air rises, roof vents are the most common choice. They should be staggered on both sides of the ridgeline to allow a gentle, even exchange of air and proper circulation. Roof vents are often used in conjunction with wall vents or louvers. Opening the wall vents results in a more aggressive air exchange and cools the greenhouse much faster than using roof vents alone. On hot days, you can open the greenhouse door to let more air inside. Also consider running small fans to enhance circulation.

Vents can be opened and closed manually, but this requires constant temperature monitoring, which is inconvenient and can leave plants wilting in the heat if you are away. It’s far easier—and safer—to use automatic vent openers. These can be thermostat-controlled and operated by a motor, which turns on at a set temperature, or they can be solar-powered. Unlike thermostat-controlled vent openers, which require electricity, solar-powered openers use a cylinder filled with wax, which expands as the temperature rises and pushes a rod that opens the vent. When the temperature drops, the wax shrinks and the vent closes. How far the vent opens is dictated by temperature: the higher the temperature, the wider the vent opens to let in more air.

A fan ventilator is a good idea if you have a large greenhouse. The fan is installed in the back opposite the greenhouse door, and a louvered vent is set into the door wall. At a set temperature, a thermostat mounted in the middle of the greenhouse activates the fan, and the louvered vent opens. Cool air is drawn in through the vent, and the fan expels the warm air. The fan should be powerful enough to provide a complete air exchange every 1 to 1.5 minutes.



Venting your greenhouse–Installing at least one operable roof vent on each side of the ridgeline creates good air movement within the structure. Adding lower intake vents helps for cooling. Adding fans to the system greatly increases air movement.

CALCULATING VENTILATION REQUIREMENTS

Greenhouse manufacturers rarely include enough vents in kits, so be sure to buy more. To determine the square footage of venting your greenhouse should have, multiply the square footage of the floor by 0.2.

This shutter assembly comes as a kit; the probe automatically opens the shutter when the heat inside the greenhouse reaches a preset level.

A simple solar opener like this can be retrofitted to a greenhouse vent window to open it whenever the heat increases on the inside of the greenhouse. A paraffin core expands, causing the opener to open the vent. Simple technology, but highly effective.

A vent fan like this one can be attached to a controller that opens the shutters and turns on the fan at precise levels of humidity or temperature, or on a timer. This actively ventilates the greenhouse, as opposed to the passive ventilation of a roof vent.

Cooling

Although vents and fans are the first line of defense when the temperature inside the greenhouse starts to climb, other cooling methods such as misting, humidifying, evaporative cooling, and shading can also help to maintain the ideal growing environment. Cooling is crucial during summer, but it can be just as important on a sunny winter day.

Shades

By blocking direct sunlight, shades protect plants from sunburn and prevent the greenhouse from getting too hot. They can be installed on the exterior or hung from cables inside the greenhouse. Both methods block the sun, but only exterior shades prevent solar energy from penetrating the glazing, thereby keeping the air inside the greenhouse cooler When choosing shades, be sure they are UV stabilized for longevity.

Two types of shades are available: cloth and roll-up. Shade cloth is usually woven or knitted from fiberglass or polyethylene and is available in many colors, although green, black, gray, and white are most common. You can also find shade cloth in silver, which, like white, reflects heat and sunlight and keeps the greenhouse cooler than darker colors. Shade cloth also varies in density, usually from 20 percent to 80 percent. The higher the density of the cloth, the more light it blocks (60 percent density blocks 60 percent of the light). Be careful when choosing shade density; too little light will slow plants' growth.

Shade cloth can be simply thrown over the greenhouse and tied down when shading is needed, but this hampers airflow through the vents (unless you cut the cloth to size and install it in sections). Better ventilation is achieved by suspending the cloth 4 to 9 inches above the exterior glazing. Be sure the vents are open when you do this. Greenhouse shade suppliers can provide framework kits.

GREENHOUSE SHADING COMPOUND

Professional greenhouse growers with large operations typically apply greenhouse shading compound to the glazing of their structures so they can control heat entry and protect their plants. Similar to paint, shading compound contains ground pigments that reflect the sun’s rays. The compound is sprayed onto the glazing with an airless sprayer (you can use a hand-sprayer for a small greenhouse). Sold in 5-gallon buckets, it is diluted with water 8 to 1 for plenty of coverage. Some types are designed to be easily removed with water and a fine nylon broom so you can make adjustments as needed. Other formulations are intended to be permanent. For more information, ask about the product at your greenhouse supply store or do an online search for Greenhouse Shading Compound.

Roof shades, along with vents, help prevent a greenhouse from overheating in direct sunlight. Here, a combination of circulating fans and cloth shades mounted on the interior of the south-facing glass helps protect plants.

A removable shade cloth like the one used on this flower-garden hobby greenhouse is convenient and effective. It can be put on or taken off in seconds and blocks a maximum of UV rays.

In addition to cloth, roll-up greenhouse shades may be constructed from aluminum, bamboo, or wood. They are convenient because you roll them up when they're not needed, and they last longer than shade cloth, but they are more expensive.

Evaporative Coolers

Evaporative coolers (also called swamp coolers) cool the air by using a fan to push or pull air through a water-saturated pad. A portable cooler might be sufficient for a small greenhouse; larger greenhouses will benefit from a unit cooler placed outside. Used when the humidity outside is less than 40 percent, these units draw dry outside air through the saturated pad, where it is cooled. The air travels through the greenhouse and exits via a vent on the opposite side. It's a good idea to use an algaecide with these coolers.

Liquid Shading

Some greenhouse gardeners choose to paint liquid-shading compounds (sometimes called whitewashing) over the outside glazing. These compounds are inexpensive and easy to apply, but they can be unattractive and tend to wash off in the rain. Liquid shading can be thinned or layered to the level desired, and the residue can be brushed off at the end of summer. (It is often almost worn off by that point anyway.) Some liquid-shading compounds become transparent during rainy weather to let in more light and then turn white when they dry.

Roof vents that are triggered to open automatically by sensor alerts are far and away the most important component of a greenhouse cooling system. But additional cooling devices may be necessary.

Workbenches + Storage

Workbenches are deceivingly important greenhouse additions that can create an efficient, pleasant work environment—or not. Misplaced, overlarge, or the wrong work surfaces will not only make it harder to move around, they can also block plant growth. That's why it's well worth your while to carefully plan exactly what work surfaces to use where.

A slatted workbench ensures plenty of usable work space in this multifaceted greenhouse, while the sink is used to collect loose material that would fall through the workbench surface. A small, white wire shelf provides additional storage, but note that the shelf itself does not block light or cast much of a shadow. In fact, the reflective coating amplifies available sunlight to a small degree.

One of the most important considerations is the space below the workbench. Left open over soil, this can be one more spot to grow young plants. However, use that area as storage and you curtail any chance of expanding the growing areas inside the greenhouse. Of course, if you've built your greenhouse with a knee wall, that area may already be shaded and prime territory for storing equipment or supplies.

Size + Shape

Some greenhouses come with workbenches and even shelves. Those may be adjustable, but often aren't. In either case, you can customize supplied work surfaces to better serve your needs and preferences. Less expensive greenhouses are basic shells. If you've purchased one of those, measure the interior space carefully, especially the width (never rely on the outside measurements; they don't include the width of the frame and glazing materials).

Before you decide on workbenches, plan for an aisle that facilitates easy movement; any greenhouse aisle should be at least 3 feet wide. Wider will always be better, because you'll be moving heavy pots, cumbersome flats of plants, and unwieldy bags of soil. The most common configuration of workbenches used in greenhouses is one on either side, with a central aisle. A U-shape configuration allows you to incorporate even more work surfaces, but sacrifices a bit of growing area.

In the standard configuration, an 8-foot-wide greenhouse would work best with 2-foot-deep workbenches on either side. Wider greenhouses can comfortably accommodate wider workbenches, but never use a workbench that you can't reach across. Although the average bench is between 28 to 32 inches high, choose a height that suits how tall or short you are.

POTTING MATERIALS

Greenhouse gardeners generally use either terra-cotta or plastic pots. Terra-cotta is more attractive and heavier than plastic, so those pots are less likely to be knocked over. They are also porous—water evaporates through the clay, so there is less risk of overwatering. However, you'll have to water plants more often. Glazed terra-cotta holds moisture better than unglazed pots, and any terra-cotta pot is more expensive than plastic. Plastic pots hold moisture better than terra-cotta does. Gardeners who plan to start seeds and propagate plants often use plastic trays, flats, and cell packs, although peat pots, cubes, and plugs are also available for starting seeds.

A built-in gable-end workbench provides abundant work surface that takes up as little space as possible (notice that the lack of legs leaves a wealth of storage space underneath). A rubber top surface is low maintenance, easy to clean, and the ideal durable material for the greenhouse. It won't rot, collect mold, or degrade under prolonged sunlight exposure.

HYDROPONIC SYSTEMS

Hydroponics is the science of growing plants without soil, and works well for home greenhouse gardeners. A hydroponic growing medium holds plants in place. The medium can be polystyrene balls, expanded clay pellets, gravel, pea stone, perlite, vermiculite, rock wool, or coconut fibers. The simplest method is to place growing medium into a pot and add a nutrient solution once or twice a day. A more complex system involves using computer-controlled pumps to automatically flush plants' roots with nutrient solution as necessary for maximum growth.

Root systems grow though the medium and down into nutrient-rich water below. Here, the system uses a child's pool. Lettuce is the most common hydroponically grown home crop.

Slatted counters are the most common, because they facilitate drainage and airflow. Some workbenches come with solid sinks, where you can collect soil during transplanting or contain water as you soak roots. Wire mesh is a less-expensive, low-maintenance work-surface option, but the mesh needs to be strong enough to support a full load of plants in newly moistened soil

—considerable weight. Plastic-coated wire mesh is more cleanable and is excellent for shallow shelves mounted above a workbench. Solid workbench countertops can support capillary mats and should be stone, metal, or pressure-treated wood to prevent rot.

Placement

Regardless of layout, it’s wisest to run workbenches east to west, so that any plants receive even sunlight throughout the day. Leave an inch or two between the back edge of any workbench and the wall, to ensure efficient air circulation. Greenhouse frame material determines whether you can install shelves. Shelves can be added to a wood-framed greenhouse, and many aluminum greenhouse kits include predrilled framing, with hardware for shelves. Just remember that shelves and whatever is kept on them can shade the surface and plants below.

Easy-to-Build DIY Greenhouses

Some greenhouse designs are so simple that construction requires only a weekend. These can be built inexpensively, and may even be constructed of found materials or those leftover from other yard, garden, or home improvement projects. The foundation can be an anchored wooden frame or, for a more permanent structure, a concrete base.

Hoophouse

Economical and versatile, a hoop-style greenhouse (also called a hoophouse or a Quonset house) is constructed of PVC or metal pipes that are bent into an inverted U shape, attached to a base, and connected at the top by a ridgepole. A hoophouse is usually covered with plastic sheeting. A door can be set at one end, and there may be an exhaust fan or flap vent that can be rolled up for ventilation. Because the hoop greenhouse is lightweight, it is not a good choice in areas with strong winds. (For instructions on building your own inexpensive hoophouse, see here to here.) DIY hoophouses are incredibly easy to construct and are scalable; you can make one as tall as you need and as long as the available space allows. Craft a base of the same tubing or materials used in the hoops, and the hoophouse will be portable as well. Most use an end flap for a simple door, but you can easily frame out an opening at one end of the structure.

A-frame Greenhouse

The industry often uses this term for any greenhouse with a peaked roof. Strictly speaking, though, an A-frame greenhouse has two walls running from the foundation, up at severe angles, meeting at the peak (forming the legs of an “A”). This simpler structure is a good DIY option that requires little framing expertise. An A-frame greenhouse is small and lightweight and can be made of wood or PVC. A series of A-frames is attached to a wood base and covered with plastic sheeting or rigid plastic panels, such as polycarbonate or fiberglass. Because of the steep pitch of the roof, this type of greenhouse easily sheds rain, snow, and leaves. It can also be portable.

There are lots of variations on homemade hoophouses. One of the most common framing materials is PVC pipe. The version shown here has been constructed with pipe connected with fittings. It’s easy to do and can serve the purpose well, although these are not the most handsome of greenhouse structures.

Greenhouse Kits

No matter what kind of greenhouse you have in mind, chances are you can find a kit to match your vision. Dozens of companies offer kits in diverse styles, sizes, materials, and prices. Some offer door options—sliding versus swinging doors, for example, with and without locks and screens. Some offer glazing combinations, such as polycarbonate roof panels with glass walls. And some even offer extension kits for certain models, so you can add onto your greenhouse as your space requirements grow.

Kit basics usually include framing, glazing panels, vents (though usually not enough—it's a good idea to buy extras), and hardware. A good kit will come predrilled and precut, so you only need a few tools to assemble it. Most kits do not include the foundation, workbenches, or accessories.

Be sure the kit you choose comes with clear, comprehensive instructions and a customer-service number for assistance. Also ensure that it complies with your local building codes and planning regulations. Depending on the company, shipping may be included in the price. Because kits are heavy, shipping can be expensive; be sure to figure it and the cost of the foundation, benches, all necessary accessories, and the installation of utilities into your budget.

This kit greenhouse has an aluminum frame and polycarbonate panels. It features sliding doors and a roof vent. With nearly 200 square feet of floor space.

Cold Frames

An inexpensive foray into greenhouse gardening, a cold frame is practical for starting early plants and hardening off seedlings. It is basically a box set on the ground and topped with glass or plastic. Although mechanized models with thermostatically controlled atmospheres and sashes that automatically open and close are available, you can easily build a basic cold frame—or several, in a range of sizes. Just be sure to make the back side of the frame about twice the height of the front so that the glazing can be slanted on top. Also ensure that the frame is tall enough to accommodate the ultimate height of the plants growing inside. The frame can be made of brick, plastic, wood, or other materials, and it should be built to keep drafts out and the soil in. Most important, the soil inside must be fertile, well tilled, and free of weeds.

If the frame is permanently sited, position it to receive maximum light during winter and spring and to offer protection from wind. An ideal spot is against the wall of a greenhouse or another structure. Ventilation is important; more plants in a cold frame die from heat and drought than from cold. A bright March day can heat a cold frame to 100°F (38°C), so be sure to monitor the temperature inside, and prop up or remove the cover when necessary. On cold nights, especially when frost is predicted, cover the box with burlap, old quilts, or fallen leaves for insulation.

HOTBEDS

Similar in construction to cold frames (but not as common), hotbeds have been around since Roman times. Emperor Tiberius directed his gardeners to grow cucumbers in dung-filled carts that were wheeled outside during the day and brought into a rudimentary "greenhouse" at night so that he had a supply of the vegetables year round. This type of garden incorporates horse or chicken manure, which releases heat as it decomposes. The manure is set within the bed frame below ground level and is then topped with a layer of soil. (If you prefer, you can forgo the manure and lay heating cables between soil layers.) To prevent overheating, ventilate a hotbed as you would a cold frame.

A prefabricated cold frame such as this offers many benefits, including an easy-to-use flip top, white plastic glazing that diffuses light, and an attractive appearance.

Sunrooms

A greenhouse can certainly satisfy the desire to grow a profusion of plants year-round, but it's not everyone's cup of tea. Even the most avid gardener will agree that operating and maintaining a greenhouse requires a major commitment—in a greenhouse, the plants depend solely on you for their well-being. The sunroom, on the other hand, allows you to surround yourself with flowers and plants in a sunny, light-filled room that is designed primarily for your comfort.

Like the greenhouse, the sunroom's roots are found in the orangeries and conservatories built on the grand estates of Europe. In the nineteenth-century conservatory, fashionable women gathered under the glass in exotic, palm-filled surroundings for tea. The twenty-first-century garden room invites us to do the same, in a comfortable interior environment from which we can appreciate the outdoors year-round. Large windows and doors open onto the terrace or garden. A high roof, which might be all glass, lets in abundant natural light. Decorative architectural features announce that this place is different from the rest of the house—separate, but in harmony. Like the conservatories of old, sunrooms can be used for growing plants and flowers indoors, but they are just as often used as sitting rooms, from which to admire the plantings outside the windows.

The sunroom can be a grand conservatory—an ornamented, plant-filled glass palace attached to an equally grand home. Or it can be a modest room containing little more than a few potted plants and a comfortable reading chair. Grand or modest, the sunroom is neither wholly of the house nor of the garden; it is a link between the two, a place in which you can feel a part of the garden but with all of the comforts of home.

Like greenhouses, sunrooms can be as simple or as elaborate as your budget and style will allow. This sunroom blends beautifully with the house.

Greenhouse Styles

When choosing a greenhouse, consider the benefits and disadvantages of each style. Some offer better use of space, some better light transmission; others offer better heat retention, and some are more stable in strong winds. Keep in mind how you plan to use the greenhouse—its size and shape will have an impact on the interior environment.

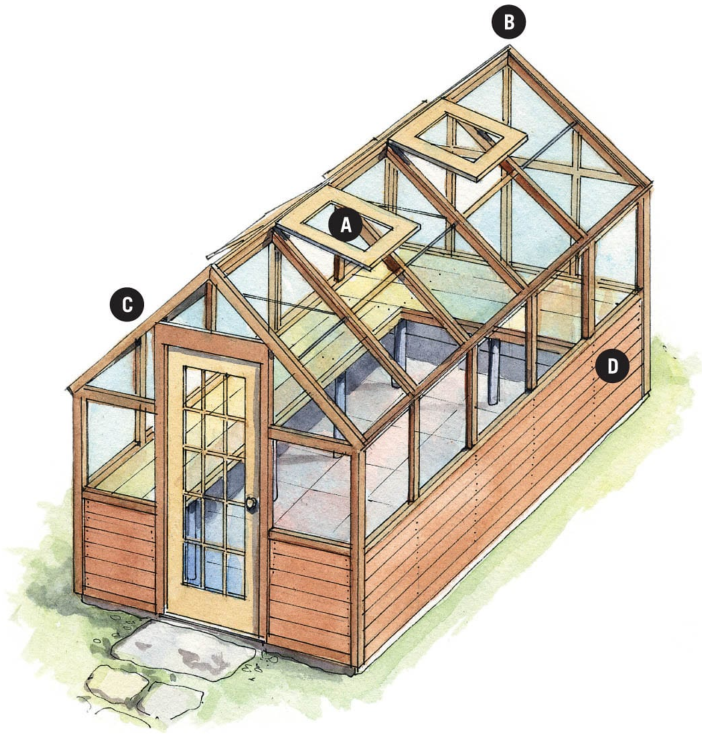
Traditional Span

A Ventilating roof windows

B High gable peak provides headroom

C 45° roof angle encourages runoff

D Solid kneewalls block wind, provide impact protection, and allow insulation



This type of greenhouse, sometimes sold in kits as an A-frame model, has vertical side walls and an even-span roof, with plenty of headroom in the center. Side walls are typically about 5’ high; the roof’s central ridge stands 7 to 8’ above the floor. This model shows a low base wall, known as a kneewall, but glass-to-ground traditional-span houses are also widely available. Kneewalls help to conserve heat but block light below the benches; glass-to-ground houses suffer more heat loss but allow in more light.

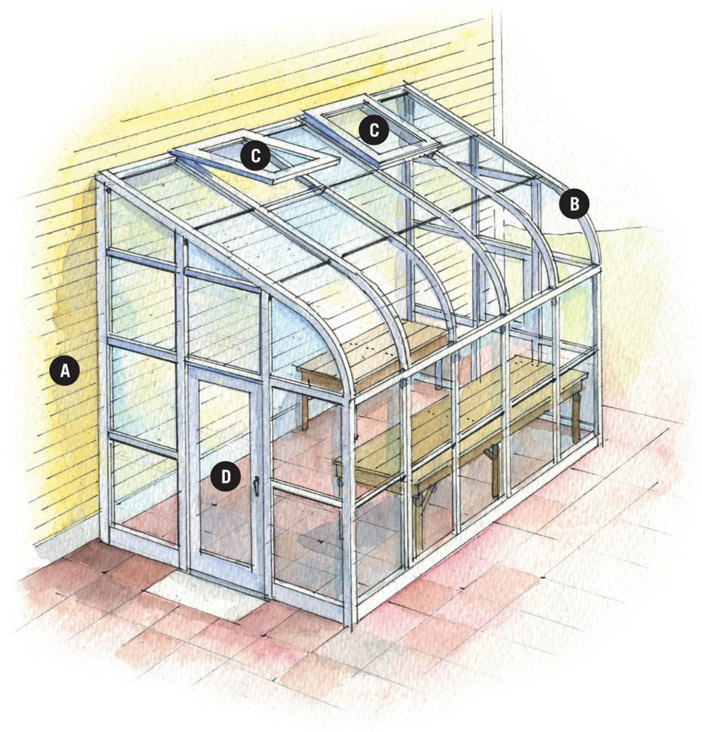
Lean-To

A Adjoining house provides structure and heat

B Aluminum frame is lightweight but sturdy

C Roof vents can be set to open and close automatically

D Well sealed door prevents drafts and heat loss



Because it is attached to the house, a lean-to absorbs heat from the home and offers easy access to utilities. This model shows curved eaves, a glazed roof, and glass-to-ground construction. Lean-tos can be built on kneewalls to provide more headroom and better heat retention than glass-to-ground styles. Sinking the foundation into the ground about 2 to 3’ can conserve even more heat.

Three-Quarter Span

A Adjoining house provides shelter

B Half-lite door insulates but allows some light in

C Operating side vent

D Gable creates headroom

Also attached to the house, this type of greenhouse offers the benefits of a lean-to with even more headroom and better light transmission (though it offers less light than a freestanding model). Because of the additional framing and glazing, this style is more expensive to build than a traditional lean-to.

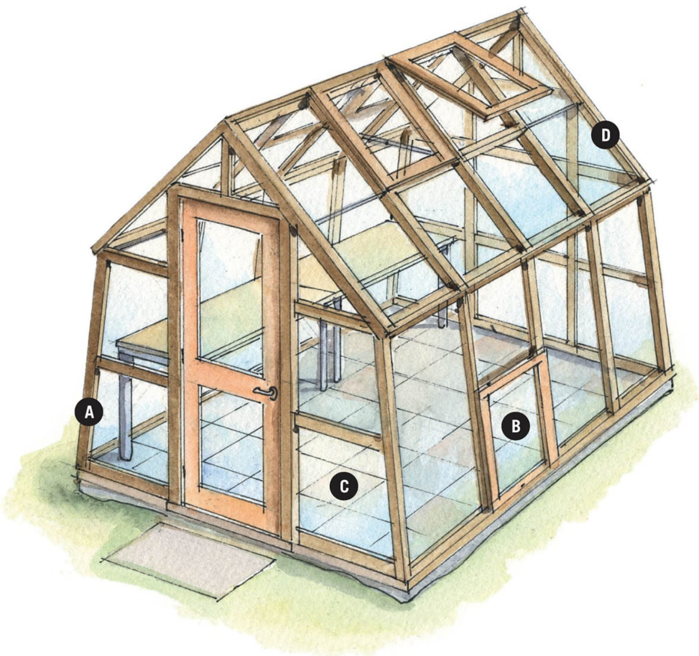
Dutch Light

A Tapered sidewalls encourage condensation to run off

B Lower side vent encourages airflow

C Tile floor retains heat

D Roof angle minimizes light reflection



Especially suitable for low-growing crops, such as lettuce, this design has sloping sides that allow maximum light transmission. However, large panes of glass, which may be 30 by 59”, are expensive to replace. The panes can be polycarbonate panels to save money or to diffuse light.

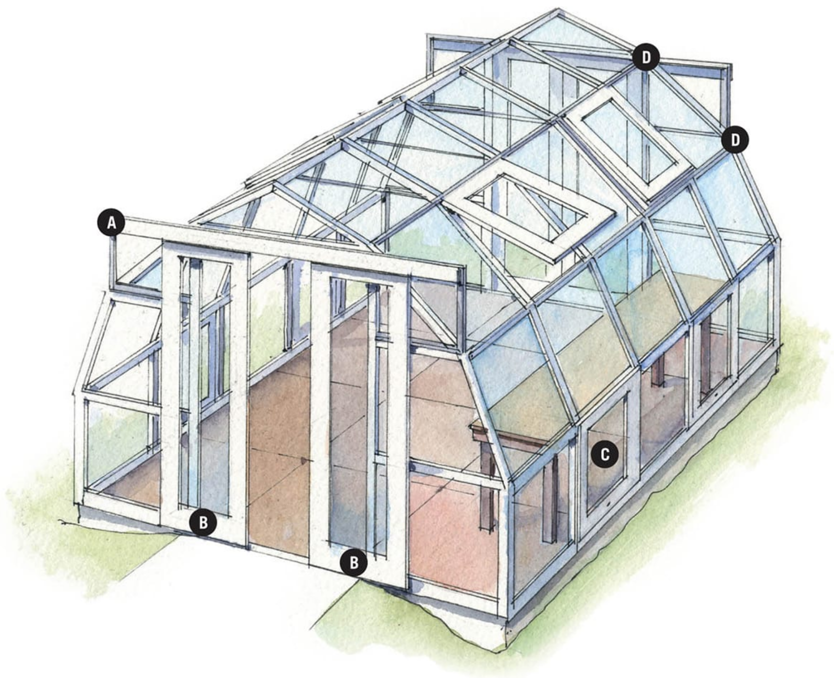
Mansard

A Full-width door frame

B Sliding doors can be adjusted for ventilation

C Lower side vents encourage airflow

D Stepped angles ensure direct light penetration any time of day or year



The slanting sides and roof panels that characterize the mansard are designed to allow maximum light transmission. This style is excellent for plants that need a lot of light during the winter. The downside is that this type of construction takes up a lot of room and can be an expensive greenhouse to build.

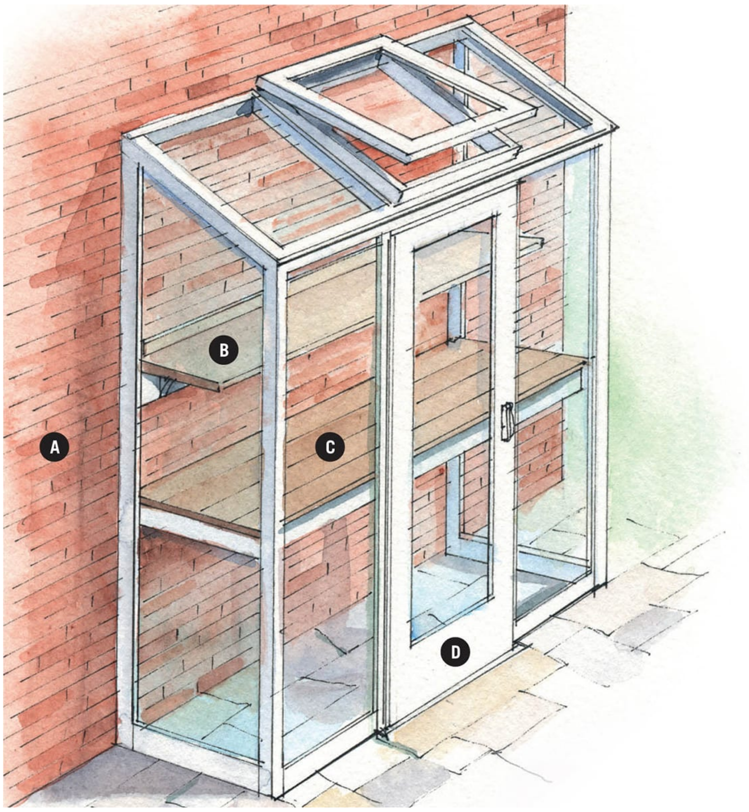
Mini-Greenhouse

A Brick wall retains heat

B Upper shelf does not block airflow

C Full-depth lower shelf creates hot spot below

D Full-lite storm door



A relatively inexpensive option that requires little space, this greenhouse is typically made of aluminum framing and can be placed against a house, a garage, or even a fence, preferably facing southeast or southwest, to receive maximum light exposure. Space and access are limited, however; and without excellent ventilation, a mini-greenhouse can become dangerously overheated. Because the temperature inside is difficult to control, it is not recommended for winter use.

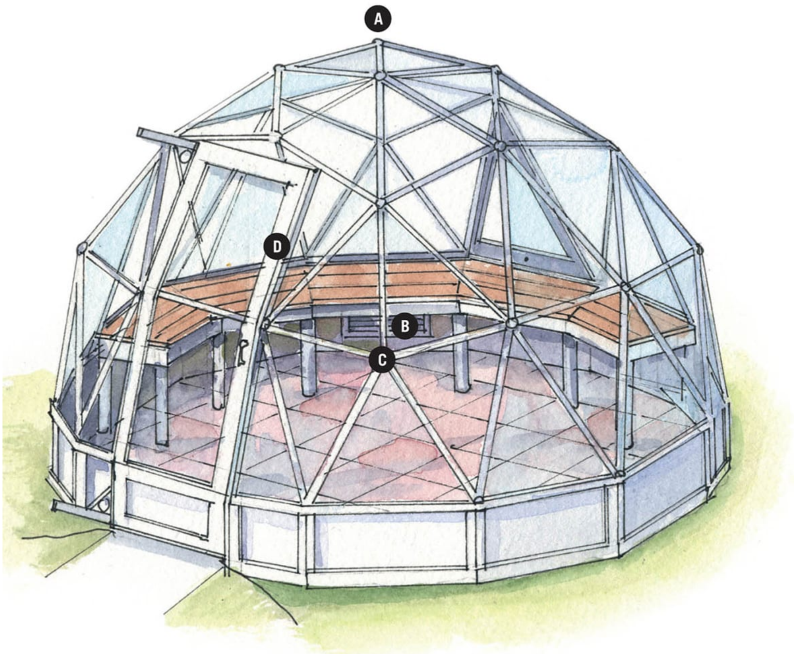
Dome

A Geometric dome shape is sturdy and efficient

B Louvered air intake vent

C Gussets tie structure together

D Articulated door is visually interesting (but tricky to make)



This style is stable and more wind-resistant than traditional greenhouses, and its multi-angled glass panes provide excellent light transmission. Because of its low profile and stability, it works well in exposed locations. However, it is expensive to build and has limited headroom, and plants placed near the edges may be difficult to reach. The structure will be far less expensive if the frame is built from a kit, and the entire greenhouse covered in plastic sheeting rather than glazed panels.

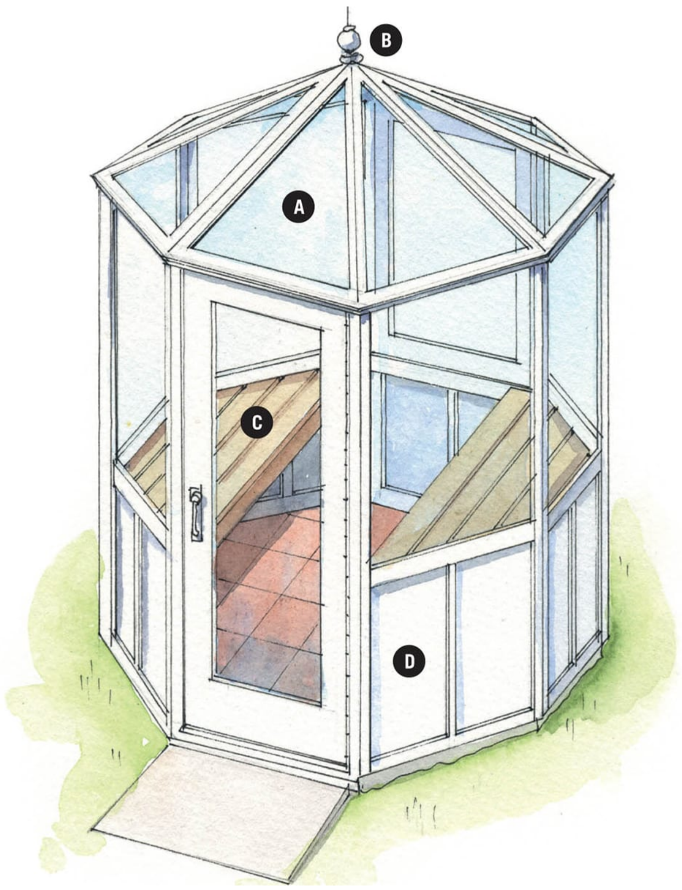
Polygonal

A Triangular roof windows meet in hub

B Finial has Victorian appeal

C Built-in benches good for planters or for seating

D Lower wall panels have board-and-batten styling



Though it provides an interesting focal point, this type of greenhouse is decorative rather than practical. Polygonal and octagonal greenhouses are typically expensive to build, and space inside is limited.

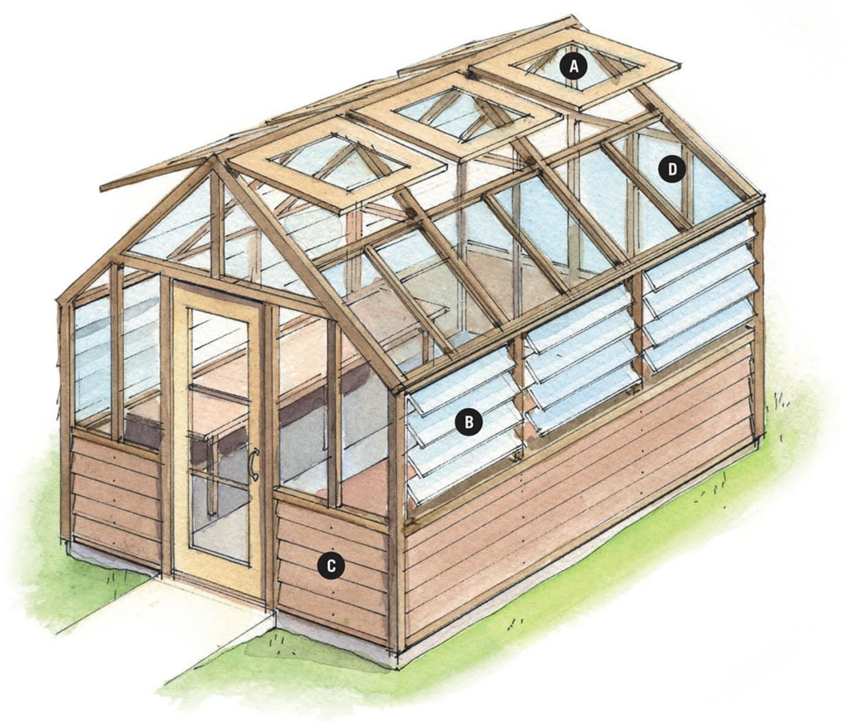
Alpine House

A Banks of venting windows at both sides of peak

B Adjustable louvers for air intake

C Cedar siding on kneewall has rustic appeal

D Fixed roof windows lend stability



Specifically designed for plants that normally grow at high elevations and thrive in bright, cool conditions, this alpine house is unheated and has plenty of vents and louvers for maximum ventilation. Doors and vents are left open at all times (except in winter). Many rock-garden plants—edelweiss, sedum, and gentian, for example—thrive in the alpine house environment.

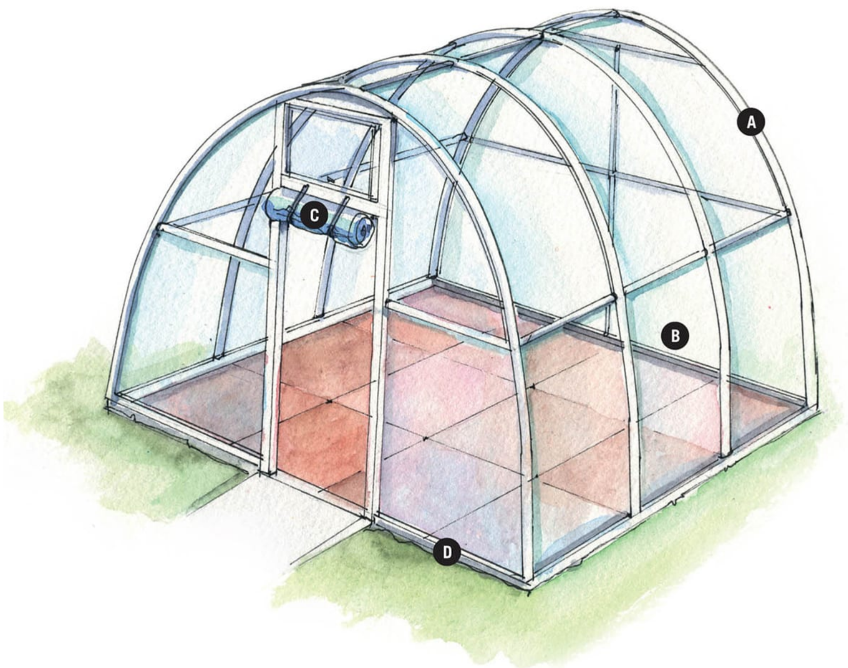
Hoophouse

A Bendable PVC tubes provide structure

B 4-mil plastic sheeting is very inexpensive glazing option

C Roll-up door

D Lightweight base makes hoophouse easy to move



Made of PVC or metal framing and plastic glazing, this lightweight, inexpensive greenhouse is used for low-growing crops that require minimal protection from the elements. Because it does not provide the warm conditions of a traditional greenhouse, it is designed mainly for extending the growing season, not for overwintering plants. Ventilation in this style can be a problem, so some models have sides that roll up.

Conservation Greenhouse

A High peak for good headroom

B Louvered wall vents

C Sturdy aluminum framing

D Broad roof surface for maximum heat collection

With its angled roof panels, double-glazing, and insulation, the conservation greenhouse is designed to save energy. It is oriented east-to-west so that one long wall faces south, and the angled roof panels capture maximum light (and therefore heat) during the winter. To gain maximum heat absorption for the growing space, the house should be twice as long as it is wide. Placing the greenhouse against a dark-colored back wall helps to conserve heat—the wall will radiate heat back into the greenhouse at night.

FREE GREENHOUSE DESIGN SOFTWARE

The United States Department of Agriculture (USDA) has developed a computer software program called Virtual Grower that you can use to create your own custom greenhouse design. It helps you make decisions about roof and sidewall materials, operating temperatures, and other variables. It even has a calculator for estimating heating costs. The software can be downloaded free of charge: https://www.ars.usda.gov/midwest-area/wooster-oh/application-technology-research/horticulture/virtual-grower/virtual-grower/

Gallery of Greenhouses

For such a basic, utilitarian structure, there is an astounding diversity of greenhouse styles. Some are purely functional, while others are over-the-top gorgeous. That's why, once you've made all the practical decisions of how big it will be, where you'll put it, what services you'll need, and what foundation it will go on, you'll still have plenty of options to choose from based purely on looks.

The traditional glass greenhouse is giving way to modern versions with synthetic panels that are often opaque, diffusing light and sparing plant leaves from burning. But the forms of the greenhouse structure haven't really changed. You can choose a traditional gabled construction, a slant-sided Dutch style, or a thoroughly modern geodesic dome. You'll find a range of options covered in the pages that follow. Use these as inspiration for your ultimate decision.

Simple and elegant, this aluminum-framed spacious greenhouse features useful sliding doors and roof vents that make it a handy four-season structure. The styling makes it an eye-catching addition to the landscape.

Grow in modern style with a high-end prefab shed greenhouse. This backyard stunner is sold as a kit but looks custom. It includes operable vent windows, and the footprint lends itself to many different greenhouse workspace configurations. Keep in mind that a greenhouse can be a backyard focal point as well as a utility building.

Optimize sunlight exposure with a dome. A little planning can make the most of the space inside, with smaller growing or immature plants around the perimeter, and tall growers in the center. Regardless, all your plants will see a lot of sunlight.

Integrate your greenhouse. This Gothic arch-style structure is a trim and inoffensive addition to a yard, but it really comes into its own as a planned part of the landscape. Positioned at the end of a path with a raised bed behind it, it seems just as permanent as the wood arbor or brick walls in this large courtyard.

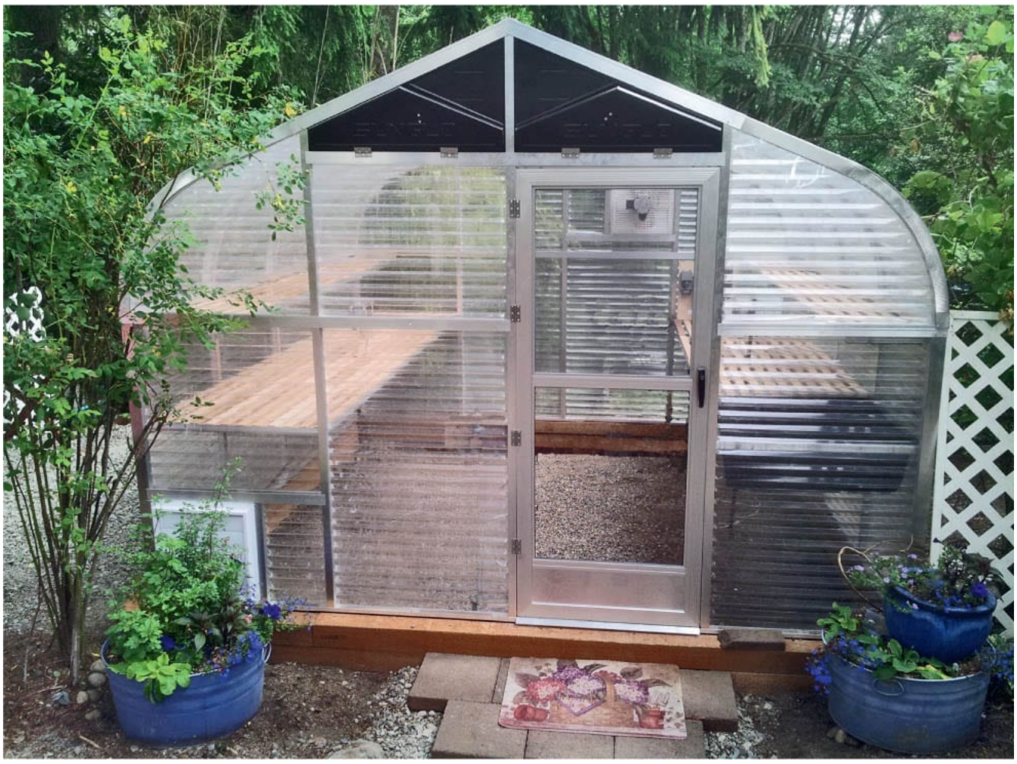
Start small with a lean-to. If you're not ready to commit to a full-blown greenhouse, a lean-to kit such as this one is a great way to get your feet wet. The simple construction belies a well-thought-out functionality. This kit comes with seals and gutters, and the homeowner has opted to create beds from mounded soil. Placing the lean-to on a brick patio meant that no foundation had to be dug.

Choose a lightweight option when you're not certain about siting. This well-constructed half-hoop kit greenhouse is a perfect starter for the novice gardener. It is easy to assemble and can be anchored in place or easily moved to a different location to suit different plants.

Do the settings justice. An elegant cottage garden stuffed with flowering shrubs, wrought iron fencing and a formal lawn all set against a dramatic forested background, calls for a stunning traditional glass Victorian (sometimes called “Cape Cod” by manufacturers) greenhouse. This one has a mortared-stone knee wall and opaque roof panels, along with decorative touches including a chandelier. Sometimes the situation calls for going a little over the top.

Go prefab for quick and easy beauty. This particular greenhouse is a prefab, not a kit. It’s delivered as a completed structure, and is a handsome one. It features southern pine framing, UV-resistant, 8 mm twin-wall polycarbonate panels, and options like interior hanging plant hooks. The details that inlcude a built-in kneewall and gable peak finial are the icing on the cake.

Do domes in style. A geodesic dome doesn't need to look simple. This one features a wood knee wall, solid door, and bump-out vent panels. The opaque UV glazing serve the purpose and add to the stylish vibe.



Go wide for room to maneuver. This wider version of the greenhouse at right features enough room in the center aisle to use a wheelbarrow or even add a potting table. Where you'll be working inside the greenhouse often, choosing a wider model makes sense.

Prep for greenhouse success. This is another Gothic arch-style prefab greenhouse that has been set up for longevity and efficiency. It sits on a framed foundation, with a dirt floor that can be used for growing and is forgiving of spills or accidents. The slotted benches are ready to hold plants in need of sun and tender care, and the stone path ensures slip-free accessibility in any season.

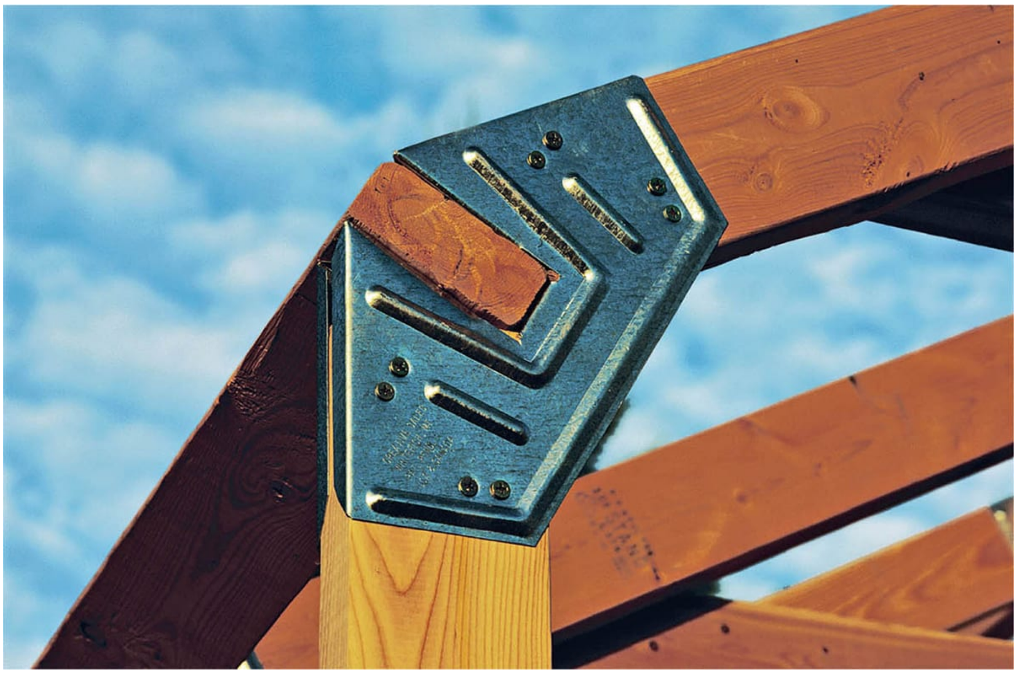
Integrate a kit greenhouse with other landscape features to make it seem at home. This tidy prefab unit is attractive enough with its crisp opaque panels, but it really seems part of the yard thanks to a bed planted next to it and planters around it.

Add built-ins for ease of use. This simple wood framed A-frame greenhouse comes outfitted with a vent fan and built-in sidewall benches. The rubber bench-top mats, and matching rubber walkway make this a practical and tidy interior space.

Match the landscape, with a redwood greenhouse that captures the nature of the wild surroundings. A brick and stone foundation add to the visual magic and provide an unshakeable foundation for the greenhouse.

Play it safe with lean-tos. A subdued, attached greenhouse will fit attractively with your house. This white-framed prefabricated lean-to provides abundant space inside and looks integrated with the house—the glass, not the frame, dominates. A brick walkway wrapping around the lean-to adds to the appeal.

Build a stunning greenhouse with wood. Few materials are quite as handsome as wood when it comes to framing a greenhouse, and the redwood that makes up this frame is especially beautiful. Left untreated, the frame will age to an elegant gray. This is a prefab all-in-one structure, even though it looks custom built.



Seek details that aid construction—modern greenhouse manufacturers offer many construction shortcuts that make building your greenhouse easier. This framing connector alleviates the need for multiple miter cuts, shaving quite a bit of time off the construction process.

Outfit for what you want to grow. Orchids are finicky plants that require carefully curated growing conditions, and this greenhouse—equipped with a variable-speed direction fan, multiple vent windows, and a sturdy heater—makes the perfect home for them. It doesn't hurt that the gorgeous redwood frame is a beautiful complement to the showstopping flowers.

Find a frame color that will work with your location. This lovely kit greenhouse is offered in different frame colors, but the green here blends with the forest-like surroundings. In tandem with a custom-made platform, the frame and opaque panels create a very elegant visual.

Supplement greenhouses with the right portable cold frame. This trim, prefab unit can be used on a patio with potted plants or placed right over young plants in a bed. It’s easy to clean, durable, and a great partner to a greenhouse in the garden.

Go big in a sun-drenched area. This sizeable “hobby” greenhouse offers plenty of room for plants of all types and plenty of window exposure to soak up the sun in a large, wide-open backyard.

Exploit plastics in your garden. This polyethylene-covered Quonset-style kit greenhouse packs a lot of usefulness in a compact footprint. Louvered air vents, stacked shelves, and a composite frame all ensure a longstanding, practical structure that also looks good anywhere in your yard or garden.

Commit to concrete. A concrete slab is perhaps the most stable and permanent of foundations. It creates a grounded look and a stage for a handsome greenhouse like the wood model here. A concrete pathway, poured at the same time as the slab, makes for easy access and a complementary visual. Over time, the gardener can fill in around the slab and walkway with potted plants to soften the look.

Pick accessories to make greenhouse gardening easy on yourself. The solar-powered automatic openers shown here make opening and closing vents and louvers one less thing you need to worry about. As the black probes are heated by increasing sunshine, they slowly trigger the opening devices, working in reverse when the sun goes down.

Determine quality by looking at the fine details. Inspect any prefab greenhouse for signs of quality construction. This quick-fit fastener makes assembly easier and less stressful, and it will ensure the long-term stability of the greenhouse.

Stage your greenhouse to make it a focal point and an incredible addition to your landscape. This smartly appointed prefab greenhouse, with its clean and sharp appearance, is shown to its best advantage by being centered on a raised foundation of crushed, colored gravel, bordered by scalloped pavers and wall blocks.

Organize your greenhouse from the start to ensure the gardening experience is as pleasant and efficient as possible. This simple greenhouse includes a center stone path that makes wheeling materials and plants in and out a breeze. The deep, sturdy workbenches ensure that plants have ample room while still leaving space for the gardener to work.

Greenhouse Projects

Hobby greenhouses of any size or type, custom or kit, are simpler structures than something like a home room addition. Even so, the focus in building one should always be on safety. After all, depending on the glazing, you may have heavy, breakable panels overhead.

Different types of greenhouses require different construction methods, but all do best on a stable, level foundation, protected from high winds and inclement conditions like hail.

Beyond those basics, the greenhouse you build will be predicated on budget, your skill level, and how much work you actually want to do (not to mention, exactly what you hope to grow in the structure). Don’t get overwhelmed; these are step-by-step buildings that don’t require professional expertise. Rather, success depends on your patience and leaving enough time for the process, precise measurements, and a focus on the details to create as air- and weather-tight a structure as possible.

In this chapter:

Custom Victorian Greenhouse

One objection to most kit greenhouses is that they tend to have little going for them on the style front: a plain metal framework supporting clear or opaque panels. If you're looking for a greenhouse project that blends with the look and character of your home, your best bet is to design and build one yourself.

The custom greenhouse seen in this project is designed and scaled to fit lean-to-style against a south-facing wall on an 1890s-era Victorian house. The principal design details that make it blend are the kneewall, which uses the same narrow wood lapsiding as the house, and the custom windows and door, which feature an arch element that is also present in the house trim. At roughly 6 × 9 feet in floorplan, the greenhouse is on the small side. But a space-conserving built-in-bench helps the gardener who designed the greenhouse get maximum usage from this small space.

The glazing on the greenhouse is ¼-inch-thick clear polycarbonate (See Resources). The roof panels are also clear ¼-inch polycarbonate, but with a hollow twin-wall construction that resists shattering and limits condensation. The roof vents are operated by lift arms with integral thermometers. When the air temperature inside the greenhouse hits around 85°F, the vents pop open automatically. The windows and the door are custom-made by sandwiching polycarbonate panels between wood frames. To allow for movement of the materials, the frames are bolted together through oversized bolt holes. All but one of the windows are hinged on the tops so they can swing open to enhance ventilation.

The greenhouse seen here features a poured concrete slab that is set apart from the house by an isolation joint. The back wall studs and roof panels are not connected to the house either, thus the greenhouse is technically a freestanding structure. Gaps between the greenhouse and the house are covered with various flashings, each of which is connected to one of the structures only. This has several advantages: primarily, it allows the structure to move and shift slightly (thereby avoiding cracking of glazing and roof panels) as the soil conditions and temperature change. And if the structure is small enough and has adequate setback distance from your property lines, you likely will not need a building permit. If the greenhouse were connected to the house, you would be required to dig full frost footings, as well.


Before
After

TOOLS + MATERIALS

Shovel

Garden rake

Hand tamper

Drill/driver

Framing square

Level

Concrete mixer

Mallet

Float

Sheet plastic

Powder-actuated tool

Clamps

Pencil

Tape measure

Circular saw

Jigsaw

Power miter saw

Pen

Drywall saw

Sandpaper

Straightedge guide

Compactible gravel

Deck screws (2½", 3")

Metal mesh

Concrete

J-bolts

Post anchors

Socket wrench

Concrete nails or screws

Skew joist hangers

Joist hanger nails

Paint and paint brush

Seaming strip

Pole barn screws

Metal flashing

Roof vent covers

Piano hinges

Automatic window vent opener (optional)

Bolts

Wood glue

8d finish nails

Exterior-rated butt hinges

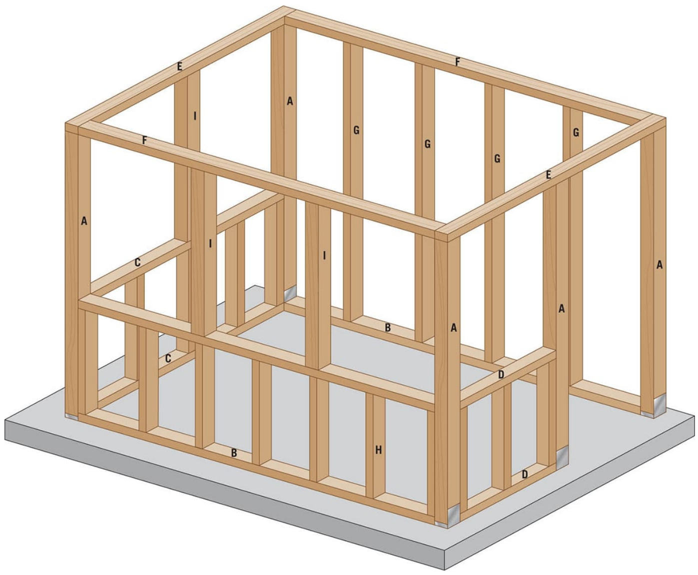
Door pulls and eyehooks

Door stop moldings

Garage door sweep

Silicone caulk

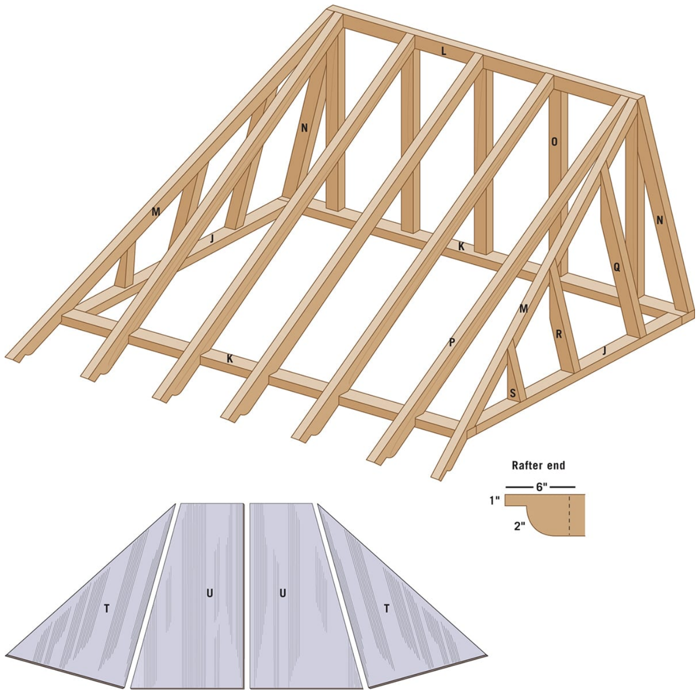
FRAMING



CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
A	Post	5	3½ × 3½ × 78”	4 × 4
B	Front/back plate	2	1½ × 3½ × 84½”	PT 2 × 4
C	End plate	2	1½ × 3½ × 56”	PT 2 × 4
D	Door wall plate	2	1½ × 3½ × 26”	PT 2 × 4
E	End cap-bottom	2	1½ × 3½ × 63”	2 × 4
F	F/B cap-bottom	2	1½ × 3½ × 84½”	2 × 4
G	Back wall stud	4	1½ × 3½ × 76½”	2 × 4
H	Kneewall stud	15	1½ × 3½ × 33”	2 × 4
I	Upper stud	3	3½ × 3½ × 42”	4 × 4

ROOF

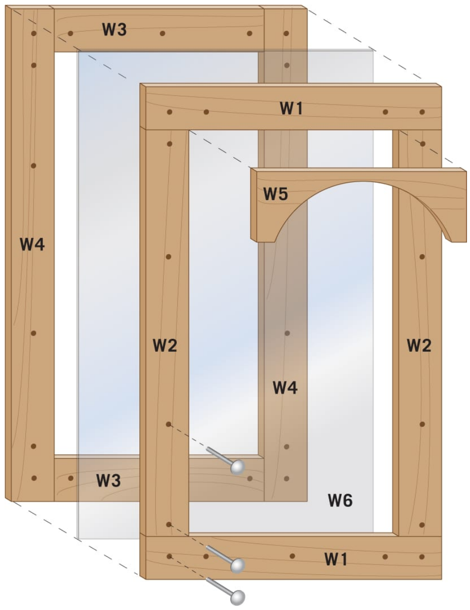


CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
J	End cap-top	2	1½ × 3½ × 56”	2 × 4
K	F/B cap-top	2	1½ × 3½ × 91½”	2 × 4
L	Roof ridge	1	1½ × 3½ × 64”	2 × 4
M	Skew rafter	2	1½ × 3½ × 79”	2 × 4
N	Roof leg	2	1½ × 3½ × 39½”	2 × 4
O	Roof support	5	1½ × 3½ × 34”	2 × 4
P	Rafter	5	1½ × 3½ × 81”	2 × 4
Q	Cripple rafter	2	1½ × 3½ × 30”	2 × 4
R	Cripple rafter	2	1½ × 3½ × 22”	2 × 4
S	Cripple rafter	2	1½ × 3½ × 12”	2 × 4

KEY	PART	NO.	DIMENSION	MATERIAL
T	Roof panel-side	2	¼ × 42 × 63”	Suntuf
U	Roof panel-main	2	¼ × 47 × 79”	Suntuf

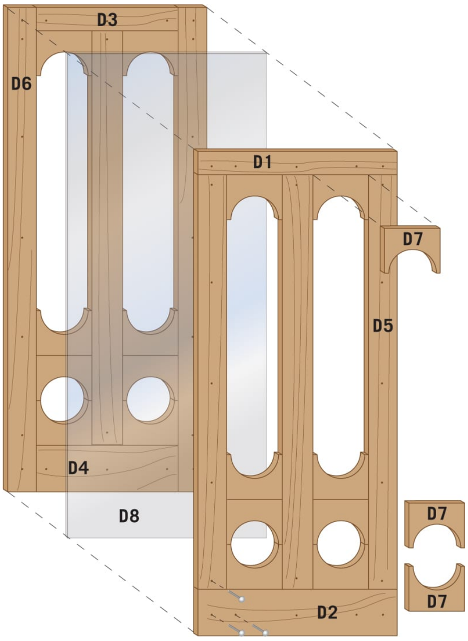
WINDOW



CUTTING LIST (26 × 40½”)

KEY	PART	NO.	DIMENSION	MATERIAL
W1	Rail-A	2	¾ × 3½ × 26”	1 × 4
W2	Stile-A	2	¾ × 3½ × 33½”	1 × 4
W3	Rail-B	2	¾ × 3½ × 19”	1 × 4
W4	Stile-B	2	¾ × 3½ × 40½”	1 × 4
W5	Insert	2	¾ × 5¼ × 19”	1 × 4
W6	Glazing	1	¼ × 26 × 40½”	Palsun

DOOR



CUTTING LIST (26 × 77½”)

KEY	PART	NO.	DIMENSION	MATERIAL
D1	Rail-A	1	¾ × 3½ × 26”	1 × 4
D2	Rail-B	1	¾ × 5½ × 26”	1 × 6
D3	Rail-C	1	¾ × 3½ × 19”	1 × 4
D4	Rail-D	1	¾ × 5½ × 19”	1 × 6
D5	Stile-A	2	¾ × 3½ × 68½”	1 × 4
D6	Stile-B	2	¾ × 5½ × 77½”	1 × 4
D7	Insert	16	¾ × 5½ × 7¾”	1 × 6
D8	Glazing	1	¼ × 26 × 77½”	Palsun

Materials for Building Custom Greenhouses

The glazing and roof panels in this custom greenhouse are made from ¼”-thick polycarbonate panels. The roof panels have vertical walls and are hollow, which makes them more dimensionally stable and less likely to crack than clear panels (a big benefit for roof). The ¼”-thick, clear polycarbonate used for the window and door glazing is very durable too. Standard ⅛”-thick clear acrylic can be used for roofs or glazing. It is relatively inexpensive and sold at most building centers. But it has a shorter lifespan than polycarbonate.

An automatic lifter arm contains a sensor that raises roof window vents when the interior temperature reaches a preset level—usually around 100°F.

Products for joining and fastening panels include a panel seam trim, which has wide flanges on both edges to accept two panels that butt together; 100% silicone caulk for sealing seams (check with the panel manufacturer for compatibility of adhesives and caulks); and rubber-gasket pole barn screws for fastening panels to rafters or purlins.

How to Build a Custom Victorian Greenhouse

Stake out the installation area for the greenhouse. Strip off vegetation and then excavate for the subbase material and that portion of the slab you want to be underground. For drainage reasons, plan your slab so at least 1 to 2” of the concrete is above grade.

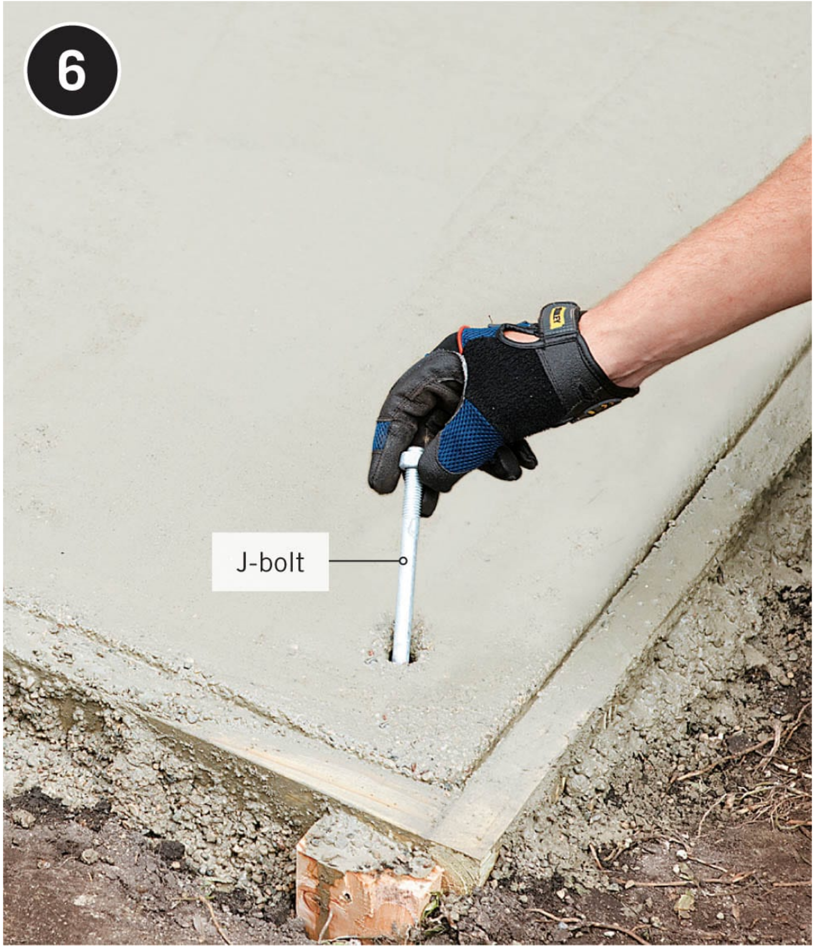
Install a 4 to 6" thick layer of compactible gravel to create a stable subbase. Tamp the gravel with a hand tamper or rental compactor. The tamped surface should slope away from the house at a very shallow rate—about $^{1}/_{16}$" per foot. Insert an isolation board strip (usually made of asphalt-impregnated fiberboard) between the slab area and the foundation wall to keep the structures separate.

Build the three-sided concrete form and position it on top of the subbase. Screw the three 2 × 4s together with deck screws and then tack a 1 × 4 or 2 × 4 across the top, back ends of the sides. Square and level the forms and then drive wood stakes outside the 2 × 4 members. Attach the form to the stakes with deck screws driven through the stakes and into the form boards.

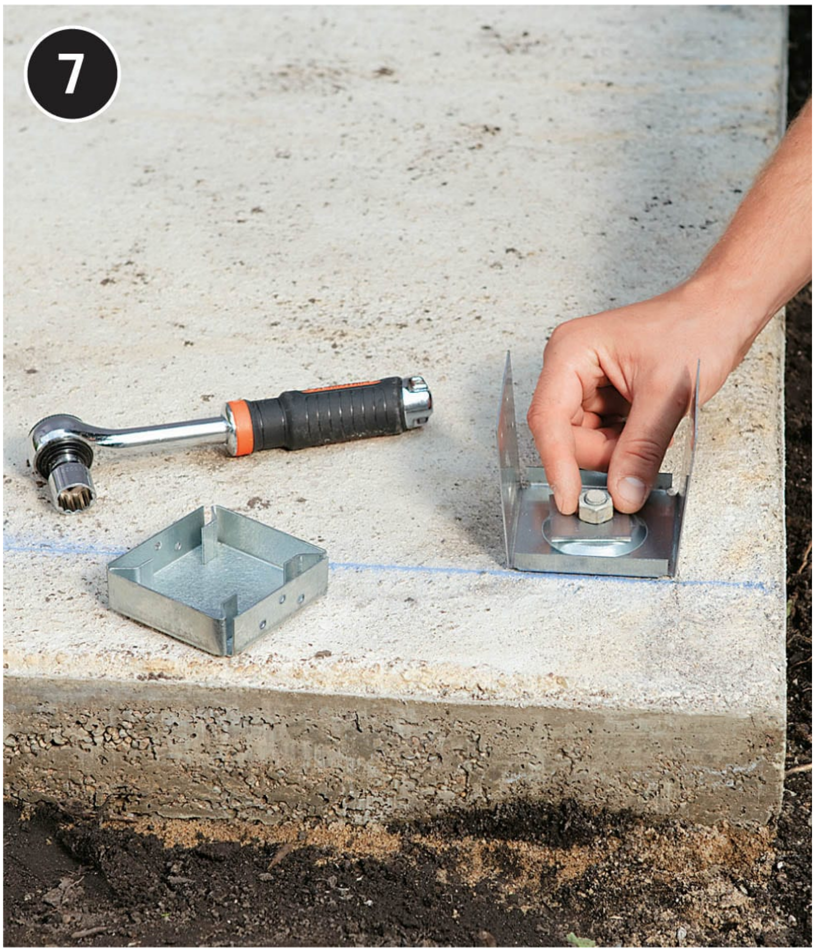
NOTE: The slab seen here is sized so there is a concrete apron of 2 to 3" around the structure, resembling a foundation wall. Some builders prefer to size the slab so the corner posts are flush with the slab edges, allowing you to cover the gap at the concrete surface with siding.

Add reinforcement in the concrete area. For most DIYers, metal re-mesh is an easy reinforcement material to work with. It is sold in 5 × 50' rolls and in 4 × 8' sheets. Prop the re-mesh on some small stones or bolsters. The edges of the reinforcement should be at least 4 to 6" away from the sides, and no closer than 1" to the concrete surface.

Pour concrete into the form. For a slab of the dimensions shown (4" thick by 68 × 84") approximately 15 cu. ft. (½ yard) of concrete is required (thirty 60-pound bags of dry mix). Settle the concrete by rapping the forms lightly with a mallet, and then strike off the material before floating.



Set J-bolts into the concrete after it sets up and after you have rounded the edges with an edger tool. Make sure to follow your plan closely for the J-bolt positions. Cover the concrete with sheet plastic and allow it to dry overnight before removing the forms.

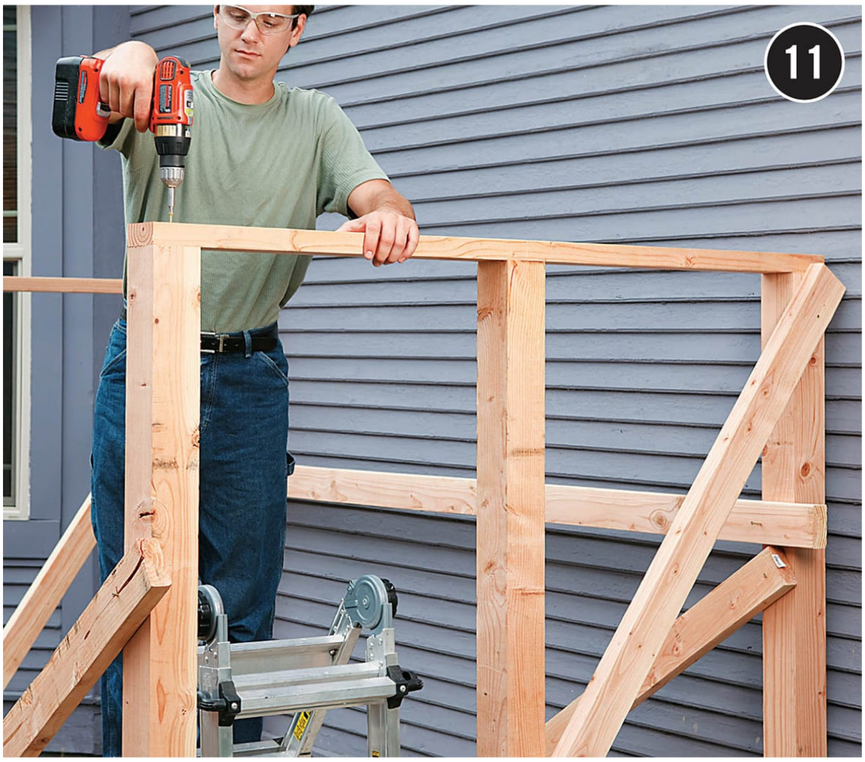


Install post anchors at the corners and at the doorjamb location. Standoff posts that elevate the post bottom slightly will greatly reduce the amount of water the post end will wick up from the footing.

Cut the 2 × 4 sill plates to fit between the posts, using pressure-treated lumber. Install the sill plates by fastening with a powder-actuated tool and concrete nails. Or, you can drill guide holes and install masonry anchor sleeves or simply drive concrete screws into the concrete.

Tack the posts in the standoff post bases with a couple of deck screws, making sure they are resting cleanly on the standoff pads. Also brace the posts with 2 × 4 braces so they are plumb. Tack all the posts in position and plumb them and then mark level cutting heights using a laser level or level for reference.

Remove the posts for trimming to final height, making sure to note which post belongs in which base. Marking and cutting in this manner ensures that the tops of all posts will be level even though the slab slopes away from the house. Precutting posts to the same length will result in a roof structure that is not flat. Reinstall the posts in the anchors and fasten with joist hanger nails or 16d galvanized nails.



Cut the 2 × 4 endwall cap plates to length and screw them to the tops of the corner posts with 3” deck screws. Test frequently to make sure the corners are square and the edges are flush with the post edges.

Clamp the doubled front and back wall cap plates together so the top plate overhangs the lower plate by 3½” on each end. Screw the top plates to the endwall cap plates and then fasten the front and back wall plates together with 2½” deck screws. Fasten the top cap plate on each end.

Build stud walls for the kneewalls between posts. Space the kneewall studs so they will be positioned beneath the intermediate posts. Attach the cap plate to the tops of the studs.

Add 1 × 6 sills to the tops of the 2 × 4 kneewalls. The sills will cover the edges of the exterior siding, so make the interior edges flush with interior wall studs and cap plate.

Add intermediate 4 × 4 posts between the sills and the undersides of the doubled cap plates. These posts should be situated directly above kneewall studs. The posts are spaced so the distances between posts will create uniform-width bays for the windows.

Install back wall studs between the back sill plate and the back cap plates, spaced 16" on center. Do not attach these studs to the house—they must remain isolated from it structurally.

Construct and attach the roof ridge support wall, featuring a 2 × 6 on edge at the top of the wall. It is easiest to build this wall on the ground and then erect it as a unit. Use a pair of 2 × 4 braces to keep the support wall stable while you attach the rafters.

Position a 2 × 4 so it spans from the ridge pole and past the header. Transfer cutting lines onto the workpiece and then cut the outer support legs to length at the marked angle. Attach the legs with deck screws.

Cut the rafters. Set workpieces in position against the 2 × 6 ridge pole and mark the point where they meet the header. Make a birdsmouth cutout in each rafter so it will rest flush on the header (top photo). Cut a decorative profile on each rafter end according to the diagram on this page (bottom photo).

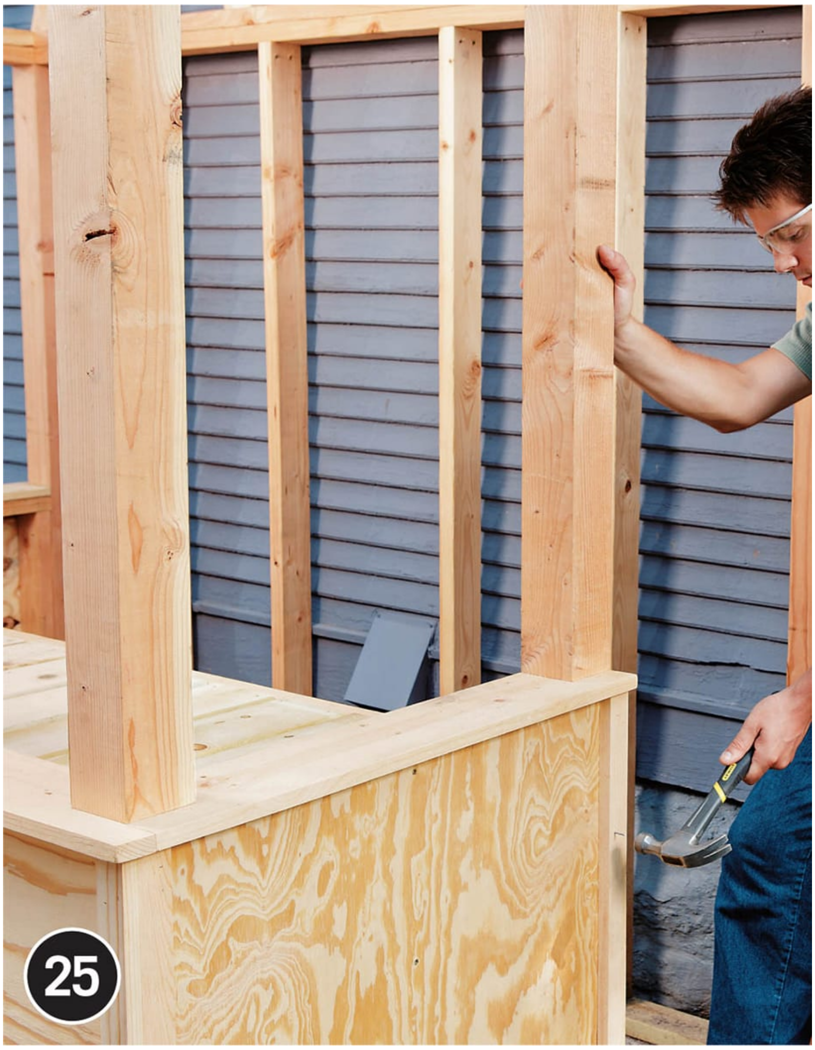
Install the corner rafters. First, attach skew joist hangers to the ends of the ridge pole for the skewed rafters that extend out to the front corners. Nail the rafters into the hangers with joist hanger nails. Toenail them (or drive screws toenail style) to the header.

Fill in the remaining rafters. If you wish, you can use joist hanger hardware to attach the rafters to the ridge pole. Or, you can nail or screw them. Spacing between rafters should be uniform.

Measure from the corner rafters to the endwall headers to find the lengths for the side rafters in the hip wall configuration. Cut 2 × 4 workpieces to length for each rafter.

Clamp the side rafter workpieces to a sturdy worksurface and cut the top and bottom angles with a circular saw or jigsaw. The side rafters in this design do not overhang the wall headers. Attach the side rafters with screws driven through pilot holes.

Cut kneewall sheathing panels from exterior plywood and attach the panels to the kneewall studs with deck screws.



Cut and install trim boards and corner boards according to your plan for siding the kneewall. The tops of the trim boards should butt against the undersides of the sills.

Install the siding on the kneewall. Generally, it is a good idea to install siding that matches the house siding. However, a well-chosen contrasting material also can have a pleasing design impact.

Paint the structure prior to adding roof panels and windows with glazing. Two coats of exterior paint is an adequate finish for an exterior lumber product, such as this cedar siding. A base coat of primer is always a good idea.

Also seal the roof structure with paint before installing the roof panels. The charcoal colored paint seen here recalls the color of wrought iron, which was used frequently to construct greenhouses and related Victorian structures, such as orangeries.

Begin to fasten the roof panels. The twin-wall corrugated polycarbonate panels seen here are fastened directly to the rafters. A panel seaming strip with channels on each edge is fastened to the center rafter to create a transition between the two abutting panels. Install the strip first so you can take more accurate width measurements for cutting the panels.

Cut the first roof panel to rough size using a circular saw fitted with a fine-tooth panel-cutting blade. Use a straightedge cutting guide. Or, use a tablesaw if you have access to one.

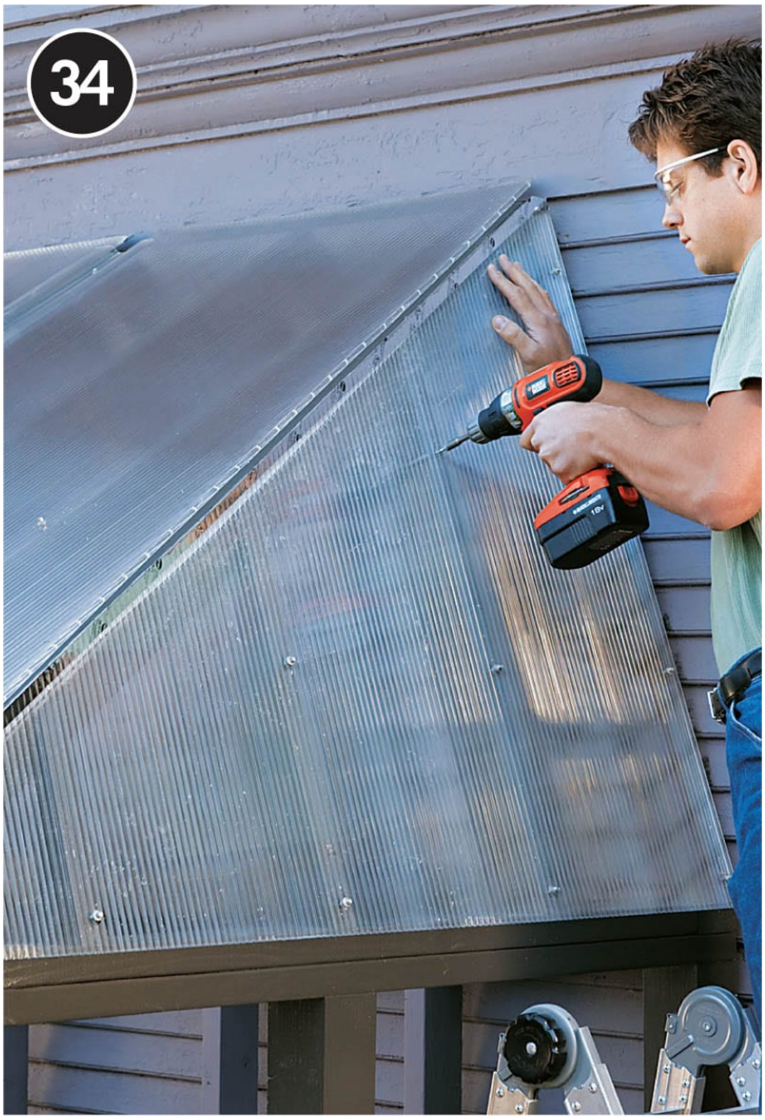
Set one edge of the panel into the slot in the seam strip so it is in the exact position you'll install it. Use a marking pen to trace a cutting line onto the panel, flush with the edge of the endwall. Remove the panel and cut it to size.

Set the panel into position and test the fit.

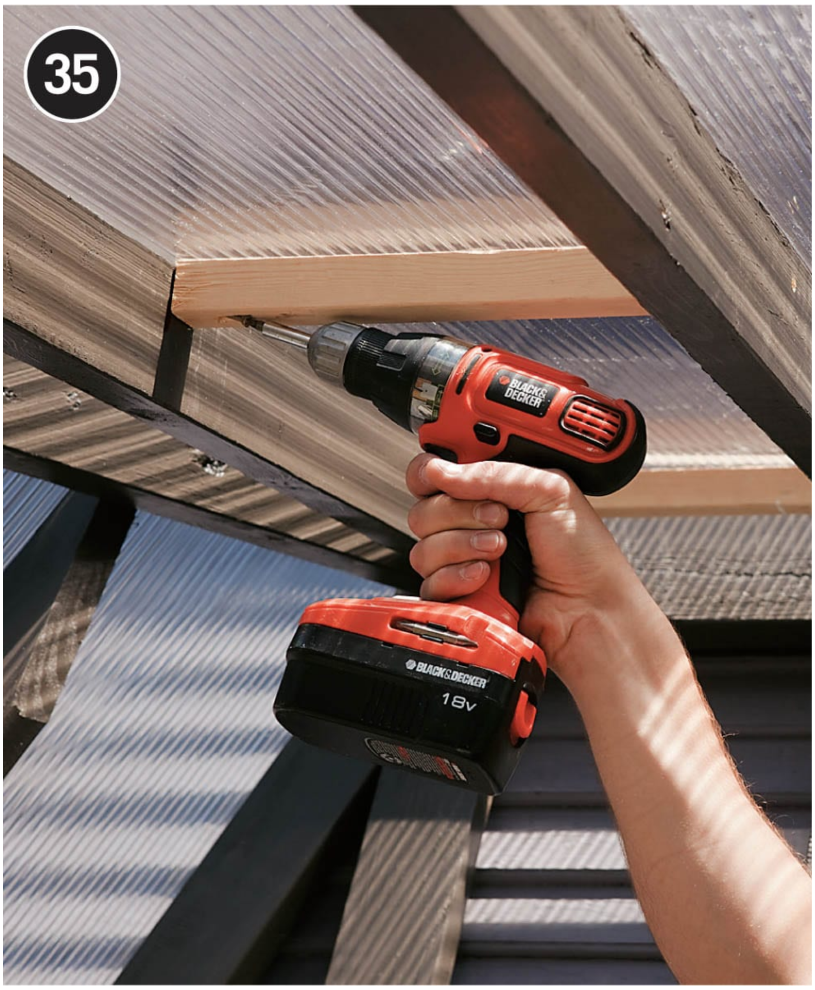
PROTECTING PANEL ENDS

Use foil tape to cover the top edges of corrugated panels, protecting the edges from moisture and insects (spiders love to lay eggs in channels like these). The edge on the bottom of the panel can be covered with foil tape also, but you'll need to poke a small weephole at the end of each channel so condensation can drain out. Or, you can use an alternate method such as L-shaped trim to protect the open panel ends (see Step 54).

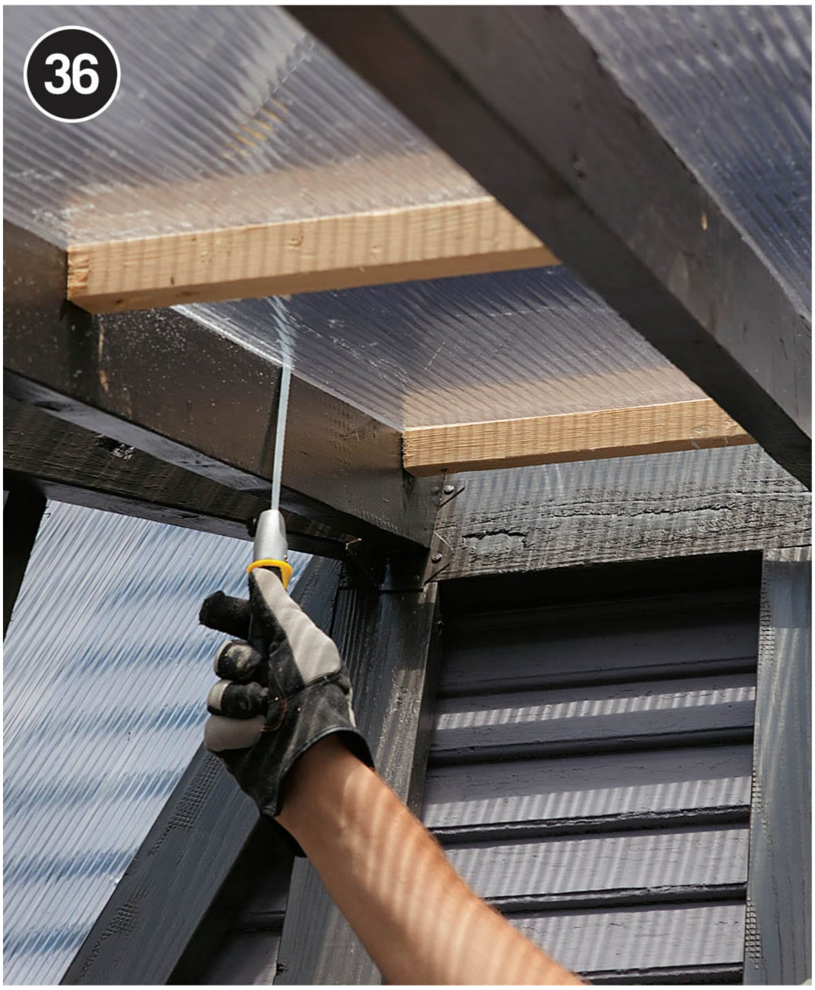
Fasten the roof panels with rubber-gasket equipped pole barn screws driven every 12" at each rafter or purlin. Take care not to overdrive the screws, but be sure they penetrate far enough to create a tight seal.



Cut the side roof panels to fit and attach them with rubber gasket screws. The hip seams will be covered with flashing (see here).



Frame openings for the roof vent cutouts. Install a pair of parallel framing members at the top and bottom of each opening. The tops of the frames should be flush against the roof panel.

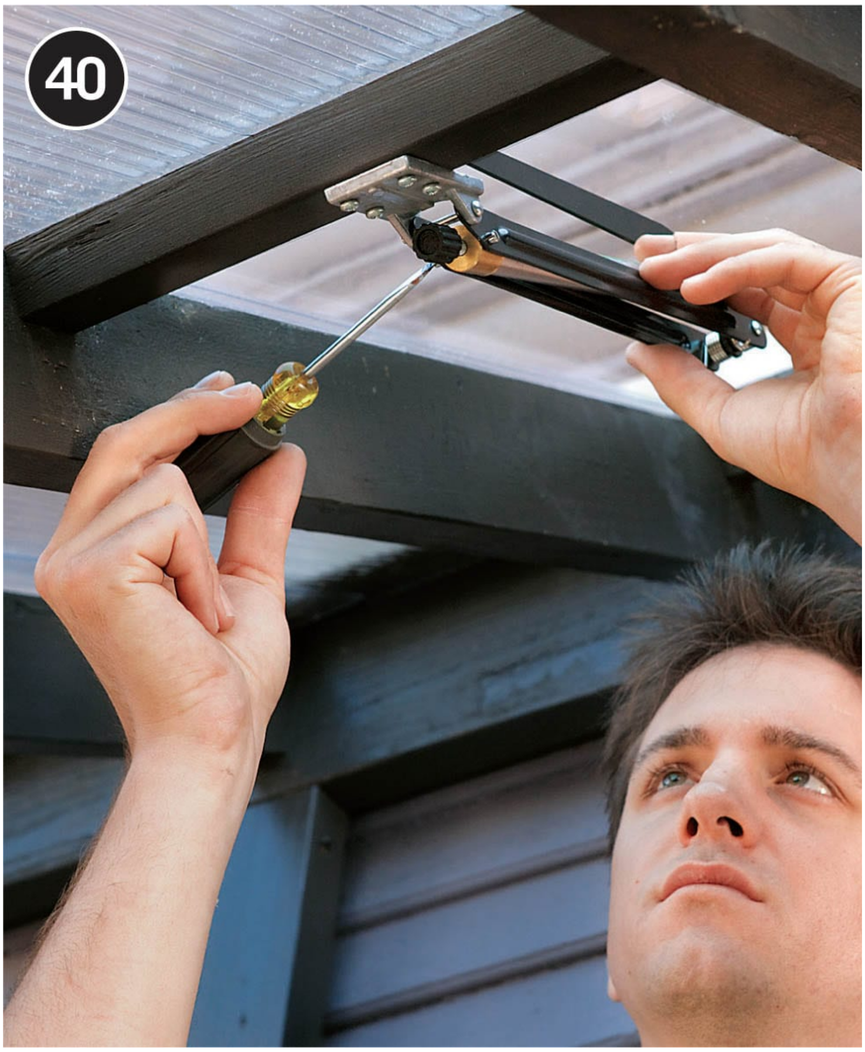


Cut out the openings in the roof panels. Drill a starter hole at each corner and then use a drywall saw to make the cuts. Clean up the cut edges with sandpaper.

Install flashing over the hip roof seams. Here, common drip cap flashing is being fastened with rubber-gasket screws driven into the roof rafters.

Cover the gap between the standalone greenhouse structure and the house with metal flashing. Aluminum handy flashing (12” width) can be fastened to the house and lightly creased so it extends over the gap and forms a seal without any physical connection to the greenhouse.

Install roof vent covers. (Here, the installation of the covers was postponed to allow access through the vent holes for installing flashing.) Use a piano hinge to attach each roof vent cover to the roof.



Attach an automatic window vent opener to each roof vent cover, according to the hardware manufacturer's instructions. These devices have internal sensors that lift the vent cover when the greenhouse overheats.

Make the greenhouse windows. First, cut the window glazing panels (¼" clear polycarbonate is used here) using a circular saw and a straightedge guide. The glazing should equal the full height and width of the window. For convenience, this greenhouse was designed with all six windows exactly the same size.

Cut the rails and stiles for the window frame to length from 1 × 4 pine stock. Assemble the frame parts around the glazing panel, clamping them together temporarily. Use the glazing panel as an alignment reference: if the panel is square and the frame edges are flush with the glazing all around, your window is square.

Drill guide holes for the bolts that draw the window parts together. Use a bit that's slightly larger than the diameter of the bolt shafts. This allows for slight expansion and contraction of the window parts as the temperature and humidity level change. Counterbore the bolt holes slightly.

Cut the arched inserts to fit at the top of the window frame opening. Install the inserts in the frame with glue and a couple of brads or pin nails. Install an insert on both the interior and the exterior sides of the window. Paint the window frames before installing and touch up after.

Attach door stop molding on the perimeter of each window opening, set so the window will be flush with the framed openings. Install fixed windows (if any) by centering the window unit in the opening side to side and driving a few 8d finish nails through pilot holes in the window and into the posts. Angle the pilot holes so the nail will not contact the glazing.

Install operable windows by centering the window unit in the opening, using shims to center it side-to-side and top-to-bottom. Hang the windows with exterior-rated pairs of butt hinges.

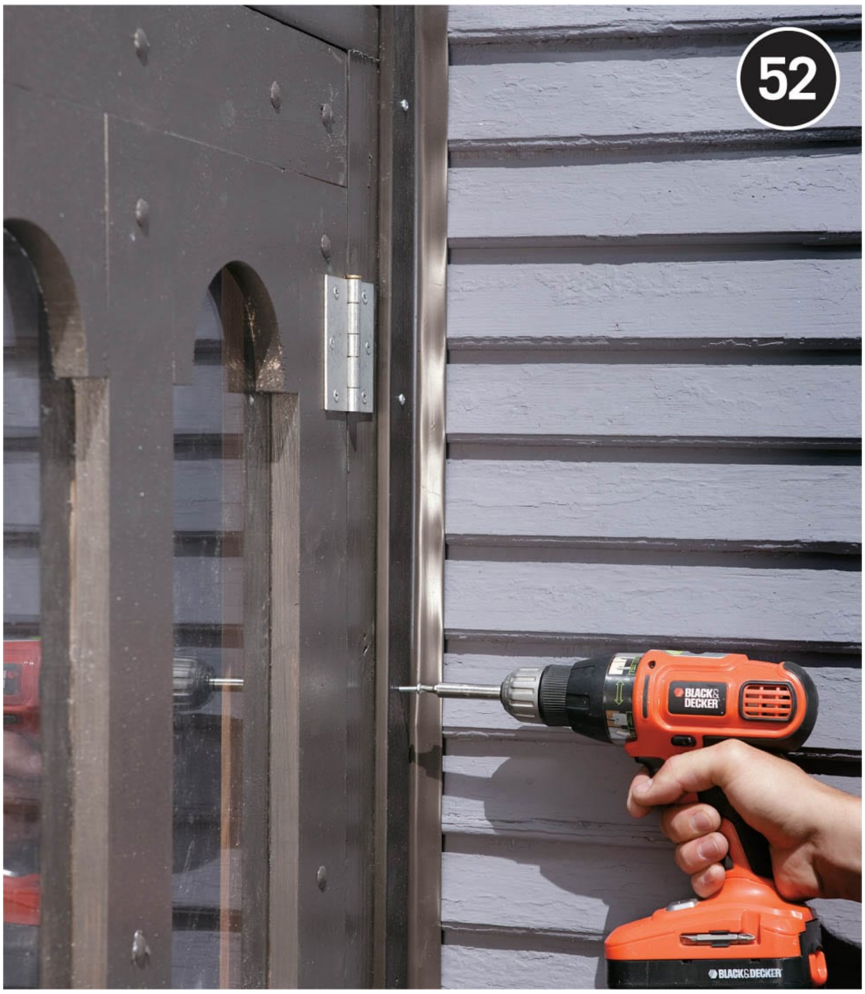
Install door pulls and eyehooks on the interior side of the window. Locate the pulls so they are centered and near the tops of the bottom window frame rails. Locate the eyehooks so there will be slight tension when the hook is in the screw eye—this will limit any rattling of the window.

Assemble the door frame. The center stiles should be attached to the frame rails with pocket screws or with deck screws driven toenail style. Clamp the parts together, sandwiching a piece of ¼” polycarbonate between the frames.

Bolt the door together in the same manner as the window, drilling over-sized guide holes and counterboring slightly for the nuts. Install two or three bolts in the center stile area to keep the frame and glazing from separating.

Cut the door panel inserts with a jigsaw and sand them smooth. Insert them into the framed openings as shown in the diagram on this page. Secure them on both sides of the glazing, using glue and brads or pin nails. Paint the door frame before installation and touch up after.

Hang the door. Door stop moldings should be installed so the door is flush with the outside greenhouse wall when closed. Add a latch and a handle. If you want to be able to lock the greenhouse, add a hasp and padlock.



Attach a garage door sweep (or comparable weatherstripping product) to cover the gaps between the greenhouse and the house. Flashing, such as drip cap, may be used to cover the gaps on the downsloping sides of the hip roof.

Make sure the foundation is clean and dry, then fill the gap between the concrete and the siding with clear silicone caulk.

Add trim elements to complete the roof. Parts of the roof trim system include: flashing over ridge (A); clear vent panel (B) attached with piano hinge (C) and automatic closer (D); seaming strip (E); metal drip cap for edges (F); ¼ × 1½” wood battens at rafter locations (G); vinyl cap molding at eave edges (H).

Finish the interior. You may add interior wallcoverings if you wish, but the exposed stud bays are good spots for adding shelving. For instructions on building this built-in potting bench, see here to here.

DIY Gabled Greenhouse

A greenhouse can be a decorative and functional building that adds beauty to your property. A greenhouse also can be a quick-and-easy, temporary structure that serves a purpose and then disappears. The wood-framed greenhouse seen here fits somewhere between these two types. The sturdy wood construction will hold up for many seasons. The plastic sheeting covering will last one to five seasons, depending on the materials you choose. It is easy to replace when it starts to degrade.

The 5-foot-high walls in this design provide ample space for installing and working on a conventional-height potting table. The walls also provide some space for plants to grow. For a door, this plan simply employs a sheet of weighted plastic that can be tied out of the way for entry and exit. If you plan to go in and out of the greenhouse frequently, you can purchase a prefabricated greenhouse door from a greenhouse materials supplier. To allow for ventilation in hot weather, we built a wood-frame vent cover that fits over one rafter bay and can be propped open easily.

You can use hand-driven nails or pneumatic framing nails to assemble the frame, if you wish, although deck screws make more sense for a small structure like this.

A wood-frame greenhouse with sheet-plastic cover is an inexpensive, semipermanent gardening structure that can be used as a potting area as well as a protective greenhouse.

TOOLS, MATERIALS + CUTTING LIST

(1) 20 × 50’ roll 4- or 6-mil polyethylene sheeting

(12) 24”-long pieces of #3 rebar

(8) 8” timber screws

Compactable gravel (or drainage gravel)

Excavation tools

Level

Circular saw

Drill

Reciprocating saw

Maul

3” deck screws

Jigsaw

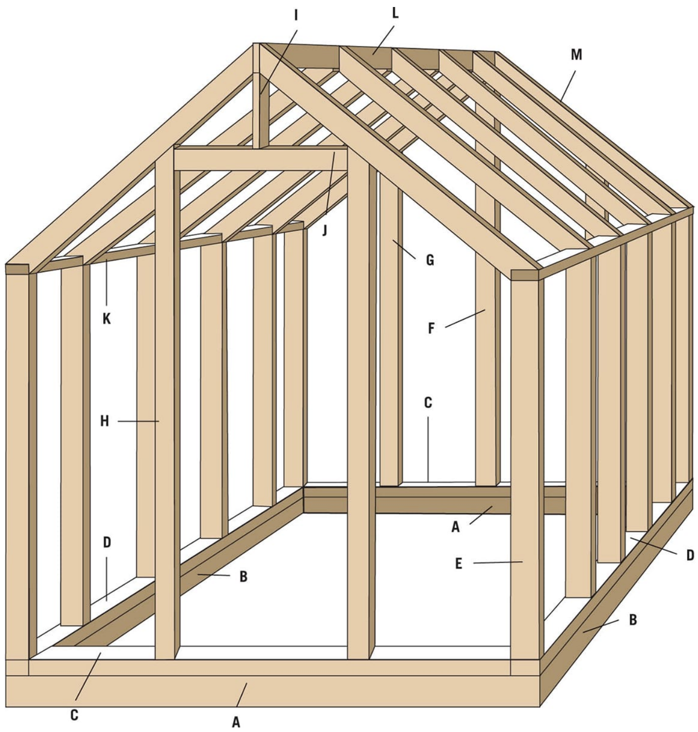
Wire brads

Brad nailer (optional)

Scissors

Utility knife

Tape measure



KEY	PART	NO.	DIMENSION	MATERIAL
A	Base ends	2	3½ × 3½ × 96”	4 × 4 landscape timber
B	Base sides	2	3½ × 3½ × 113”	4 × 4 landscape timber
C	Sole plates end	2	1½ × 3½ × 89”	2 × 4 pressure-treated
D	Sole plates side	2	1½ × 3½ × 120”	2 × 4 pressure-treated
E	Wall studs side	12	1½ × 3½ × 57”	2 × 4
F	Ridge support	1	1½ × 3½ × 91”	2 × 4
G	Back studs	2	1½ × 3½ × 76” *	2 × 4
H	Door frame sides	2	1½ × 3½ × 81” *	2 × 4
I	Cripple stud	1	1½ × 3½ × 16”	2 × 4
J	Door header	1	1½ × 3½ × 32”	2 × 4

KEY	PART	NO.	DIMENSION	MATERIAL
K	Kneewall caps	2	1½ × 3½ × 120”	2 × 4
L	Ridge pole	1	1½ × 3½ × 120”	2 × 4
M	Rafters	12	1½ × 3½ × 60” *	2 × 4

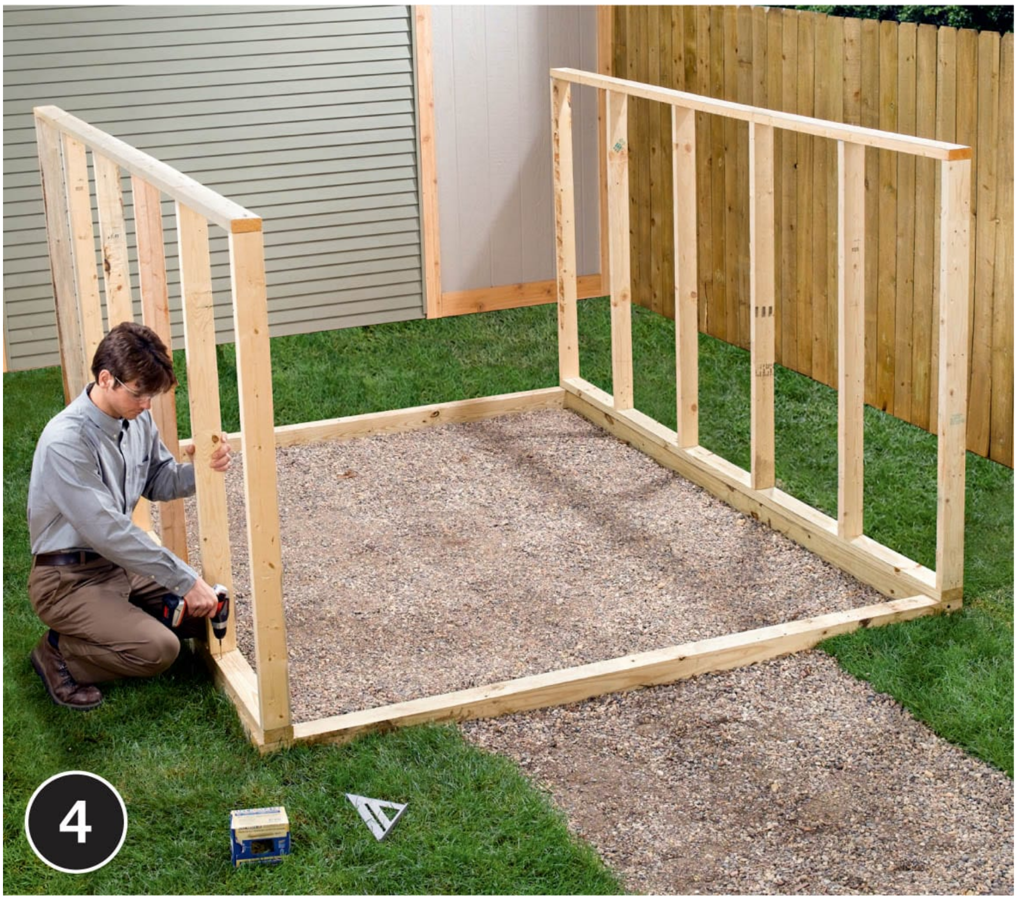
**Approximate dimension; take actual length and angle measurements on structure before cutting.*

How to Build a Gabled Greenhouse

Prepare the installation area so it is flat and well drained; then cut the base timbers to length. Arrange the timbers so they are flat and level and create a rectangle with square corners. Drive a pair of 8" timber screws at each corner, using a drill/driver with a nut-driver bit.

Cut 12 pieces of #3 rebar to length at 24” (if necessary), using a reciprocating saw or hacksaw. Drill a ⅜”-diameter pilot hole through each timber, near both ends and in the middle. Confirm that the timber frame is square by measuring diagonally between opposing corners (the measurements must be equal). Drive a rebar spike through each hole, using a hand maul, until the bar is flush with the timber.

Cut the sole plates, caps, and studs for the two kneewalls. Mark the stud layouts onto the plates and caps, spacing the studs at 24” on center. Assemble each kneewall by driving 3” deck screws through the sole plates and caps and into the ends of the studs.



Install the kneewalls onto the timber base. Set each wall onto a side timber so the sole plate is flush with the ends and side edges of the timber frame. Fasten the sole plate to the timber with 3" deck screws.

Begin the endwalls by cutting and installing the end sole plates to fit between the side plates, using 3” deck screws. Cut the ridge support posts to length. Toenail one post at the center of each end sole plate. Check the posts with a level to make sure they’re plumb before fastening.

NOTE: The front post will be cut later to create the door opening.

Set the ridge pole on top of the support posts and check it for level. Install temporary cross braces between the outer wall studs and each support post, making sure the posts are plumb before fastening the braces. Double-check the posts and ridge for plumb and level, respectively.

Create a template rafter by cutting a 2 × 4 at about 66". Hold the board against the end of the ridge and the top outside corner of a wall cap. Trace along the face of the ridge and the cap to mark the cutting lines for the rafter. Cut along the lines, then test-fit the rafter and make any necessary adjustments for a good fit.

Mark and cut the remaining rafters, using the template to trace the cutting lines onto each piece of stock.

TIP: A jigsaw or handsaw is handy for making the bottom-end cuts without having to over-cut, as you would with a circular saw.

Install the rafters, using the deck screws driven at an angle into the kneewall caps and the ridge. The rafters should be aligned with the studs and perpendicular to the ridge.

Mark the two door frame studs by holding them plumb and tracing along the bottom edge of the rafter above. Position the studs on-the-flat, so the inside edge of each is 16” from the center of the support post (for a 32”-wide door, as shown). Install the studs with angled screws. Cut and install two studs on the rear endwall, spacing them evenly between the kneewalls and support post.

Complete the door frame: Mark the front support post 78” (or as desired) up from the sole plate. Make a square cut at the mark, using a circular saw or cordless trim saw (inset), then remove the bottom portion of the post. Cut the door header (from the post waste) to fit between the door studs. Fasten the header to the door studs and remaining post piece with screws.

Begin covering the greenhouse with the desired cover material (6-mil poly sheeting shown here), starting at the endwalls. Cut the sheeting roughly to size and secure it to the framing with wood tack strips fastened with wire brads. Secure the sheeting at the top first, the sides next, and the bottom last. Trim the excess material along the edges of the strips with a utility knife.

Attach sheeting to the edges of the sole plate on one side of the greenhouse, then roll the sheeting over the top and down the other side. Draw it taut, and cut it a little long with scissors. Secure the sheeting to the other sole plate (using tack strips), then attach it to the outside edges of the corner studs.

Create the door, using a piece of sheeting cut a little larger than the door opening (or purchase a door kit; see photo below). Secure the top of the door to the header with a tack strip. Weight the door's bottom end with a 2 × 4 scrap cut to length.

OPTION: Make a vent window. First, cut a hole in the roof in one rafter bay and tack the cut edges of the plastic to the faces (not the edges) of the rafters, ridge pole, and wall cap. Then build a frame from 1 × 2 stock that will span from the ridge to the top of the kneewall and extend a couple of inches past the rafters at the side of the opening. Clad the frame with plastic sheeting and attach it to the ridge pole with butt hinges. Install a screw-eye latch to secure it at the bottom.

GREENHOUSE DOORS

Plastic door kits, available from greenhouse suppliers, include self-adhesive zipper strips and are easy to roll up and tie for access or ventilation. You can also create your own roll-up door with zipper strips and plastic sheeting purchased from a building center.

Freestanding Kit Greenhouse

Building a greenhouse from a prefabricated kit offers many advantages. Kits are usually very easy to assemble because all parts are prefabricated and the lightweight materials are easy to handle. The quality of kit greenhouses varies widely, though, and buying from a reputable manufacturer will help ensure that you get many years of service from your greenhouse.

If you live in a snowy climate, you may need to either provide extra support within the greenhouse or be ready to remove snow whenever there is a significant snowfall because the lightweight aluminum frame members can easily bend under a heavy load. Before buying a kit, make sure to check on how snowfall may affect it.

Kit greenhouses are offered by many different manufacturers, and the exact assembly technique you use will depend on the specifics of your kit. Make sure you read the printed instructions carefully, as they may vary from this project.

The kit here is made from aluminum frame pieces and transparent polycarbonate panels and is designed to be installed over a subbase of gravel about 5 inches thick. Other kits may have different subbase requirements.

When you purchase your kit, uncrate it and examine all the parts before you begin. Make sure all the pieces are there and that there are no damaged panels or bent frame members.

A perfectly flat and level base is crucial to any kit greenhouse, so work carefully. Try to do the work on a dry day with no wind, because the panels and frame pieces can be hard to manage on a windy day. Never try to build a kit greenhouse by yourself. At least one helper is mandatory, and you'll do even better with two or three.

Construction of a kit greenhouse consists of four basic steps: laying the base, assembling the frame, assembling the windows and doors, and attaching the panels.

Kit greenhouses come in a wide range of shapes, sizes, and quality. The best ones have tempered-glass glazing and are rather expensive. The one at right is glazed with corrugated polyethylene and is at the low end of the cost spectrum.

Organize and inspect the contents of your kit to make sure all of the parts are present and in good condition. Most manuals will have a checklist. Staging the parts makes for a more efficient assembly. Just be sure not to leave any small parts loose, and do not store parts in high-traffic areas.

A cordless drill/driver with a nut-driver accessory will trim hours off of your assembly time compared with using only hand tools.

Rent outdoor power equipment if you need to do significant regrading to create a flat, level building base. Be sure to have your local utility company inspect for any buried utility lines first. (You may prefer to hire a landscaping company to do regrading work for you.)

How to Build a Freestanding Kit Greenhouse

Establish layout lines for the gravel subbase, using stakes or batterboards and mason's string. The excavation area for the subbase should be at least 2" wider and longer than the outside dimensions of the greenhouse. Make sure the layout is perfectly square (the lines are perpendicular to one another) by measuring diagonally between opposing corners: the layout is square when the measurements are equal.

Excavate the site to a depth of 5", using the layout strings as a guide. As you work, use a straight 2 × 4 and a 4' level to check the excavation to make sure it is level and flat. Tamp any loose soil with a plate compactor or hand tamp. Cover the excavation with commercial-grade landscape fabric (do not use plastic; the membrane must be water-permeable). Fill the area with 2 or 3" of compactible gravel, grade and level it, then tamp it thoroughly. Add more gravel, level, and tamp for a final subbase depth of 5".

Assemble the greenhouse base, using the provided corner and end connectors. Set the base onto the subbase and make sure the base is level. Measure the diagonals to check for square, as before. Add a top dressing of gravel or other fill material inside the base, up to about 1” below the base’s top lip. Smooth and level the gravel as before.

Attach the bottom wall plates to the base pieces so that the flanged edges face outside the greenhouse. In most systems, the floor plates will interlock with one another, end to end, with built-in brackets.

Fasten the four corner studs to the bottom wall plates, using hold-down connectors and bolts. In this system, each corner stud is secured with two connectors.

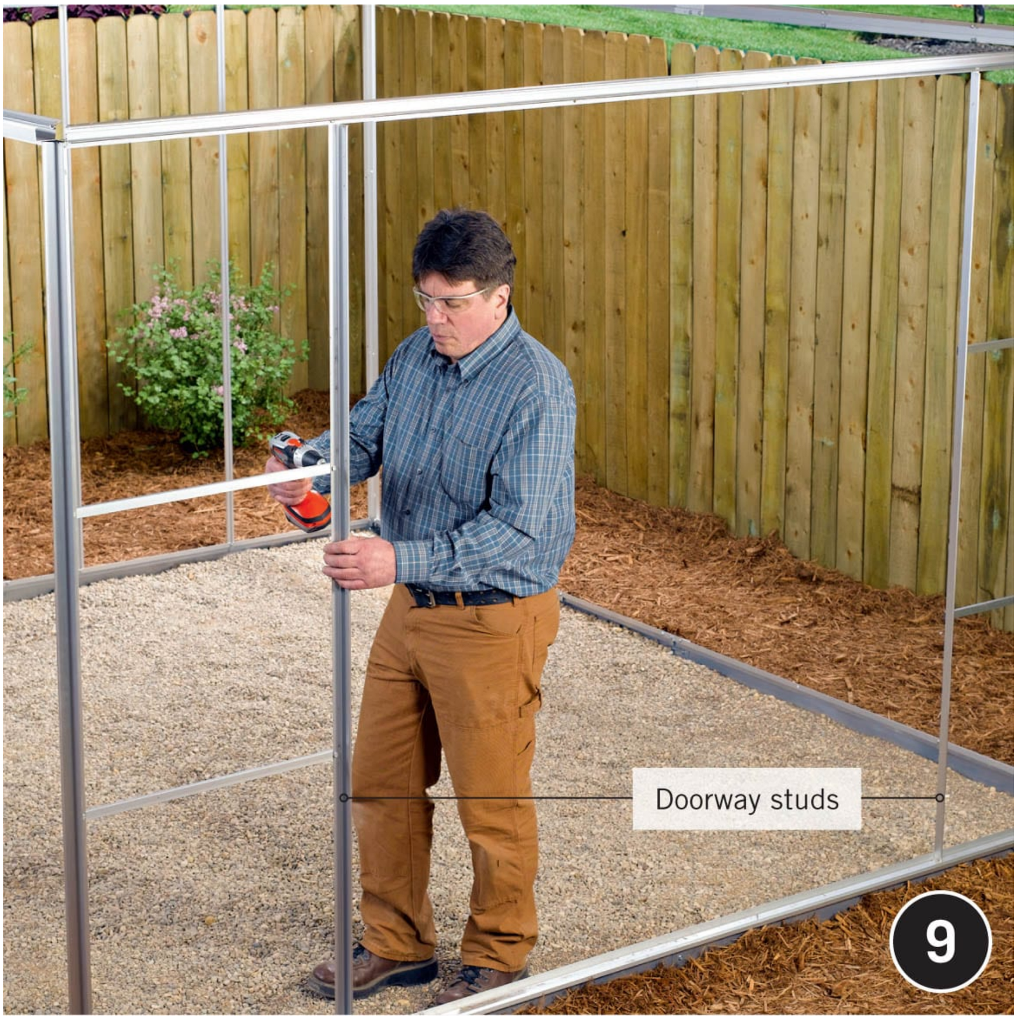
Install the ceiling plates: Assemble the pieces for each side ceiling plate. Attach each side plate against the inside of the two corner studs along each side of the greenhouse, making sure the gutter is positioned correctly. Attach the front ceiling plate to the outsides of the corner studs at the front of the building.

Attach the other side ceiling plate along the other side, flat against the inside of the corner studs. Then attach corner brackets to the rear studs, and construct the back top plate by attaching the rear braces to the corners and joining the braces together with stud connectors.

Fasten the left and right rear studs to the outside of the rear floor plate, making sure the top ends are sloping upward, toward the peak of the greenhouse. Attach the center rear studs to the rear floor plate, fastening them to the stud connectors used to join the rear braces.

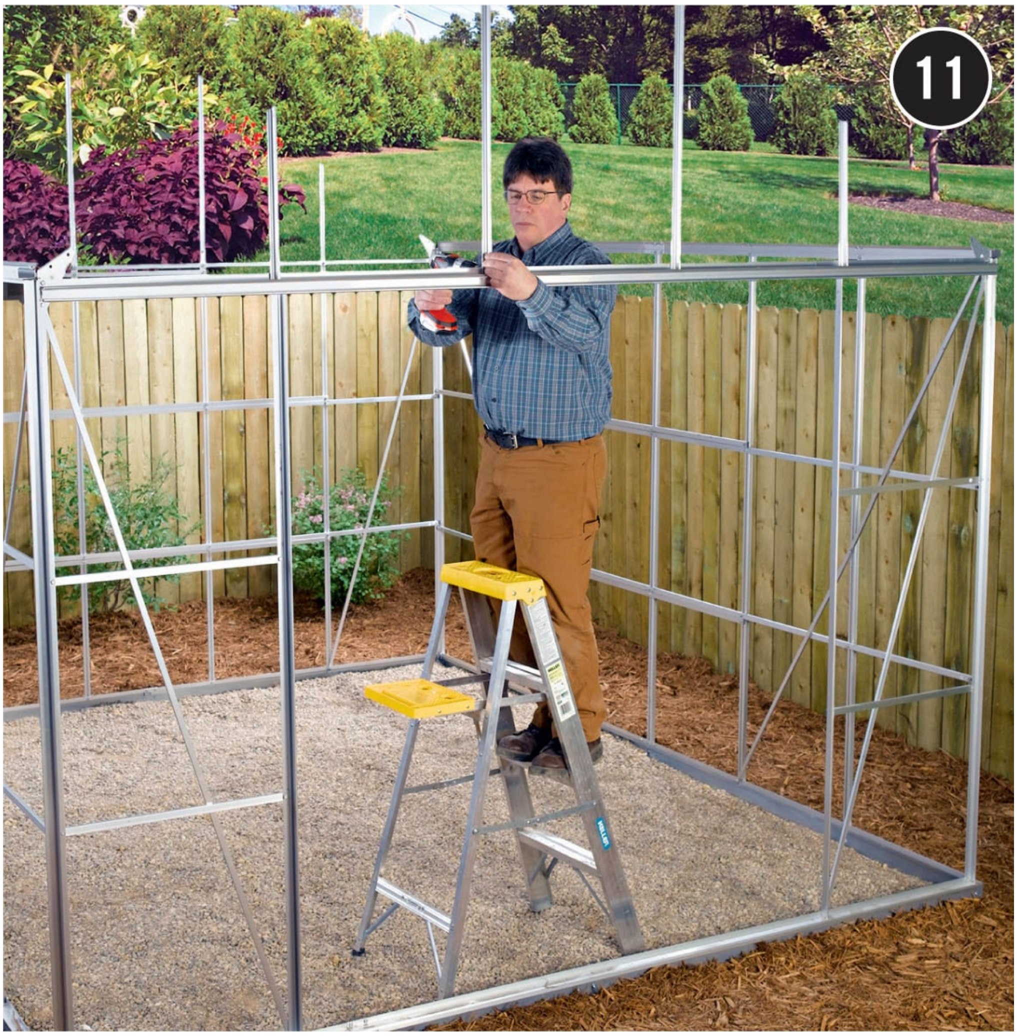
BACKWARD AND FORWARD

With some kits you need to go backward to go forward. Because the individual parts of your kit depend upon one another for support, you may be required to tack all the parts together with bolts first and then undo and remake individual connections as you go before you can finalize them. For example, in this kit you must undo the track/brace connections one at a time so you can insert the bolt heads for the stud connectors into the track.

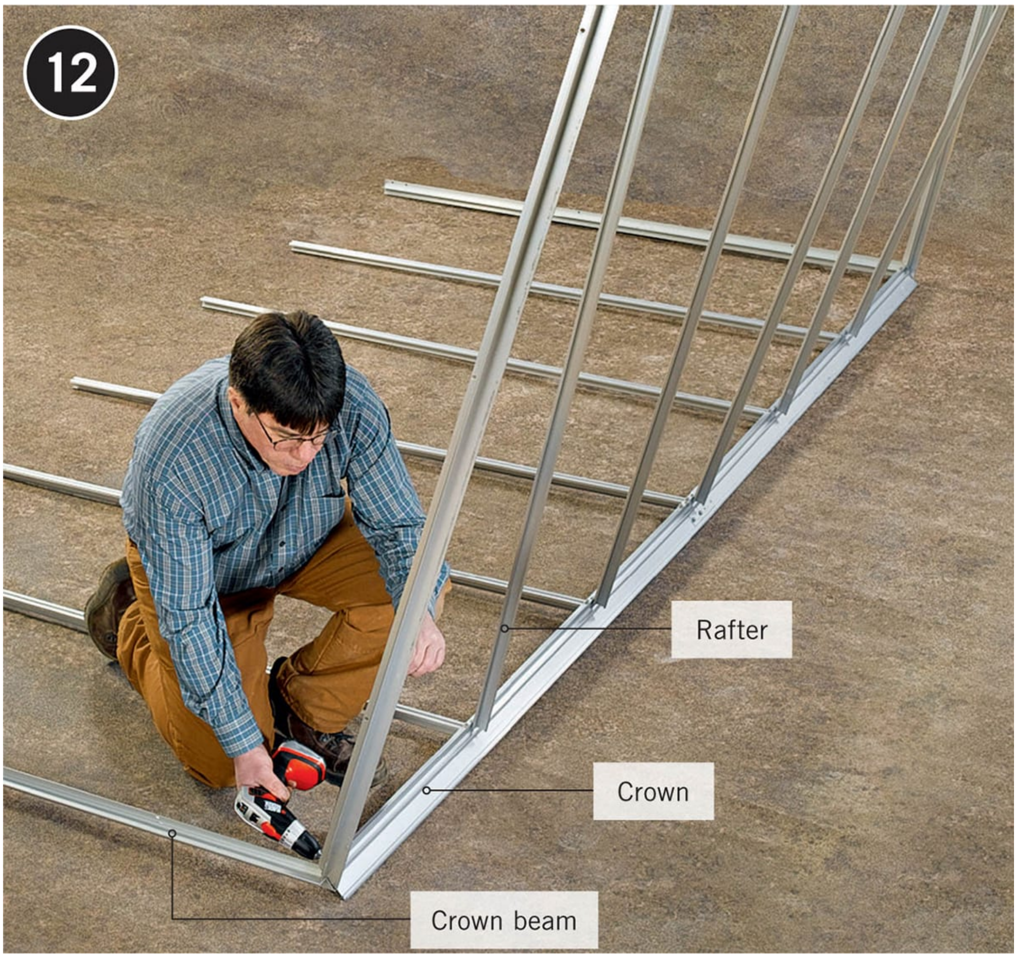


Install the doorway studs at either side of the greenhouse door on the front end of the building. Install the side studs along both side walls of the greenhouse.

Add diagonal struts, as directed by the manufacturer. The struts help to stiffen and square up the walls. As you work, take diagonal measurements between opposing corners at the tops of the walls, to make sure the structure remains square.



Fasten the gable-end stud extensions to the front and back walls of the greenhouse. The top ends of the studs should angle upward, toward the peak of the greenhouse.

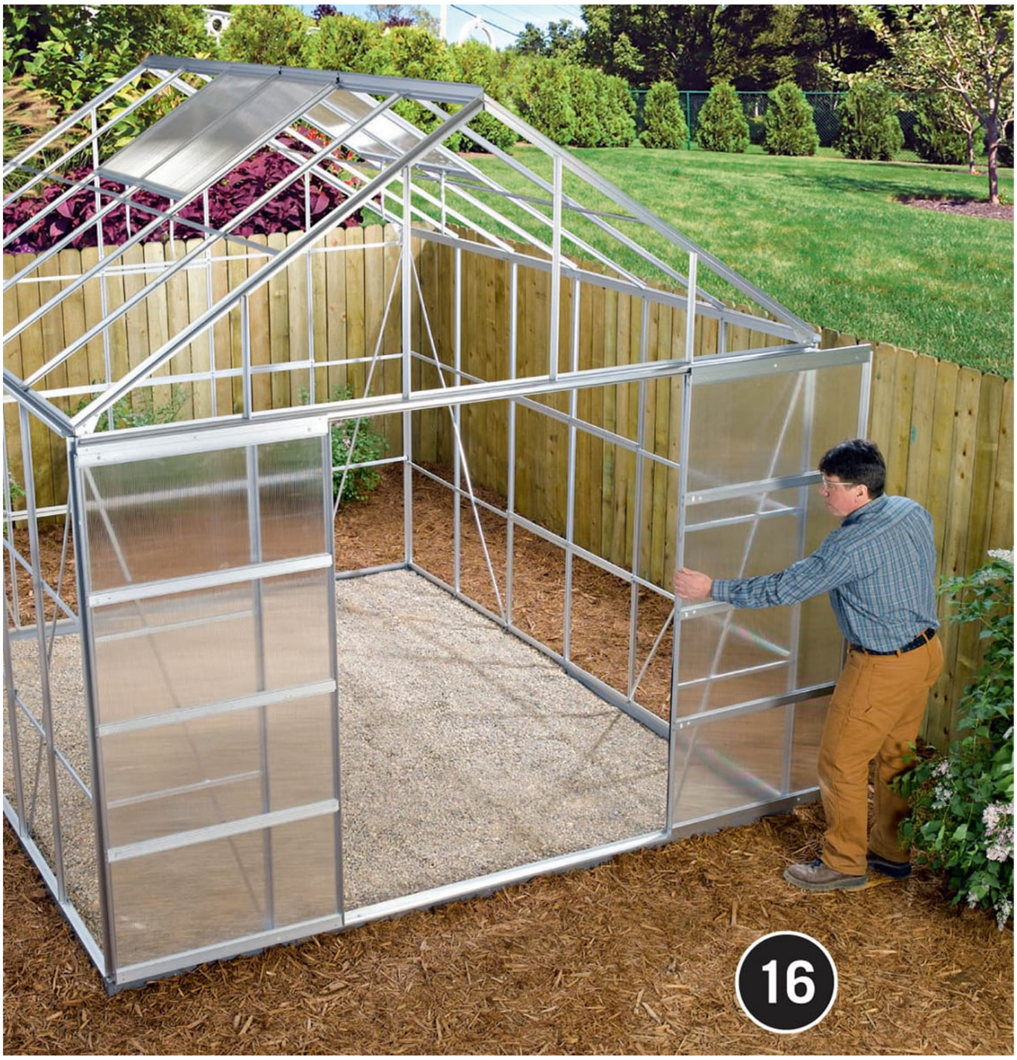


Assemble the roof frame on a flat area near the wall assembly. First assemble the crown-beam pieces; then attach the rafters to the crown, one by one. The end rafters, called the crown beams, have a different configuration, so make sure not to confuse them.

With at least one helper, lift the roof into place onto the wall frames. The gable end studs should meet the outside edges of the crown beams, and the ends of the crown beams rest on the outer edge of the corner bracket. Fasten in place with the provided nuts and bolts.

Attach the side braces and the roof-window support beams to the underside of the roof rafters, as specified by the manufacturer's instructions.

Build the roof windows by first connecting the two side window frames to the top window frame. Slide the window panel into the frame; then secure it by attaching the bottom window frame. Slide the window into the slot at the top of the roof crown; then gradually lower it in place. Attach the window stop to the window support beam.



Assemble the doors, making sure the top slider/roller bar and the bottom slider bar are correctly positioned. Lift the door panels up into place onto the top and bottom wall plates.

Install the panels one by one, using panel clips. Begin with the large wall panels. Position each panel and secure it by snapping a clip into the frame, at the intervals specified by the manufacturer's instructions.

Add the upper panels. At the gable ends, the upper panels will be supported by panel connectors that allow the top panel to be supported by the bottom panel. The lower panels should be installed already.

Install the roof panels and roof-window panels so that the top edges fit up under the edge of the crown or window support and the bottom edges align over the gutters.

Test the door and window operation, and make any necessary adjustments so they open and close smoothly.

PVC Hoophouse

The hoophouse is a popular garden structure for two main reasons: it is cheap and easy to build. In many agricultural areas you will see hoophouses snaking across vast fields of seedlings, protecting the delicate plants at their most vulnerable. Because they are portable and easy to disassemble, they can be removed when the plants are established and less vulnerable.

While hoophouses are not intended as substitutes for real greenhouses, they do serve an important agricultural purpose. And building your own is a fun project that the whole family can enjoy.

The hoophouse shown here is essentially a Quonset-style frame of bent ¾-inch PVC tubing draped with sheet plastic. Each semicircular frame is actually made from two 10-foot lengths of tubing that fit into a plastic fitting at the apex of the curve. PVC tubes tend to stay together simply by friction-fitting into the fittings, so you don’t normally need to solvent glue the connections (this is important to the easy-to-disassemble-and-store feature). If you experience problems with the frame connections separating, try cutting 4- to 6-inch-long pieces of ½-inch (outside diameter) PVC tubing and inserting them into the tubes and fittings like splines. This will stiffen the connections.

A hoophouse is a temporary agricultural structure designed to be low-cost and portable. Also called Quonset houses and tunnel houses, hoophouses provide shelter and shade (depending on the film you use) and protection from wind and the elements. They will boost heat during the day, but are less efficient than greenhouses for extending the growing season.

TOOLS + MATERIALS

Hand sledge

Plastic tubing cutter or hacksaw

Wood or rubber mallet

Circular saw

Stapler

Drill

Utility knife

Stakes and mason's string

Eye protection

Tape measure

Work gloves

(2) ½" × 10' CPVC pipes

(11) ¾" × 10' PVC pipes

(3) ¾" PVC cross fittings

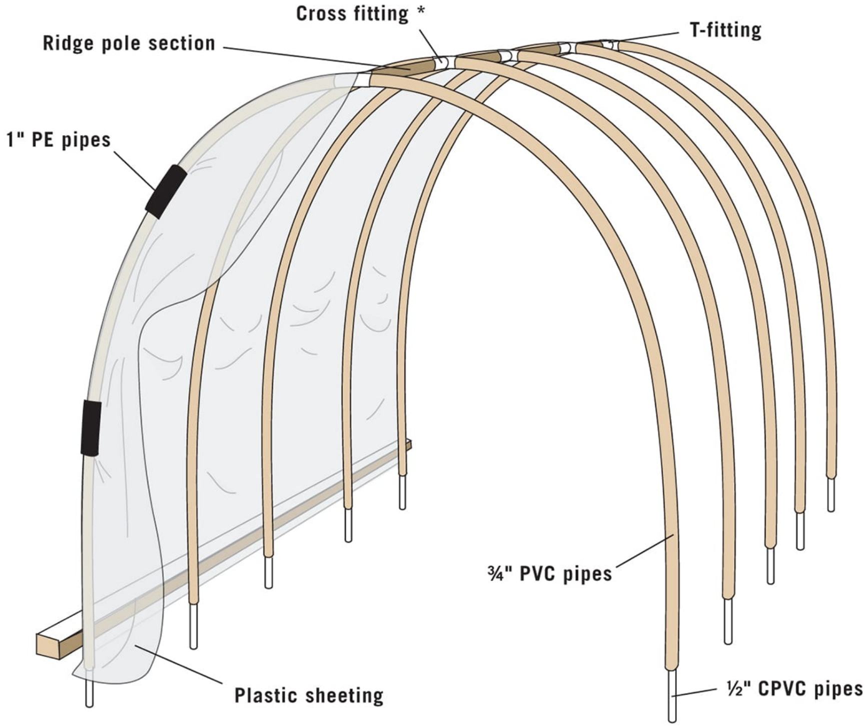
(2) ¾" PVC T-fittings*

16 × 24' clear or opaque 6-mil plastic sheeting

(4) 16' pressure-treated 2 × 4s

2½" deck screws

(1) 1" × 6' PE tubing (black, flexible)

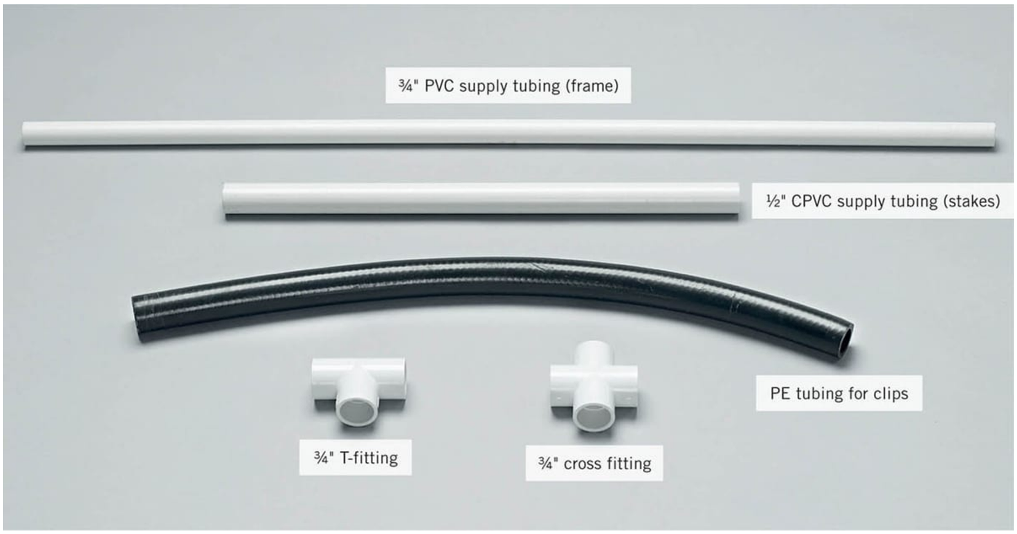


*** If you can’t find cross fittings, use a T fitting placed off center in each direction for the center hoops, and a filler piece of pipe between them**

BUILDING A HOOPHOUSE

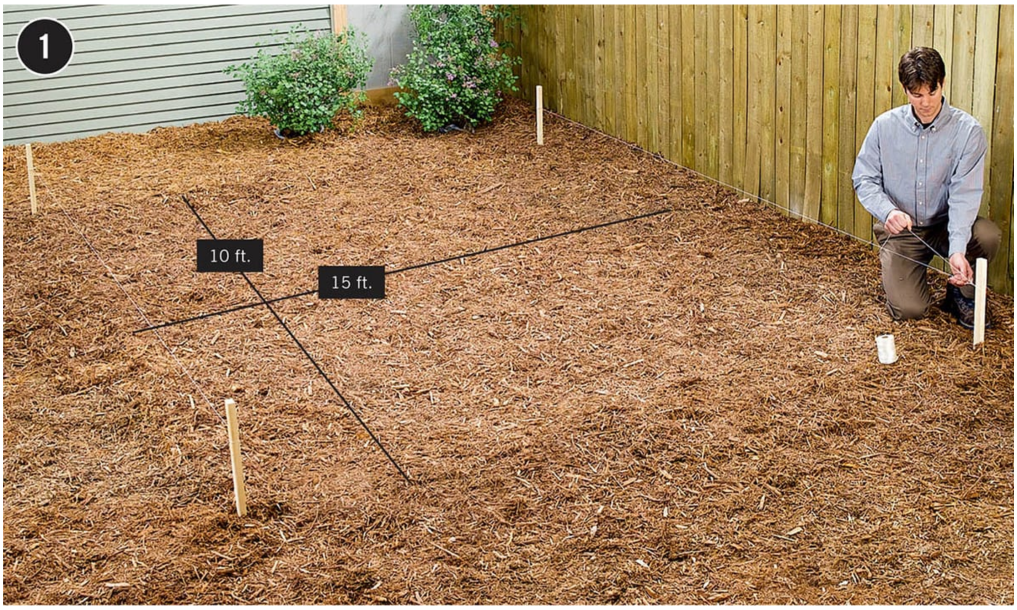
- Space frame hoops about 3’ apart.
- Leave ridge members a fraction of an inch (not more than ¼”) shorter than the span, which will cause the structure to be slightly narrower on top than at the base. This helps stabilize the structure.
- Orient the structure so a wall faces into the prevailing wind.
- Because hoophouses are temporary structures that are designed to be disassembled or moved regularly, you do not need to include a base.
- Hoophouses can act a lot like boat sails and will fly away if they’re not anchored securely. Be sure to stake each hoop to the ground at both ends (with 24” or longer stakes), and carefully weight down the cover with boards (as shown here) or piles of dirt.
- Clip the hoophouse covers to the end frames. Clips fastened at the intermediate hoops will either fly off or tear the plastic cover in windy conditions.

Sheet plastic is an inexpensive material for creating a greenhouse. Obviously, it is less durable than polycarbonate, fiberglass or glass panels. But UV-stabilized films at least 6 mil thick can be rated to withstand four years or more of exposure. Inexpensive polyethylene sheeting (the kind you find at hardware stores) will hold up for a year or two, but it becomes brittle when exposed to sunlight. Some greenhouse builders prefer to use clear plastic sheeting to maximize the sunlight penetration, but the cloudiness of opaque poly makes it effective for diffusing light and preventing overheating. For the highest quality film coverings, look for film rated for greenhouse and agricultural use.



Plastic tubing and fittings used to build this hoophouse include: light-duty ¾” PVC tubing for the frame (do not use CPVC—it is too rigid and won’t bend properly); ½” CPVC supply tubing for the frame stakes (rigidity is good here); polyethylene (PE) tubing for the cover clips; T-fittings and cross* fittings to join the frame members.

How to Build a PVC Hoophouse



Lay out the installation area, using stakes and mason’s string. Stake the four corners to create a rectangle that is 10’ wide and 15’ long. To make sure the layout is square (the strings are perpendicular), measure diagonally between opposing corner stakes: when the measurements are equal, the layout is square.

Cut a 24”-long stake from ½” CPVC pipe for each leg of each frame hoop. Plastic pipe is easy to cut with a plastic tubing cutter or a hacksaw. Mark the layout strings at 36” intervals, using tape or a marker. Drive a stake at each marked location, using a hand sledge or hammer. Keep the stakes plumb and drive them in 14” deep, so only 10” is above ground.

Join the two legs for each frame hoop with a fitting. Use a T-fitting for the end hoop frames and a cross fitting for the intermediate hoop frames. No priming or solvent gluing is necessary. (The friction-fit should be sufficient, but it helps if you tap on the end of the fitting with a mallet to seat it.)

Slip the open end of one hoop-frame leg over a corner stake so the pipe is flush against the ground. Then bend the pipes so you can fit the other leg end over the stake at the opposite corner. If you experience problems with the pipes pulling out of the top fitting, simply tape the joints temporarily until the frame is completed.

Continue adding hoop frames until you reach the other end of the structure. Wait until all the hoop frames are in place before you begin installing the ridge poles. Make sure the cross fittings on the intermediate hoop frames are aligned correctly to accept the ridge poles.

Add the ridge pole sections to tie together the hoop frames. The correct length for the ridge poles depends on the socket depth of the fitting you use, so you'll have to measure the fittings and calculate length of the ridge pieces. If necessary, tap the end of each ridge piece with a wood or rubber mallet to seat it fully in the fitting socket.

Cut four 2 × 4s to length (15’ as shown). Cut the cover material to length at 16’ (or as needed so it is several inches longer than the house at both ends). Staple one edge of the cover to one of the 2 × 4s, keeping the material taut and flat as you work from one end to the other

Lay another 2 × 4 over the first so their ends and edges are flush and the cover material is sandwiched in between. Fasten the two boards together with 2½” deck screws driven every 24” or so. Position the board assembly along the base of the hoops and pull the free end of the material over the tops of the hoops to the other side.

Pull the cover taut on the other side of the house, and repeat the process of stapling it to one board then sandwiching with the other 2 × 4s.

Secure the cover at the ends with 6” lengths of 1” PE tubing. Cut the tubing pieces to length, then slit them lengthwise to create simple clips. Use at least six clips at each end of the house. Do not use clips on the intermediate hoops.

OPTION: Make doors by clipping a piece of cover material to each end. (It's best to do this before attaching the main cover.) Then cut a slit down the center of the end material. You can tie or tape the door material to the sides when you want it open and weigh down the pieces with a board or brick to keep the door shut. This solution is low-tech but effective.

Shed-Style Greenhouse

This unique outbuilding is part greenhouse and part shed, making it perfect for a year-round garden space or backyard sunroom, or even an artist's studio. The front facade is dominated by windows—four 29- × 72-inch windows on the roof, plus four 29- × 18-inch windows on the front wall. When appointed as a greenhouse, two long planting tables inside the shed let you water and tend to plants without flooding the floor. If gardening isn't in your plans, you can omit the tables and cover the entire floor with plywood, or perhaps fill in between the floor timbers with pavers or stones.

Some other details that make this 10- × 12-foot shed stand out are the homemade Dutch door, with top and bottom halves that you can open together or independently, and its traditional saltbox shape. The roof covering shown here consists of standard asphalt shingles, but cedar shingles make for a nice upgrade.

Because sunlight plays a central role in this shed design, consider the location and orientation carefully. To avoid shadows from nearby structures, maintain a distance between the shed and the structure that's at least 2½ times the height of the obstruction. With all of that sunlight, the temperature inside the shed is another important consideration. You may want to install some roof vents to release hot air and water vapor.

Building the Shed-Style Greenhouse involves a few unconventional construction steps. First, the side walls are framed in two parts: You build the square portion of the endwalls first, then move onto the roof framing. After the rafters are up, you complete the "rake," or angled, sections of the side walls. This makes it easy to measure for each wall stud, rather than having to calculate the lengths beforehand. Second, the shed’s 4 × 4 floor structure also serves as its foundation. The plywood floor decking goes on after the walls are installed, rather than before.

With slight modifications, many ordinary sheds can be redesigned as greenhouses. The addition of glass roof panels turns this shed design into an effective greenhouse.

TOOLS + MATERIALS

Circular saw

Power miter saw

Hammer

Level

Hand tamper

Ladder

Eye protection

Framing square

Plumb bob

Caulk

Caulk gun

Screwdriver

Work gloves

CUTTING LIST

PART	QUANTITY/SIZE	MATERIAL
Foundation/Floor		
Foundation base + interior drainage beds	5 cu. yds.	Compactible gravel
Floor joists + blocking	7 @ 10’	4 × 4 pressure-treated landscape timbers
4 × 4 blocking	1 @ 10’ 1 @ 8’	4 × 4 pressure-treated landscape timbers
Box sills (rim joists)	2 @ 12’	2 × 4 pressure-treated
Nailing cleats + 2 × 4 blocking	2 @ 8’	2 × 4 pressure-treated
Floor sheathing	2 sheets @ 4 × 8’	¾” ext.-grade plywood
Wall Framing		
Bottom plates	2 @ 12’, 2 @ 10’	2 × 4 pressure-treated
Top plates	4 @ 12’, 2 @ 10’	2 × 4
Studs	43 @ 8’	2 × 4
Door header + jack studs	3 @ 8’	2 × 4
Rafter header	2 @ 12’	2 × 8
Roof Framing		
Rafters—A + C, + nailers	10 @ 12’	2 × 4
Rafters—B + lookouts	10 @ 10’	2 × 4
Ridge board	1 @ 14’	2 × 6
Exterior Finishes		

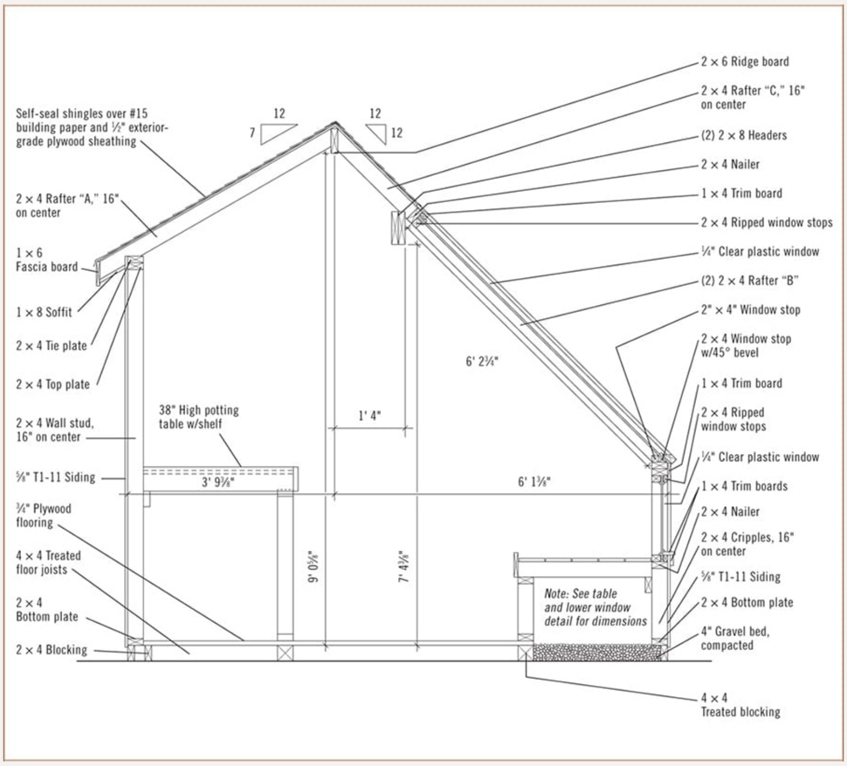
Rear fascia	1 @ 14’	1 × 6 cedar
Rear soffit	1 @ 14’	1 × 8 cedar
Gable fascia (rake board) + soffit	4 @ 16’	1 × 6 cedar
Siding	10 sheets @ 4 × 8’	⅝” Texture 1-11 plywood siding
Siding flashing	10 linear ft.	Metal Z-flashing
Trim*	4 @ 12’ 1 @ 12’	1 × 4 cedar 1 × 2 cedar
Wall corner trim	6 @ 8’	1 × 4 cedar
Roofing		
Sheathing	5 sheets @ 4 × 8’	½” exterior-grade plywood roof sheathing
15# building paper	1 roll	
Drip edge	72 linear ft.	Metal drip edge
Shingles	2⅔ squares	Asphalt shingles—250# per sq. min.
Windows		
Glazing	4 pieces @ 31¼ × 76½” 4 pieces @ 31¼ × 20¾”	¼”-thick clear plastic glazing
Window stops	12 @ 10’	2 × 4
Glazing tape	60 linear ft.	
Clear exterior caulk	5 tubes	
Door		
Trim + stops	3 @ 8’	1 × 2 cedar
Surround	4 @ 8’	2 × 2 cedar
Z-flashing	3 linear ft.	
Plant Tables		

(Optional)		
Front table, top + trim	6 @ 12’	1 × 6 cedar or pressure-treated
Front table, plates + legs	4 @ 12’	2 × 4 pressure-treated
Rear table, top + trim	6 @ 8’	1 × 6 cedar or pressure-treated
Rear table, plates + legs	4 @ 8’	2 × 4 pressure-treated
Fasteners + Hardware		
16d galvanized common nails	5 lbs.	
16d common nails	16 lbs.	
10d common nails	1½ lbs.	
8d galvanized common nails	2 lbs.	
8d galvanized box nails	3 lbs.	
10d galvanized finish nails	2½ lbs.	
8d galvanized siding nails	8 lbs.	
1” galvanized roofing nails	7 lbs.	
8d galvanized casing nails	3 lbs.	
6d galvanized casing nails	2 lbs.	
Door hinges with screws	4 @ 3½”	Corrosion-resistant hinges
Door handle	1	
Sliding bolt latch	1	

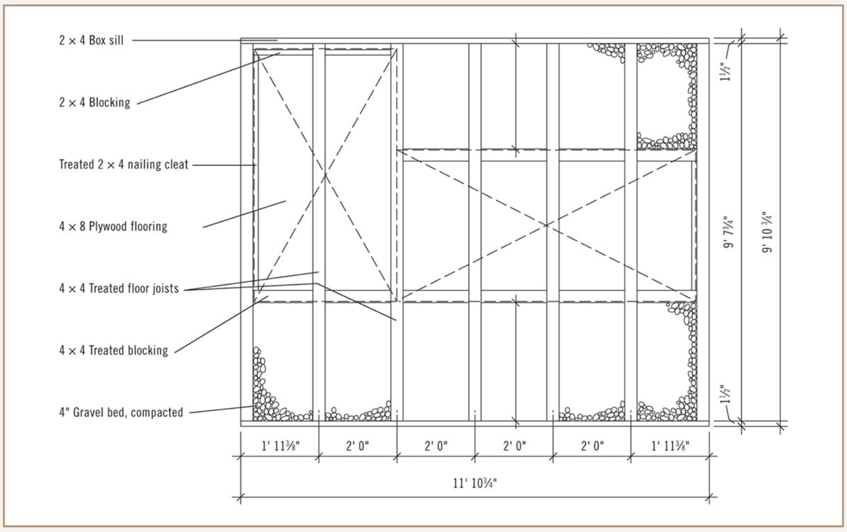
Construction adhesive	1 tube

**Note: The 1 × 4 trim bevel at the bottom of the sloped windows can be steeper (45° or more) so the trim slopes away from the window if there is concern that the trim may capture water running down the glazing (see WINDOW DETAIL).*

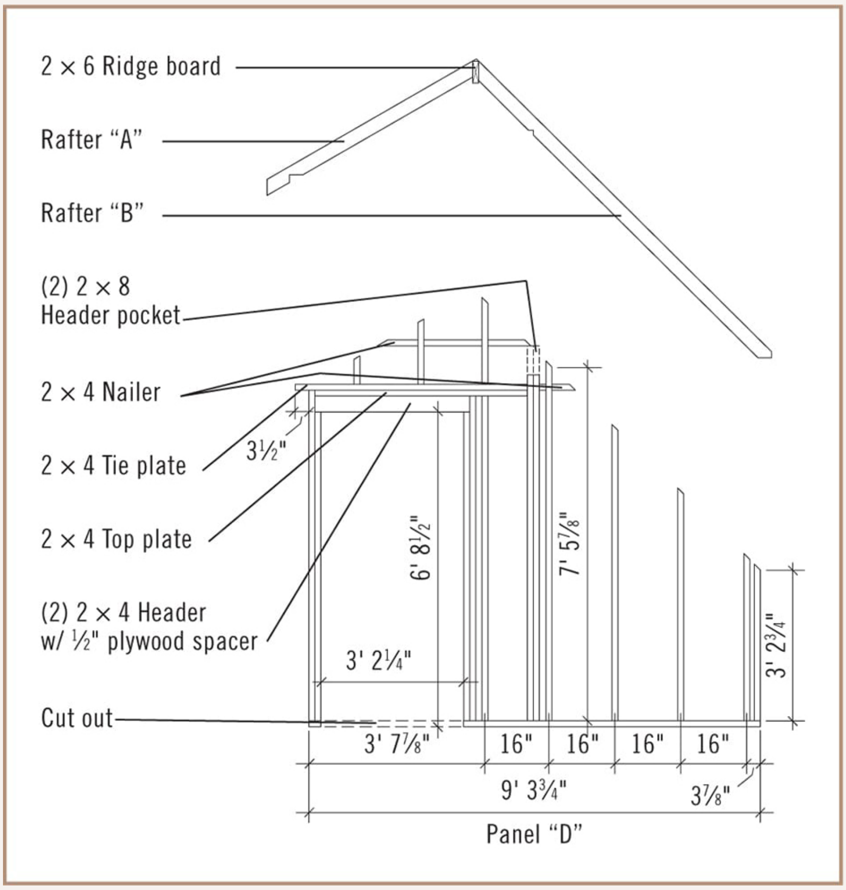
BUILDING SECTION



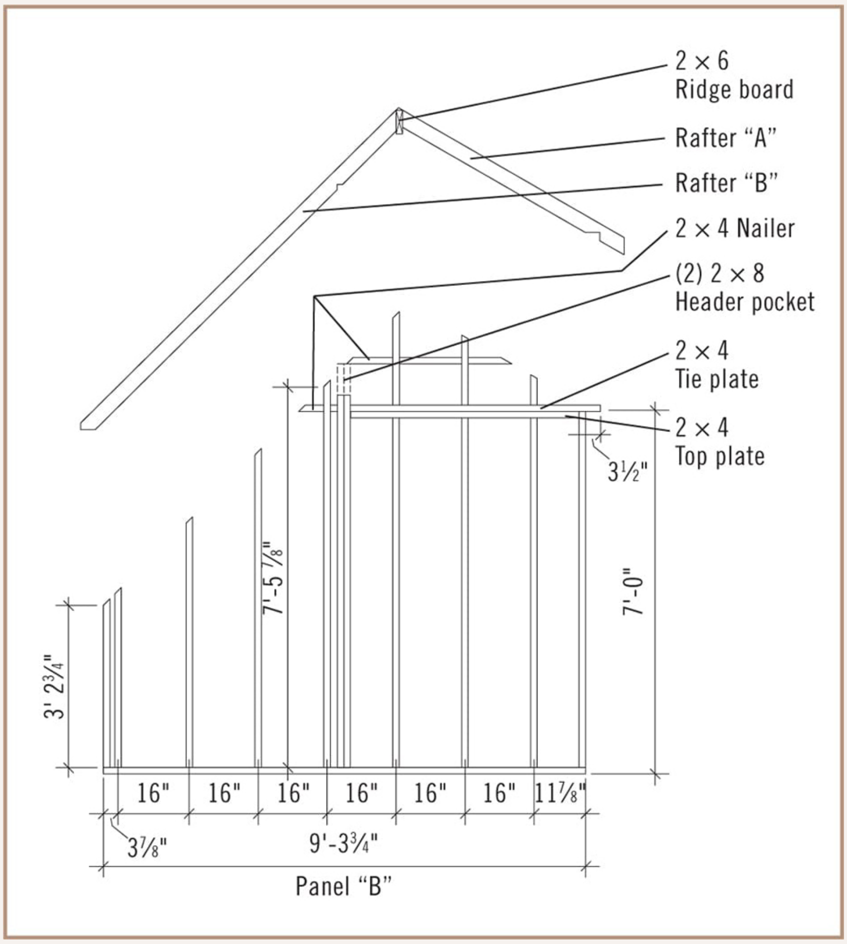
FLOOR FRAMING PLAN



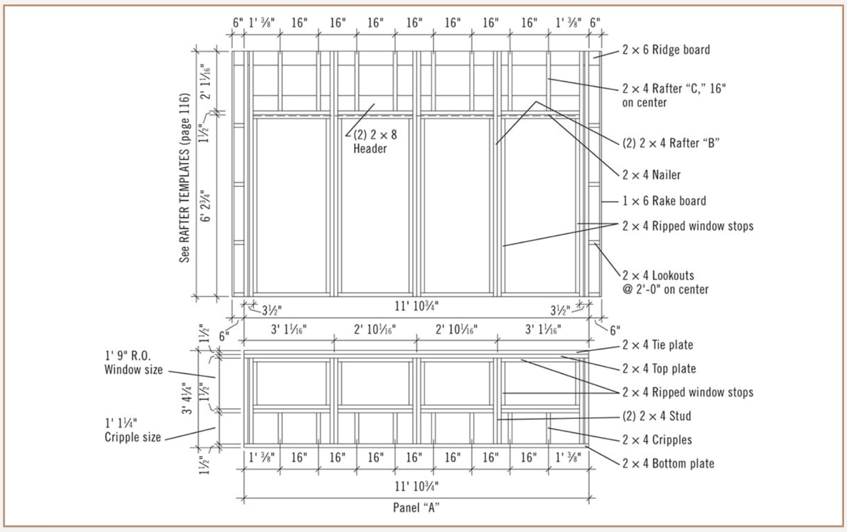
LEFT SIDE FRAMING



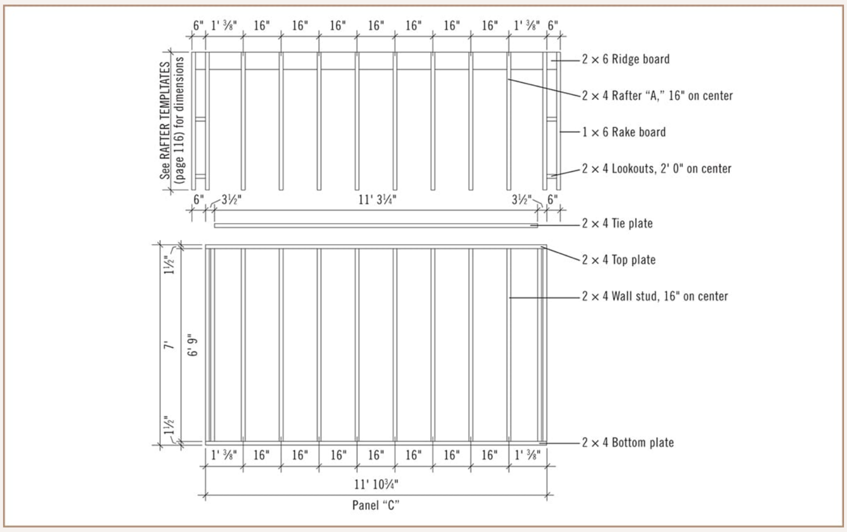
RIGHT SIDE FRAMING



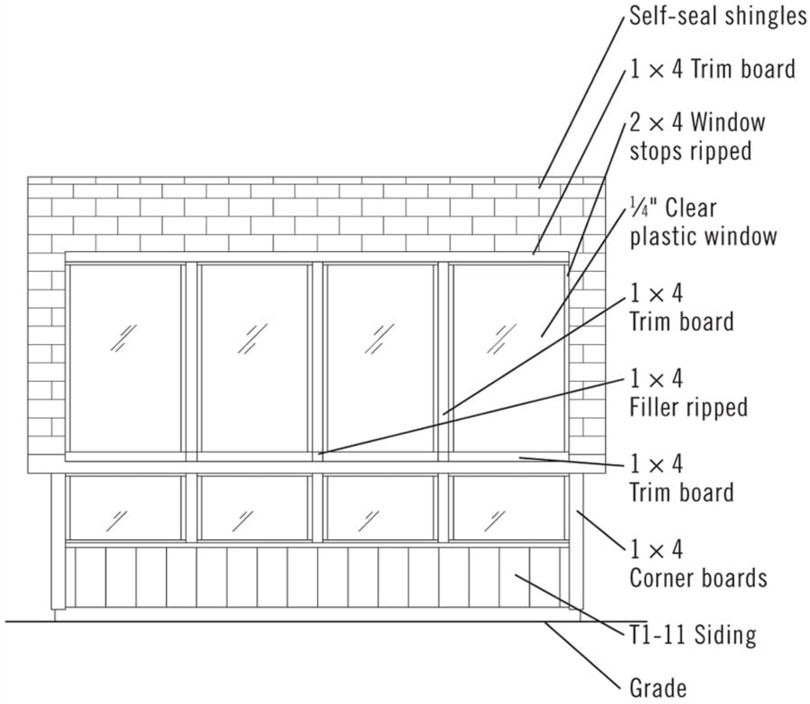
FRONT FRAMING



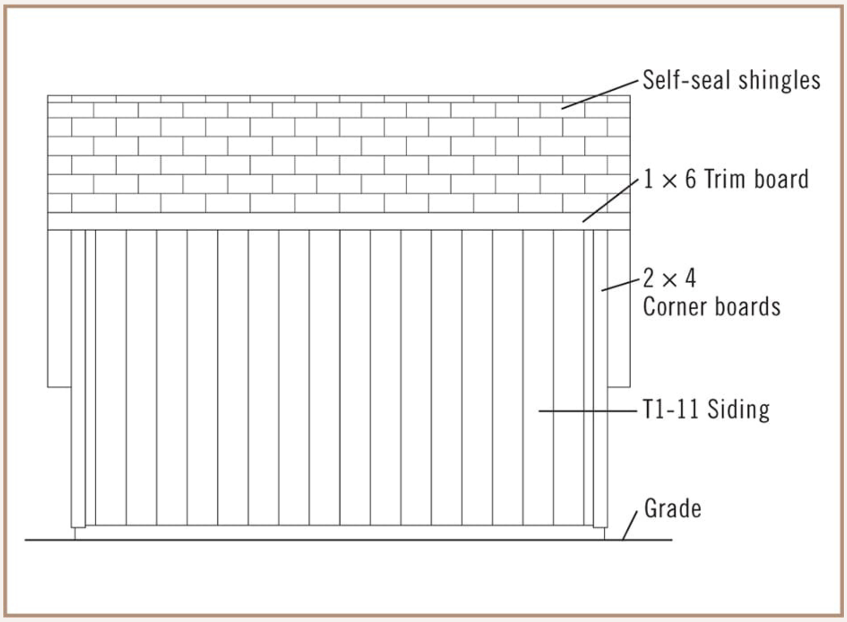
REAR FRAMING



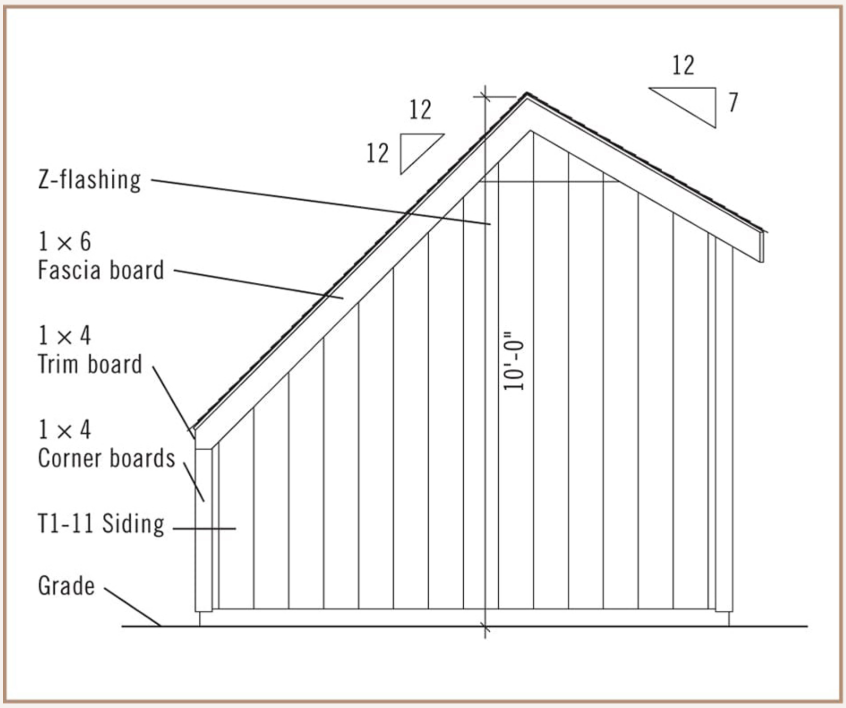
FRONT ELEVATION



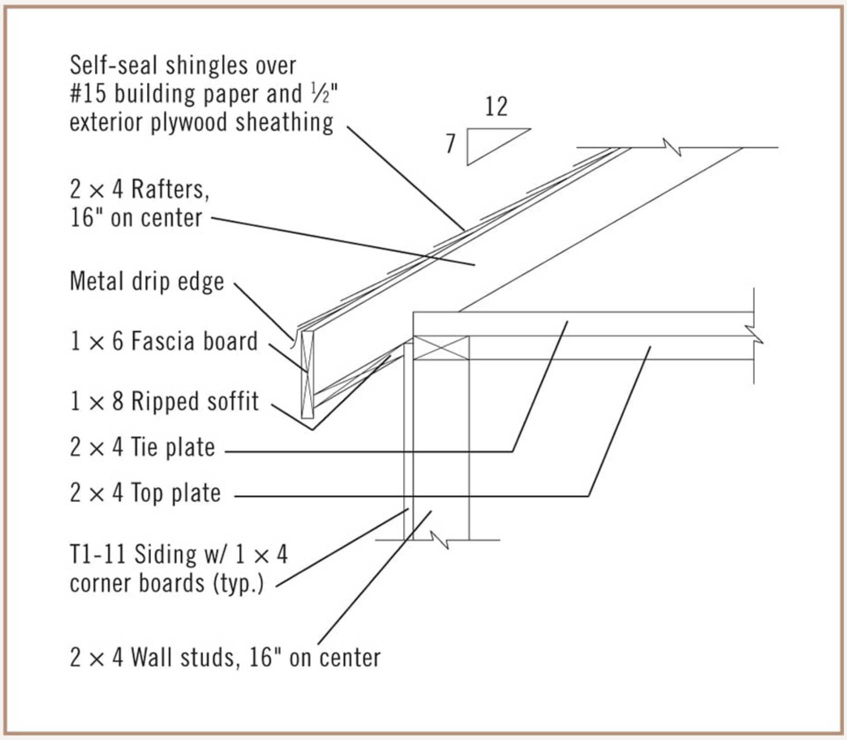
REAR ELEVATION



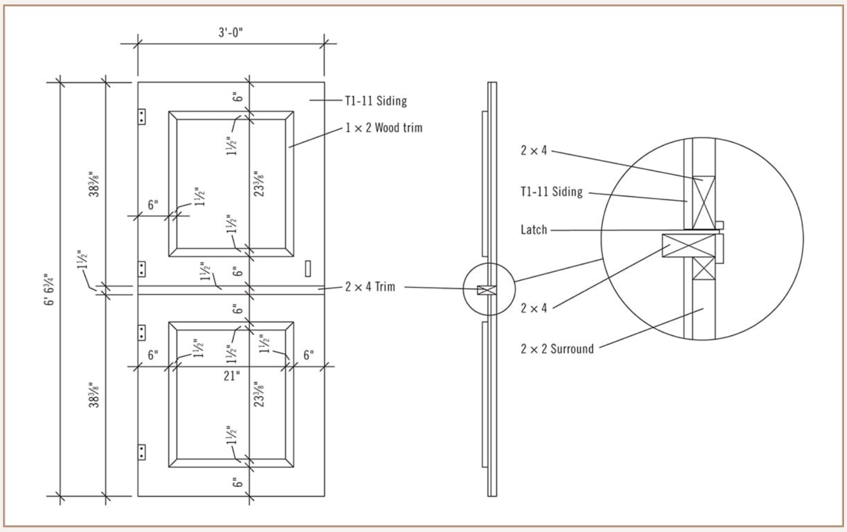
RIGHT SIDE ELEVATION



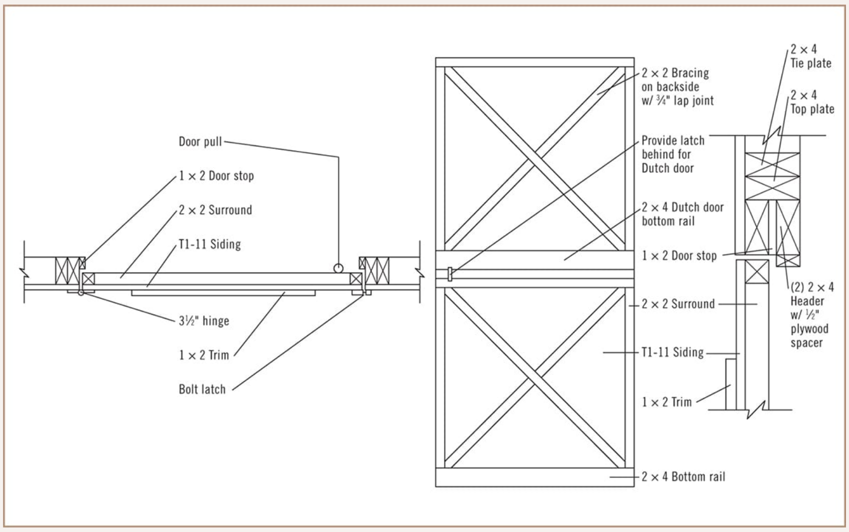
SOFFIT DETAIL



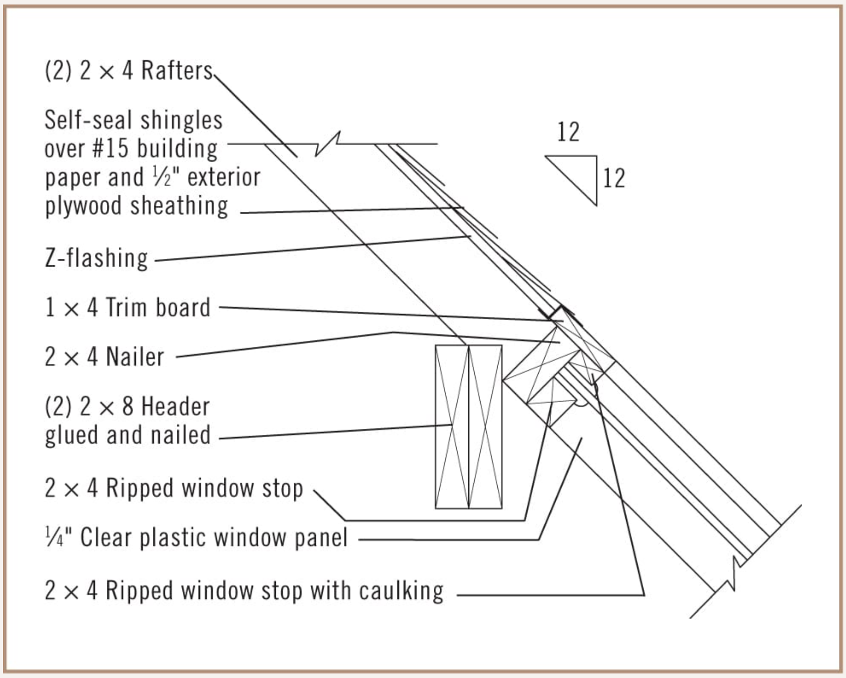
FRONT + SIDE DOOR CONSTRUCTION



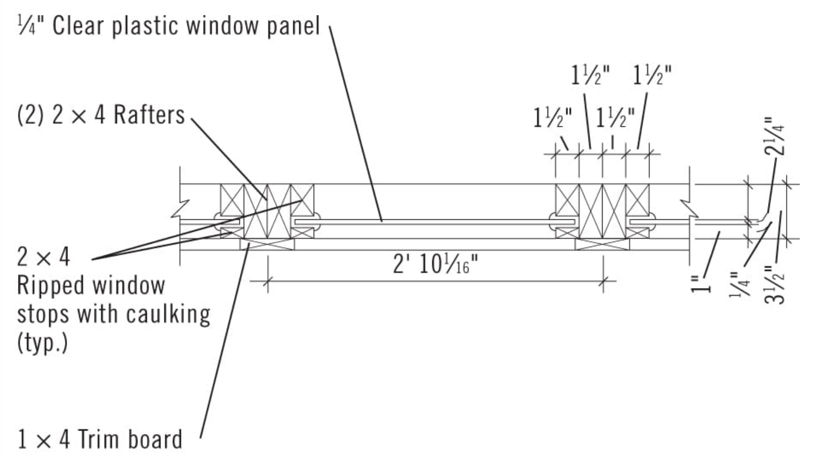
FRONT + SIDE DOOR CONSTRUCTION (DOORJAMB, REAR, DOOR HEADER)



HEADER + WINDOW DETAIL



WINDOW SECTION



WINDOW DETAIL

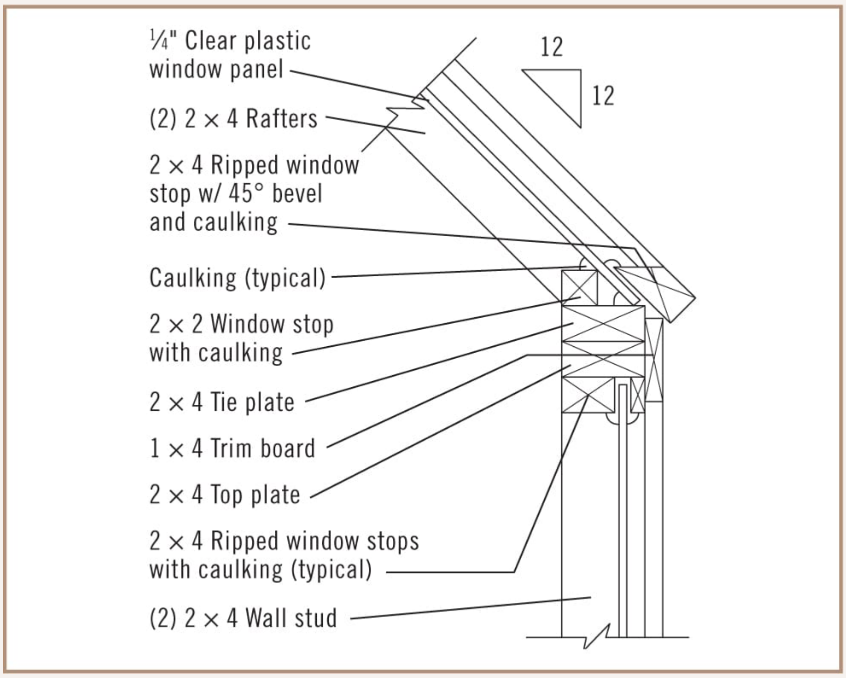
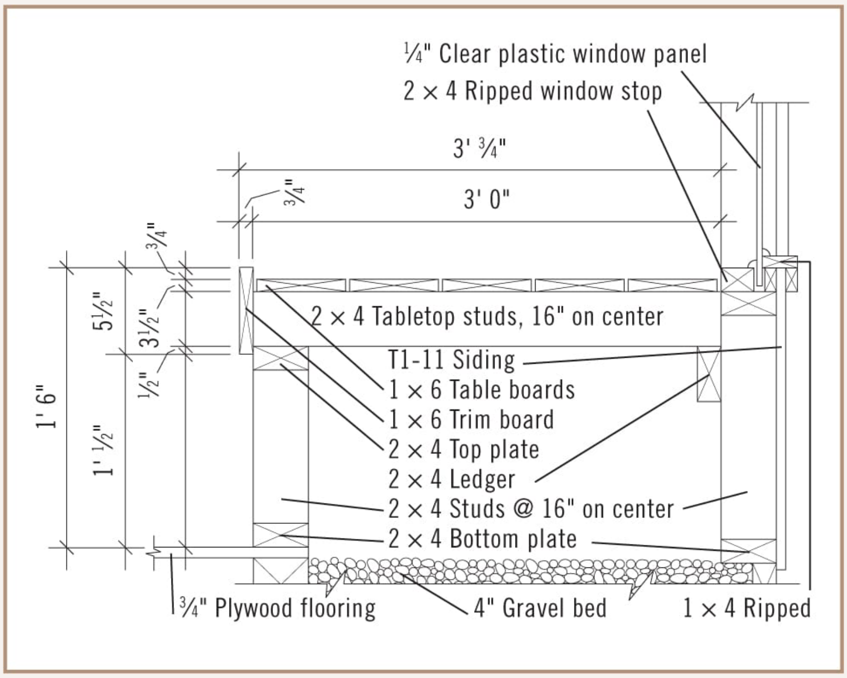
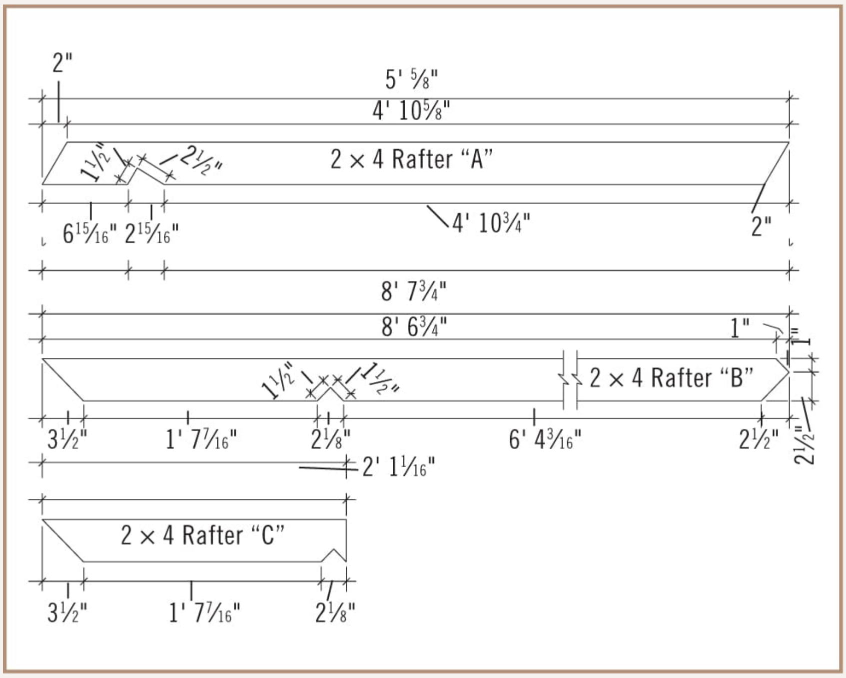


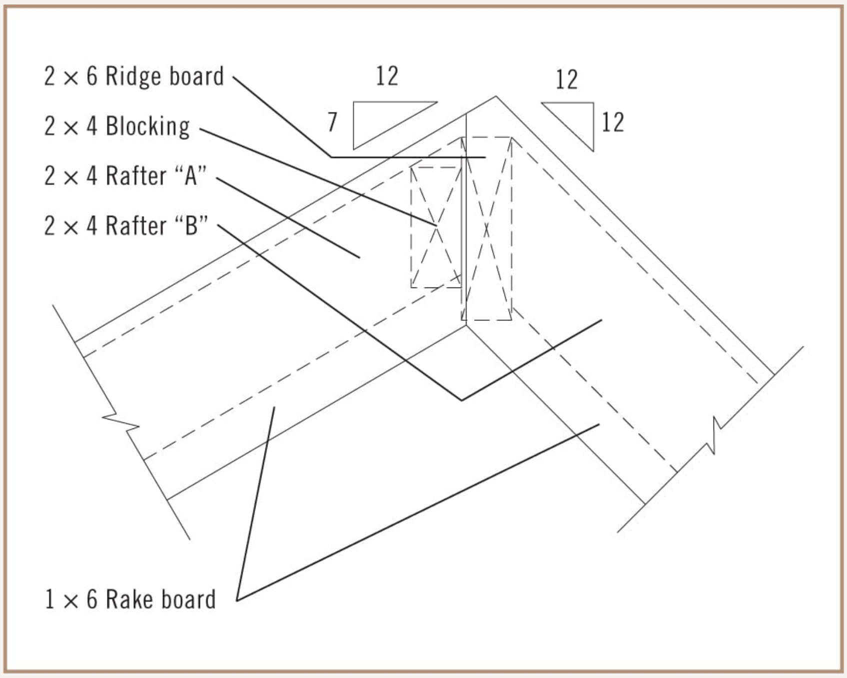
TABLE + LOWER WINDOW DETAIL



RAFTER TEMPLATES



RAKE BOARD DETAIL



How to Build a Shed-Style Greenhouse

Build the foundation, following the basic steps used for a wooden skid foundation. First, prepare a bed of compacted gravel. Make sure the bed is flat and level. Cut seven 4 × 4” × 10’ pressure-treated posts down to 115¾” to serve as floor joists. Position the joists as shown in the FLOOR FRAMING PLAN. Level each joist, and make sure all are level with one another and the ends are flush. Add rim joists and blocking: Cut two 12’ 2 × 4s (142¾”) for rim joists. Fasten the rim joists to the ends of the 4 × 4 joists (see the FLOOR FRAMING PLAN) with 16d galvanized common nails.

Cut ten 4 × 4 blocks to fit between the joists. Install six blocks 34½” from the front rim joist, and install four blocks 31½” from the rear. Toenail the blocks to the joists. All blocks, joists, and sills must be flush at the top.

To frame the rear wall, cut one top plate and one pressure-treated bottom plate (142¾”). Cut twelve studs (81”). Assemble the wall following the layout in the REAR FRAMING (here). Raise the wall and fasten it to the rear rim joist and the intermediate joists, using 16d galvanized common nails. Brace the wall in position with 2 × 4 braces staked to the ground.

For the front wall, cut two top plates and one treated bottom plate (142¾”). Cut ten studs (35¾”) and eight cripple studs (13¼”). Cut four 2 × 4 window sills (31$1^{1}/_{16}$“). Assemble the wall following the layout in the FRONT FRAMING (here). Add the double top plate, but do not install the window stops at this time. Raise, attach, and brace the front wall.

Cut lumber for the right side wall: one top plate (54⅞”), one treated bottom plate (111¾”), four studs (81”), and two header post studs (86⅞”); and for the left side wall: top plate (54⅞”), bottom plate (111¾”), three studs (81”), two jack studs (77½”), two posts (86⅞”), and a built-up 2 × 4 header (39¼”). Assemble and install the walls as shown in the RIGHT SIDE FRAMING and LEFT SIDE FRAMING (here). Add the doubled top plates along the rear and side walls. Install treated 2 × 4 nailing cleats to the joists and blocking as shown in the FLOOR FRAMING PLAN (here) and BUILDING SECTION (here).

Trim two sheets of ¾" plywood as needed and install them over the joists and blocking as shown in the FLOOR FRAMING PLAN, leaving open cavities along the front of the shed and a portion of the rear. Fasten the sheets with 8d galvanized common nails driven every 6" along the edges and 8" in the field. Fill the exposed foundation cavities with 4" of gravel and compact it thoroughly.

Construct the rafter header from two 2 × 8s cut to 142¾". Join the pieces with construction adhesive and pairs of 10d common nails driven every 24" on both sides. Set the header on top of the side wall posts, and toenail it to the posts with four 16d common nails at each end.

Cut one of each “A” and “B” pattern rafters using the RAFTER TEMPLATES (here). Test-fit the rafters. The B rafter should rest squarely on the rafter header, and its bottom end should sit flush with outside of the front wall. Adjust the rafter cuts as needed, then use the pattern rafters to mark and cut the remaining A and B rafters.

Cut the 2 × 6 ridge board (154¾"). Mark the rafter layout onto the ridge and front and rear wall plates following the FRONT FRAMING and REAR FRAMING. Install the A and B rafters and ridge. Make sure the B rafters are spaced accurately so the windows will fit properly into their frames; see the WINDOW SECTION (here).

Cut a pattern “C” rafter, test-fit, and adjust as needed. Cut the remaining seven C rafters and install them. Measure and cut four 2 × 4 nailers ($31^{1}/_{16}$“) to fit between the sets of B rafters (as shown). Position the nailers as shown in the HEADER + WINDOW DETAIL (here) and toenail them to the rafters.

Complete the rake portions of each side wall. Mark the stud layouts onto the bottom plate, and onto the top plate of the square wall section; see the RIGHT and LEFT SIDE FRAMING. Use a plumb bob to transfer the layout to the rafters. Measure for each stud, cutting the top ends of the studs under the B rafters at 45° and those under the A rafters at 30°. Toenail the studs to the plates and rafters. Add horizontal 2 × 4 nailers as shown in the framing drawings.

Create the inner and outer window stops from 10'-long 2 × 4s. For stops at the sides and tops of the roof windows and all sides of the front wall windows, rip the inner stops to 2¼" wide and the outer stops to 1" wide; see the WINDOW SECTION and WINDOW DETAIL (here). For the bottom of each roof window, rip the inner stop to 1½"; bevel the edge of the outer stop at 45°.

Install each window as follows. Attach inner stops as shown in the drawings, using galvanized finish nails. Paint or varnish the rafters and stops for moisture protection. Apply a heavy bead of caulk at each location shown on the drawings (HEADER + WINDOW DETAIL, WINDOW SECTION/DETAIL, TABLE + LOWER WINDOW DETAIL). Set the glazing in place, add another bead of caulk, and attach the outer stops. Cover the rafters and stop edges with 1 × 4 trim.

Cover the walls with T1-11 siding, starting with the rear wall. Trim the sheets as needed so they extend from the bottom edges of the rafters down to at least 1" below the tops of the foundation timbers. On the side walls, add Z-flashing above the first row and continue the siding up to the rafters.

Install 1 × 6 fascia over the ends of the A rafters. Keep all fascia ½" above the rafters so it will be flush with the roof sheathing. Using scrap rafter material, cut the 2 × 4 lookouts (5¼"). On each outer B rafter, install one lookout at the bottom end and four more spaced 24" on center going up. On the A rafters, add a lookout at both ends and two spaced evenly in between. Install the 1 × 6 rake boards (fascia) as shown in the RAKE BOARD DETAIL (here).

Rip 1 × 6 boards to 5¼" width (some may come milled to 5¼" already) for the gable soffits. Fasten the soffits to the lookouts with siding nails. Rip a 1 × 8 board for the soffit along the rear eave, beveling the edges at 30° to match the A rafter ends. Install the soffit.

Deck the roof with ½" plywood sheathing, starting at the bottom ends of the rafters. Install metal drip edge, building paper, and asphalt shingles. If desired, add one or more roof vents during the shingle installation. Be sure to overlap shingles onto the 1 × 4 trim board above the roof windows, as shown in the HEADER + WINDOW DETAIL.

Construct the planting tables from 2 × 4 lumber and 1 × 6 boards, as shown in the TABLE + LOWER WINDOW DETAIL and BUILDING SECTION. The bottom plates of the table legs should be flush with the outside edges of the foundation blocking.

Build each of the two door panels using T1-11 siding, 2 × 2 bracing, a 2 × 4 bottom rail, and 1 × 2 trim on the front side; see the DOOR CONSTRUCTION drawings (here). The panels are identical except for a 2 × 4 sill added to the top of the lower panel. Install 1 × 2 stops at the sides and top of the door opening. Hang the doors with four hinges, leaving even gaps all around. Install a bolt latch for locking the two panels together.

Complete the trim details with 1 × 4 vertical corner boards, 1 × 4 horizontal trim above the front wall windows, and ripped 1 × 4 trim and 1 × 2 trim at the bottom of the front wall windows (see the TABLE + LOWER WINDOW DETAIL). Paint the siding and trim, or coat with exterior wood finish.

Special Section: Sunrooms

A sunroom is a more permanent version of a lean-to greenhouse and is often used for a wider variety of purposes. The idea was executed in Europe as orangeries or conservatories, where wealthy individuals and royalty could grow citrus fruits and other tropical plants, as well as taking in sun during the colder parts of the year. When not built as a formal addition to the home, these are sometimes called "sun porches."

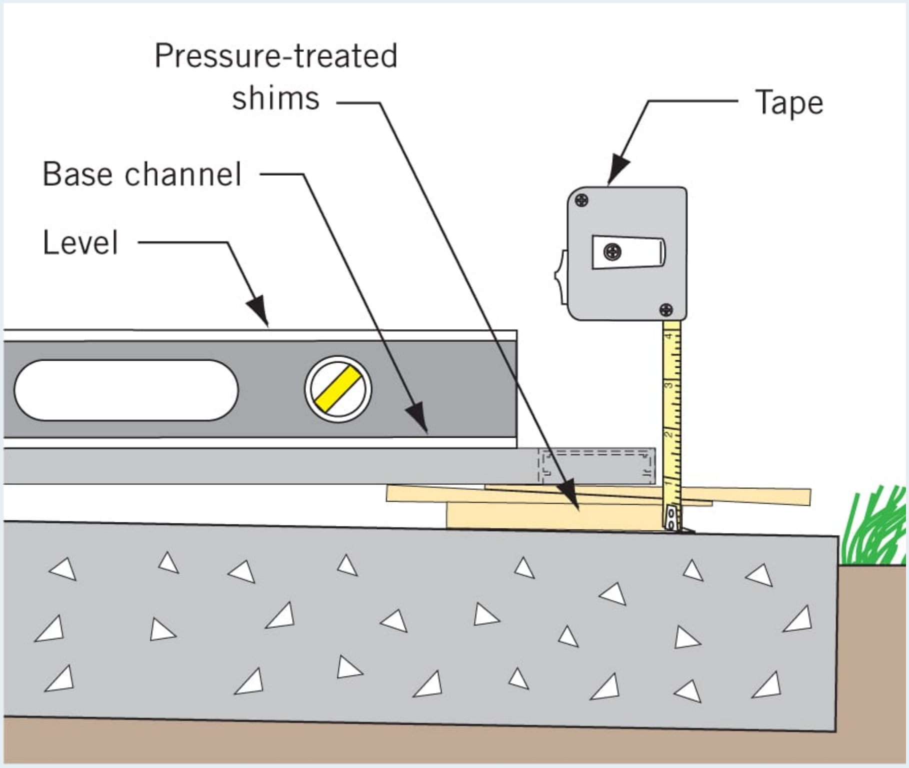
Call it what you will, certain elements are common whether the structure is added to the exterior or created as an extension of interior space. The walls and at least a portion of the roof are glass or plastic glazing. Those surfaces allow sunlight in, trapping the heat so that it raises the ambient room temperature. Some sunrooms are meant specifically for out of season or tropical gardening. Other versions are used just for relaxation or socializing.

Custom-built by a contractor, a sunroom will be as expensive as any other room addition. There is, however, another option: a sunroom kit. Complete DIY kits are available from a range of suppliers and arrive in cardboard boxes. You'll need only a few basic tools and a modicum of do-it-yourself experience, as well as the better part of a weekend. But you'll have a sunroom for a lot less than you would pay a contractor.

A sunroom can be an excellent controlled environment for growing out-of-season produce or even tropical fruits that would not otherwise grow in your area. Some people, though, use the space for growing at certain points of the year, and as a relaxation room at other times. You can even combine the two functions to create a welcoming indoor space full of plants and comfortable furnishings.

COUNTERING SLOPE

Make sure the wood deck, patio, or other installation base is level before installing the sunroom. If not, you may need to install long wood wedges that fit under the floor plates or take other corrective measures as suggested in your installation manual.

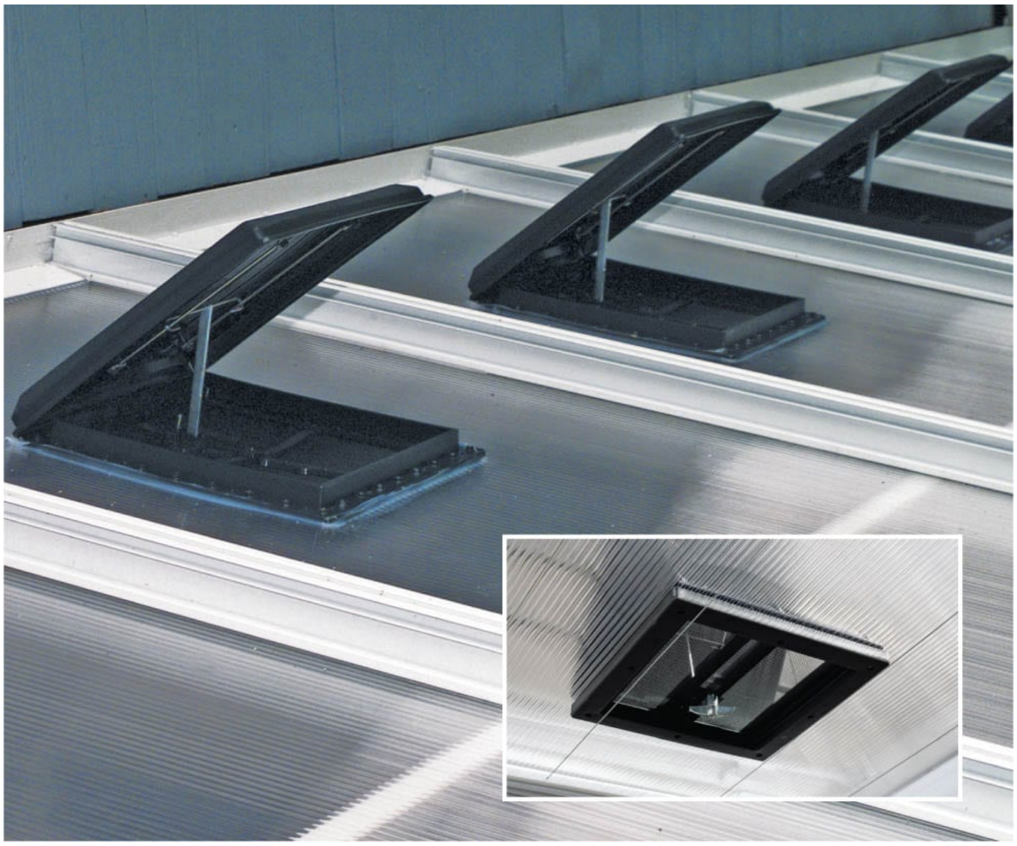


Kit sunrooms are designed for ease of installation and versatile applications. Some are meant to be fastened to directly to the house, using a patio or deck as the foundation. This eliminates a lot of site-prep work. Even if you don't have a patio or deck, you can easily build an inexpensive foundation using landscape timbers and creating a floor surface inside the sunroom from brick pavers, stone, wood decking tiles, or other suitable material. The sunroom manufacturer and your local building department can help you with the planning and construction.

Some manufacturers offer customization so that you can design the kit to suit your specific requirements. The standard kit includes a front wall and two side walls. Operable, removable windows make any sunroom even more versatile. If you’re going to be use the room for three or four-season growing, you’ll also want vents in the structure. Whatever kit you buy, the parts are typically predrilled and precut, so that assembly is just base prep and then following instructions.

Be aware that local building codes may apply to a sunroom kit, because it usually involves fastening a structure to your home. Always begin by consulting with the local building department professionals to determine if you need any permits, and if there are any restrictions on adding a sunroom.

Skylight shades give you control over light and heat coming through the roof panels. These 2-in-1 shades have a solid reflective panel that blocks most of the sun's light and heat and a translucent panel that blocks only half of the sunlight to reduce glare and heat gain while letting light filter through.



Optional roof vents allow hot air to escape and help to flush the interior of the sunroom with fresh air. Adjustable covers let you control the rate of airflow. The opening and closing mechanism is easy to operate from inside the sun porch.

Sun Porch Terms

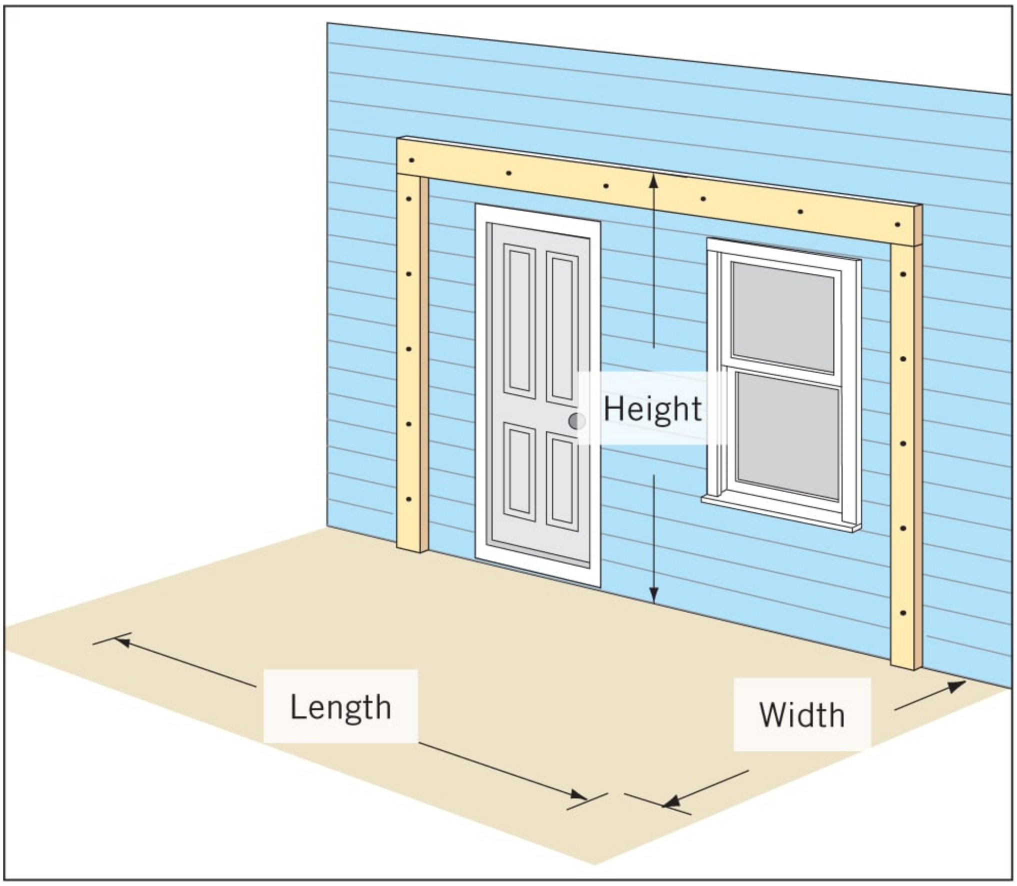
Mounting Surface: May be a level wood deck, concrete slab, or stone patio.

Endwalls: Reference to "right" or "left" is always with your back to the house looking out.

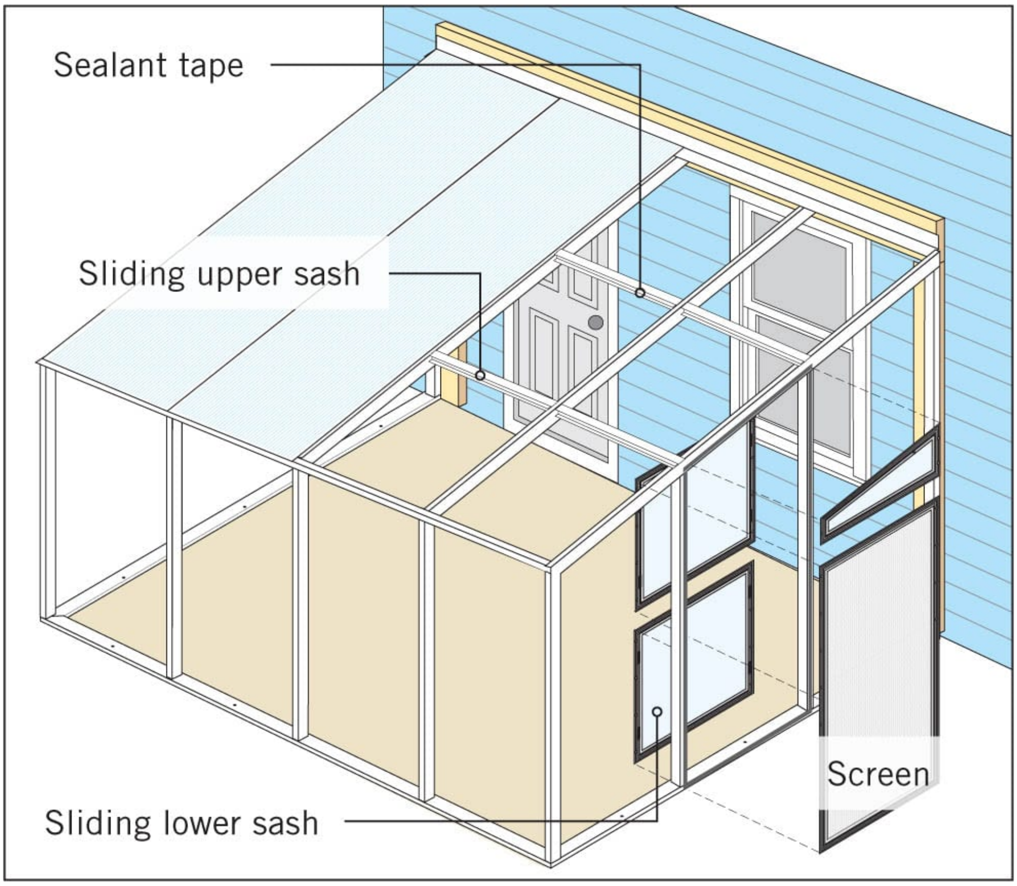
Kneewall (not shown): Site-built wall on the lower half or one-quarter of the sunroom's outside walls.

Door specs: Doors are usually supplied to be positioned in the front wall, although some are designed for use with an end wall that is deep enough to accommodate the door swing. Door openings are usually 33" wide by 72" high. Doors swing out and can be hinged for right or left "handedness."

Preparing the Installation Site

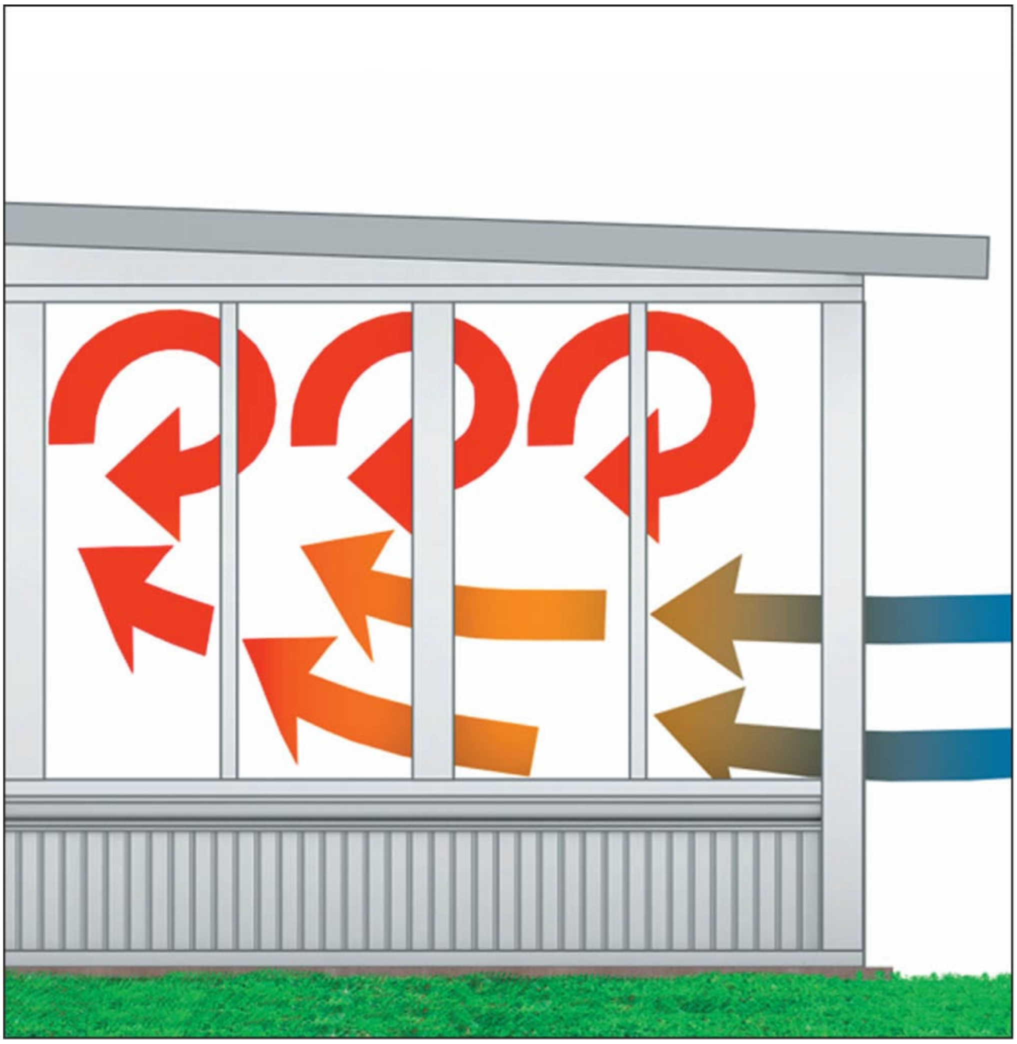


Attach a sunroom to an exterior wall by fastening a 2 × 6 or 2 × 8 horizontal ledger at the sunroom's roof height. Fasten 2 × 4 vertical side cleats under either end of the head cleat.

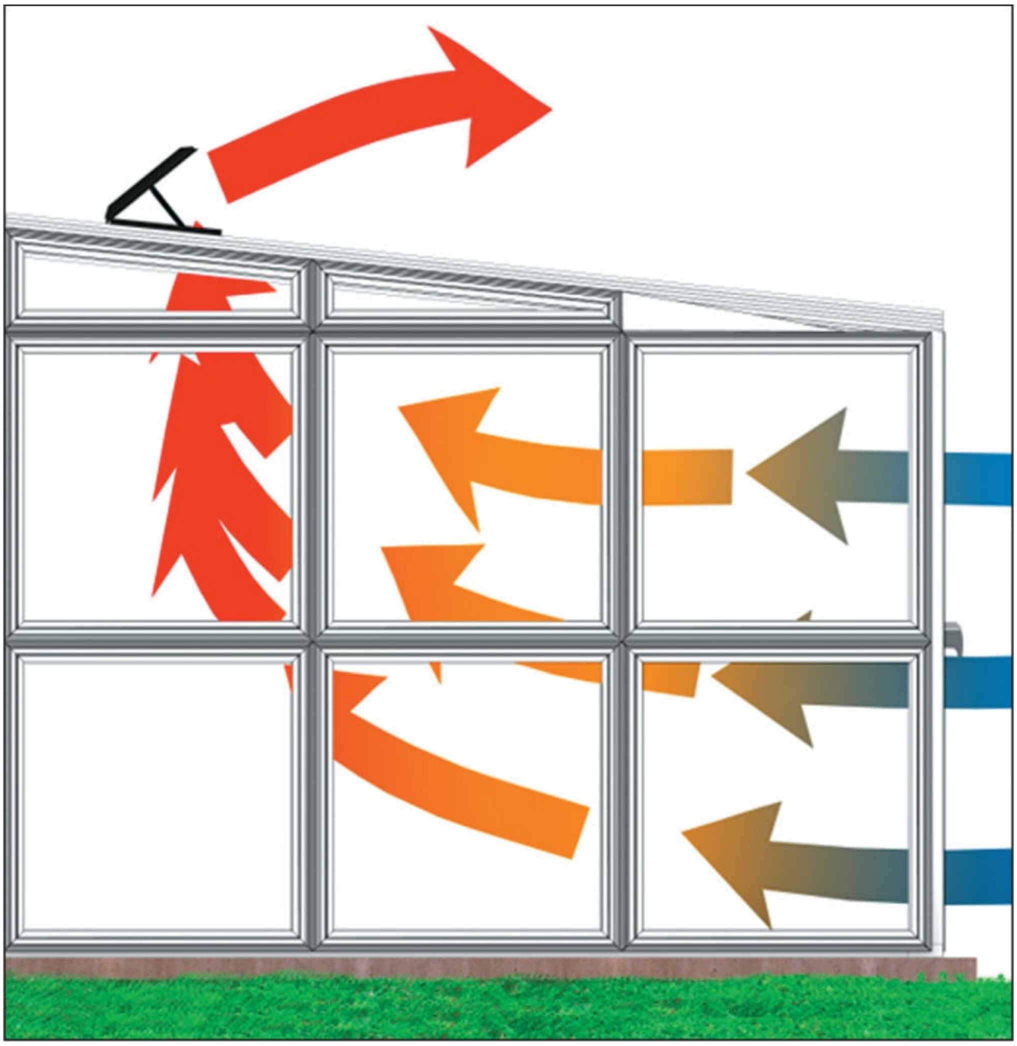


Sunroom kits with plastic panels can be mounted on practically any hard surface because they are light enough that they do not require a reinforced floor. You do need to make sure the floor is level, however, and that the base channels you lay out create square corners.

The Benefits of Roof Ventilation

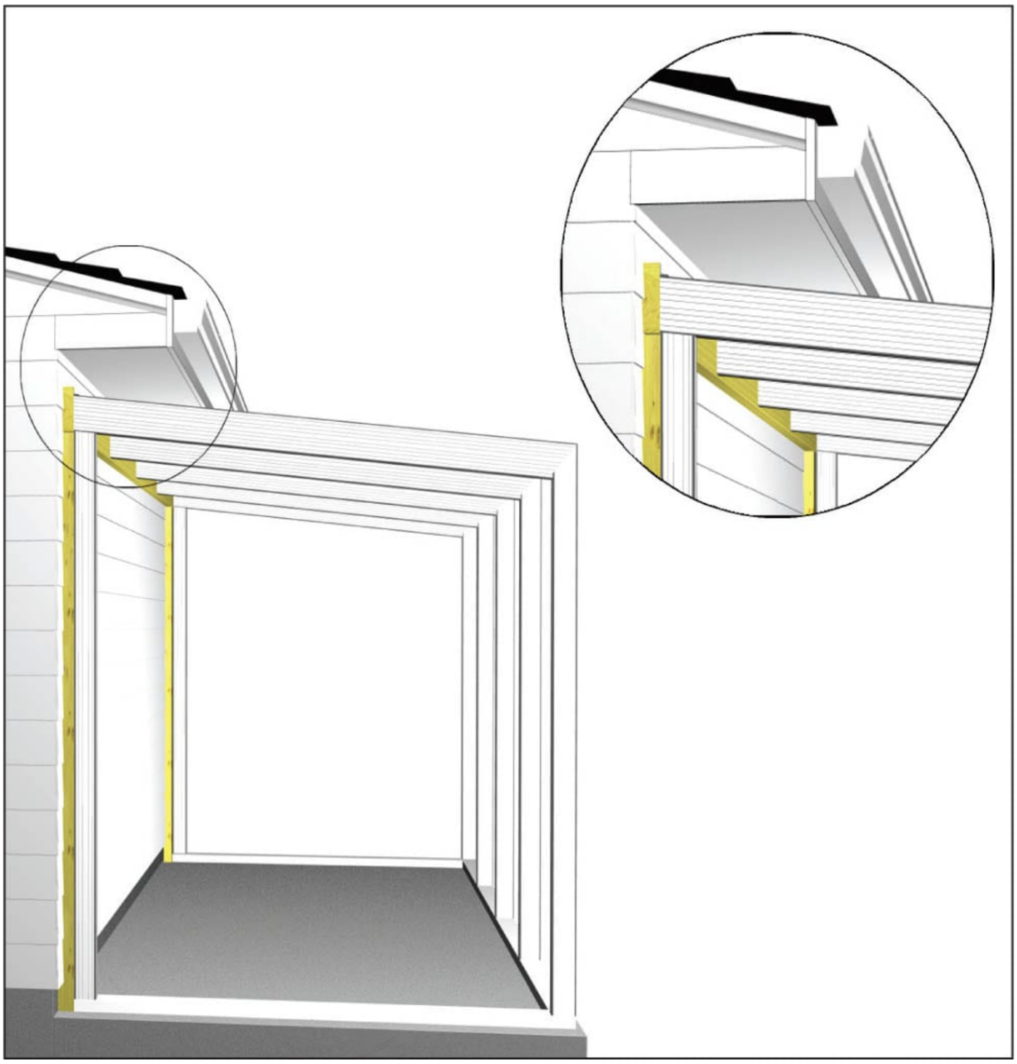


Without roof vents, hot air is trapped in the sunroom, making it uncomfortable for users and inhospitable to plants.

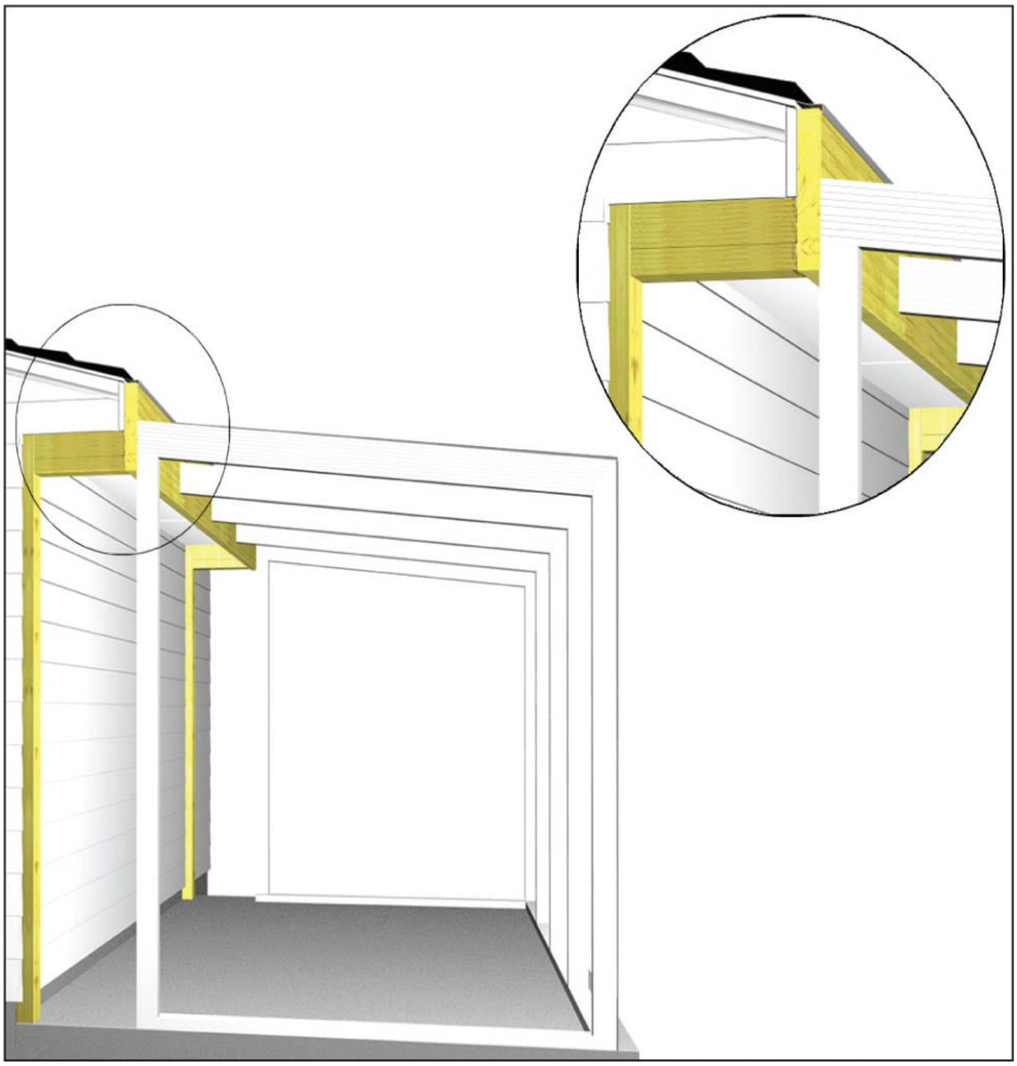


A single roof vent creates an escape route for hot air, allowing you to regulate the temperature and keep the room cooler during hot weather. Multiple roof vents increase the ventilation efficiency but increase the chances for leaks.

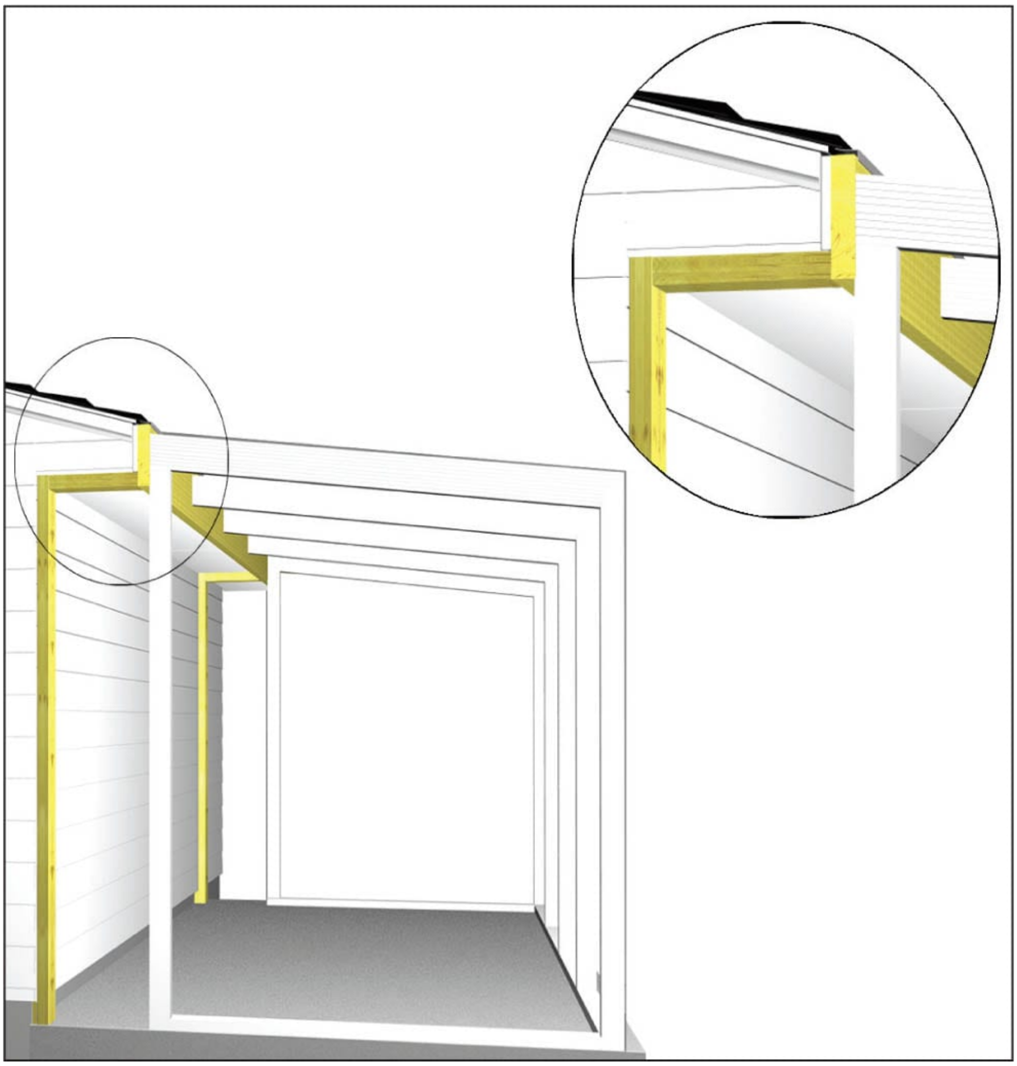
Options for Attaching a Sunroom Kit to Your House



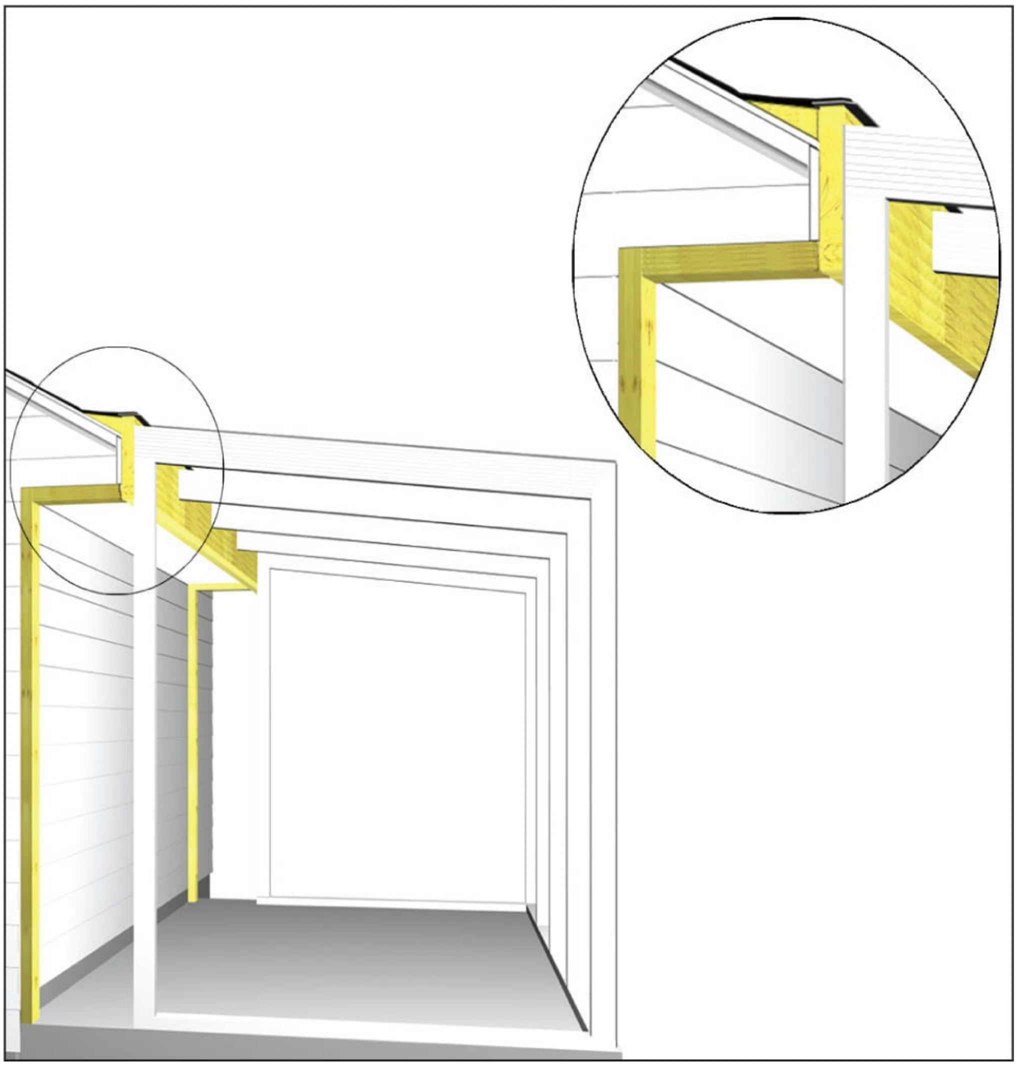
Attach the ledger directly to the wall if there is no eave overhang or if there is at least 6” of clear working space between the top of the ledger and the bottom of the eaves.



If the maximum height of the sunroom brings it up against or within 6” of the bottom of the eave overhang, extend the fascia on the eave downward and fill in with boards or siding between the cornice and the back post for the sunroom.



The ledger for the sunroom can be attached directly to the fascia board as long as the highest point of the sunroom roof remains slightly lower than the roof covering. Be sure to attach the ledger so the lag screws hit into the ends of the rafter tails.



If the sunroom is slightly taller than the roof eaves, you can add a ledger that's taller than the fascia, but it cannot extend more than a couple of inches higher. Fill in the open area beneath the roof covering created at the side using a full-width wood wedge and caulk. The roof covering must retain a slight slope with no swales.

Low-Maintenance Sunroom

Kits aren't the only way to have a glorious sunroom. In fact, you can construct a sunroom for your exact needs and circumstances, and several manufacturers will help you do that, fabricating the pieces and hardware you'll need to complete your own unique sunroom.

The structure shown in this project is typical of custom offerings. Although this is unique to the site, the steps taken will give you a good idea of the construction process, and the key points you need to consider. All in all, a custom sunroom is achievable by even a moderately experienced home DIYer. You'll need to allot enough time to tackle the project and pay close attention to the measurements and details because this involves modifying some elements of your home's structure.

The sunroom shown here is a three-season enclosure on a second-story walk-out deck. The room is a modular kit that was fabricated to the homeowner's design and then assembled on site. Except for some custom framing work where the rooflines intersect, the installation was accomplished in a single day.

Built from rigid PVC panels that fit into aluminum frames, this sunroom measures 14 × 14 feet with a 10-foot gable peak. The sidewalls are 7 feet high. The underlying deck area is covered with plywood sheathing that will become a substrate for the finished floor, vinyl tiles in this case. Window glazing is a clear vinyl fabric, which stretches to absorb impact and accommodates building expansion and contraction.

Although they are not seen in the photos, electrical receptacles were installed in the sunroom floor. The feeder cables run back to the house through conduit in the deck joist cavities, because the solid foam panels in the walls and ceilings do not readily accept cables.

TOOLS + MATERIALS

Drill/driver

Circular saw

Reciprocating saw

Power miter saw

Tape measure

Caulk gun

Level

Utility knife

Custom wall panels

Custom doors with latches

Roof panels

Aluminum floor track

Aluminum vertical wall track

Aluminum upper wall track

Roof I-beams

Three-part ridge pole support

Ridge pole (engineered beam)

Snap-in fascia

Snap-in gutter with downspouts

Moisture-resistant floor covering

Roof covering (shingles)

Framing lumber

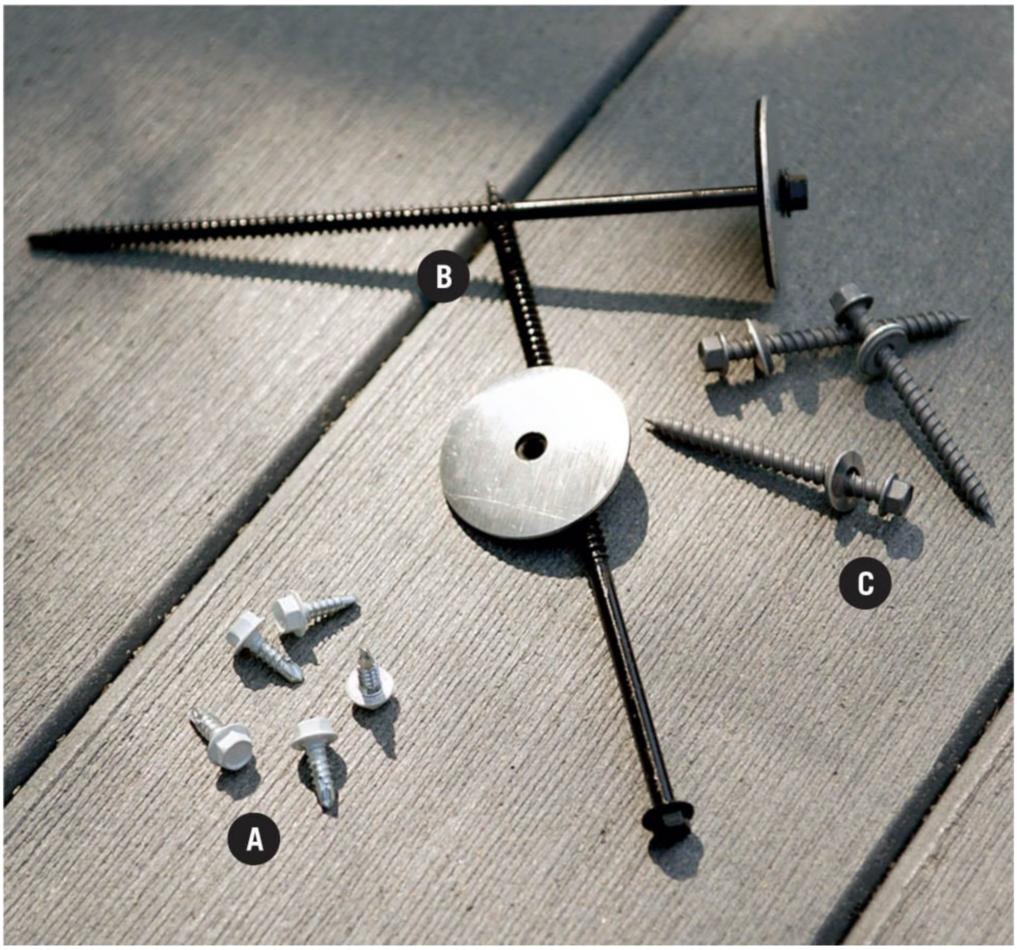
Weatherproof silicone sealant

Hex-head screws (1”, 2”, 7”)

To prepare for this new sunroom addition, an old deck was replaced with a new, beefier model. It features a sturdy staircase with enough room on the left side of the addition for an open-air grilling area that is accessed through a door in the sunroom. Instead of decking, the deck area in the sunroom installation area is covered with ¾” tongue-in-groove plywood sheathing.

Low-Maintenance Sunroom Kit Parts

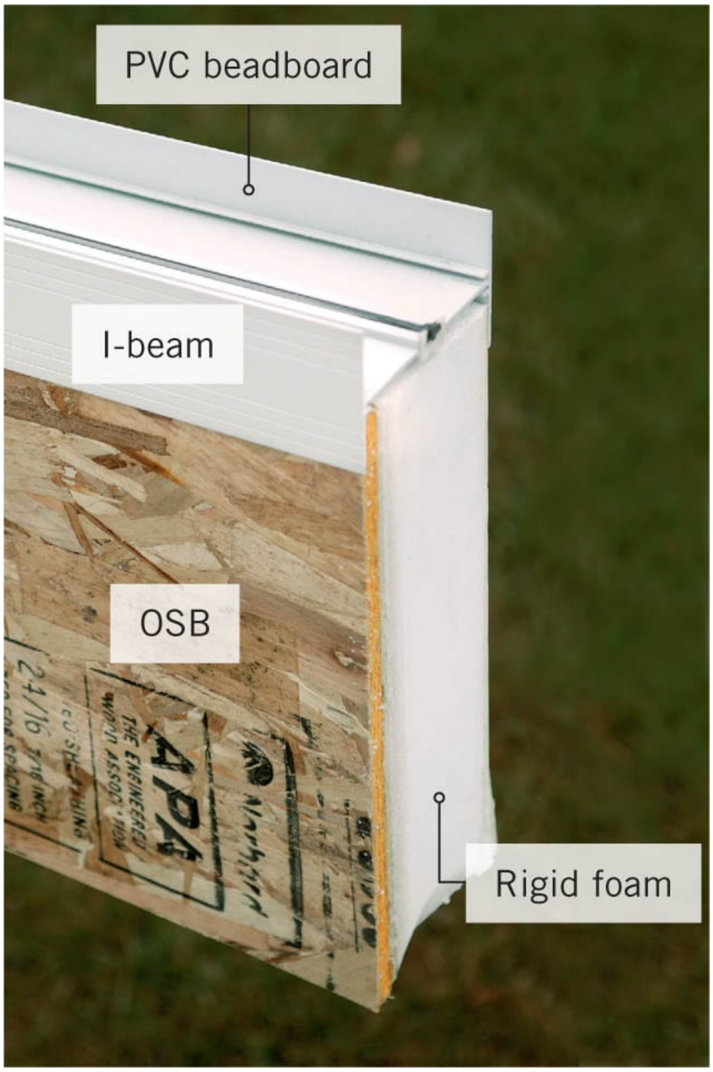
Aluminum tracks secure the prefabricated wall panels. Shown are sections of floor track (A), vertical wall track (B), and upper wall track (C).



Fasteners for this sunroom include self-tapping hex-head screws (1”) with low-visibility white heads (A), insulation screws (7”) with 2”-dia. fender washers (B), and galvanized self-tapping hex-head screws (2”) with self-sealing EPDM rubber washers (C).

Wall panels for sunroom kits consist of rigid PVC frames with foam insulation in the core. The window sash telescopes downward in four tracks to provide maximum ventilation when open.

Clear vinyl glazing stretches under impact and will not shatter or crack. It is also light enough that sunroom kits often can be installed without structural reinforcement that may be required for units with glass-glazed windows.



Roof panels come in varying thicknesses depending on the thickness of the rigid foam insulation board that is used (here, 4”). The narrow filler panel seen here features washable PVC beadboard on the interior side to create a ready-to-go ceiling once it is installed. The exterior side of the panel is ⅝” oriented strand board (OSB) to create a surface for installing building paper and asphalt shingles.

How to Install a Low-Maintenance Sunroom

Install the aluminum floor track channels at the perimeter of the installation area. Use a bead of weatherproof silicone sealant and self-tapping, 2" hex-head screws with EPDM rubber washers to secure the track. Square layout lines should be marked prior to installation. If your plywood substrate layer is treated with ACQ or copper azole wood treatment, protect the aluminum tracks from corrosion by installing an isolation layer of PVC flashing (sold in rolls).

Prepare the house walls for installation of the vertical wall tracks. Mark a cutting line on the siding at the track location and remove siding so you can fasten the tracks to the wall sheathing.

TIP: Use a cordless trim saw with a standard blade installed backward to cut vinyl siding.

Remove gutters and other obstructions from the installation area. The exact requirements for this step depend on the configuration of your roof and how you will be tying into the roofline or wall to make space for the sunroom roof.

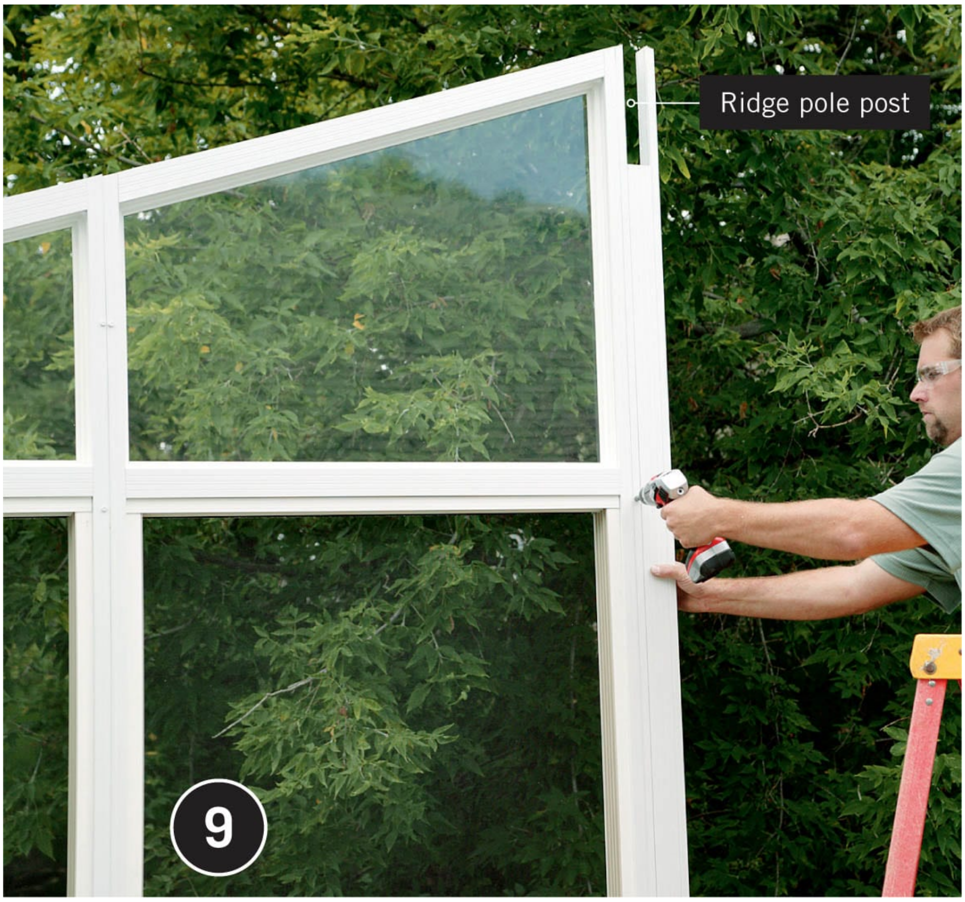
Install the vertical wall track channels with silicone sealant and self-sealing screws. If the wall sheathing will not accept screws and is not backed by plywood sheathing, you will need to install sturdy wood or wood sheathing backers to secure the track.

Install the first wall panel. In many cases, the first panel will be a narrow filler strip that is simply a solid wall panel and does not contain windows. Install the panel by driving 1” self-tapping screws through the floor track flanges and into the bottom frame of the panel. Make sure the panel is plumb and firmly seated against the track.

Add the next panel according to the installation sequence diagram that comes with your kit. Make sure the panel is plumb and then tack it into position by driving self-tapping screws through the floor flange. The panels lock together at the edges, which will hold them temporarily until the upper wall track can be installed. If you are working in windy conditions, you may need to brace the panels.

Install a corner post at the first corner. The flange on the side of the L-shaped post (inset photo) should capture the end of the first wall's last wall panel. The second wall's first wall panel will fit into the other leg of the L.

Fit the upper wall track over the entire first wall after cutting it to length. The end of the track that joins with the track on the next wall should be mitered to make a neat joint. If the adjoining wall is gabled, this will mean making a relatively tricky compound miter cut. Refer to your plan for the exact angle and don't be shy about asking for help.

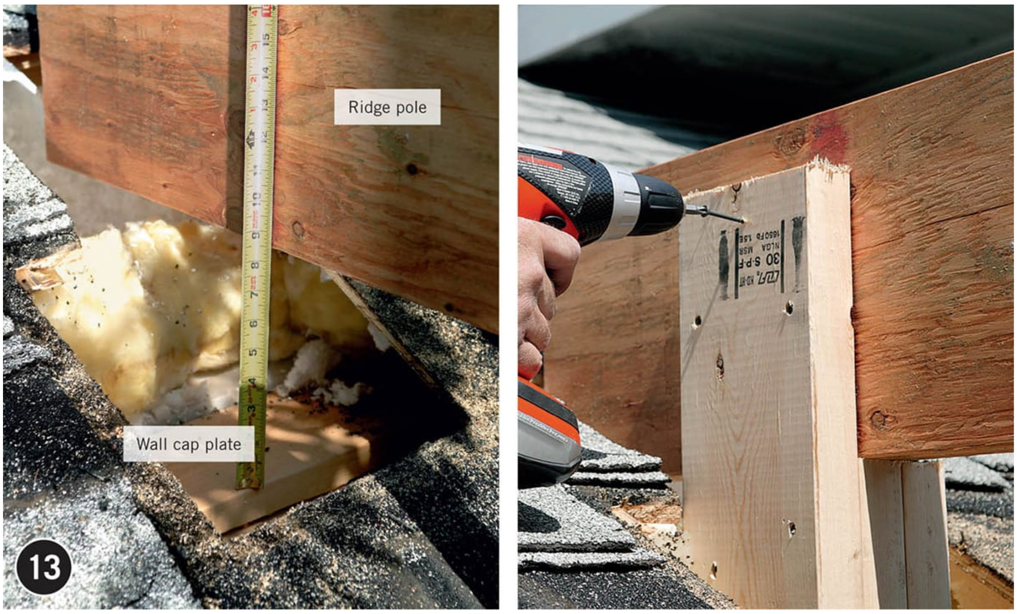


Continue installing panels on the second wall. If it is a gabled wall, install panels up to the midpoint; then cut the three-part, ridge pole support post to fit, and install it by driving screws through the post and into the wall panel. Make sure the saddle formed at the top of the post is sized to accept the ridge pole.

Install the remaining wall panels, creating corners and adding upper wall tracks as you go. Frequently check for plumb and level, and make sure all panels are seated firmly in the tracks.

Mark the upper wall tracks at the gable for cutting by transferring the edges of the ridge pole saddle onto the ends of tracks. Cut them to length and the correct angle with a power miter saw and metal cutting blade. Or, you can use an old combination blade that you don't mind making dull.

Set the ridge pole into the saddle in the ridge pole post, and adjust it until the overhang is correct. Check the length: if the pole does not end at the correct point on the other end, recut it or adjust your overhang amount. Secure the end by driving screws through the ridge pole post and into the ridge pole.



Secure the house-end of the ridge pole. Begin by installing a temporary post near the house wall that is the same height as the bottom of the saddle opening in the ridge pole post. Make sure the ridge pole is level and then measure for attaching it to the house. The exact method you use depends on the house structure. Here, the exterior wall that will support the ridge is set back 18" from a pair of bay windows that are covered by the same roof. This means that the cap plate for the bearing wall that will support the ridge pole is lower than the bottom of the pole. The distance is measured (left photo) and a 2 × 6 half-lap post anchor is constructed. The anchor is nailed to the cap plate on the wall and then the ridge pole is attached to the anchor with deck screws (right photo).

Begin installing roof panels. The full-width panels seen here are 4’ wide, yet they are strong enough to meet minimum dead load (“snow”) requirements even in cold climates. The panels are attached with long insulation screws that are fitted with fender washers and driven into the ridge pole and upper wall track.

Install I-beams on the roof next to the first roof panel. The track on one side of the I-beam should capture the leading edge of the first roof panel. Attach the I-beam to the roof panel with self-tapping screws driven through the I-beam flange and down into the OSB panel surface.

Add the next roof panel to the roof, sliding it into the open side of the I-beam. Square the panel with the roof, and then drive insulation screws down through the panel and into the ridge pole and the upper wall track. Add the next I-beam and fasten it with self-tapping screws.

Continue installing panels and I-beams until the roof is complete. Complete one full side before beginning the other.

Install fascia and gutters. The materials seen here are designed specifically to work with the roof panel system of this kit. The fascia snaps over the ends of the roof panels and is secured with screws. The gutters fit into tracks on the fascia and are secured with screws.

Install the prehung doors by fastening the door nailing flanges to the frames that create the door opening. Make sure the door is level and plumb before driving fasteners. Attach the door handle and latch.

Make finishing touches, such as trimming off excess insect screening and painting or cladding the ridge pole. If your sunroom does not have a finished ceiling, add one (tongue-and-groove cedar carsiding is a good choice). Install floorcoverings.

Upcycled Greenhouses + Cold Frames

A garden of any type is the ideal place to practice environmentally conscious strategies. Few are as ecologically friendly as "upcycling"—using old, discarded items in new, unique, and practical ways. This section is chock-full of ideas to do just that.

Whether it involves increasing the insulation value of a cold frame or raised bed, or creating a whole new greenhouse, upcycling is all about taking what would have been waste and turning it into a valuable resource. It doesn't hurt that in the process, you'll likely save a nice chunk of change.

Read through this section and you'll be a little surprised at how many re-uses there are for materials most people would consider trash. Hopefully, this gives you a different perspective. You may even find your own novel uses for what would have ended up in a landfill.

In this chapter

Where to Start

You need look no further than the local landfill to see how the volume of our waste material is overwhelming our ability to contain it. Efficient reuse of that material starts with filling a need.

Looking to build a full-blown greenhouse from reclaimed waste? That will probably entail finding an outside source for reclaimed lumber and old windows. But if your needs are more modest—such as a cloche, a simple cold frame, or even a quick and easy raised bed—everything you require may be right in your own backyard, in the recycling bin, or the back of the garage. Plastic gallon jugs, plumbing odds and ends, and lumber scraps can all be efficiently upcycled. Once you've got an idea of the structure or structures you want to build, it's time to search for the appropriate raw materials.

The ideal is always "free." Check Craigslist (craigslist.org), the Freecycle Network (freecycle.org), and the postings on local co-op or community bulletin boards for free materials. The best source for free upcycle materials is the most unpleasant: dumpster diving. Look behind large stores for discarded pallets. Check the dumpsters at large-scale demo projects—such as a tear-down of a condemned building. You'll find usable wood, old windows, and possibly even plumbing scraps on the worksites of major remodeling projects. (Always ask before going into a dumpster on private property or a job site.)

If you can't find the material you need for free, you can often buy it at very low cost. Check the local

Yellow Pages for salvage companies, or visit local Habitat ReStore outlets.

UPCYCLING RULES

The rules of upcycling are simple and straightforward.

1. Don't scavenge from private property.
2. Safety first. Don't use unsafe materials or methods, and don't create unsafe structures from upcycled materials.
3. Don't create more waste than you reuse.
4. Use whatever materials you recycle in as close to original form as possible.
5. The end product must have a functional purpose.

CULTIVATION UNDER CLOCHE

Greenhouses, cold frames, and hoophouses are all fine for entire beds or large areas of the garden, but if you want to protect just one or a few plants, a cloche can be the perfect solution. *Cloche* is the French word for "bell," and the first cloches were bell-shaped glass jars that produce-market vendors used to grow vegetables out of season for Parisian restaurants and farmers' markets. Today, manufacturers offer many lightweight, low-cost versions, from basic plastic "solar bells" to aluminum-and-plastic lantern cloches. But really, a plastic milk jug or liter bottle will do the job just as well. In addition, the screw-top lid on most plastic bottles gives a bit more control over how hot the plant gets. (In a traditional cloche, you prop up the side to vent and cool the plant.) Keep in mind, however, that no matter what you use as a cloche, it's meant to simply extend the frost date of the plant, not grow it throughout the winter.

The Materials

If you use your imagination, almost anything in the garbage can find a purpose elsewhere. But some materials are naturally better suited to repurposing for greenhouses and gardens than others.

Plastic bottles: There is an epidemic of plastic bottles in America. Vastly more are produced than are recycled, and they constitute much of the waste quickly filling landfills (not to mention covering the ocean). Bottle plastic doesn't break down, so if a bottle isn't reused or recycled, it will remain forever wherever it lands. But the translucent structure and the fact that plastic doesn't breathe make this material ideal for repurposing in the garden. Plastic bottles can be used as simple cloches (see the box on this page), filled with poor-quality soil, dirt, or other material and stacked to create garden walls, and even used in the walls of a greenhouse. The bad news about bottles is also good news for upcyclers: they're everywhere, and few people will complain if you collect them from recycling or garbage bins! (Make sure this is not illegal in your community; in some locales, recycled materials are a revenue stream for the municipal government.)

Plastic bottles have largely become an environmental disaster. But they can be put to good use in the garden, protecting small, vulnerable plants from cold snaps and extreme temperature variations. The cap provides a vent that allows you to release hot air and humidity as necessary.

Pallets: Used wherever goods are transported in bulk (which is to say everywhere), pallets are almost as ubiquitous as plastic bottles. One broken board or cracked brace means a pallet is unusable for its intended purpose, but it may still be usable for your greenhouse. Pallets can be used whole, as a solid, level surface that can serve as the floor or workbench of a greenhouse, or they can be modified and used to make potting tables, garden chairs, and even side walls for a greenhouse. Avoid using pallets that have been treated with preservatives, fungicides, or other chemicals, and avoid those with paint on them if you can. On the other hand, keep an eye out for the mark “HT”—that stands for “Heat Treated,” which means the pallet has been processed to kill any pathogens.

Modifying a pallet like this—removing the center rails and replacing them with 6-mil polyethylene sheeting—is one of the many ways you can upcycle these handy throwaways. This crude “window” can be used as a building block to form walls and a roof for a greenhouse.

Wood: Old fence wood, rescued deck boards, discarded clapboard siding, and broken lumber can all benefit the garden. Reclaimed wood can be used in greenhouses, cold frames, and many other structures. The chances are that you’ll have to adapt the wood to your purpose, but a little sanding, ripping, or sawing is a small price to pay for free wood. Even wood scraps can be handy. Leftover 2 × 4 sections can be laminated together to form long 4 × 4 timbers for greenhouse foundations, skids, or raised bed walls. Cut down damaged 2× wood for the slotted tops of greenhouse workbenches or to use as stakes for the frame of a hoophouse.

If you're reclaiming wood from a much older building or any that has been around for decades, keep in mind that the wood may be actual size rather than nominal size—in other words, what looks like a 4 × 4 may actually be 4 inches by 4 inches, rather than 3½ inches by 3½ inches. That may mean adjusting building plans. Be leery of any wood that might have been treated with chemicals. For instance, old railroad track ties were once quite popular for garden bed borders, until gardeners realized that most of these have been treated with toxic, heavy-metal-based preservatives. The best woods to reclaim are naturally pest- and rot-resistant varieties—specifically cedar and redwood, or any hardwood.

You don't have to look far to find secondhand wood that can be reused in garden structures, but take steps to ensure old, potentially toxic paint and finishes are removed before you upcycle reclaimed wood.

Windows: Old windows are obvious choices for crafting a greenhouse or cold frame. It's fairly easy to find old storm windows or double-hung units that have been replaced with insulated windows. Look on Craigslist, or touch base with local window contractors. The one drawback is that you can never be sure of what size you'll get, so be ready to adapt your plans. Wood-framed windows are the easiest to upcycle because it's much simpler to drill, saw, or modify wood. Metal and vinyl frame windows can work, but you'll need carbide drill bits and a bit more patience. Single-pane windows without mullions are the best option, because they cast the least amount of shadow on plants. If you're using reclaimed windows for a greenhouse, you'll also want the windows to be as airtight as possible; your garden may be better served if you take a little time and recaulk the windows before integrating them into a cold frame or greenhouse.

Old, discarded windows are the environmentally conscious greenhouse gardener’s treasure. They can easily be turned into a simple cold frame, or combined to create a nearly free greenhouse.

Tires: Discarded car and truck tires represent an environmental disaster. Not only do they take up a lot of room in landfills (and in many unofficial, illegal dumpsites), they are also slow to break down. Worse still, waste tires represent a significant fire hazard. The good news? It’s not hard to find discarded tires, and you can put them to work with little effort. The thick rubber surface of even worn tires is a great insulator. It also absorbs and holds heat, making it a fantastic choice for a raised bed in a greenhouse, where it will absorb heat all day and release it slowly at night.

A tire is also a great way to protect a tender plant or plants. Make a crude cold frame out of a tire by placing it over a plant and topping it with an old window (cut away the side walls with a reciprocating saw to increase the planting area). Lay the window across the tire and use a bolster to prop it up when you need to ventilate or cool the plant (or just cover the top with plastic sheet secured with bricks).

You can also use a tire as a quick and easy potato bed. Fill the tire with soil and plant the seed potatoes. When the first growth breaks through the surface, stack another tire on top and fill with soil.

A used tire makes a wonderful raised bed that can be placed where it is most convenient for the gardener. Inside a greenhouse, the rubber becomes a heat sink that releases heat after the sun goes down.

Buckets: Buckets, specifically 5-gallon buckets, are used to hold everything from bulk food ingredients to drywall compound and much more. They are also incredibly durable and won't break down in landfills. You can use buckets as beds for deep-rooted plants and even tree saplings, and they also make effective heat sinks. Paint the bucket black, fill it with water, and let the sun warm it all day; at night, it will slowly release heat, preventing the greenhouse from cooling too fast or too much.

Stones: All kinds of reclaimed stone and brick can be put to good use in the greenhouse and garden. Use flagstone or brick—especially darker colors—for the floor of a greenhouse to incorporate a natural heat sink. A brick or stone floor is also a stunning addition to any greenhouse and one that creates a stable surface on which to stand and work. You can make wonderfully eye-catching raised beds inside or outside of a greenhouse with field stones or other irregularly shaped, uncut stones. A black bucket filled with river rock or trap stone can be an efficient heat sink.

Reclaimed granite "curbstones" can serve as a tremendous foundation for a permanent greenhouse. They also make attractive walls for raised beds.

Plumbing pipe: A pile of old plumbing pipe and connectors might look like a mess, but look again. Plastic pipe can be used to fashion hoophouses and row cover frames. Old metal plumbing pipes and elbows can be repurposed into frames for cold frames and even for greenhouses. Any pipe can be crafted into a serviceable trellis to use along the back wall of a greenhouse for vining or tall-growing plants.

It might look like a chaotic mess of plumbing leftovers, but this is actually a cold frame or greenhouse frame just waiting to be rescued and assembled.

Upcycled Projects

Separating your recyclables and putting them out in the proper bin on the proper day is certainly an environmentally conscientious step in the right direction. But the rubber really hits the road when you put waste materials to work in your own garden so that they never enter the waste stream and no fuel is burned in transportation or the recycling process itself.

The projects that follow use a range of reclaimed materials in some surprisingly innovative ways. You can take these right off the page and build them yourself or use them as points of departure for imagining new projects that reuse your remodeling leftovers and garage debris. In either case, keep in mind that even as you break down materials to make them work for the structure you’re building, the scraps are reusable. Cutting down a PVC pipe for a hoophouse? Cut the scraps into stakes to use for a raised bed. Have leftover lumber that’s too short to use for framing or a greenhouse floor? Keep it handy for when you want to build shelves or a small potting table.

A STRAW-BALE COLD FRAME

Straw bales are growing in popularity as a medium for gardening, but they can also serve as excellent insulated walls for a cold-weather cold frame that you can assemble in minutes and move at a whim.

There are several ways to create the cold frame, but in every case, you start by building a stepped frame with a shorter wall on the south side. Then it's just a matter of deciding on your glazing material, which can be a totally opportunistic decision. For example, do you have an old single-pane window that you meant to take to the dump? Don't. Lay it with one long edge resting on the north wall of your bales, nestled into between the two side walls. Prop the window up as necessary to vent or cool down the plants inside. You can use the same idea with a role of plastic sheeting over a plumbing pipe or lumber scrap frame—just roll the sheet up or down as needed to modulate the temperature inside the cold frame.

An old window (or two) is the perfect partner for straw bales,creating an easy, quick, and efficient cold frame. Construct the cold frame so the face is sloped toward the best sun exposure.

USING CLEAR PLASTIC BOTTLES FOR GREENHOUSE PANELS

Building panels out of plastic bottles may be a bit labor intensive, but it's a perfect upcycle use. Passive solar panels made from ordinary clear plastic bottles can be used for everything from a top cover for a cold frame box to the entire wall and roof panels for full greenhouse. No matter what the scale, it's also a wonderful school project or weekend event for a group of kids because the actual work itself is so simple, plus it's a hands-on way to teach them the importance of recycling and reusing. The more kids, the merrier.

Start by collecting the bottles you need. It's easy to find them in abundance in curbside recycling bins on collection day, inside the dumpsters in back of restaurants, or in the garbage cans at outdoor music events or other public gatherings. (As noted previously, make sure this is legal where you live.)

It's essential to clean the bottles inside and out to avoid attracting insects. Strip any labels off the plastic to ensure that a maximum amount of light passes through.

Begin by creating whatever greenhouse frame structure you're planning. At the large end of the scale, you can frame out a simple gable or shed-roof greenhouse using reclaimed wood, scraps leftover from other projects, or other material you have on hand. The greenhouse shouldn't be large—the finished project will have too many gaps for air and water penetration for the structure to function as a fully fledged greenhouse. However, on sunny days, it will be able to maintain an interior temperature about 40 degrees warmer than the outside air.

Once you have built whatever frame you are using, you can begin assembling the simple columns that will compose various panels. You can use poles made from ¾-inch to 1-inch dowels, leftover metal conduit, bamboo canes, straight and thin branches, rebar, or even wire. No matter what you make them from, the poles need to be long enough to span the frame members.

Cut the bottoms off the bottles and thread them onto the pole, nesting each additional bottle over the one below. Attached the completed poles to the framing at each end with pipe clamps.

As mentioned, the resulting surfaces will necessarily have gaps, but the cumulative effect of the enclosure will be to allow light through while keeping temperatures high.

Once you cut the bottoms off of the plastic bottles, they'll stack easily on whatever you're using for a pole. In our example, the plastic-bottle panel will be used as a simple cold-frame top to cover a small raised bed garden.

5-Gallon Bucket Cold Frame

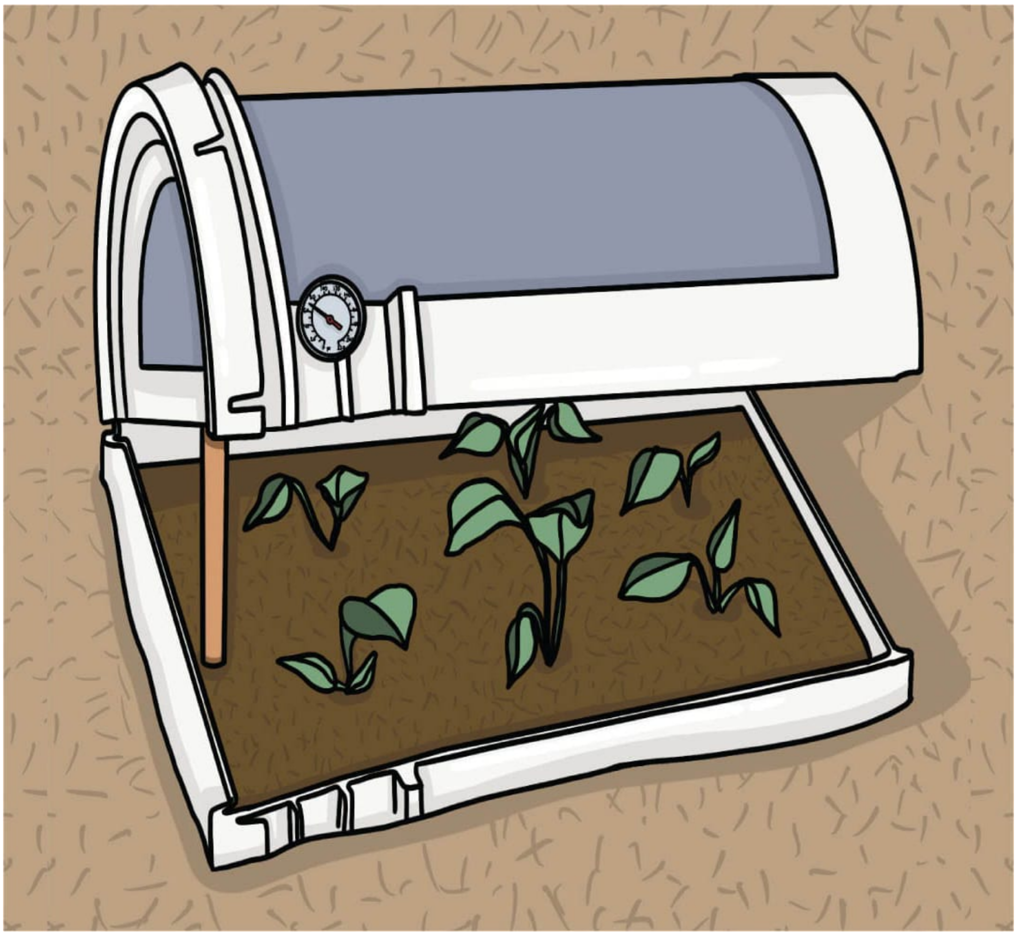
The humble 5-gallon bucket is used to transport everything from industrial-sized portions of ranch dressing to pool chemicals. That means that there are a whole lot of these buckets leftover and hanging around, just begging to be upcycled. Fortunately, the material and the shape itself are incredibly durable, and adaptable to a number of innovative new uses, including several that can serve the home gardener.

Take the main project here, for instance. This is a superhandy cold frame that can be put anywhere in the garden. It is a protective enclosure that allows you to overwinter plants that might not survive a harsh winter in your local climate. It can also be used to start plants early, before the soil and air temperature warm to seasonal temperatures. You can even use a cold frame as a transitional space, to “harden off” seedlings that you’ve started inside but that may be too tender for early spring temperatures.

No matter what purpose you use it for, the plastic will help insulate against cold temperatures in both the soil and air. It is also durable and can take a beating and still be useful for years to come.

Although the version shown here captures both the soil and plants inside the bucket itself, you can certainly use this as more traditional cold frame by cutting the bottom half of the bucket in half again, so that it can be pressed down into the soil around existing plantings.

We’ve included a variation that can serve different garden and greenhouse purposes. A mini-greenhouse option allows you to grow individual specimen plants, or small groups of seedlings, inside, even while it’s still winter outside. This is an amazingly simple solution to getting a jump on the season and is incredibly inexpensive and easy to make.



A simple cold frame like this can grow a small crop of salad additions, radishes, and other low growers. Use several of these low-cost options for maximum garden variety.

TOOLS + MATERIALS

5-gallon bucket with snug-fitting lid (white)

6-mil plastic

Tape measure

Compass or trammel

Permanent marker sharpie

Handsaw

Metal straightedge

Jigsaw or frameless hacksaw

Drill and bits

Level

(2) 2½” galvanized steel butt hinges

Machine screws and bolts to match the hinges

Analog stem thermometer

2-part epoxy adhesive, or plastic glue labeled for use with HDPE

6-mil plastic sheet

Cutting pliers

Heavy-duty shears

Sanding block

60-grit sanding paper

Work gloves

Safety glasses

CHOOSING THE RIGHT 5-GALLON BUCKET

For such a simple structure, there are many colors and several types of 5-gallon bucket. Most in circulation today are made from high-density polyethene (HDPE). That's a superdurable plastic that holds its shape even when subject to high temperatures, and will last several seasons under prolonged UV-ray exposure. However, there are other, flimsier types of buckets. Always look for the marking "HDPE" when upcycling a 5-gallon bucket.

Any bucket that will come into direct contact with edible plants or the soil they're grown in should be "food grade." Nonfood grade buckets may contain traces of harmful compounds that can leach into the soil.

Fortunately, 5-gallon buckets themselves often reveal what they held. Any residual label listing edible contents like salad dressing are a dead giveaway that the bucket is food grade. A snowflake embossed in the plastic (usually on the bottom) indicates the bucket and whatever it originally carried can be frozen, and that, too, indicates food. A wave is a similar sign and indication, one that means the bucket is microwave safe.

You can also do a web search of any code on the bucket. Those codes will often reveal the original company of use, that may in turn tell you what the bucket transported. Lastly, finding a number 1, 2, 4, 5, or 7 imprinted on the bottom is a good clue that the bucket was used to transport foodstuffs.

Potential Sources

It's a testament to the 5-gallon bucket's many useful qualities that this storage container is so ubiquitous. That also means that free buckets are relatively easy to find. Here are a few sources to consider for free buckets. If you come up empty on your search, take heart; new 5-gallon buckets are only a few dollars at any home center. One caveat though: Always respect the privacy of any potential bucket source. Do not enter private property or take any bucket that has not obviously been discarded as trash.

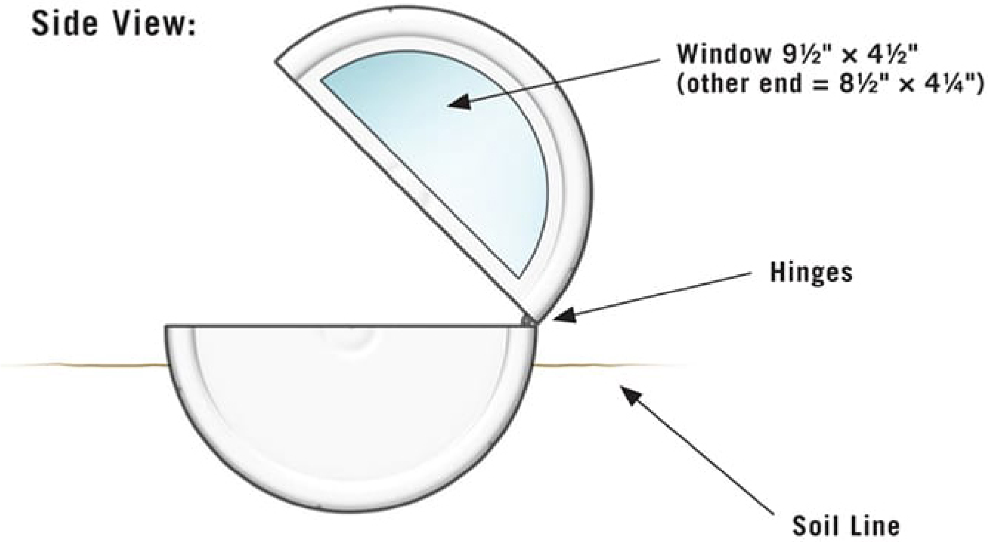
- **Restaurants, delis, bakeries, and supermarkets.** A sure way to find food-grade buckets is to check in the dumpster or trash area behind a food retailer, for empty, discarded buckets. Even though these are likely food grade, clean them thoroughly before use because they may contain microorganisms that could infiltrate plant soil.

- **Construction sites.** Most builders and contractors do not recycle the many 5-gallon buckets they go through. Although these generally contained materials like drywall compound, they are usually easy to clean and upcycle. However, as stated above, do not go on private property or a construction site without explicit permission from the company working there.

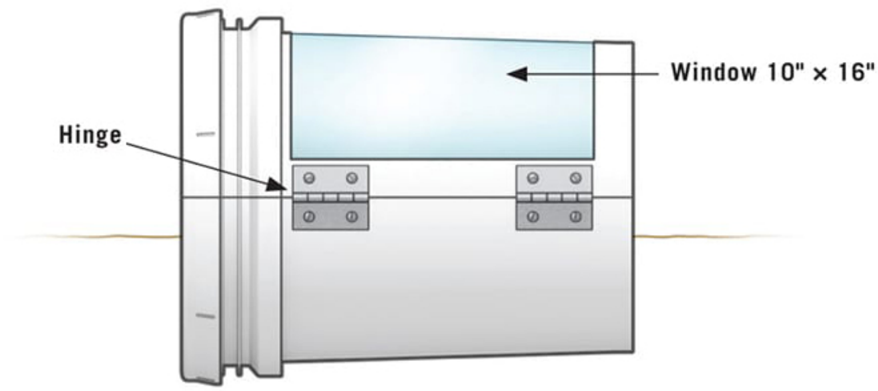
- **Schools and other government buildings with cafeterias.** You can find many food-grade buckets in the trash are of schools, but carefully check the bucket for markings. Some may have been used to transport potentially harmful chemicals for janitorial uses.

How to Make a 5-Gallon Bucket Cold Frame

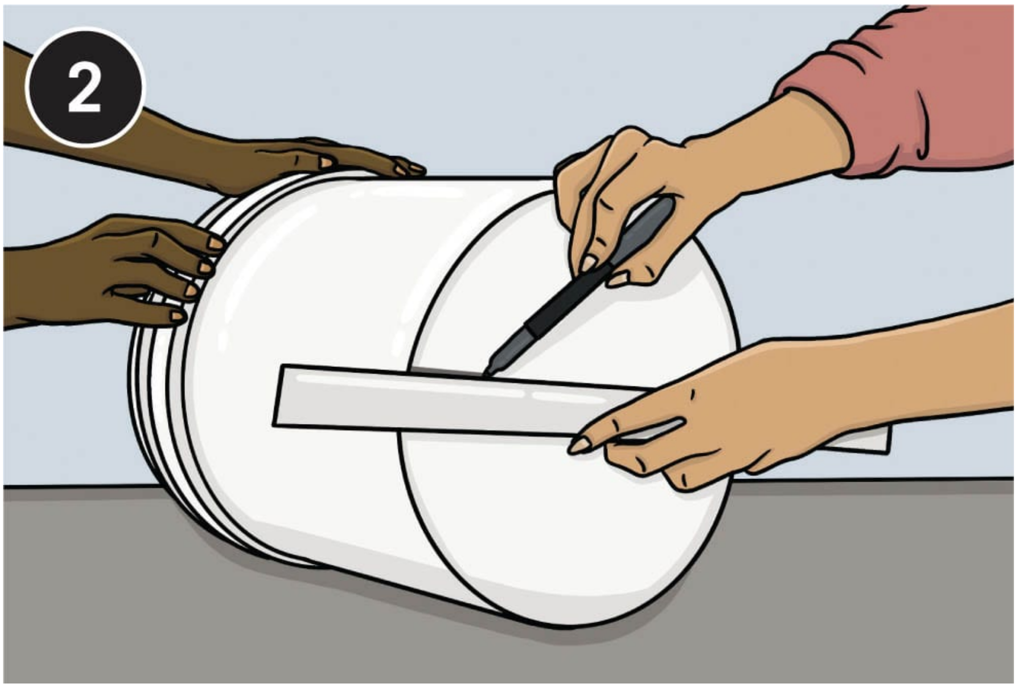
Side View:



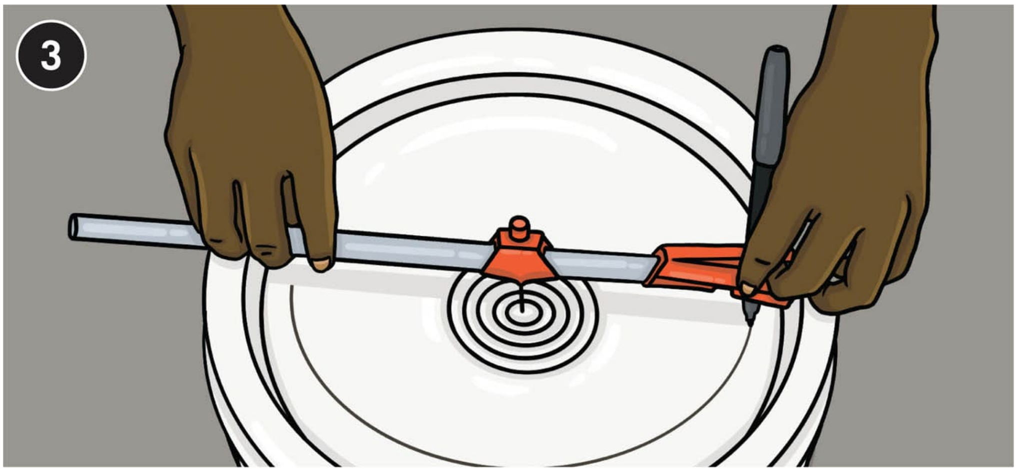
Rear View:



Clean the bucket thoroughly. Remove the bucket handle, by cutting each side where it goes into the bucket, with heavy-duty cutting pliers.

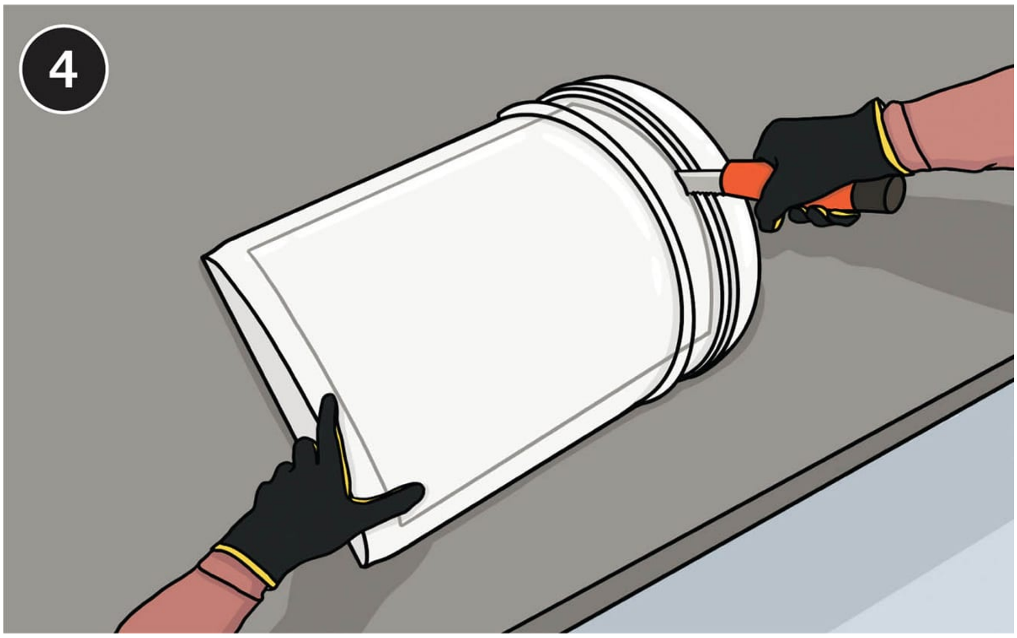


With the lid securely attached, carefully measure and mark a cut line across the center of the lid. Use a level to extend the cut line down each side of the bucket and across the center of the bottom.



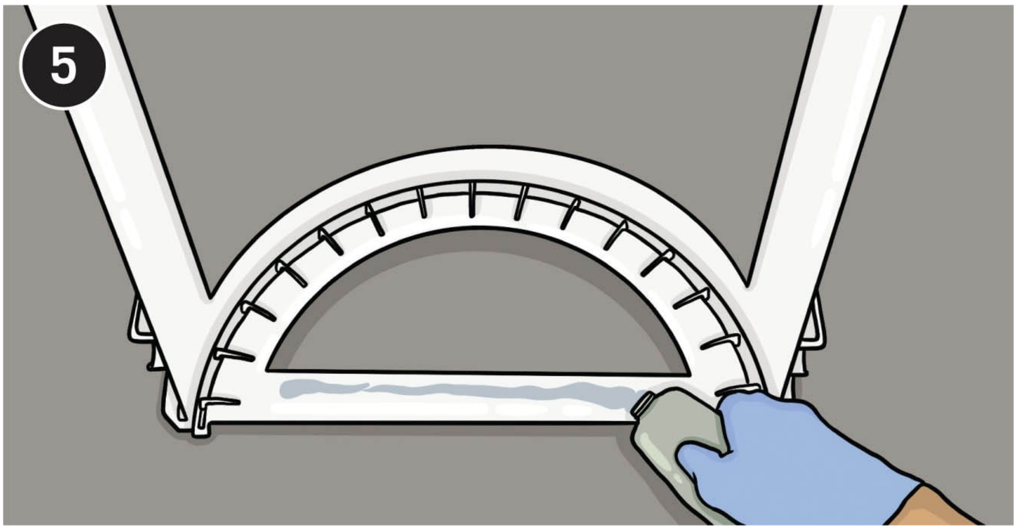
Use a compass or trammel on the bottom and lid of the bucket to mark a centered circle on each. The circle should be about 9½” in diameter on the lid and about 8½” in diameter on the bottom. Use a handsaw to cut the bucket in half.

Use a level as a straightedge to connect the two sides of the marked arcs on the bottom and lid of one bucket half, leaving about a ½” margin between the cut line and cut edge. Drill an access hole and use a jigsaw or frameless hacksaw to cut out the half circles. These will be the end windows for the cold frame.

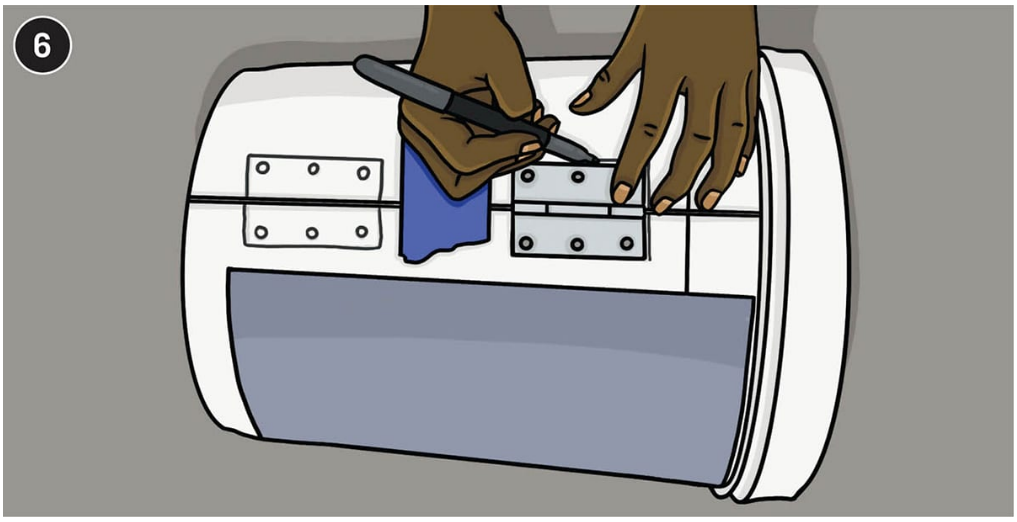


Measure and mark a 10” × 16” window in the bucket half with the end windows, centered across the body of the bucket. Drill an access hole and cut out the window. Note: A good shortcut for this is to cut out a 10” × 16” piece of stiff cardboard and use it as a template to mark the cutout.

Use the bucket end window openings to trace 6-mil plastic sheeting for the windowpanes. Measure and mark the plastic for the main window. Use scissors to cut out the windows, leaving ½” extra all the way around.



Use plastic epoxy to glue the 6-mil plastic windowpanes in place on the inside of the bucket, covering the window openings.

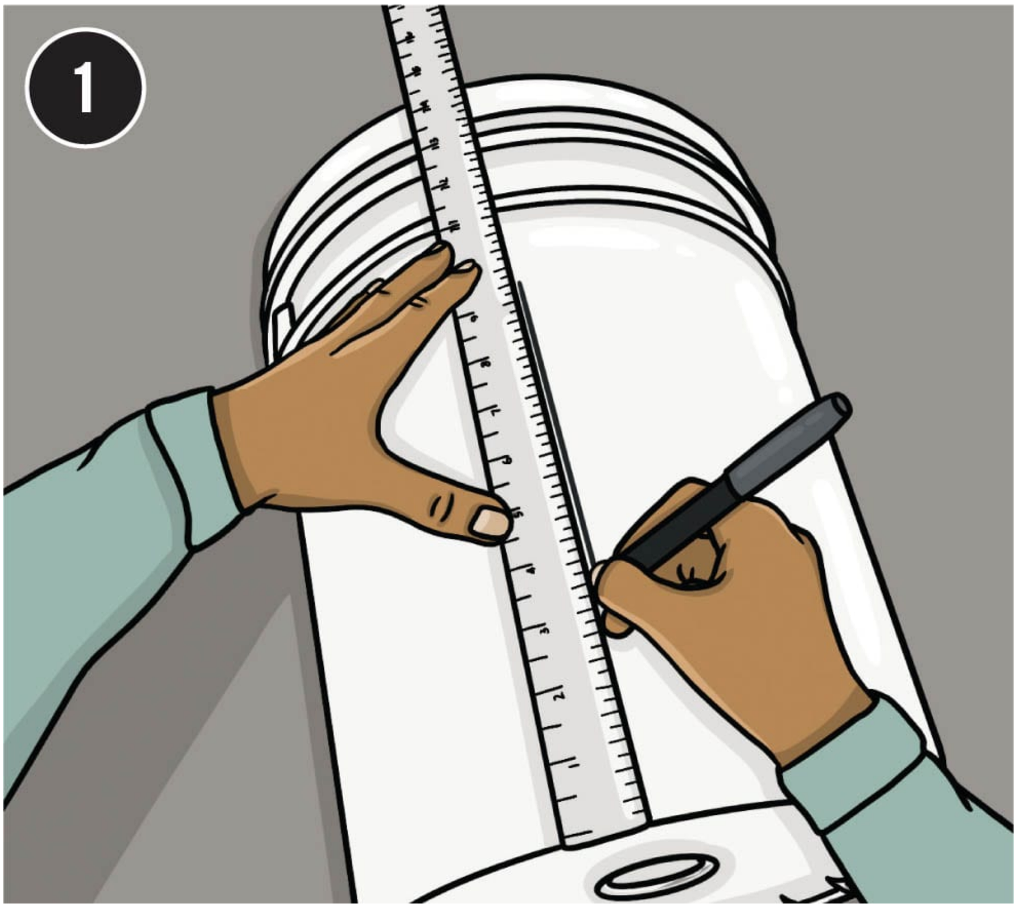


Using painter's tape to tape the two bucket halves together and mark one long side for the placement of the hinges. They should be centered along the line, about 6" apart.

Drill holes at the marks on both halves, and then fasten the hinge leaves to one half with the machine screws and bolts. Fasten the opposite hinge leaf to the second bucket half.

Drill the hole for the stem thermometer in between two of the bucket top flanges. The stem should pass through the hole but be snug. Dig a concave hole for the bottom of the cold frame, set it into the ground, and fill the bottom half with soil, making sure the bottom half is sitting level. Plant the plants and close the top of the cold frame. Slide the thermometer in place.

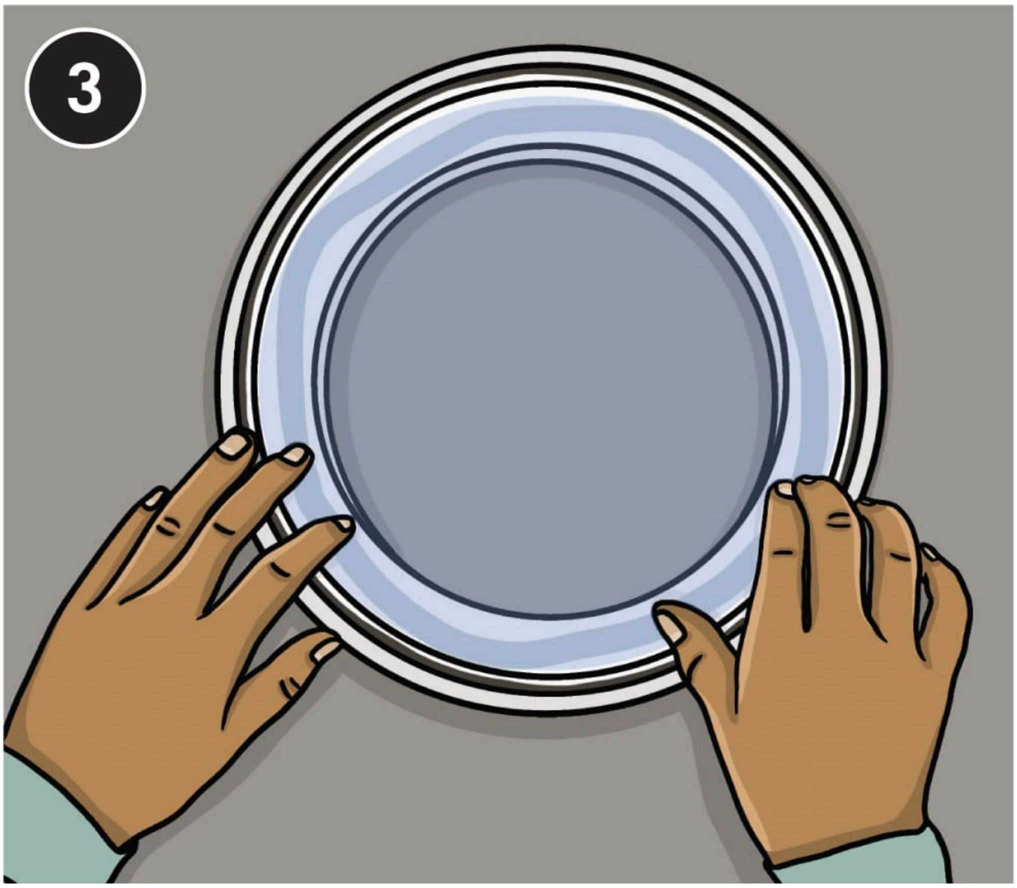
How to Make a 5-Gallon Bucket Tabletop Greenhouse



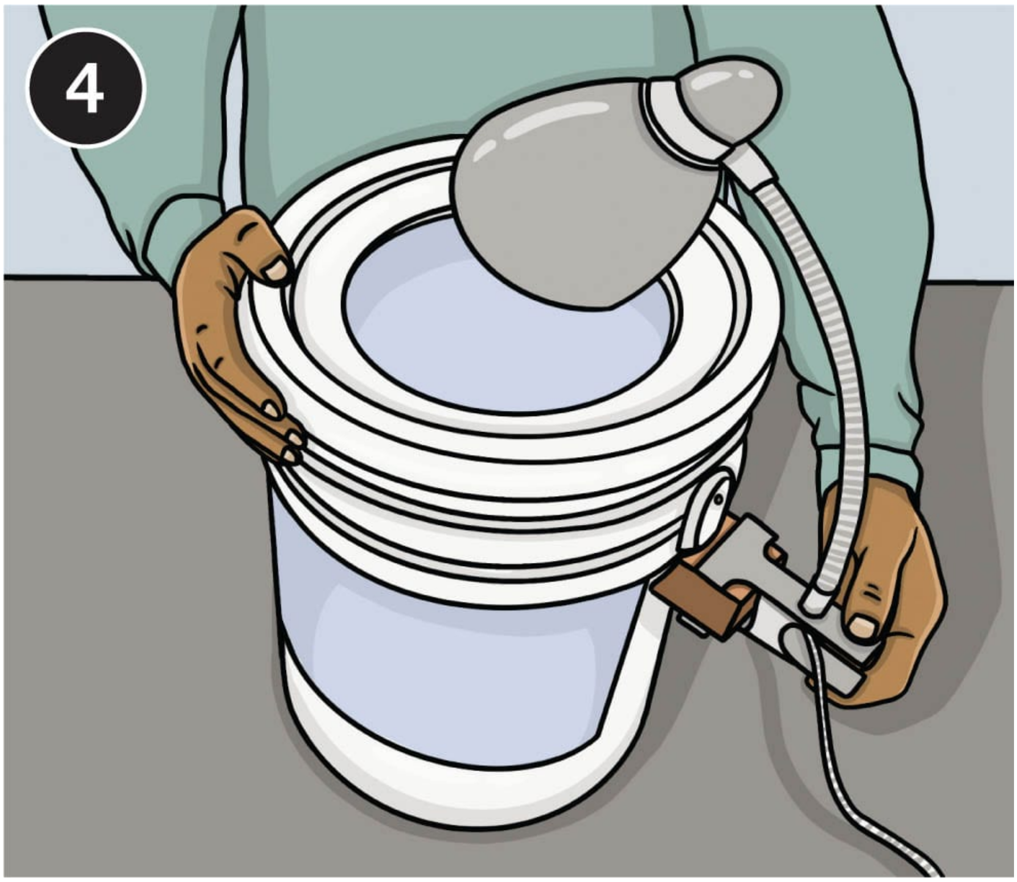
Measure and mark two 2” vertical spines on opposite sides of the bucket. The spines should run from right under the bottom ridge on the mouth of the bucket, down to 3” from the bottom. Use a flexible straightedge to draw a cut line from the bottom corner of each spine to the bottom corner of the opposite one, on each side. This will create the outline of two windows.

Drill an access hole and use a jigsaw to cut out the two windows, leaving the spines and bottom section. Drill a random pattern of $^{5}/_{64}$" drainage holes in the bottom of the bucket.

Use a compass or trammel to draw an 8" (20.3 cm)-diameter circle centered on the lid. Drill an access hole and use a jigsaw or frameless hacksaw to cut out the top window in the lid. (See Step 3, here.)



Use scissors to cut 6-mil plastic sheeting into panels that are ½” larger on all sides than the windows in the bucket. Cut the circular window for the lid 1” larger in diameter than the opening. Use duct tape or silicone adhesive to fasten each window on the inside of the bucket and underside of the lid.



Cut a 3” long mounting block from a 1 × 2 scrap. Use 2” deck screws to mount it at the top of one of the spines. Fill the base with potting soil and plant the seeds you want to grow. Place the bucket in its final location on top of the second lid. Clip a flexible stem grow light to the mounting block and set a timer at the plug.

Old-Window Greenhouse

Old, discarded windows are just about the most obvious choice for reuse in upcycled greenhouses. As homeowners across the country upgrade to insulated windows, older windows are relegated to the junk heap. These include wood-framed units that have seen better days, aluminum-framed storm windows that are no longer needed, and even vinyl-clad insulated windows that have come to the end of their lifespan. You can find them in dumpsters, piled up on remodeling job sites, for sale cheaply through salvage companies, and online through various sources—often for free.

The trick to reusing these windows for a greenhouse is that you have to take what you get. Sizes vary, sometimes radically. The design shown here is typical, featuring a small footprint and a simple shed roof. The recycled windows used are 28 inches wide by 62 inches high; the larger windows are used in the walls, and the smaller are used in the roof. In both cases, these instructions assume wood-framed units.

Wood framing is always best when it comes to adapting old glazing to a new hobby greenhouse, but you have to make sure that the wood is in good shape. The lumber used is all of common sizes and should be readily available through salvage companies or from job sites. The design can be scaled up or adapted to different sizes of windows fairly easily, as the framing details have intentionally been left somewhat crude to allow adaptation without a lot of fuss. A kneewall base ensures that no matter what windows you reuse, they'll be well supported. We've also used fiberglass panels, which are widely available and simple to install, for the roof.

When creating a design such as this, using mostly recycled materials, it’s a great idea to lay the windows and framing studs out on a big, flat work surface—for example, a garage floor or expanse of lawn. If you’re not necessarily good with the nitty-gritty of detailed measurements and nominal lumber sizes, this can be a way to verify that everything will fit and to make quick adjustments without having to tear things apart. Whatever the case, it’s always wisest to try to find multiple windows in the same size; cobbling together windows of odd sizes throughout the structure can lead to a nightmare and create an unstable and unsafe greenhouse.

That said, any upcycling project involves certain compromises. This greenhouse will not be as airtight as most polycarbonate panel or plastic-film kit greenhouses would be (and certainly not as much of a high-quality custom structure), so it is at best going to serve you as a three-season structure—it just wouldn’t be cost effective to heat it over a cold winter. You can make the structure a little more efficient by recaulking the window panes in wood-framed windows and covering smaller openings or gaps between the windows in the roof and the wall top plates with plastic.

Build a greenhouse of old windows and you not only save money, but you also create a distinctive structure that puts a dumpster worth of waste materials to great use.

TOOLS + MATERIALS

Cordless power drill and bits

Claw hammer

Paintbrush

Sealant or paint

Stepladder

Clear silicone caulk

Construction adhesive

Caulk gun

Nails (6d, 8d)

Finish nails

Circular saw

12” spikes

Jigsaw

Tamper

Level

Speed square

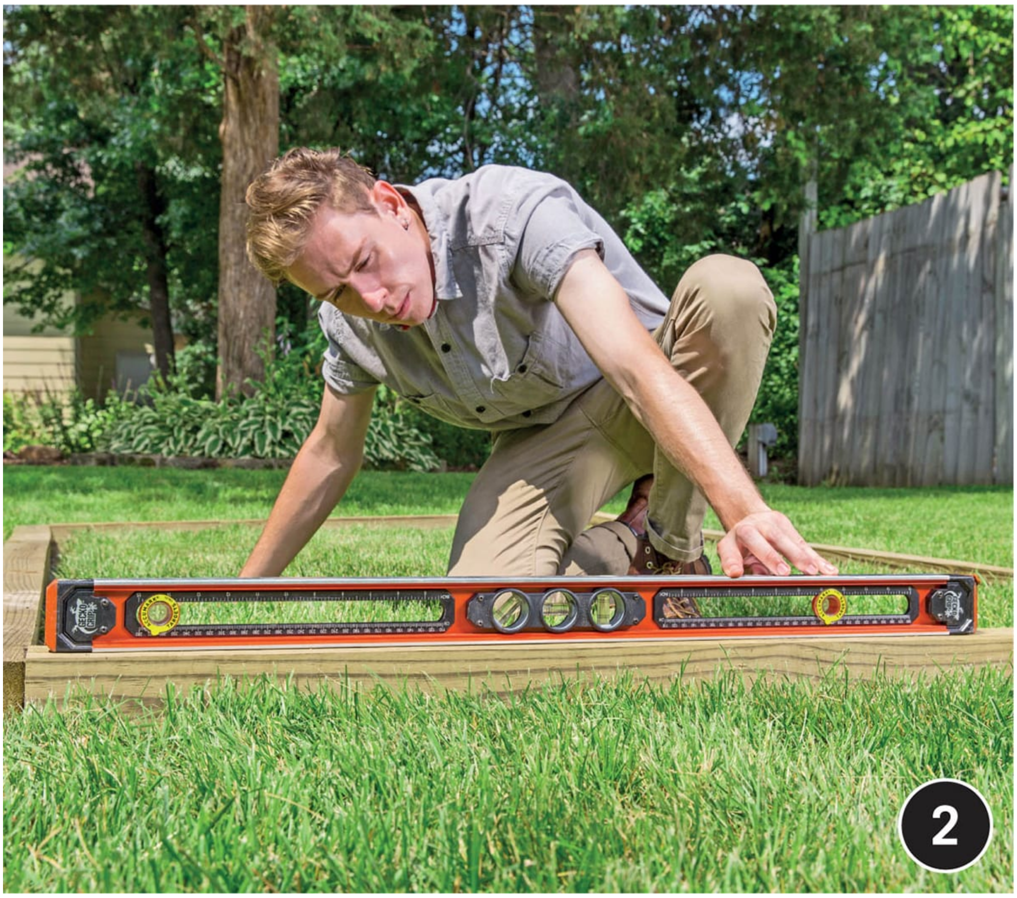
Wood screws (2½”, 3”)

1” screws

Rubber washers

How to Build an Old-Window Greenhouse

Inspect all of the windows for significant defects you might have missed during the reclaiming process. Look for rust, excessive warping, and hidden insect damage or rot (if you're using wood-framed units). Clean up the windows and sand or use a wire wheel to remove loose or flaking finishes or rough areas. Paint the frames with primer or coat with preservative. Measure and mark the trenches for 4 × 4 foundation timbers. Dig them 4" deep and fill with crushed gravel. Tamp the gravel down all around.

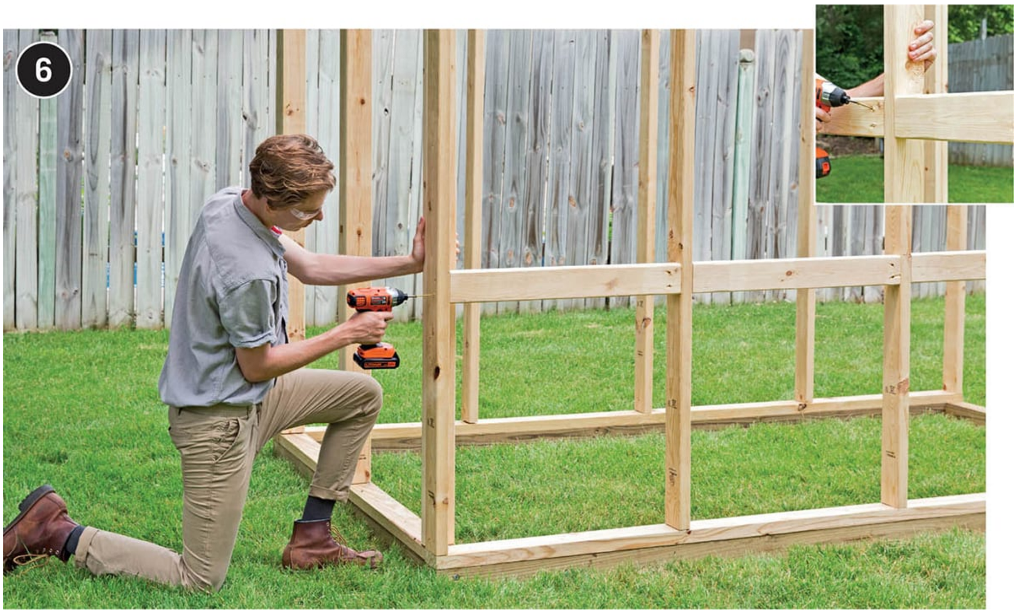


Fasten the 4 × 4 frame together by joining the timbers at the corner with 12" spikes, countersunk. Check the frame for level on all sides, side by side, and diagonally. Add or remove gravel under the foundation to level any one side.

Working on a clean, flat surface such as the lawn here, lay out and build one side wall. Nail the sole and top plates to the studs after ensuring that each stud is at a 45° angle to the plate with a speed square.

Raise the wall, check for plumb, and brace it into position. Nail the sole plate to the foundation timber with 8d nails.

Once the two side walls are constructed and nailed in position, build and raise the rear (nondoor) wall into place and nail it to the foundation 4 × 4. Screw the walls together at the corners with 3” wood screws.



Screw 2 × 4 × 28¼" spreaders in the stud cavities of the side and back walls. Toe-screw the spreaders on the inside edges and face-screw through the corners (inset). The tops of spreaders should be 32" above the 4 × 4 base, faces flush with the outside edges of the wall studs.

Face-nail a 2 × 4 cedar ledger around the perimeter of the greenhouse so that the top of the ledger is flush with the tops of the 2 × 4 spreaders.

Use a jigsaw to cut notches in 5/4 cedar decking to use as window sills on top of the spreaders.

Dry-fit the cedar sills and then miter the corners if the fit is correct. Coat the tops of the spreaders with construction adhesive and nail the cedar sills in place with exterior finish nails.

Miter-cut retainer strips from ¾” quarter-round stock for the window openings. Drill pilot holes for nailing, then coat the bottom faces of the strips with construction adhesive and nail them in place with exterior finish nails. You may have to adjust for the windows you reclaim. The windows here varied in height by up to ½”.

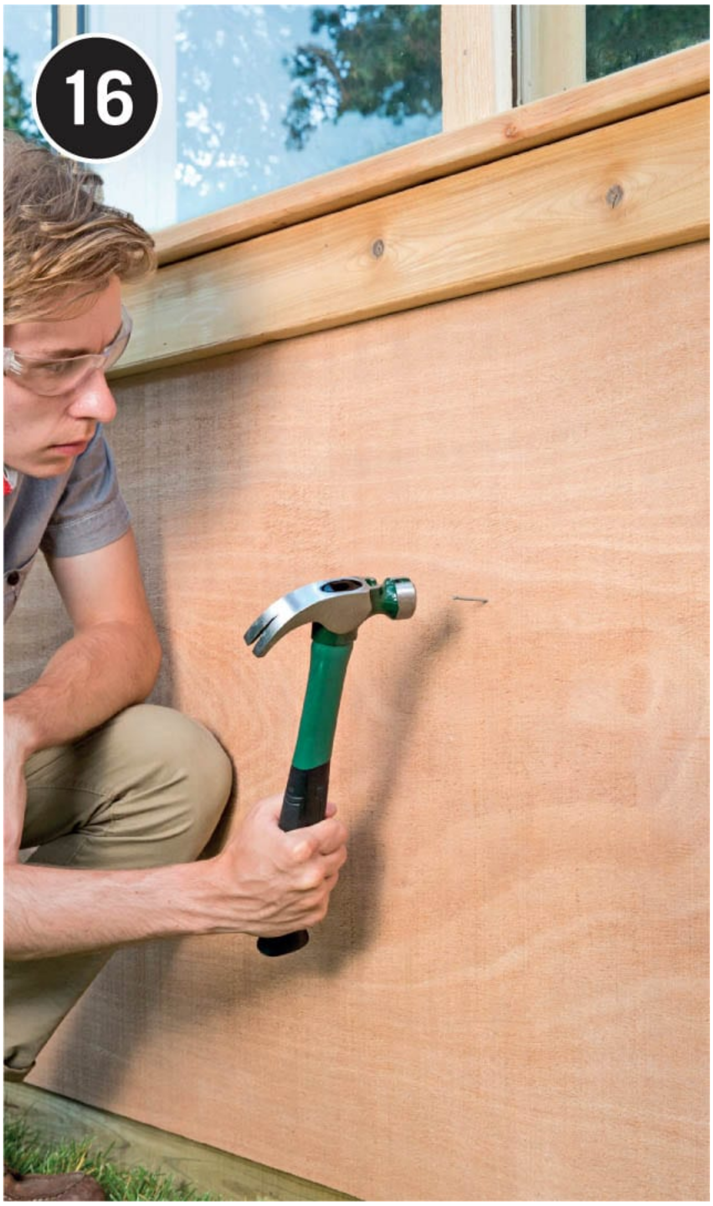
Lay a thin bead of clear silicone caulk into the retainer strip channel for the first window.

With a helper, carefully and evenly set the window into position. Have the helper hold the window in place for the next step.

Pin the window in place with small brads to allow the silicone to set. Repeat the installation process with the rest of the windows for the three walls.

Measure and cut 2 × 6 fascia boards for the top of each wall. Use 3” 6d galvanized nails to tack the board to the top plates of the wall all the way around. The fascia should cover any gaps at the tops of the windows.

Measure and cut 1 × 3 cedar strips to run between the fascia at the top and the sill. Drill pilot holes and nail the strips in place on the studs with 3” 6d nails.



Measure and cut ½” exterior grade plywood for the half-wall cladding at the bottom of each wall. Nail it in place with 2” 6d nails.

Measure and cut 2 × 4 cedar base trim, 1 × 3 cedar corner boards, and 1 × 3 cedar battens. Nail them in place with exterior finish nails, positioning the battens between the base trim and the underside of the sill, continuing the vertical line of the stile trim.

Frame the front wall (12" higher than the side walls) in place by measuring and marking stud and doorjamb positions and toe-nailing the members in place. Nail the top cap to the top of the studs and install the door header. Install the door so that it opens outward.

Use 2½" deck screws to toe-screw the front cripple studs for the triangular top walls on both sides.

Measure and cut the other cripple studs in each top wall and toe-screw them in place with 2½" deck screws. Check that each is plumb and square to the top plate. Miter each end of the top plates and screw them to the cripple studs on each wall.

Measure and cut the 2 × 4 rafters and toe-screw them running front wall to back wall. There should be a 6” overhang on both ends.

Measure and cut the 2 × 2 purlins for the gaps between the rafters. Toe-screw them in place, spaced 11½" on center.

Cut and screw the fiberglass panel nailing strips to the top of each purlin.

Drill pilot holes for the fiberglass panels and screw them in place to the purlins using 1” screws and rubber washers. Paint or stain the exterior of the greenhouse and, if using in a cooler season, cover all the clerestory windows with 6- to 8-mil plastic sheeting stapled in place.

Old-Window Portable Cold Frame

A simple, portable cold frame can be incredibly useful in the early-spring garden (or, in some cases, the late-fall garden). Depending on where you live, you’ll realize an extra six to eight weeks of growing time—a chance to get a big head start on your garden and harden off seedlings.

This cold frame will do the job well without taking a bite out of your pocketbook. It is built with reclaimed 1 × 6 cedar fence boards and scrap pressure-treated 2 × 4 braces, and the top is a 24 × 36- inch salvaged wood-frame window. But keep in mind that you can use this design as a baseline; this is somewhat smaller than most cold frames, which makes it more portable, but it may not be suited to a large garden bed. It’s easy to alter to suit whatever window you happen to use—or even a glass door. You can also use a vinyl-clad window or aluminum-framed unit, although they will both make the box less attractive in the garden. Or, for a sturdier box, use 2 × 6 reclaimed lumber. That will make the cold frame much less portable but better suited to take abuse from the elements, pets, and small children.

The design here includes mitered top edges along the length of the front and back frame members, which allows the window to close flush to the surface. If you aren’t equipped to make those miters or just prefer to avoid the extra work, switch the frame configuration so that the sides are positioned inside the front and back frames. The window top will still close along the slope, although the seal on the front and back will be slightly less secure.

Why build just one old-window cold frame when you can build an entire bank of them, like this greenhouse owner did?

TOOLS + MATERIALS

- Tape measure
- Table saw or jigsaw
- Power drill and bits
- (3) 4” galvanized T-hinges
- (1) stainless-steel sash handle
- 2” galvanized screws
- 6d galvanized nails
- Speed square
- Sandpaper
- Caulk
- Paint
- Paintbrush

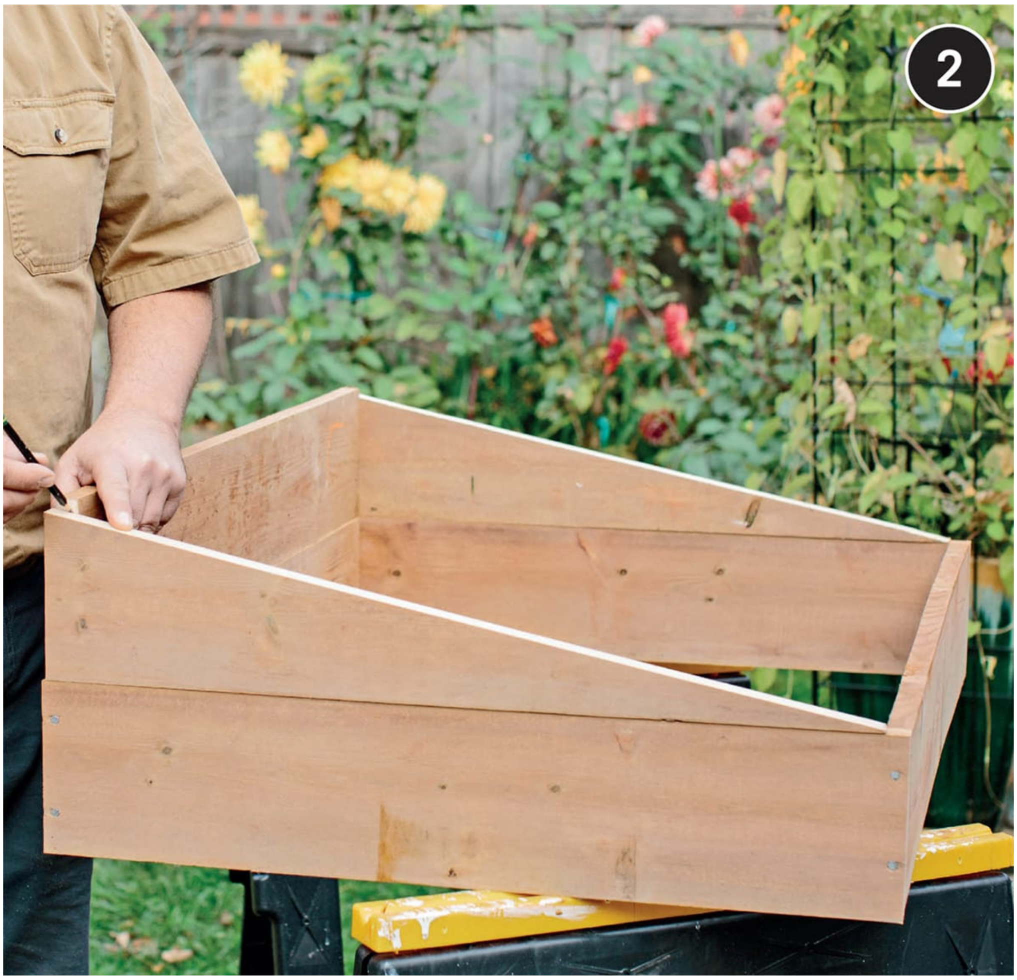
This old-window cold frame can be built with materials found on most any home renovation site, or you may even have them in the back of your garage or basement.

CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
A	Sloped side frame	2	¾ × 5¼ × 23¼”	Cedar
B	Side frame base	2	¾ × 5¼ × 23¼”	Cedar
C	Front + back frame	3	¾ × 5¼ × 34½”	Cedar
D	Rear frame posts	2	1½ × 3½ × 10½”	PT
E	Front frame posts	2	1½ × 3½ × 7”	PT

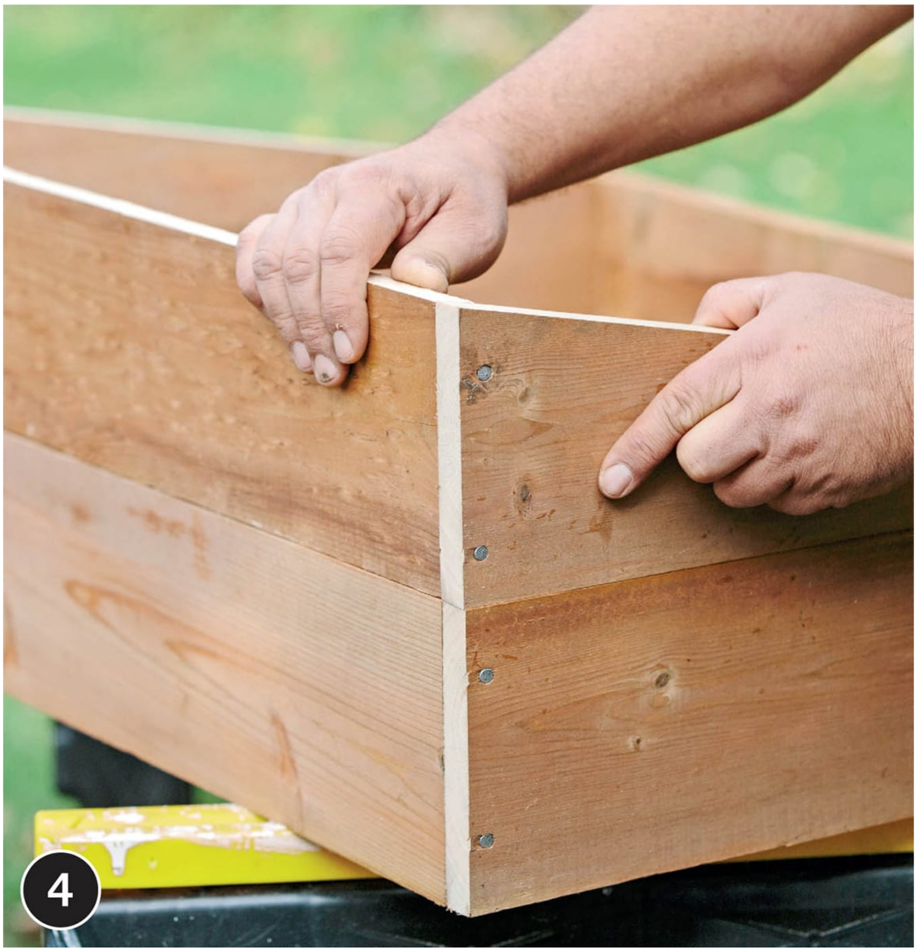
How to Build an Old-Window Portable Cold Frame

Inspect a 1 × 6 fence board, at least 24” long, to ensure that it is straight and free of defects. Measure from one corner, down 24” to the bottom edge of the board, creating a right-angle triangle. Use a speed square, or the edge of the window, to mark a straight line up from the bottom point of the triangle (the lower tip of the hypotenuse).



Cut the board along the marked lines to make the sloped tops of the side frames. Stand a rear frame board with the face flush to the back edge of the sloped side frame piece. Mark the angled bevel cut on the edge of the rear frame board. Repeat the process with the front frame board.

Use a table saw adjusted to the correct angle, or a jigsaw set to the miter, to bevel-cut the top edges of the front and back frame boards. Drill pilot holes in the edges of the framing pieces, two for each board, at each joint. Tack the frame together with 6d common nails. Check to make sure that the window you've reclaimed fits the frame perfectly and make any adjustments if it does not.



Hold each back post in place and mark a cutting line along the sloped side frame. Do the same with the front posts. Use a table saw or handsaw and miter box to make the angled cuts on each post.

Drill pilot holes and screw the posts in place in each corner of the box.

Clean up the window, sanding rough spots as necessary, and recaulking the window if needed. Prime and paint the window (paint it a darker color to absorb heat during the day and release it at night).

Mark the placement of the three hinges and screw them to the window frame and rear box frame. Measure and mark for the sash handle on the front of the frame and screw it in place. If desired, cut a 1× scrap piece to about 15” long to use as a support post to hold the window open when you work in the cold frame.

Tree Branch Hoophouse

This rudimentary structure bridges the gap between a full-blown greenhouse and a simple hoop-row cover frame. It follows many of the guiding principles of the Old-Window Greenhouse—it's lightweight, it's easy to assemble, it uses mostly upcycled components, and it should be exceedingly inexpensive to build.

There are tradeoffs, of course. This hoophouse is somewhat less durable than it would be if it were made with PVC hoops and thicker, clear, new lumber. If durability is important to you, you might want to upgrade to 2× lumber in place of the 1× members specified, and it would definitely be a good idea to anchor the hoophouse if you live in a region where strong winds or curious wildlife are factors.

The goal throughout is to make the most of scraps and project odds and ends. You may have even better ideas than the upcycled materials specified in this project. Don't be afraid to be imaginative. The baseboards may come from old deck fascia, torn-down fences, or clapboard siding from a defunct building. Branches serve as the hoops, and they will probably be the most challenging building material to find. If you don't have mature trees that need pruning in your yard, you can usually find suitable branches in a forest or woods. (Consider it a good reason for a hike!) If possible, look for ideal branches are at least 10 feet long, green enough to be supple and flexible, and roughly the same diameter all along their length. Ideal branches are hard to find, though, and it is perfectly acceptable to form each hoop from shorter branches bent over from each side and lashed together at the top. This is the method used in our example.

Don't be fooled by the modest footprint of this hoophouse. There is enough room inside to grow an ample bed of edibles or ornamentals, and the height allows for tall plants. If, however, you'd prefer to cover a larger area, it's simple to scale the structure up. Just increase it in foot increments, adding one branch hoop per foot.

A simple hoophouse like this, formed of branches and reclaimed lumber, can be a wonderful addition to any garden for little or no cost.

TOOLS + MATERIALS

Level

Scissors

Tape measure

Circular saw

Hacksaw

Power drill and bits

2” galvanized screws

Loppers

Sandpaper

(4) 1” steel round conduit brackets

(20) galvanized pipe clamps (sized to match PCV stakes)

Zip ties

Wood mallet

Staple gun and staples

2 rolls 6-mil polyethylene sheeting

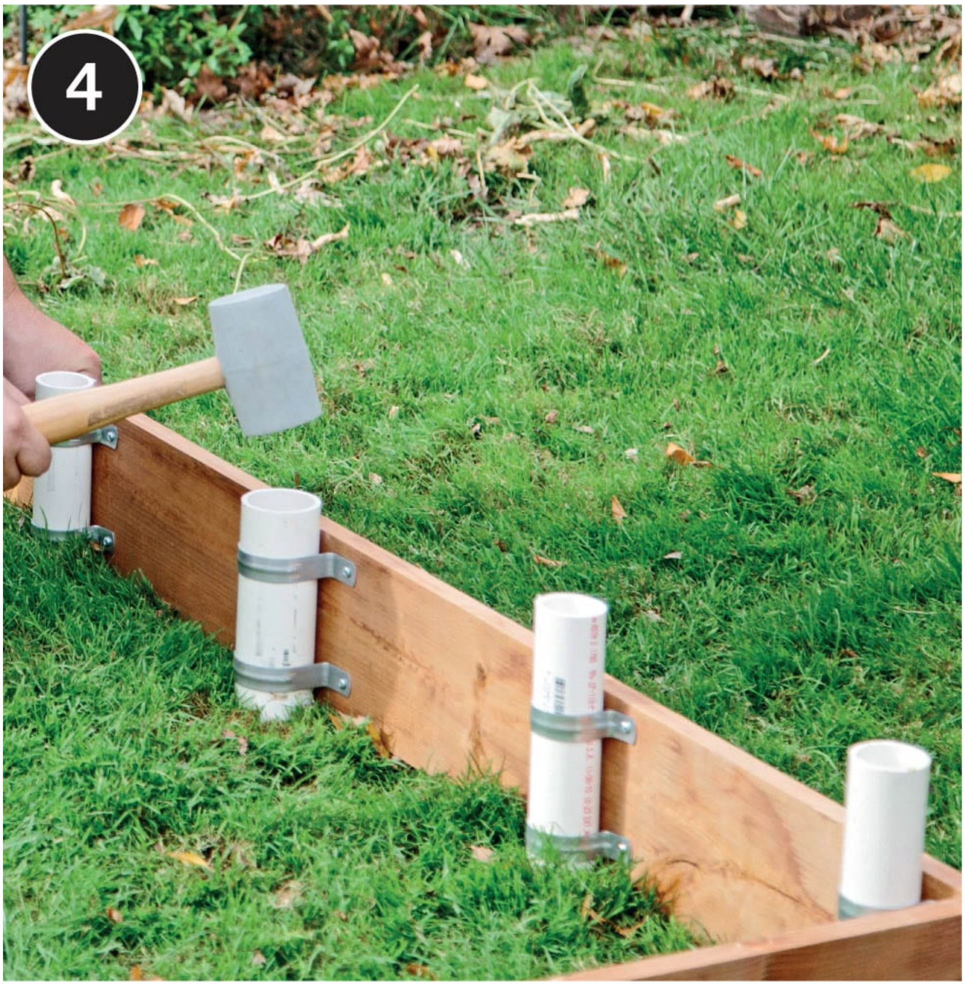
Look for green, freshly cut branches ¾ to 1” in diameter. If you can find 10-footers, that’s perfect; otherwise, lash shorter ones together as shown in this project.

How to Build a Tree Branch Hoophouse

Clear the hoophouse site of large rocks and yard debris. On a clean, flat surface, assemble the base frame by drilling pilot holes through the frame edges and screwing the frame together with 2" galvanized screws. Cut individual branches with loppers to length as necessary. Cut off or sand down any protrusions that might puncture the plastic.

Use a hacksaw to cut the PVC pipe scraps to 8” long (they can be longer, but not shorter). Cut one end of each pipe scrap on the diagonal at a severe angle to create a stake point.

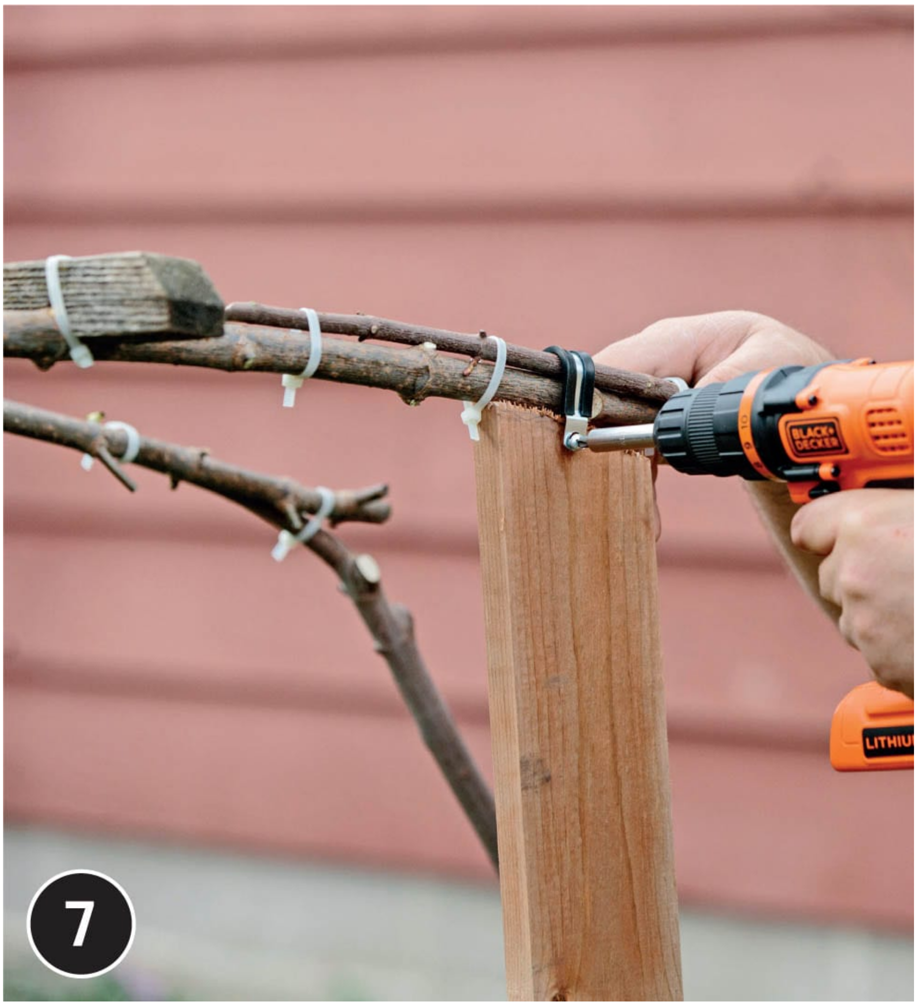
Attach the PVC pipes to the inside frame faces, spacing them 1’ apart. Use two pipe strap clamp brackets per pipe. The pipes should project about 1” above the top edge of the frame side.



Move the base frame to the final site. Check that the frame is level and square by measuring diagonals and adjust as necessary. Use a wood mallet to hammer the PVC stakes into the ground, alternating sides, until the frame is secure.

Install the branch hoops by placing one end of each branch in a PVC stake and slowly bending the other ends across the top. Secure the branches together at the top with several zip ties. The branches should hold securely in the stakes with friction, but if any of them wants to pop out, drive a screw through the side of the PVC stake and into the branch.

Lay the ridge pole along the top edge of the frame base side and mark the positions of the PVC pipe stakes on the branch. Cut slight notches at the marks with a jigsaw. Lay the ridge branch across the hoops so they fit into the notches and ziptie the hoops to the ridge pole.



Position each front and back support in place with one end against the ground on the inside of the frame and the other against the end hoops. Mark cutting lines where the end hoops intersect the tops of the supports, then cut the front and back supports to fit. Screw the front and back supports to the frame at the bottoms, and secure the top to the hoops with conduit brackets.

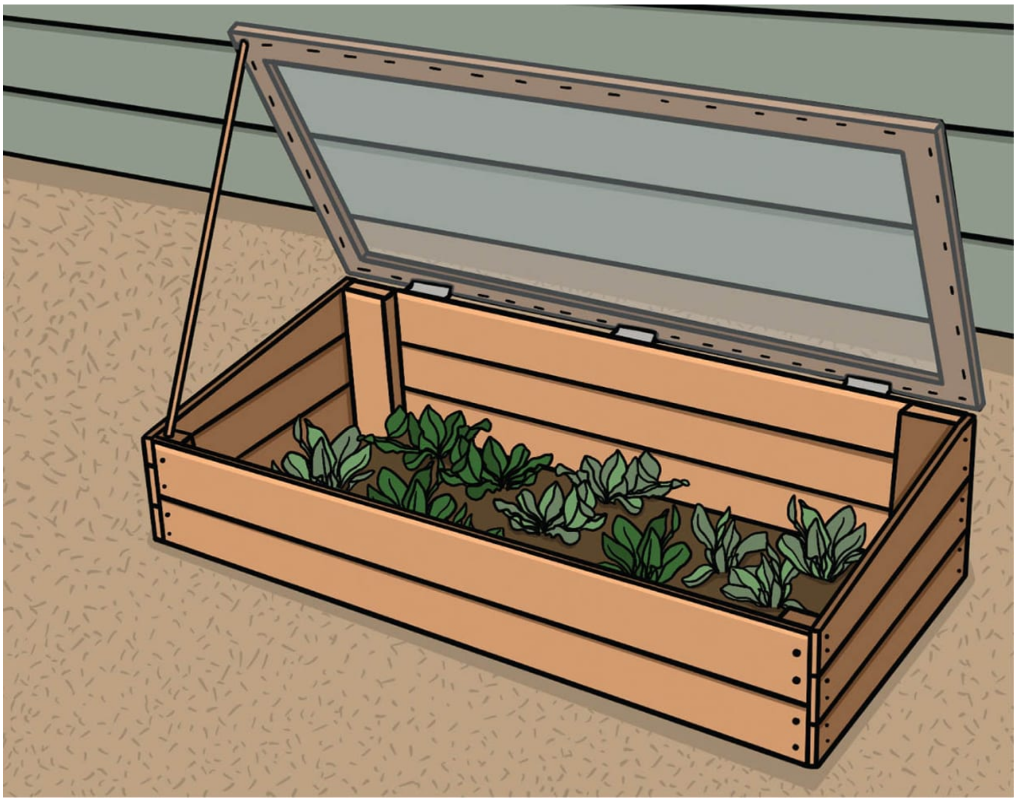
Drape the hoops with the plastic sheeting. Cut the sheet to fit, then either double-fold the edges and staple them to the base frame or let them flow over onto the ground and secure them with bricks. Cut a smaller piece of plastic to use as a door flap, and staple it into place.

Pallet-Wood Cold Frame

Pallets are the shipping platform for just about everything that gets transported and sold, not only in this country, but internationally as well. By governmental estimates, there are billions of pallets in circulation at any one time. They are simple in construction, durable, and incredibly useful. However, they do eventually break and usually get discarded.

That represents a huge opportunity for the enterprising upcycler. Pallets in their original form can be used to create greenhouse walls and other structures. More commonly, a pallet is broken down—taken apart so that the wood pieces can be reused in new ways. That’s the type of upcycling used in this project.

As with all upcycling projects, adaptation is key when working with pallets. There are several different types of pallets. Most use hardwood boards, but the actual measurements and conditions of the boards varies widely. The most common construction involves 1 × 6 inch, or 1 × 4 inch “deck” boards (creating the surface on which transported goods rest), connected by beefier 2 × 4 or similar “stringers.” The reclaimed wood is often damaged or defective to one degree or another, so you have to be careful in measuring for projects. Cut down pieces and then be creative. For instance, the triangular side pieces used in this project should be cut from boards that have flaws along one edge.



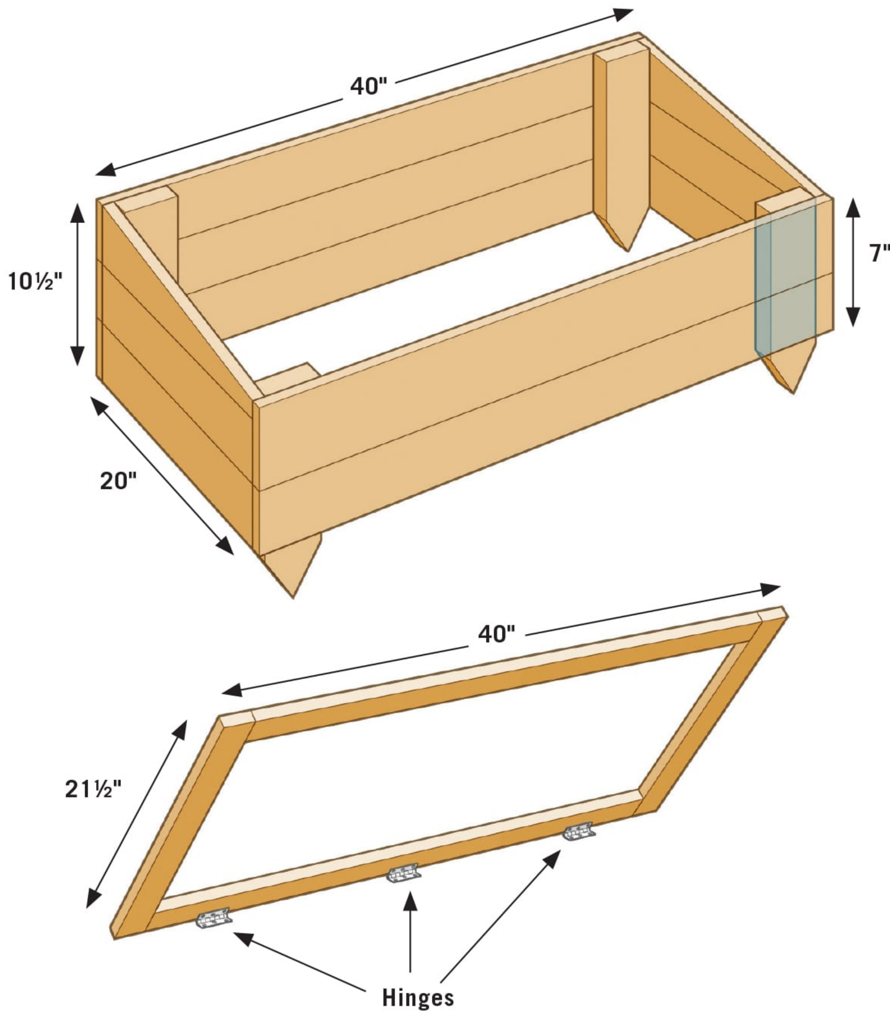
A pallet-wood cold frame can be an excellent, durable, inexpensive alternative to store bought versions, or even other custom made types.

SAFETY FIRST

Pallets are used underneath just about everything that is transported by truck or rail. That means just about everything, including toxic materials. Avoid pallets that have been painted; those are usually used to transport chemicals. For the same reason, don't use pallets marked with "MB" because they have been treated with methyl bromide; a chemical that could contaminate garden soil. The marking "HT", however, is a good sign. It indicates the wood has been heat treated to kill microorganisms that may have survived initial production.

Of course, getting to the wood requires breaking down the pallets. That is sometimes easier said than done. You can use a "pallet buster," a tool made to break them apart, or use a crowbar, claw hammer, or other brute-force tool. If all else fails, turn to a circular or reciprocating saw and salvage whatever wood you can.

Regardless, you’ll find waste pallets near the dumpsters outside of large trucking companies, box stores, and even grocery stores. Obviously broken and discarded pallets are usually fair game. However, never go on private property without permission, and do not take pallets that aren’t obviously been thrown away (they are regularly reused, even when they have a lot of miles and grunge on them).



TOOLS + MATERIALS

1 reclaimed pallet

Circular saw or table saw

Tape measure

Metal straightedge or 4’ level

Carpenter’s pencil

Drill and bits

Pocket jig

Mallet

C-clamps

Staple gun and staples

Palm sander (optional)

2” wood screws

3” wood screws

6-mil plastic sheeting

(3) 2” butt hinges

½ × 24” dowel

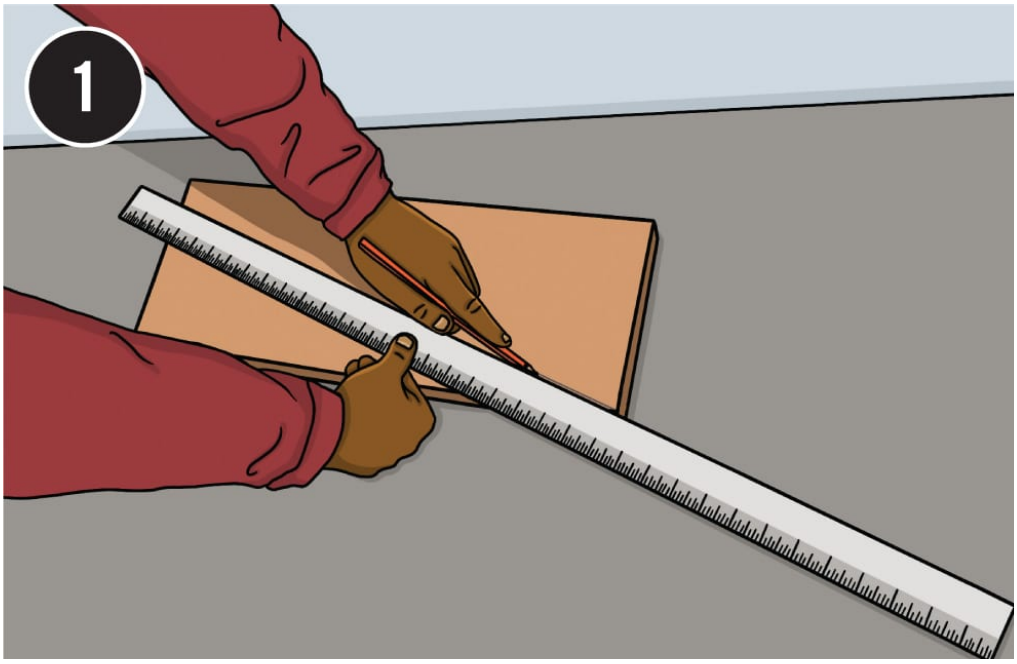
Sandpaper (optional)

Paint (optional)

Work gloves

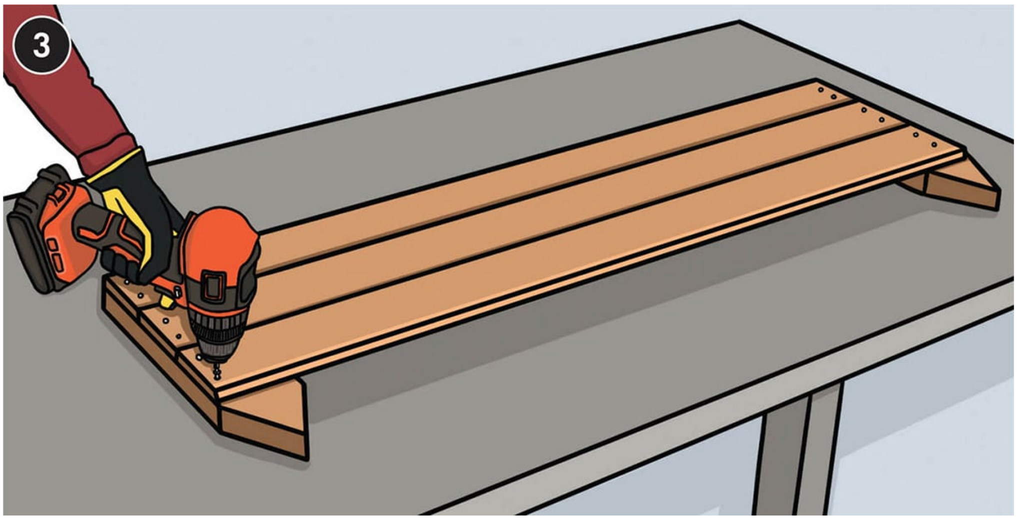
Safety glasses

How to Build a Pallet-Wood Cold Frame



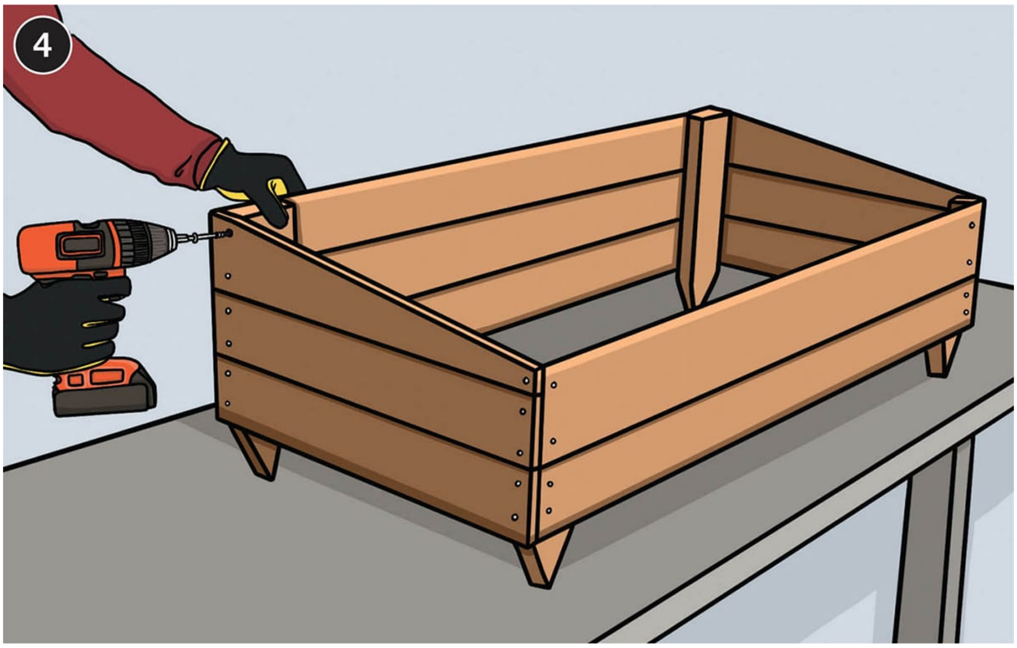
Saw four 4 × 20” side-panel boards from the pallet deck boards. Saw two 6 × 20” side-panel boards for the top of each side. Measure and mark these boards for trapezoid cuts from one corner to 1” above the opposite corner using a metal straightedge or 4’ level. Cut each top board to the angle marked.

Saw two 13½”-long corner post stakes from pallet stringers. Cut two corner posts 12” long. Saw the ends of all the posts in 3” points. The points don’t need to be precise; cut them with a table saw if you have access to one, or with a circular saw or hand saw.

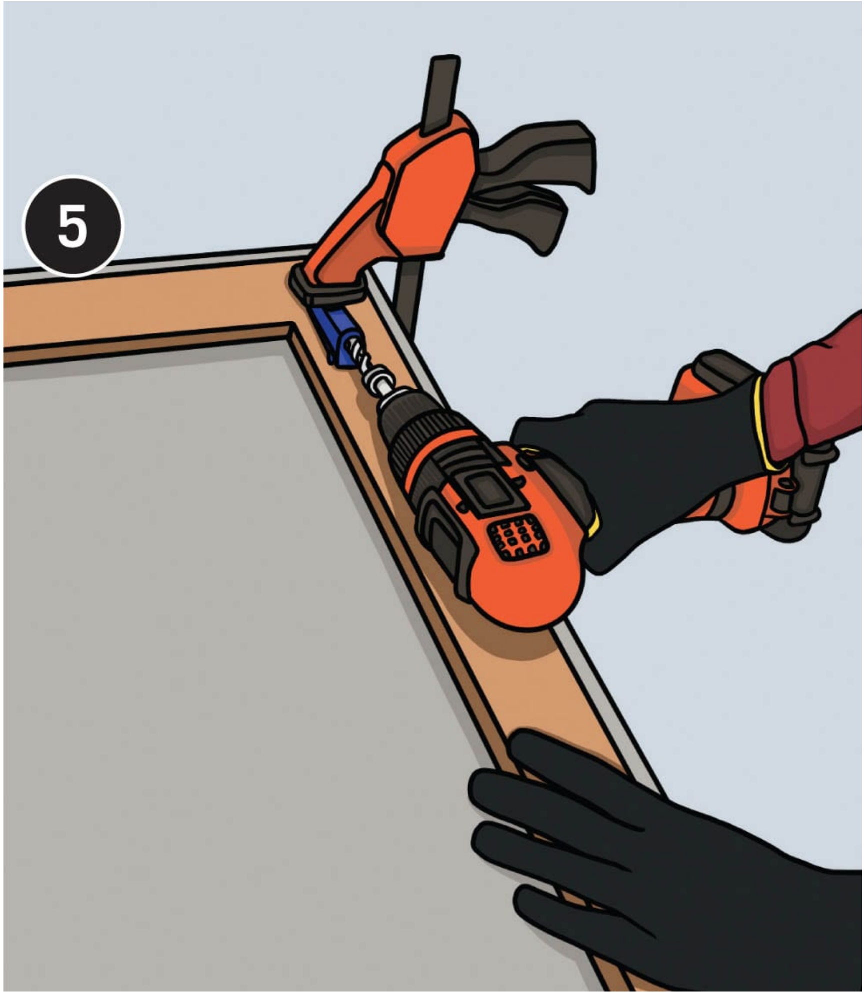


Lay out three deck boards stacked in a column. Align the longer post stakes with the column's top and outside edges, on both sides of the column. Screw them to the boards with 2" wood screws. Repeat the process with the shorter stakes and two deck boards (the top front deck board must be a wider 6" board) to construct the front wall.

Use two deck boards for the lower side boards, screwing them to the front and back stakes flush with the bottom front and back wall boards.

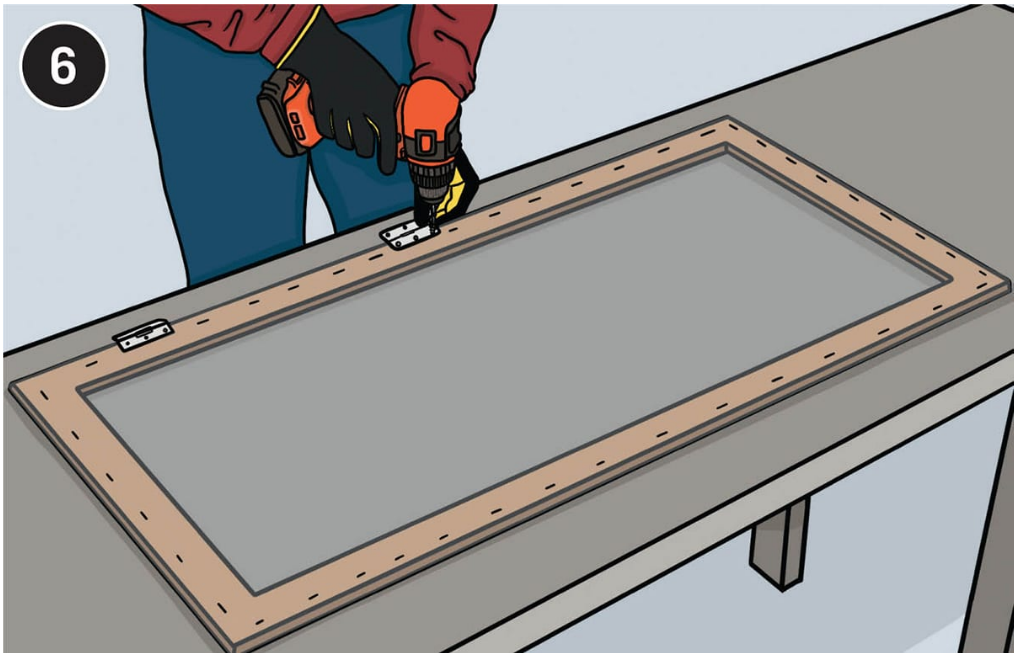


Screw the wide end of the triangular top boards to the back wall stakes. Drill pilot holes and screw the front, narrow ends to the front wall stakes.

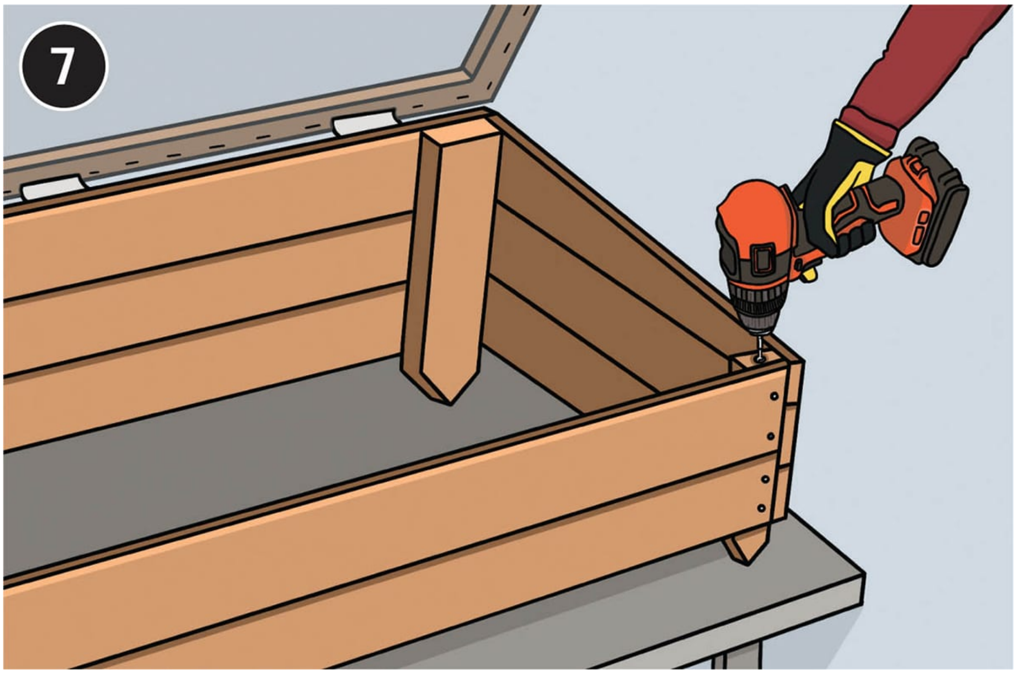


Cut and rip two window frame rails 2 × 36”, from deck boards. Cut and rip two stiles 2 × 21½”. Lay out the frame on a flat, level work surface with the longer rails butted to the inside of the stiles. Measure the diagonals to ensure square, and clamp the pieces to the work surface. Drill pocket holes in the rail faces using a pocket jig. Screw the frame together using 3” wood screws.

Measure and mark the location of the three hinges equidistant along one long frame rail. If you’re staining or painting the frame, sand and finish it now. Cut a window from 6-mil plastic sheeting ½” larger all around than the frame inner opening, center it and staple it taut in place.



Screw the butt hinges to the frame. Set the frame in place on the cold frame, and screw the hinges to the back wall.



Drill a shallow ¼” hole in the top of one front corner post. Drill a matching hole in the frame corner, where it sits over the post. Use a ¼” dowel to prop the lid open as necessary for ventilation and temperature control.

Place the cold frame in its final location and pound the stakes to anchor the frame into the ground.

Greenhouse Companion Projects

Don’t let the title “companion” fool you; all the projects in this section are just as useful and rewarding on their own, even if they are not paired with a greenhouse. In fact, these projects are easier and quicker to build than a greenhouse would be, and they can serve the novice gardener better.

Some of these are simply nice additions to your gardening equipment. Others, like workbenches, are essential for any serious gardener, and truly can make a greenhouse more convenient and organized. Regardless of which you choose, though, they are all relatively easy to build and exceedingly durable.

In this chapter:

Cold Frame Box

An inexpensive foray into greenhouse gardening, a cold frame is practical for starting plants six to eight weeks earlier in the growing season and for hardening off seedlings. Basically, a cold frame is a box set on the ground and topped with glass or plastic. Although mechanized models with thermostat controls and sashes that automatically open and close are available, you can easily build a basic cold frame yourself from materials you probably already have around the house.

The back of the frame should be about twice as tall as the front so the lid slopes to a favorable angle for capturing sunrays. Build the frame tall enough to accommodate the maximum height of the plants before they are removed. The frame can be made of brick, block, plastic, wood, or just about any material you have on hand. It should be built to keep drafts out and soil in.

If the frame is permanently sited, position it facing south to receive maximum light during winter and spring and to offer protection from wind. Partially burying it takes advantage of the insulation from the earth, but it also can cause water to collect, and the direct soil contact will shorten the lifespan of the wood frame parts. Locating your frame near a wall, rock, or building adds additional insulation and protection from the elements. Keep an inexpensive thermometer in a shaded spot inside the frame for quick reference. A bright spring day can heat a cold frame to as warm as 100 degrees Fahrenheit, so prop up or remove the cover as necessary to prevent overheating. And remember, the more you vent, the more you should water. On cold nights, especially when frost is predicted, cover the box with burlap, old quilts, or leaves to keep it warm inside.

A cold frame is positioned over tender plants early in the growing season to trap heat and moisture so they get a good, strong start. This cold frame doesn’t rely on finding old windows for the top, so anyone can build it.

COLD FRAME BOX

TOOLS + MATERIALS

(2) 3 × 3” butt hinges (ext.)

Exterior paint

(2) 4” utility handles

Deck screws (2” or 2½”)

(4) Corner L-brackets (¾ × 2½”)

#8 × ¾” wood screws

(1) ¾” × 4 × 8’ plywood (ext.)

Circular saw

⅛ × 37 × 38” clear Plexiglas

Drill/driver

Exterior caulk/adhesive

Caulk gun

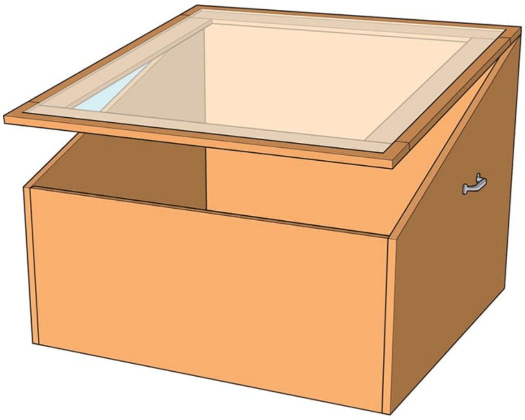
Pipe clamps

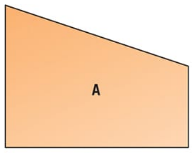
Exterior wood glue

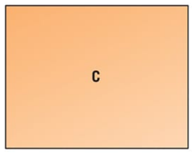
Straightedge cutting guide

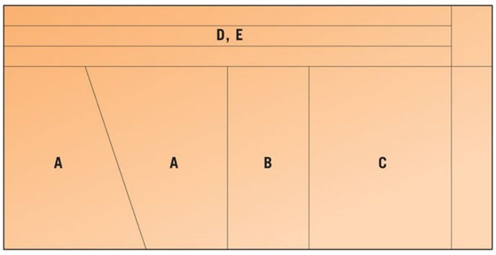
Eye protection

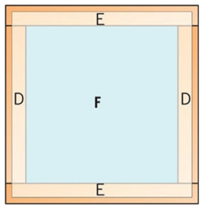
Work gloves







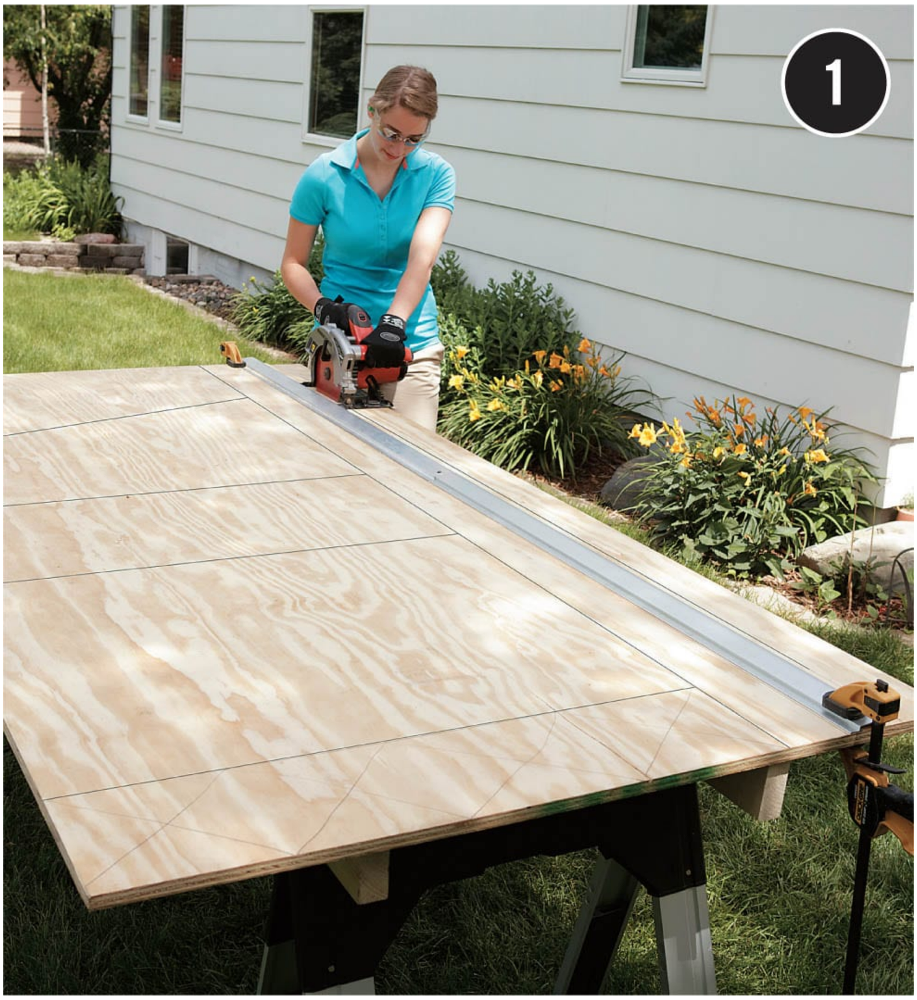




CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
A	Side	2	¾ × 16/28 × 36”	Ext. Plywood
B	Front	1	¾ × 16 × 36”	Ext. Plywood
C	Back	1	¾ × 28 × 36”	Ext. Plywood
D	Lid frame	2	¾ × 4 × 31”	Ext. Plywood
E	Lid frame	2	¾ × 4 × 38”	Ext. Plywood
F	Cover	1	⅛ × 37 × 38”	Plexiglas

How to Build a Cold Frame Box



Cut the parts. This project, as dimensioned, is designed to be made entirely from a single 4 × 8 sheet of plywood. Start by cutting the plywood lengthwise to make a 36”-wide piece.

TIP: Remove material in 4” wide strips and use the strips to make the lid frame parts and any other trim you may want to add.

Cut the parts to size with a circular saw or jigsaw and cutting guide. Mark the cutting lines first (See diagram, previous page).

Assemble the front, back and side panels into a square box. Glue the joints and clamp them together with pipe or bar clamps. Adjust until the corners are square.

Reinforce the joints with 2 or 2½" deck screws driven through countersunk pilot holes. Drive screws every 4 to 6" along each joint.

Make the lid frame. Cut the 4”-wide strips of ¾” plywood reserved from step 1 into frame parts (2 @ 31” and 2 @ 38”). Assemble the frame parts into a square 38 × 39” frame. There are many ways to join the parts so they create a flat frame. Because the Plexiglas cover will give the lid some rigidity, simply gluing the joints and reinforcing with an L-bracket at each inside corner should be more than adequate structurally.

Paint the box and the frame with exterior paint, preferably in an enamel finish. A darker color will hold more solar heat.

Lay thick beds of exterior adhesive/caulk onto the tops of the frame and then seat the Plexiglas cover into the adhesive. Clean up squeeze-out right away. Once the adhesive has set, attach the lid with butt hinges and attach the handles to the sides.

Move the cold frame to the site. Clear and level the ground where it will set if possible. Some gardeners like to excavate the site slightly.

Jumbo Cold Frame

A cold frame of any size works on the same principle as a greenhouse, capturing sunlight and heat while protecting plants from cold winds and frost. But when your planting needs outgrow a basic backyard cold frame with a window-sash roof, it makes sense to look to the greenhouse for more comprehensive design inspiration. This jumbo version offers over 17 square feet of planting area and combines the convenience of a cold frame with the full sun exposure of a greenhouse. Plus, there's ample height under the cold frame's canopy for growing taller plants.

The canopy pivots on hinges and can be propped all the way up or partially opened to several different positions for ventilating the interior to control temperature. The hinges can be separated just like door hinges (in fact, they are door hinges), so you can remove the canopy for the off season, if desired. Clear polycarbonate roofing panels make the canopy lightweight yet durable, while admitting up to 90 percent of the sun's UV rays (depending on the panels you choose).

The base of the cold frame is a simple rectangle made with 2 × 6 lumber. You can pick it up and set it over an existing bed of plantings, or give it a permanent home, perhaps including a foundation of bricks or patio pavers to protect the wood from ground moisture. For additional frost protection and richer soil for your seedlings, dig down a foot or so inside the cold frame and work in a thick layer of mulch. Because all sides of the canopy have clear glazing, you don't have to worry about orienting the cold frame toward the sun; as virtually all of the interior space is equally exposed to light.

A cold frame can extend the growing season in your garden to almost—or truly—year-round. Use an oversized cold frame like the one in this project and there may be no need to put up vegetables in the fall, because you'll have all the fresh produce you can handle.

TOOLS + MATERIALS

Circular saw or miter saw

Cordless drill and bits

Hacksaw

Deck screws (2”, 2½”, 3”)

(5) ½” × 10’ thin wall PVC pipes (the flexible type used for lawn irrigation, not schedule 40 type)

(2) 25 × 96” corrugated polycarbonate roofing panels

30 × 24” clear acrylic panel

16” treated stakes

Screwdriver

Roofing screws with EPDM washers

(2) 3½” exterior-grade butt hinges with screws

(2) ¼ × 4” eyebolts

3½ × $^{5}/_{16}$” stainless-steel machine bolts (2 bolts with 8 washers and 2 nuts)

(2) Heavy-duty hook-and-eye latches

Outdoor thermometer with remote sensor

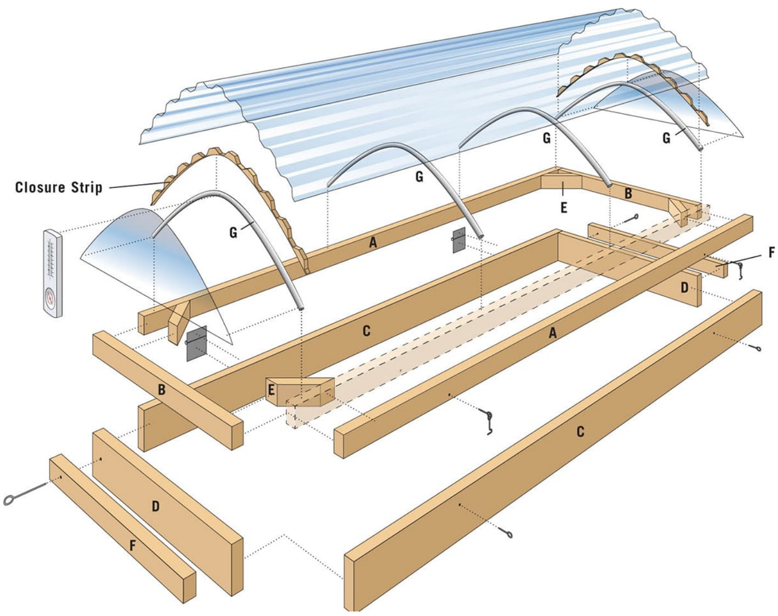
Work gloves

Eye protection

BUILDING A JUMBO COLD FRAME

CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
A	Frame side	2	1½ × 2½ × 94”	2 × 3
B	Frame end	2	1½ × 2½ × 30”	2 × 3
C	Base side	2	1½ × 5½ × 94”	2 × 6
D	Base end	2	1½ × 5½ × 30”	2 × 6
E	Frame brace	4	1½ × 2½ × 8”	2 × 3
F	Prop stick	2	¾ × 1½ × 30”	1 × 2
G	Rib	4	½ × ½ × 37”	½” PVC pipe



How to Build a Jumbo Cold Frame

Drill pilot holes and fasten the frame end pieces between the frame side pieces with 3" deck screws to create the rectangular frame. Do the same with the base pieces to create the base. Use two screws for each joint.

Stabilize the corners of the canopy frame with braces cut to 45° angles at both ends. Install the braces on-the-flat, so their top faces are flush with the tops of the canopy frame. Drill pilot holes and fasten through the braces and into the frame with one 2½” screw at each end. Then, drive one more screw through the outside of the frame and into each end of the brace. Check the frame for square as you work.

Assemble the canopy glazing framework using ½” PVC pipe. Cut all the ribs 37” long. You can cut these easily with a miter saw, hacksaw, or jigsaw.

Use 2” deck screws as receptors for the PVC pipes. Drive the screws in 1” from edge and ¾” from the ends, angling the screws at about 35 to 45° toward the center. Leave about ¾” of the screw exposed. Drive two additional screws in at 32¼” from each end.

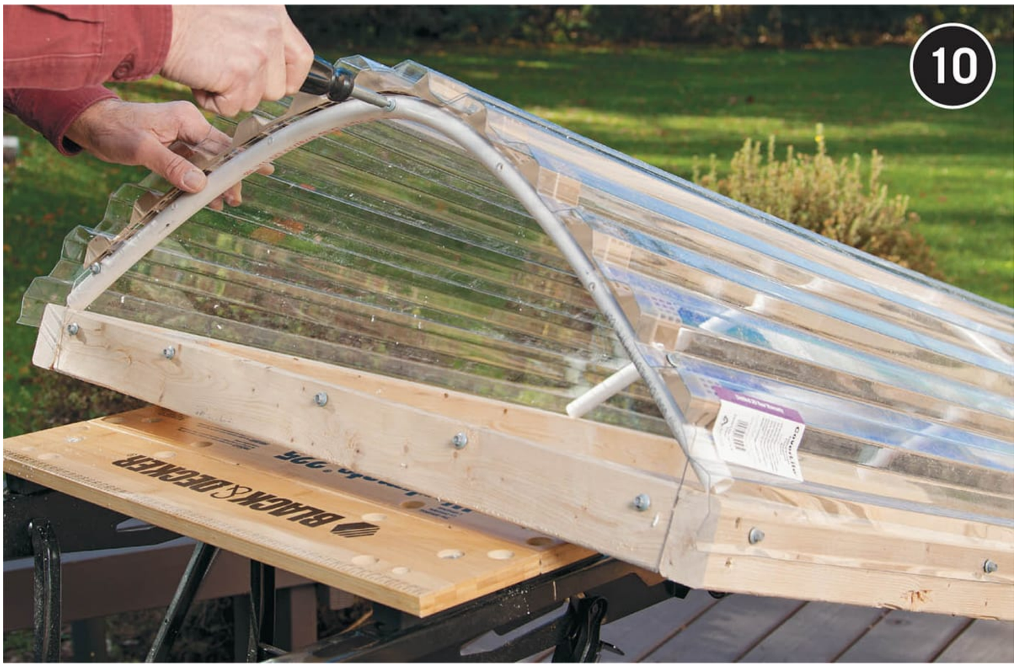
Install the PVC ribs by putting one end over the 2” screw, then curving the PVC until the other end fits over the opposite screw. Take your time with this, and use a helper if you need.

Hold up and mark a smooth piece of clear acrylic for the end panels. The clear acrylic should cover the 2 × 3 and follow the curving top of the PVC. Cut the clear acrylic with a plastic-cutting jigsaw blade.

Drill ¼” holes along the bottom of both panels about ⅝” up from the edge of the panel. Space the holes 2½” from ends, then every 16”. Also mark and drill rib locations on the roof panels about 6” up from bottom, spacing the holes at 1⅝” and 33¼” from each end. Install the panels 1½” up from the bottom of the 2 × 3 with the roofing screws. The ends of the panels should extend 1” beyond the 2 × 3s.

Adjust the PVC ribs until the predrilled holes in the roof panels are centered on them, then predrill the PVC with a ⅛" bit. Fasten the panels to the two center ribs.

Lap the second sheet over the first, leaving roughly the same amount of panel hanging over the 2 × 3. Fasten the second sheet the same way as the first. Insert filler strips at each end under the polycarbonate, then drill through those into the PVC ribs. Now add additional screws about every $^{1}/_{6}$“. You can just predrill the holes with the ⅛” bit (the polycarbonate panels are soft enough that the screws will drive through them without cracking).



Set the clear acrylic end panels in place, butting them against the filler at the top. Mark screw locations. Place the panel on a piece of plywood and predrill with a ¼" diameter bit to avoid cracking the clear acrylic, which isn't as soft or flexible as the polycarbonate. Screw the panels in place with roofing screws, hand-tightening with a screwdriver to avoid cracking the clear acrylic. Don't overtighten.

Mount the canopy to the cold frame base with two exterior hinges. The canopy frame should fit flush over the base on all sides. Screw in two hook-and-eye latches in front.

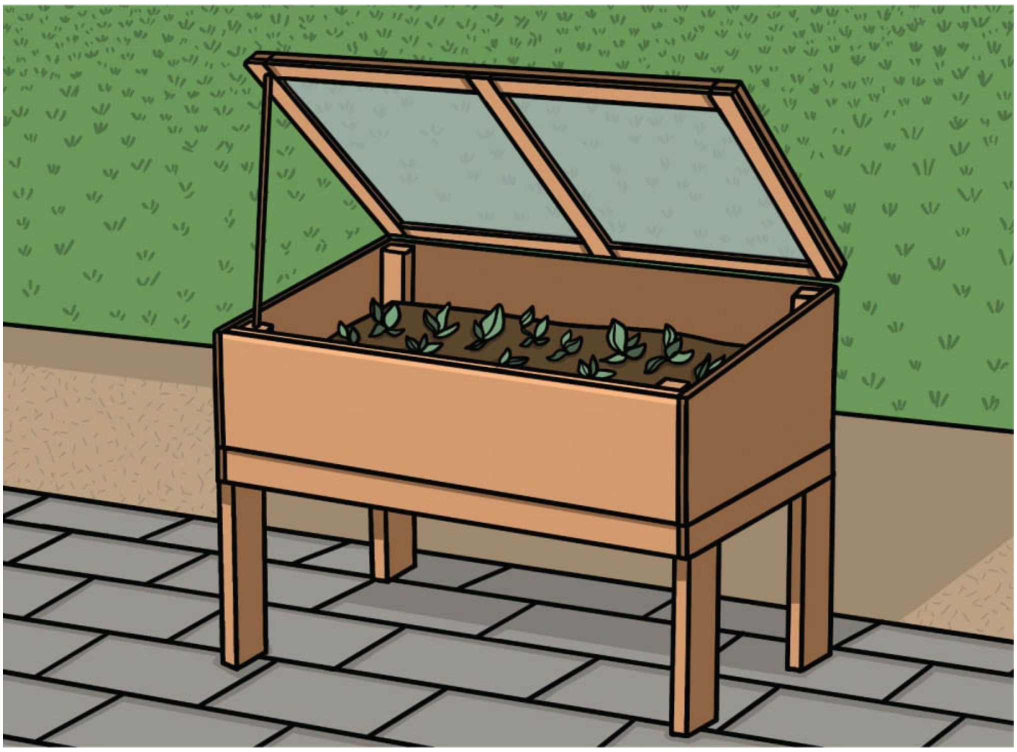
Attach a prop stick to each side with a stainless-steel bolt and nut. Insert three washers (or more) between the prop stick and the 2 × 6 base so the prop stick clears the clear acrylic side panel. Drill a few additional $^5/_{16}$" holes in the stick and the frame for the eyebolts, so you can prop the canopy open at different heights. Now, prepare the ground and place the cold frame in the desired location. Anchor the base to the ground using 16" treated stakes or heavy-duty metal angles driven into the ground and secured to the frame.

Freestanding Cold Frame

Sometimes it's not convenient to use a traditional cold frame over an in-ground bed or plot. In fact, some homeowners have no usable garden space whatsoever. Townhomes and condos, for instance, may have only a concrete patio or deck for outdoor space. Fortunately, that doesn't mean that you can't garden.

Whether you're dealing with a lack of usable soil, or just want to complement your existing garden, this ingenious construction offers all the benefits of growing inside a cold frame without the need for actual garden space.

It's not hard to build this box. It is designed for ease of construction and shouldn't take a modestly skilled homeowner more than a long afternoon to fabricate. You can even ask the local home center or lumberyard to make the plywood sheet cuts for you when you buy your materials (that's something they can do much quicker and easier than you will be able to, thanks to a commercial-size table saw). You can also choose to insulate the interior of the box to increase its usefulness and protect against freezing temperatures.



A standing cold frame is ideal for anyone who is space challenged and also for those whose health prevents prolonged kneeling or bending.

CUTTING LIST

PART	NO.	DIMENSION
Plywood box sides + back	3	48 × 10½ × ½”
Plywood box front	1	48 × 5½ × ½”
Plywood box floor	1	48 × 48 × ½”
Pressure-treated wood legs	4	4 × 4 × 26”
Rear cleats	2	2 × 2 × 8”
Rear cleats	2	2 × 2 × 5”
Front + back skirt boards	4	1 × 3 × 48”
Side skirt boards	4	1 × 3 × 47½”
Top frame stiles	3	1 × 3 × 50⅛”
Bottom frame stiles	2	1 × 3 × 45⅛”
Top frame rails	2	1 × 3 × 48”
Bottom frame rails	3	1 × 3 × 20¼”

TOOLS + MATERIALS

Tape measure

Carpenter's pencil

Metal straightedge

Speed square

Circular saw

Drill and bits

Staple gun and staples

4 × 8' sheet exterior grade ½" plywood

(2) 4 × 4" × 6' pressure-treated posts

(9) 1 × 3" × 8'

2 × 2 × 36" furring strip

1¾" deck screws

1¼" deck screws

6-mil plastic sheeting

(2) 3½" gate or T-hinges + screws

Landscape cloth

Paint or stain (optional)

2" all-purpose brush (optional)

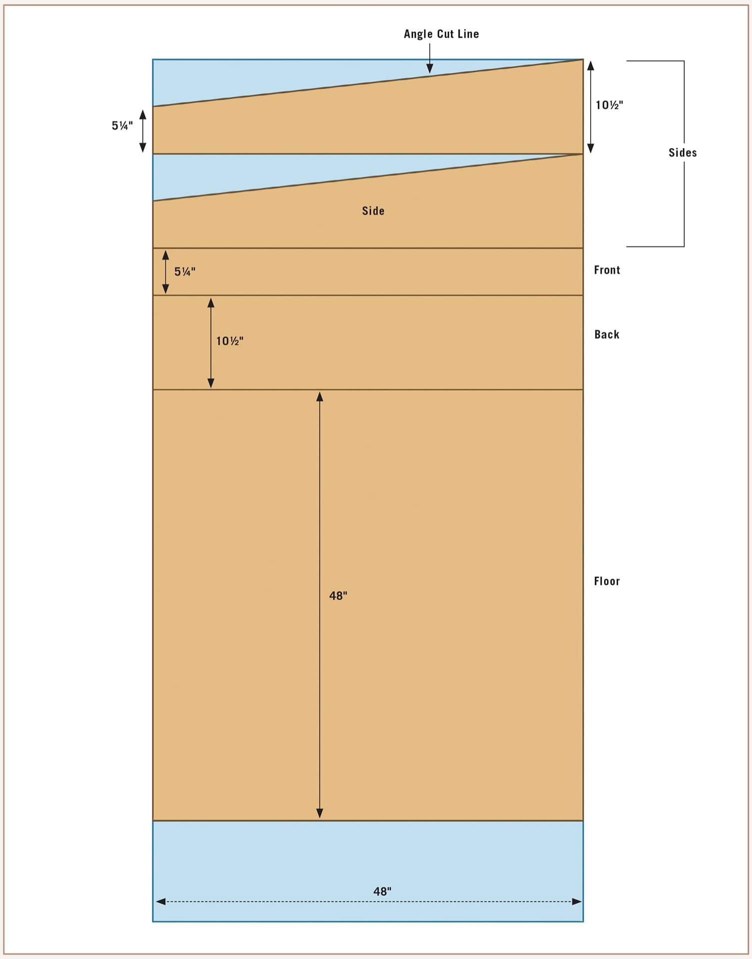
80-grit sandpaper (optional)

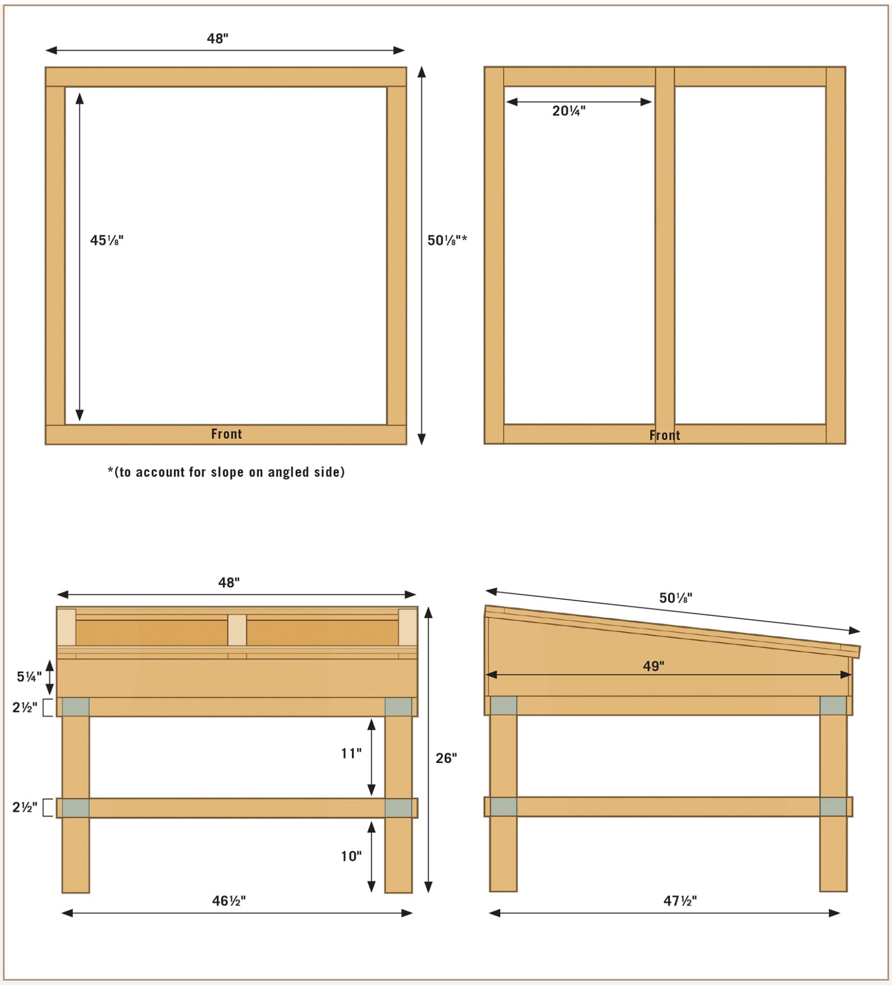
Palm sander (optional)

Work gloves

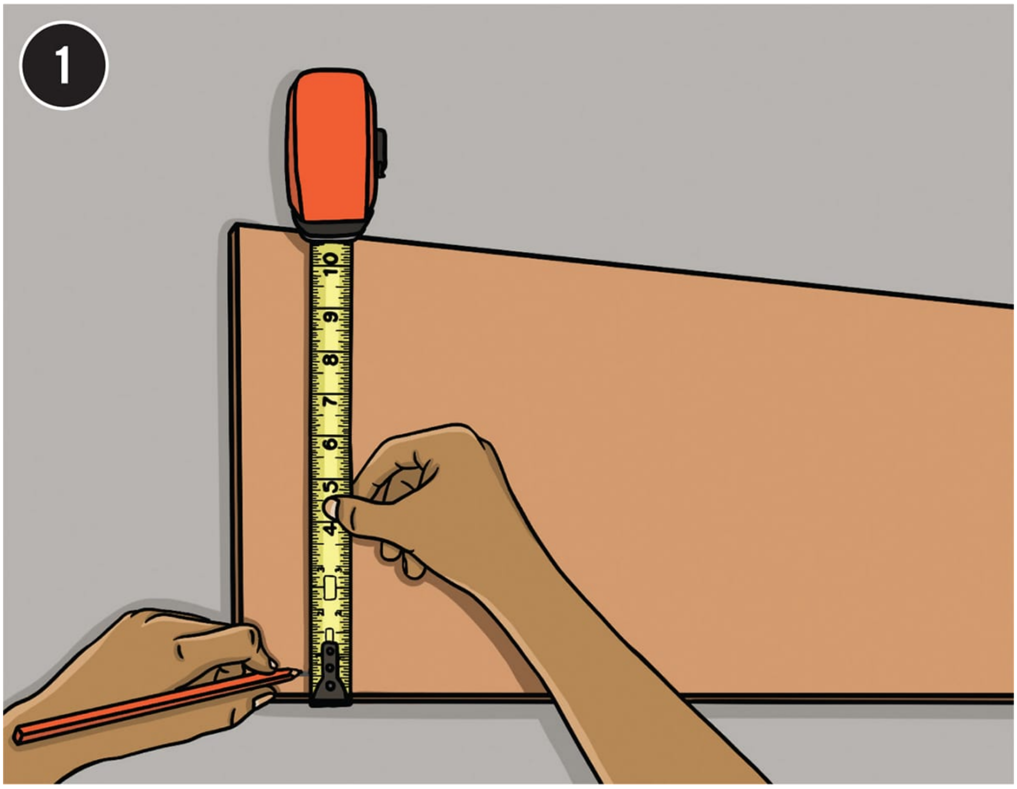
Safety glasses

FREESTANDING COLD FRAME PLANS



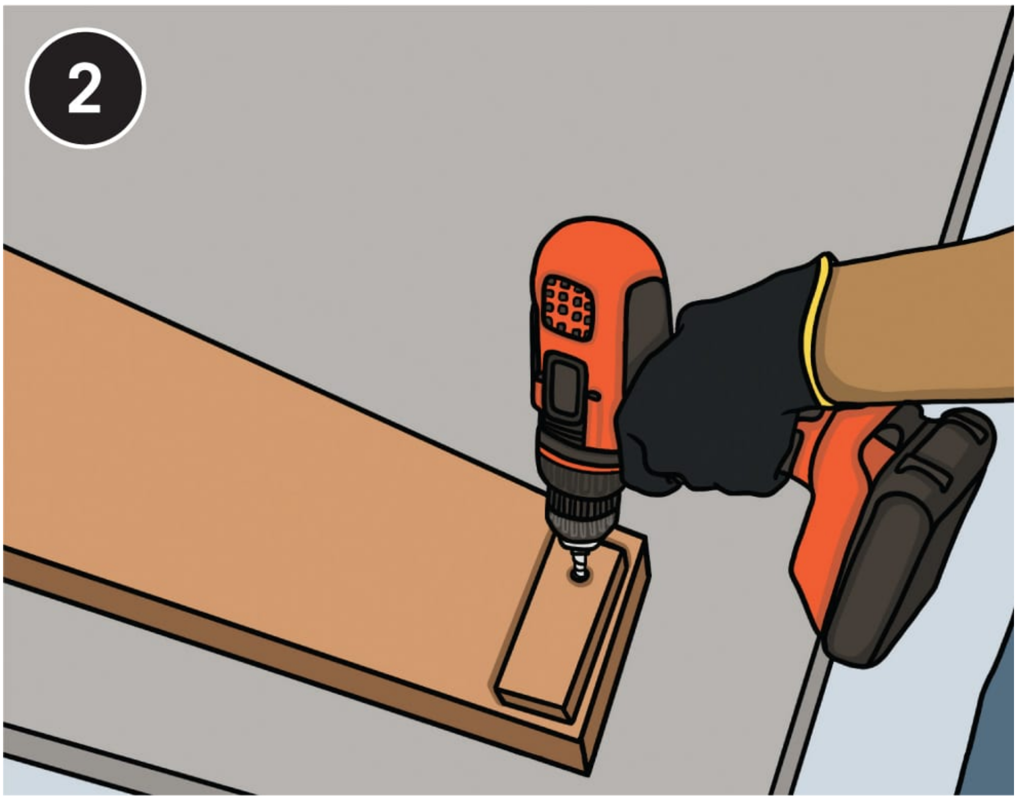

48"
45⅛"
50⅛"*
20¼"
Front
Front
*(to account for slope on angled side)
48"
5¼"
2½"
11"
26"
2½"
10"
46½"
50⅛"
49"
47½"

How to Build a Freestanding Cold Frame

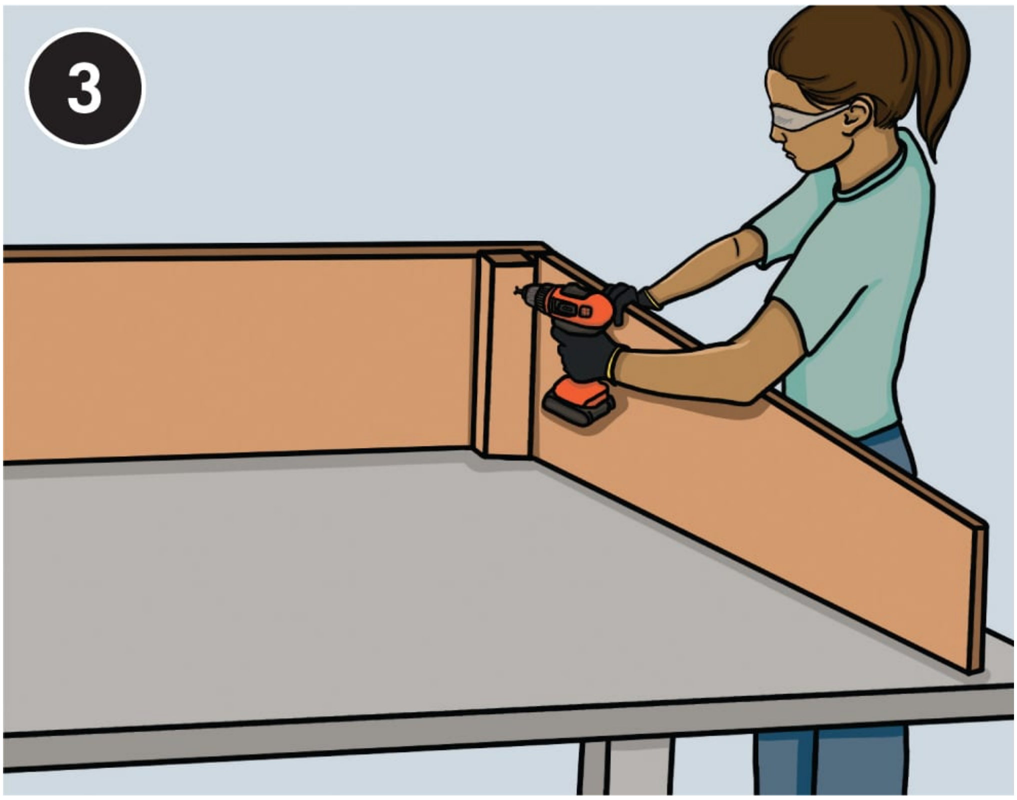


Measure, mark, and cut the plywood sheet according to the cut diagram (here). Cut the other lumber for the project to size.

Measure and mark ½” up from the bottom of one side, along the back edge (this will leave a gap for the box floor). Repeat this process at the front edge of the side, for placement of the smaller cleat. Measure and mark the second side in the same way.



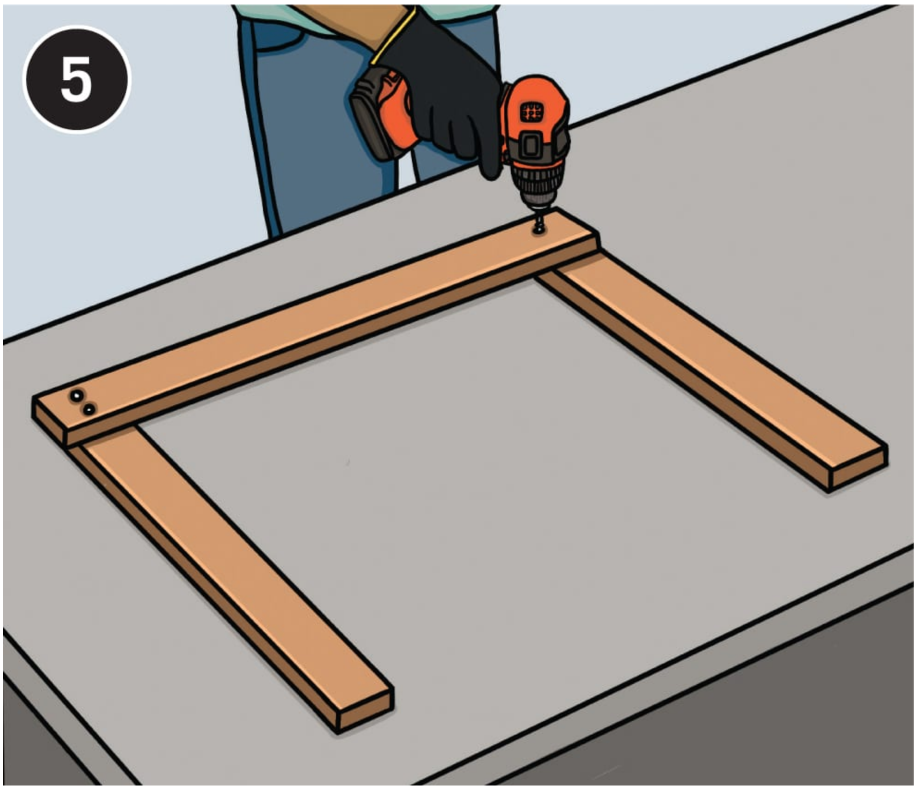
Align a rear (long) cleat along the back edge, with the bottom of the cleat at the mark. Screw the cleat to the side using 1¾” deck screws. Repeat with the front cleat, along the front edge. Screw the cleats to the second side panel.



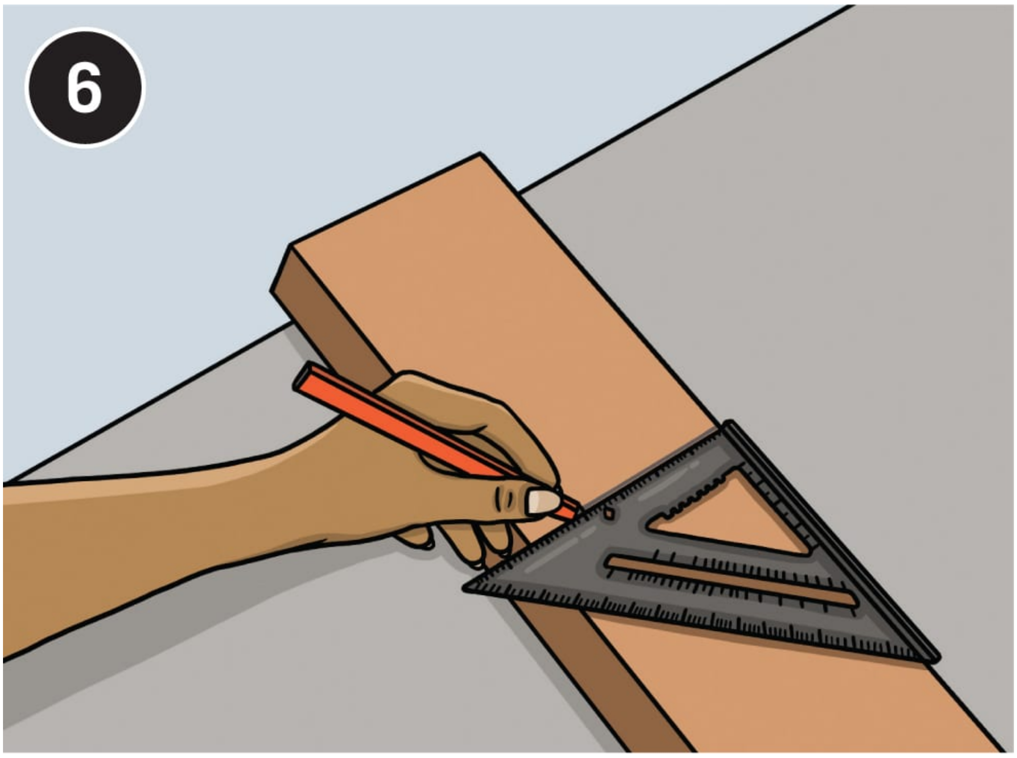
Assemble the box frame on a flat, level work surface. Align the box back along the back edge of one side, and screw the cleat to the back with 1¾” deck screws. Repeat the process to attach the second side to back. Finish the frame by screwing the front cleats to the front.

Drill a random pattern of $^{1}/_{16}$" or $^{3}/_{32}$" holes across the box floor, for drainage. Set the box frame on its side and screw the floor to bottom of each cleat.

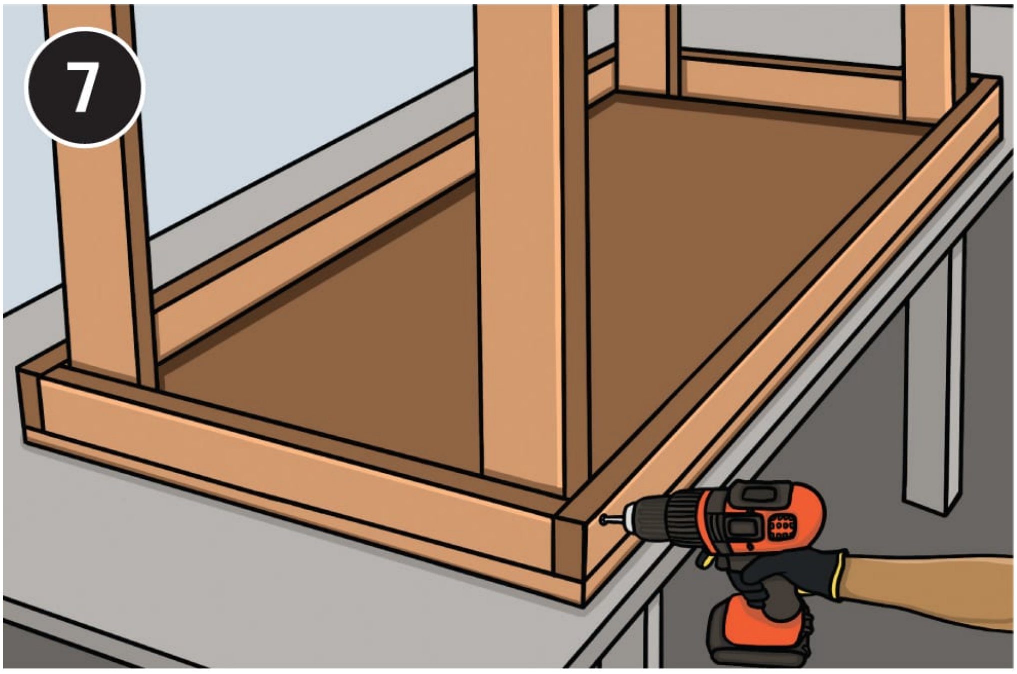
Optional: If you experience extremes of cold in your location, you can insulate this box with foam board insulation. Simply cut panels of the insulation to fit, with a utility knife. Secure them to the inside of the box with construction adhesive and then just fill with soil and plants as you would otherwise. Plant roots will stay much warmer.



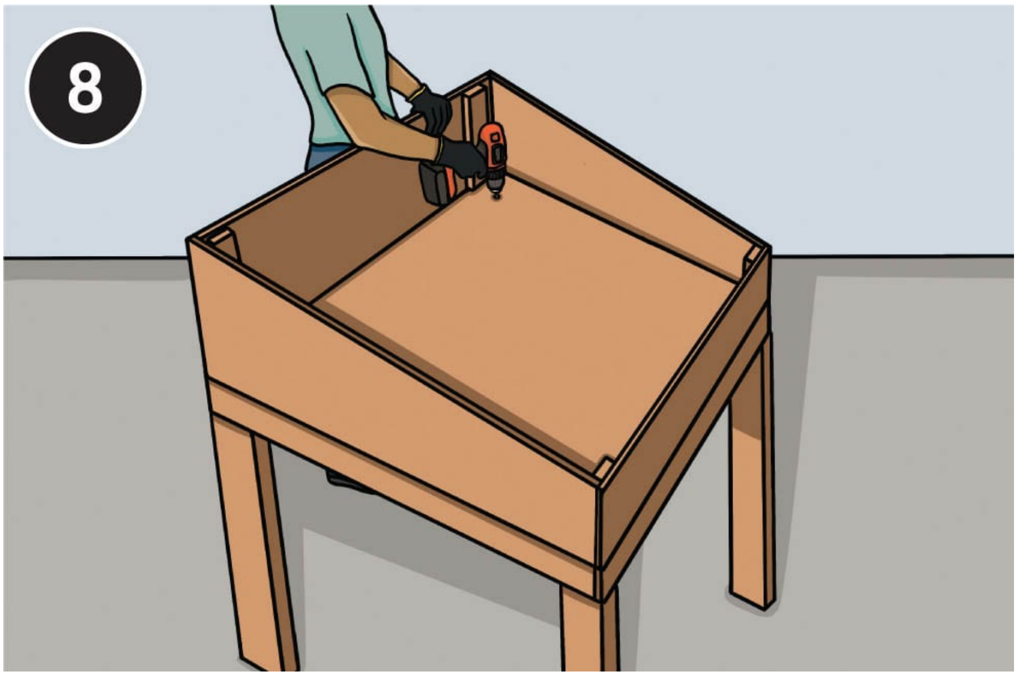
Set two 4 × 4 legs on a flat, level work surface, parallel to each other. Place a side skirt board across the legs. Align it flush to the end and the outside edge of each leg. Drill a two pilot holes on each end of the board, and screw the skirt board to the legs with 2” deck screws.



Measure up from the bottom of the legs and use a speed square or straight edge to mark lines 10” up from the bottom of each leg. Use the lines as guides for positioning the lower skirt board. Drill pilot holes and screw the boards to the legs as before. Repeat the other two legs.

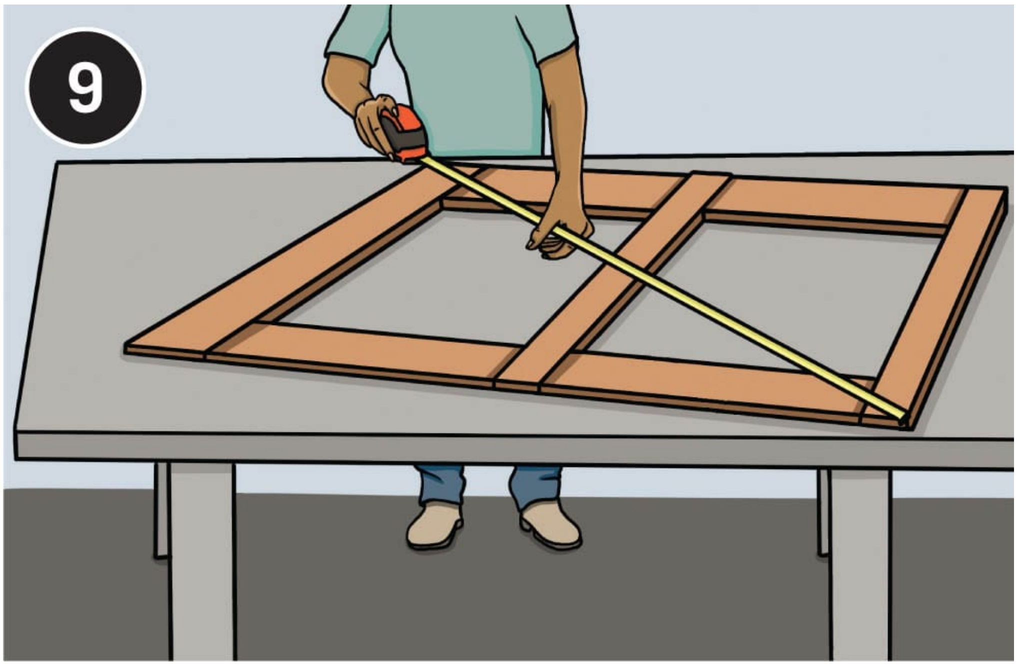


Stand the leg pairs upside down on the work surface, on their ends, parallel to one another (the skirt boards should be facing out). Position a top front skirt board between the legs, overlapping the ends of the side skirt boards you attached in step 6. Drill pilot holes and screw the board in place. Repeat with the second skirt board, and then the opposite side to complete the base.

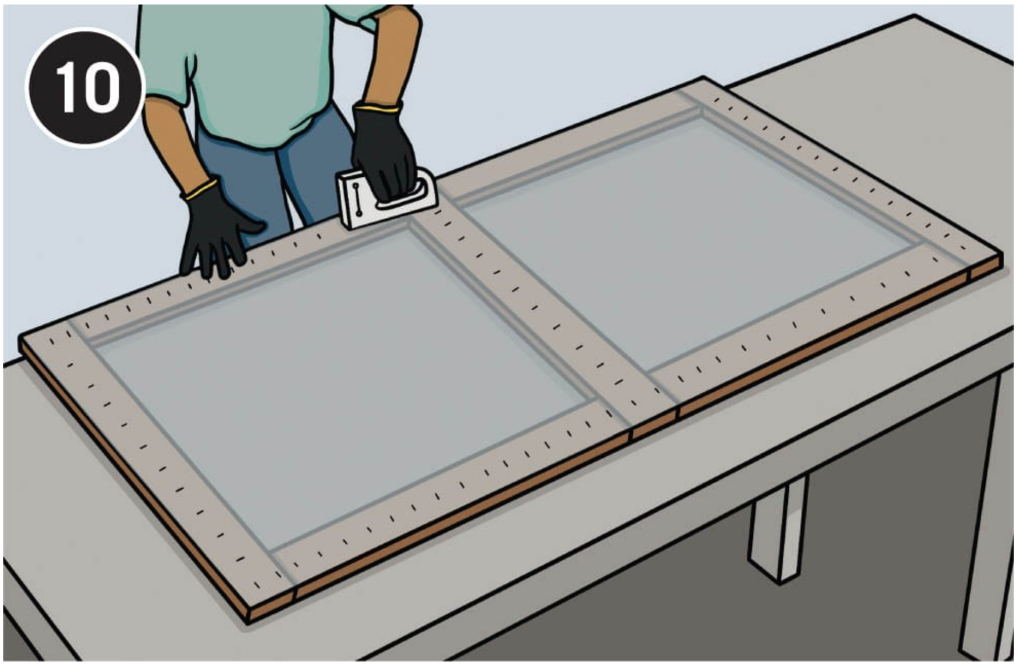


Stand the base upright on a flat, level surface. Set the box frame in place on the top of the base. Check that it is properly oriented; the box should be flush with the skirt boards all around. When you're sure the position is correct, screw the floor of the box to the top of each leg with at least two 2” deck screws.

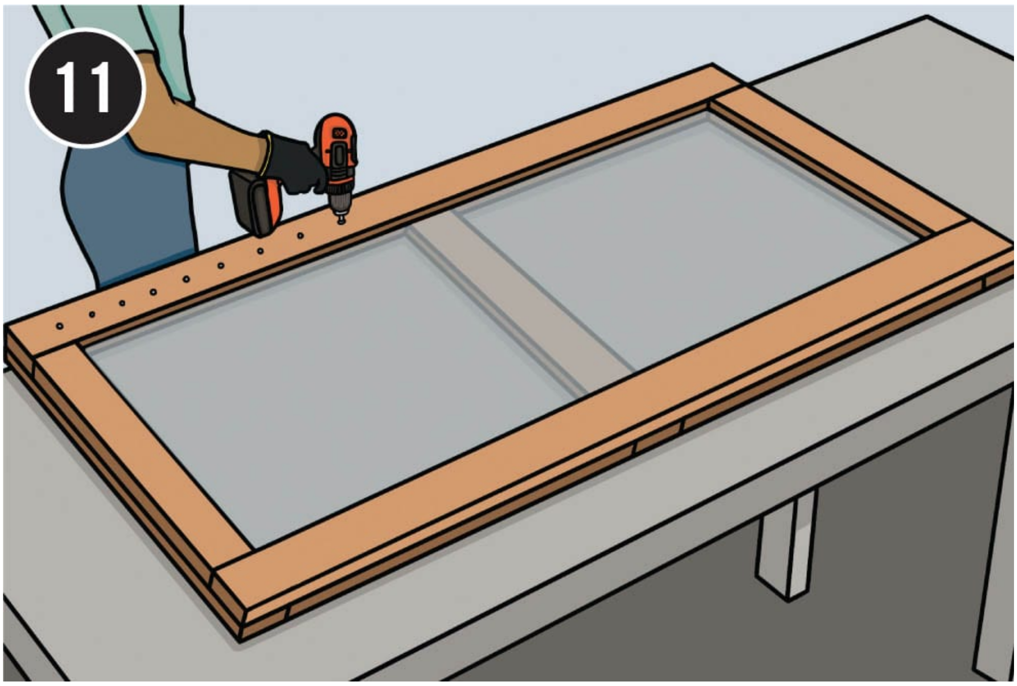
Lightly sand and stain or paint the box, base, and frame pieces.



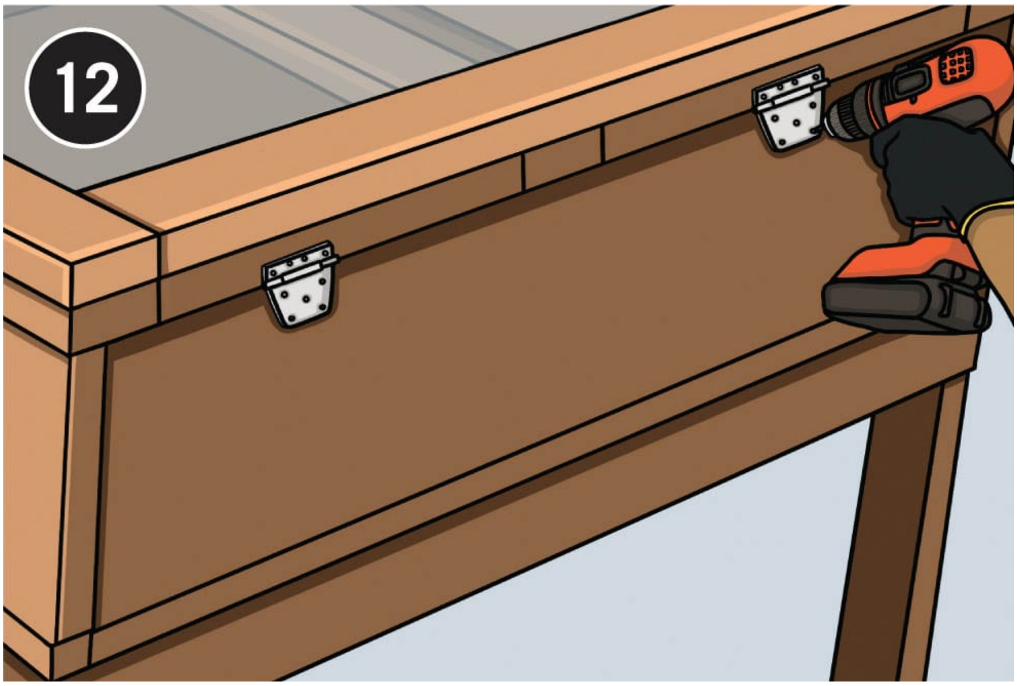
Layout out the lid bottom frame on the work surface, with short rails separating the three stiles at their ends. Check the diagonal measurements to ensure the frame is square, then staple the boards together.



Staple the plastic sheeting taut across the frame. Trim off any extra with a sharp utility knife.



Lay the bottom frame pieces on top of the top frame. Make sure it is aligned all the way around, and then screw the frame boards to the top frame, using 1” deck screws. Use one screw every 3”.



Place the lid on top of the box as it will rest when closed. Measure, position, and mark the hinge screw holes. Screw the hinges to the box and the lid edge.

Cut a 14” long prop stick from any leftover lumber, or scrap. Cut a section of landscape cloth for the bottom of the box, and lay it in place. Position the box in its final location, and fill with soil and plants. Water well.

Raised Planting Bed

If you live on a rural homestead with ample acreage, siting your gardens usually comes down to choosing among many good options. But if you live in a home with a smaller lot, your foray into gardening will take more planning. It will require you to make extremely efficient use of your gardening space to achieve the volume of produce you want. In many cases, this challenge is addressed by sowing your plants in raised garden beds.

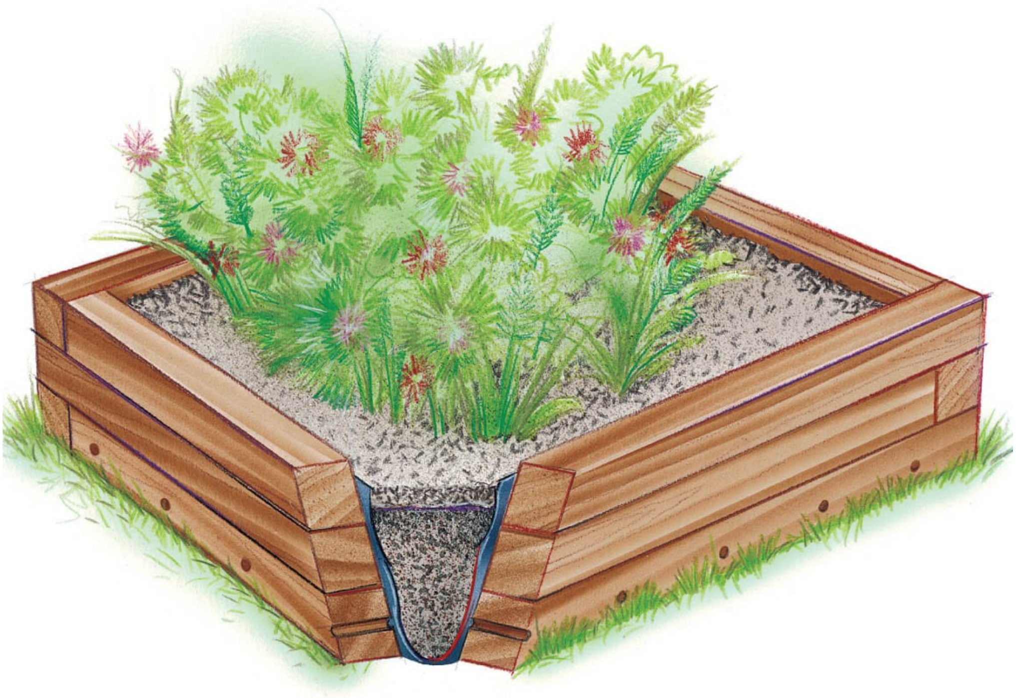
Raised garden beds offer several advantages over planting at ground level. When segregated, soil can be amended in a more targeted way to support high density plantings. Also, in raised garden beds, soil doesn’t suffer compaction under foot traffic or machinery, so plant roots are free to spread and breathe more easily. Vegetables and flowers planted at high densities in raised beds are placed far enough apart to avoid overcrowding but close enough to shade and choke out weeds. In raised beds, you can also water plants easily with soaker hoses, which deliver water to soil and roots rather than spraying leaves and inviting disease.

Raised garden beds can easily be customized to fit the space you have available. Just make sure you can reach the center easily. If you can only access your raised bed from one side, it’s best to build it no wider than 3 feet. Beds that you can access from both sides can be as wide as 6 feet, as long as you can reach the center. You can build your raised bed as long as you’d like.

TIP: For low-growing plants, position the bed with a north-south orientation, so both sides of the bed will be exposed to direct sunlight. For taller plants, position the bed east-west.

Raised garden beds are easy to weed, simple to water, and the soil quality is easier to control, ensuring that your vegetable plants yield bountiful fresh produce. Your garden beds can be built at any height up to waist-level. It's best not to build them much taller than that, however, to make sure you can reach the center of your bed.

How to Build a Raised Planting Bed with Timbers



This basic but very sturdy raised bed is made with 4 × 4 landscape timbers stacked with their ends staggered in classic log-cabin style. The corners are pinned together with 6” galvanized spikes (or you can use timber screws). It is lined with landscape fabric and includes several weep holes in the bottom course for drainage. Consider adding a 2 × 8 ledge on the top row. Corner finials improve the appearance and provide hose guides to protect the plants in the bed.

Outline a 3 × 5' area with stakes and mason's string. Remove all grass inside the area, then dig a 2"-deep × 6"-wide trench along the inside perimeter of the outline. Cut each of the four timbers into one 54" piece and one 30" piece, using a reciprocating saw or circular saw.

Set the first course of timbers in the trench. Check the timbers for level along their lengths and at the corners, adding or removing soil to adjust, as needed. Position the second course on top of the first, staggering the corner joints with those in the first course. Fasten the courses together at each corner with pairs of 6” nails driven through $^{3}/_{16}$” pilot holes.

Line the bed with landscape fabric to contain the soil and help keep weeds out of the bed. Tack the fabric to the lower part of the top course with roofing nails. Some gardeners recommend drilling 1”-diameter weep holes in the bottom timber course at 2’ intervals. Fill with a blend of soil, peat moss and fertilizer (if desired) to within 2 or 3” of the top.

Raised Planting Bed + Cover

Raised planting beds solve a number of gardening challenges. A raised bed is much like a container garden in that it offers total control over the soil content and quality, without the worry of compaction from walking through the garden. Containment of the soil also prevents erosion, helps with weed encroachment, and improves water drainage. For many urban gardeners, a raised bed is the best—and often only—way to grow vegetables and other crop plants in tight spaces.

Another advantage of a raised bed is that the frame around the bed provides a structure for adding covers to protect plants from cold, wind, and snow, or to erect netting to keep out pests. The simple cover frame shown here is much like a hoophouse structure used by farmers to shelter rows of crops on a temporary basis. Ours is made with PVC pipe and is easy to disassemble for storage at the end of the season. The lightweight frame is perfect for a canopy of plastic sheeting (for warmth in colder weather), spun fleece (for insect protection), or deer netting (to deter deer or any other hungry critters).

The raised bed frame is made with a single course of 2 × 10 lumber. You can use smaller lumber for a shallower bed, or go higher with more courses and taller corner posts. Unless your bed will be used strictly for ornamental plants (not food), don’t use pressure-treated lumber, due to the risk of chemical contamination. Instead, choose a naturally decay-resistant species such as all-heart redwood, cedar, cypress, or Douglas fir.

Filled with carefully prepared soil, a raised bed offers high yields in a relatively small space. This simple, inexpensive bed design includes wood sills installed along its top edges—a handy feature for clamping down covers of all types.

RAISED PLANTING BED + COVER

TOOLS + MATERIALS

Tape measure

Hammer

Circular saw

Square or straightedge

Drill and countersink bit and $^{3}/_{16}$" twist bit

Reciprocating saw or handsaw

Hand sledge

Level

Permanent marker

Hacksaw or pipe cutter

Eye protection

Work gloves

(2) 10' 2 × 10

(1) 8' 2 × 10

Deck screws (3½", 1¼")

(1) 8' 4 × 4

(1) 8' 2 × 4

(1) 8' 1 × 4

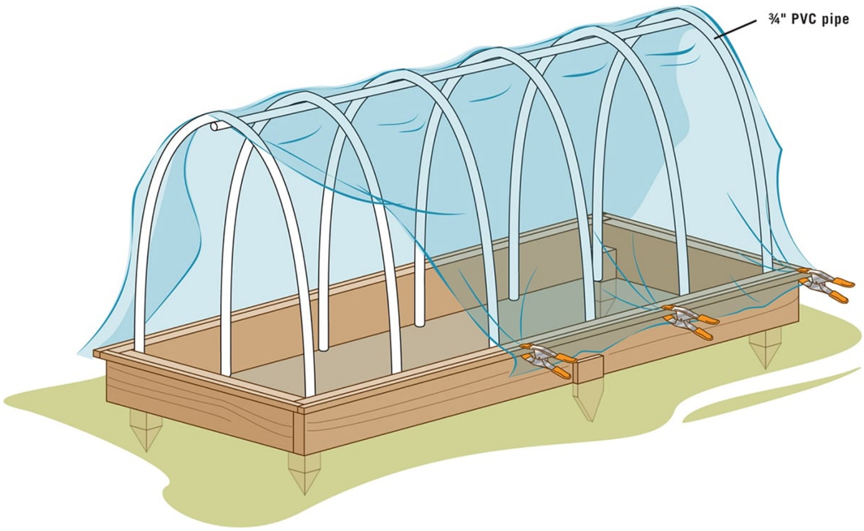
(7) ¾"-dia. × 10' PVC pipe

(6) 1½" #8 stainless-steel machine bolts and wing nuts

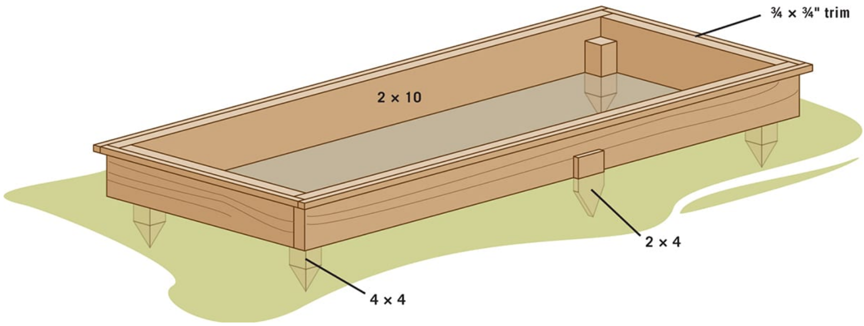
Cover material (8 × 14')

(12) spring clamps

Covered



Uncovered



How to Build a Raised Bed + Cover

Cut the two frame ends to length (45”) from an 8’ 2 × 10, using a circular saw and a square or straightedge to ensure straight cuts. For the frame side pieces, trim the ends of the 10’ 2 × 10s, if necessary, so they are square and measure 120”.

Assemble the frame by setting the sides over the ends of the end pieces so they are flush at the top and outside edges. Drill three evenly spaced pilot holes through the sides and into the end pieces and fasten the pieces with 3½" deck screws.

Create the corner posts by cutting the 8’ 4 × 4 into four pieces roughly 24” each. Trim the ends of each post to a point, using a reciprocating saw or handsaw.

Set the bed frame into place, then measure diagonally between opposing corners to check for square: the frame is square when the measurements are equal.

TIP: For general soil preparation, turn over the soil beneath the bed and add compost or manure, as desired, before setting down the frame.

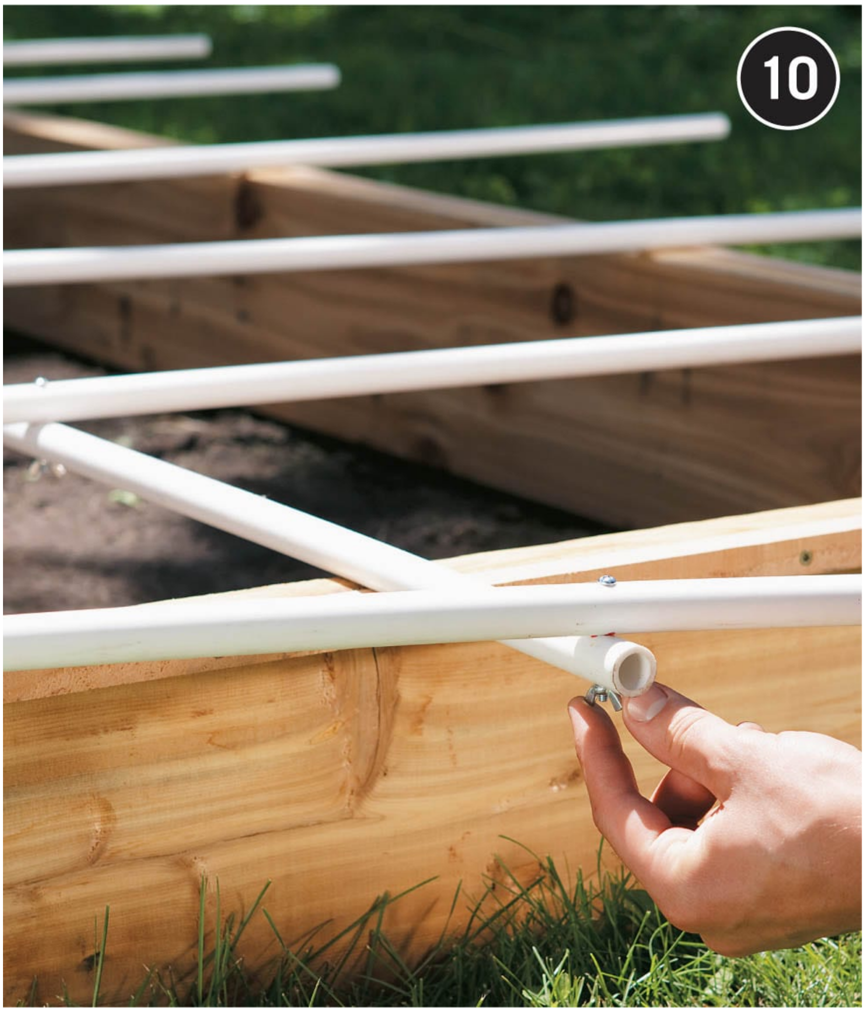
Drive a post at each corner inside the frame, using a hand sledge and a wood block to prevent mushrooming the post top. Drive the posts until the tops are about 2” below the top of the bed frame. Check the frame for level, then drill pilot holes and fasten each side and end piece to a post with 3½” deck screws.

Add a 2 × 4 stake at the midpoint of each frame side, to help keep the lumber from bowing out over time. Cut the stake to a point and drive it down below the top edge of the frame. Tack the stake to the frame with a couple of screws.

Install the cleats: Rip a 1 × 4 into four ¾"-wide strips, using a circular saw or table saw (it's okay if the last strip isn't exactly ¾"). Fasten the strips along the perimeter of the bed frame, flush with the top edges, using 1¼" deck screws driven through pilot holes. Cut the strips to length as needed to complete each run. Fill the bed with soil and compost, as desired.

Mark and drill the ridge pole for the cover frame, using one of the 10' PVC pipes. Make a mark 1" from each end, then mark every 24" in between. The marks should form a straight line down the length of the pipe. At each mark, drill a $^3/_{16}$"-diameter hole straight down through the pipe.

Prepare the cover frame ribs by cutting six ¾"-diameter PVC pipes to length at 96", using a hacksaw or tubing cutter. Then, make a mark at the midpoint (48") of each rib, and drill a $^{3}/_{16}$" hole straight through the pipe at each mark.



Assemble the cover frame, using 1½" machine bolts and wing nuts. Fit a rib over the top of the ridge pole at each hole location. Insert the bolt through the rib and ridge and secure with a wing nut. The wing nuts allow for quick disassembly of the frame.

ANCHOR THE FRAME

For a more secure frame that is less likely to blow away, anchor the ¾” tubing onto pieces of ½” CPVC tubing that are set into holes drilled into the raised bed walls. A ¾” bit should makes holes that are sized just right for the CPVC tubes, but drill a hole in a scrap piece first and test the fit. For extra holding power and to prevent the holes from filling with water, squeeze caulk into the hole before inserting the CPVC pipe.

Install the cover frame into the bed by fitting one end of each rib against a frame side, inside the box area, and then bending the rib and fitting the other end inside the frame. It helps to have two people for this job, starting at one end of the frame and working down.

Add the cover material of your choice. Drape the cover over the cover frame, center it side-to-side and end-to-end, and secure it on all sides with clamps fitted over the cleats. To prevent overheating with plastic covers, you can roll up the cover at the ends and clamp it to the outside ribs.

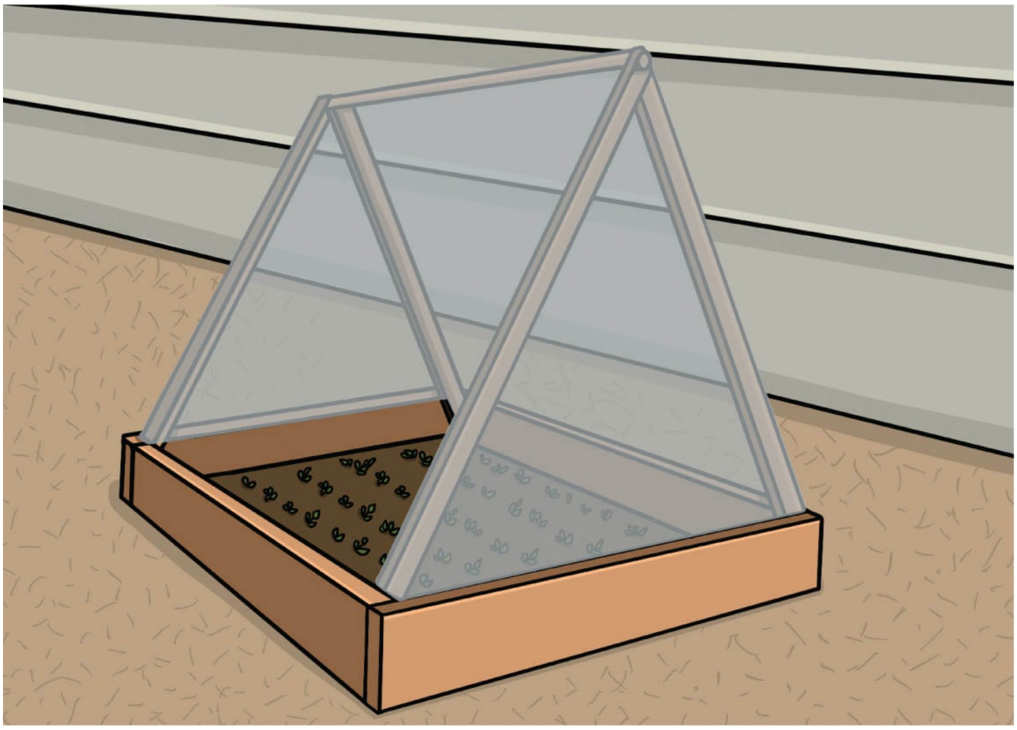
Tent Cold Frame

Like the raised-bed hoophouse project, this simple and easy-to-construct A-frame turns any raised bed into a cross between a mini-greenhouse and spacious cold frame. It can also be used over a garden bed, to protect and nurture in-ground plants.

There are a couple unique advantages to this construction. Not only will you increase sun exposure over a typical cold frame, you also open up the possibility of growing much taller plants in the center of the bed, with shorter plants on the edges. This frame is also portable and folds flat for easy removal and storage over the summer months.

The A-frame has been designed for maximum adaptability. The legs can be spread less or more to accommodate different widths of raised beds (or garden plots). The plastic can be doubled up to extend the growing season on either end. The side flap-slash-door is superconvenient and allows maximum access to the plants inside and a quick and efficient way to ventilate the cold frame.

The frame is also extremely easy and inexpensive to construct. Friction between the leg brace and raised bed top edges holds it in place. That simple principle is forgiving of slight mismeasurements or sawing mistakes. You can also change the length—or even the height—to suit. (This version has been designed to efficiently use 4-foot and 8-foot lengths of lumber.)



This simple cold frame couldn't be easier to build and provides more height inside than most other cold frames.

Last, but certainly not least, an A-frame tent cover like this is a handsome addition to any yard and garden. You can make it even more so by folding over the edges of the plastic to create a neat hem everywhere the plastic is stapled to the wood.

TOOLS + MATERIALS

- Tape measure
- Carpenter's pencil
- Circular saw
- Drill and bits
- ¾" spade bit
- Staple gun + staples
- 6-mil plastic sheeting
- Permanent market
- Heavy-duty shears
- Sealant and/or stain (optional)
- 2" all-purpose brush (optional)
- Work gloves
- Safety glasses
- 2 × 2 lumber
- ¾" × 48" dowel
- (3) 2 × 2" × 8' furring strips
- (1) 1 × 2" × 4' furring strip

CUTTING LIST

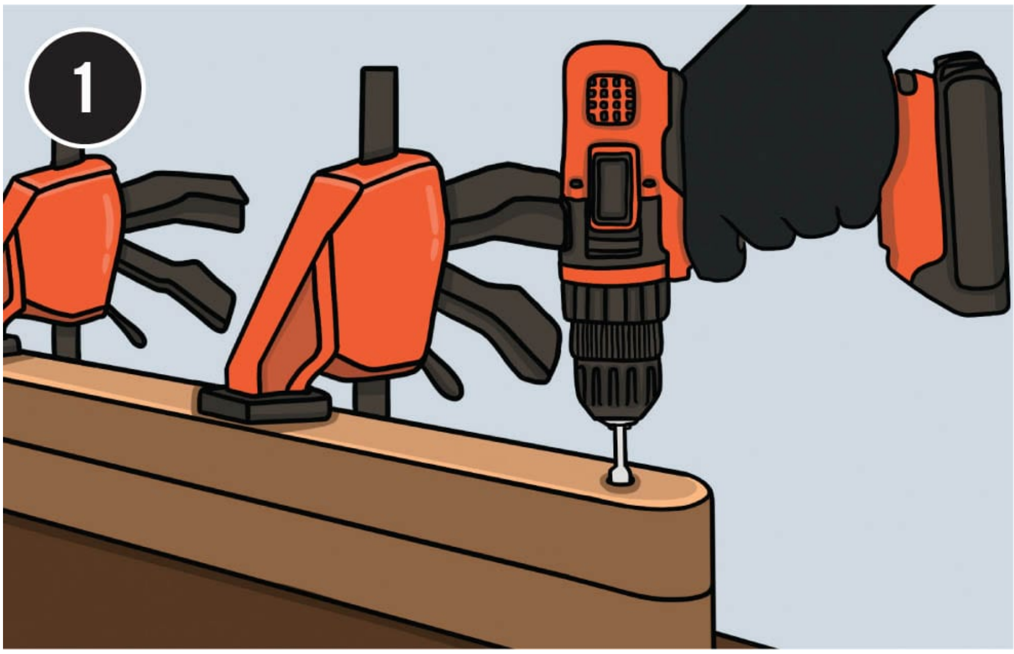
PART	NO.	DIMENSION
Dowel ridge pole	1	¾ × 48"
Base brace	1	2 × 2 × 48"
Base brace	1	2 × 2 × 45"
Legs	4	2 × 2 × 48"
Flap weight	1	1 × 2 × 48"

RAISED BED AND COLD FRAME IDEAL PLANT PARTNERS

VEGETABLE	LOVES	DOES NOT GET ALONG WITH	PLANTING SEASON
Asparagus	Tomatoes, parsley, basil		Early spring
Beans (bush)	Beets, carrots, cucumbers, potatoes	Fennel, garlic, onions	Spring
Cabbage + broccoli	Beets, celery, corn, dill, onions, oregano, sage	Fennel, pole beans, strawberries, tomatoes	Spring
Cantaloupe	Corn	Potatoes	Early summer
Carrots	Chives, leaf lettuce, onion, parsley, peas, rosemary, sage, tomatoes	Dill	Early spring
Celery	Beans, cabbage, cauliflower, leeks, tomatoes		Early summer
Corn	Beans, cucumbers, peas, potatoes, pumpkins, squash		Spring
Cucumbers	Beans, cabbages, corn, peas, radishes	Aromatic herbs, potatoes	Early summer
Eggplant	Beans	Potatoes	Spring
Lettuce	Carrots, cucumbers, onions, radishes, strawberries		Early spring
Onions + garlic	Beets, broccoli, cabbages, eggplant, lettuce, strawberries, tomatoes	Peas, beans	Early spring
Peas	Beans, carrots, corn, cucumbers, radishes, turnips	Chives, garlic, onions	Early spring
Potatoes	Beans, cabbage, corn, eggplant, peas	Cucumber, tomatoes, raspberries	Early spring

VEGETABLE	**LOVES**	**DOES NOT GET ALONG WITH**	**PLANTING SEASON**
Pumpkins	Corn	Potatoes	Early summer
Radishes	Beans, beets, carrots, cucumbers, lettuce, peas, spinach, tomatoes		Early spring
Squash	Radishes	Potatoes	Early summer
Tomatoes	Asparagus, basil, carrots, chive, garlic, onions, parsley	Cabbages, fennel, potatoes	Dependent on the variety
Turnips	Beans, peas		Early spring

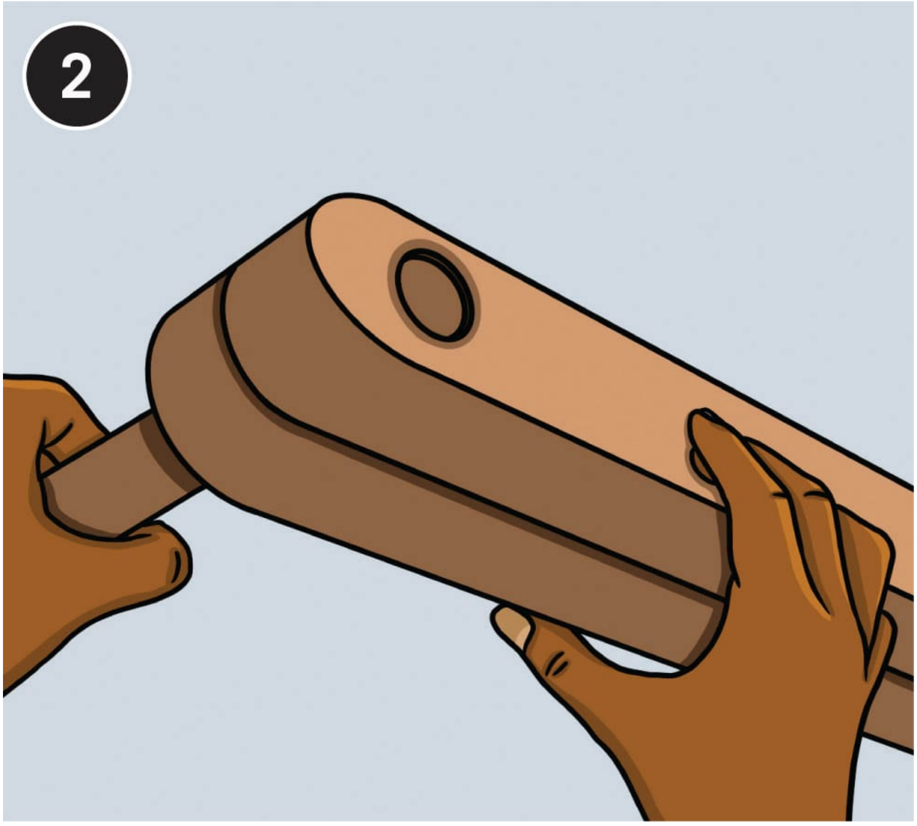
How to Build a Tent Cold Frame



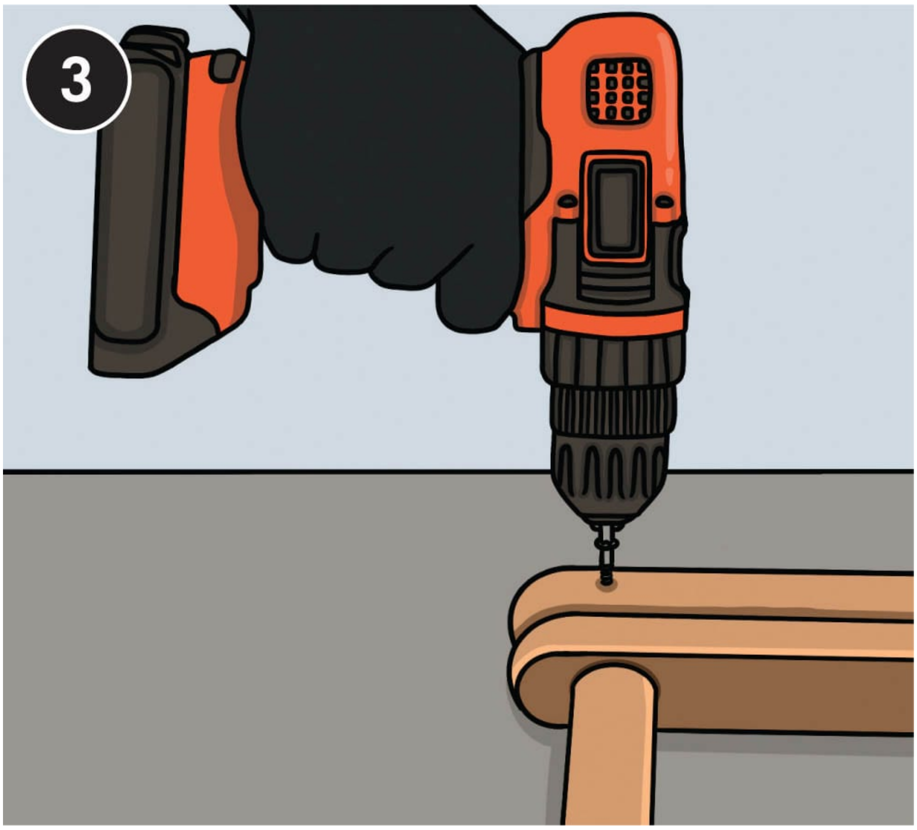
Measure, mark, and cut the frame pieces according to the cut list. If you've purchased 4' lengths of lumber, you may only need to cut the shorter frame brace.

Measure, and mark a point 1" from the top of one leg (the rounded end, if you've chosen that option), centered side to side. Clamp this board flush to a second leg, over a sacrificial piece. Center the point of a ¾" spade bit on the mark, and drill a hole through both boards. Repeat with second pair of legs.

OPTION: For a more polished look, cut one end of each 2 × 2 leg to a half-circle. Measure down 3” from one end, and mark a point centered side to side. Use that point to anchor a carpenter’s compass or homemade trammel, to mark an arc along the end of the leg. Cut the arc using a jigsaw.



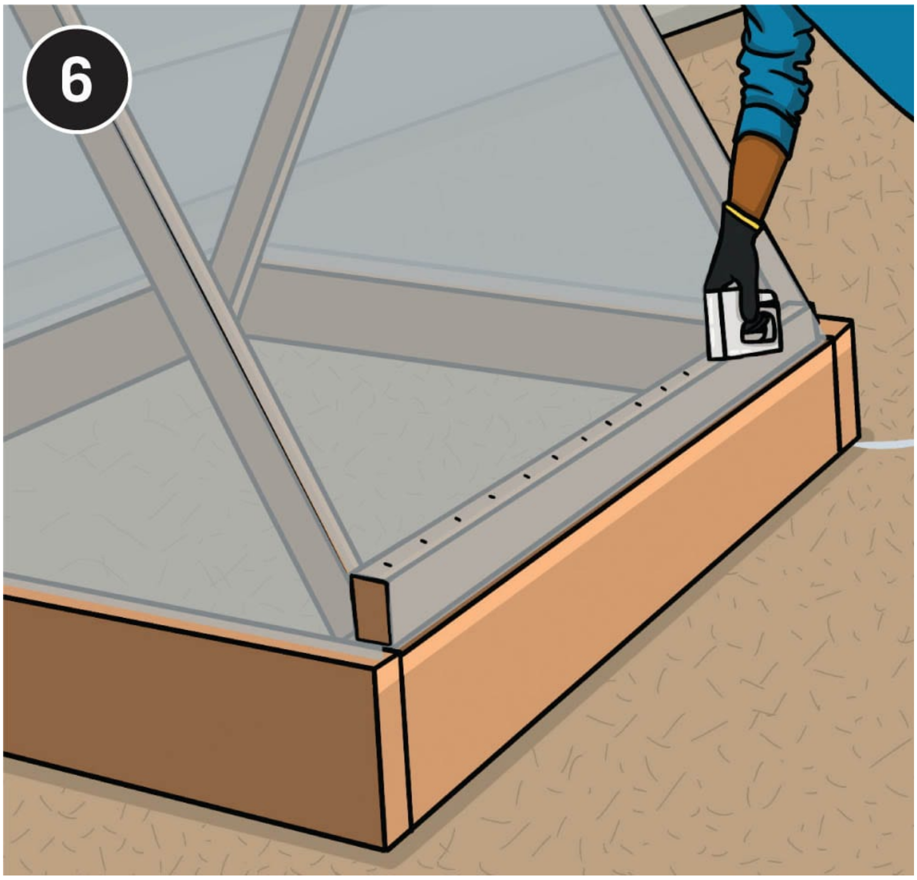
Set two of the legs on edge, flush to one another, side by side on a flat, level work surface. Align the holes in the ends of each leg. Slide the end of the dowel into the holes, until the end of the dowel is flush with the outside face of the leg pair. If the fit is tight, tap the opposite end of the dowel until it is through the holes. Repeat to fasten the second leg pair onto the opposite end of the dowel.



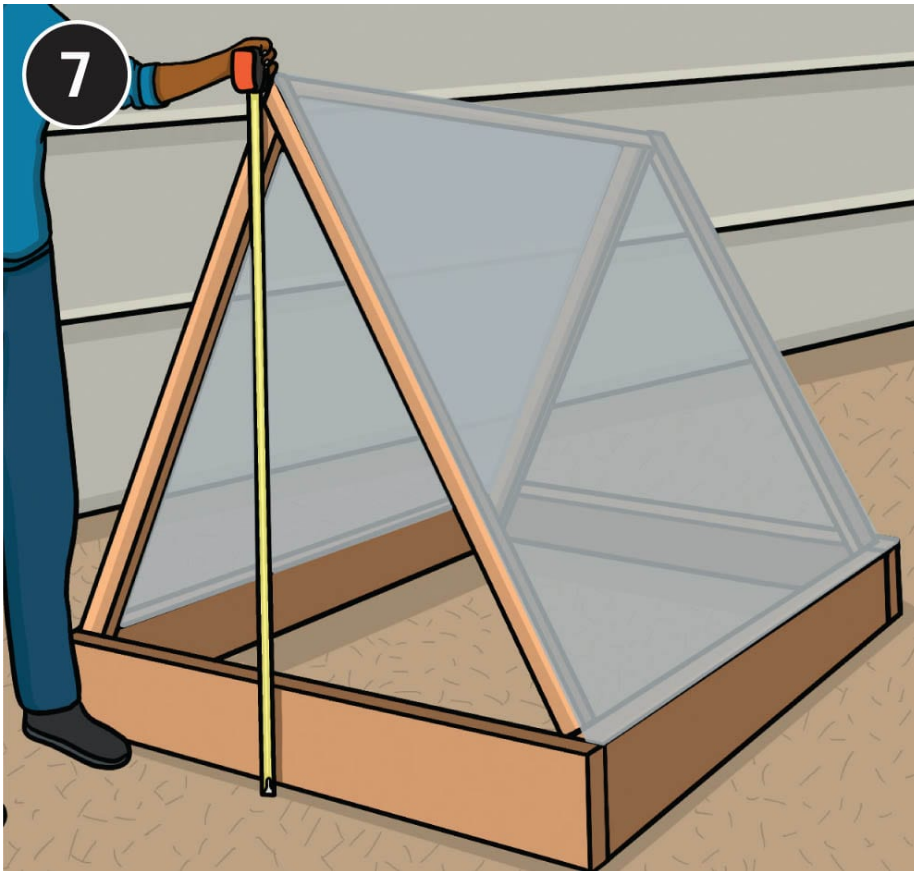
Measure and mark 1” from the end of the outside board of the leg pair. Drill a pilot hole, and then screw the outer leg to the dowel with a #4 × 2” screw. Repeat with the opposite leg pair.

Measure and mark 6-mil plastic sheeting for a rectangle 100” × 49”. Use shears to cut out the rectangle. Open and stand the tent frame upright, and drape the sheet over the ridge. Starting at the bottom of the inner legs, fold over about ½” and staple the plastic to the bottom of the legs. Continue stapling it over a couple of inches up the edges of the legs and finishing with tops of the legs. Leave the sheet loose on the opposite side.

Set the long brace across the leg pairs. Drill pilot holes and screw the brace to the edges of the outside legs, flush all around. Repeat with the opposite, shorter base brace.



Cut the 1 × 2 to length for the door flap, if necessary. Wrap the free end of the plastic sheet around the board, until the board sits flush against the base brace with the door closed (the plastic will overlap the leg edges on both sides). When you're sure the length is correct, staple the plastic to the weight board.



Set the frame in place. Measure the triangle opening on one side. Add 2” all around, transfer the measurements to the plastic sheet, and cut the triangle for the tent ends. Repeat with the opposite side.

Staple the triangles of plastic on the ends of the tent, with an even amount of leftover plastic on the sides, top, and along the edge of the raised bed. To make the tent more airtight, place bricks spaced equidistant along the top edge of the raised bed, to hold the plastic down.

Seed Starter Rack

A seed starter rack provides a spot for you to germinate seeds and grow seedlings indoors, any time of the year (in particular, immediately before the start of the outdoor growing season). Starting your own seeds can save money over buying established plants each growing season. And in many cases, it also lets you grow less-common varieties that might not be locally available in plant form. This accessory is particularly useful if you have a modest greenhouse without supplied heating, or live in a particularly cold area with long winters.

This simple starter rack is perfect for a basement or utility room. The basic structure is built with 2 × 4s and has shelves made from ½-inch plywood. Plants that need the warmest temperatures should go on the upper shelf.

Each shelf of the rack measures 24 × 48 inches—plenty of room for four full-size seedling flats. Two fluorescent shop lights illuminate each shelf and are fully height-adjustable so you can raise or lower them as needed to provide plants with the right amounts of light and heat at different stages of development. Because seeds and seedlings can require as much as 20 hours of light per day, it’s most convenient to control the lights with an automatic timer. This should be plugged into a GFCI-protected receptacle, due to all of the water used in the area. Even so, it’s best to remove flats before misting or watering, to keep water away from the lights.

As with many projects in this book, you can easily modify the dimensions of the rack as shown to suit your specific needs. For a smaller unit, switch to 2-foot or 3-foot lights and resize the shelves accordingly, or make the shelves half as deep and use a single fixture for each. For a larger rack, you can make the shelves square and hang four 4-foot lights over each shelf.

This easy-to-build starter rack (above left) holds up to 12 full-size seedling flats or trays and can be located practically anywhere with an accessible electrical outlet. The top shelf offers a handy space for storing extra flats and other supplies. Wire utility shelving (above right) offers an easy-to-assemble alternative to building your own rack. Most inexpensive units are only 14” deep and can accommodate one row of seedling flats per shelf. Use one or two light fixtures above each shelf, as appropriate for your needs.

SEED STARTER RACK

TOOLS + MATERIALS

Circular saw

Drill/driver

Framing square

(2) 10’ 2 × 4

(8) 8’ 2 × 4

(1) ½” × 4 × 8’ plywood

Deck screws (3½”, 2½”, 1⅝”)

(3) 48” fluorescent light fixtures with two 40W lamp capacity and plug-in cord

Chain (10 linear ft.)

(6) S-hooks

Grounded power strip

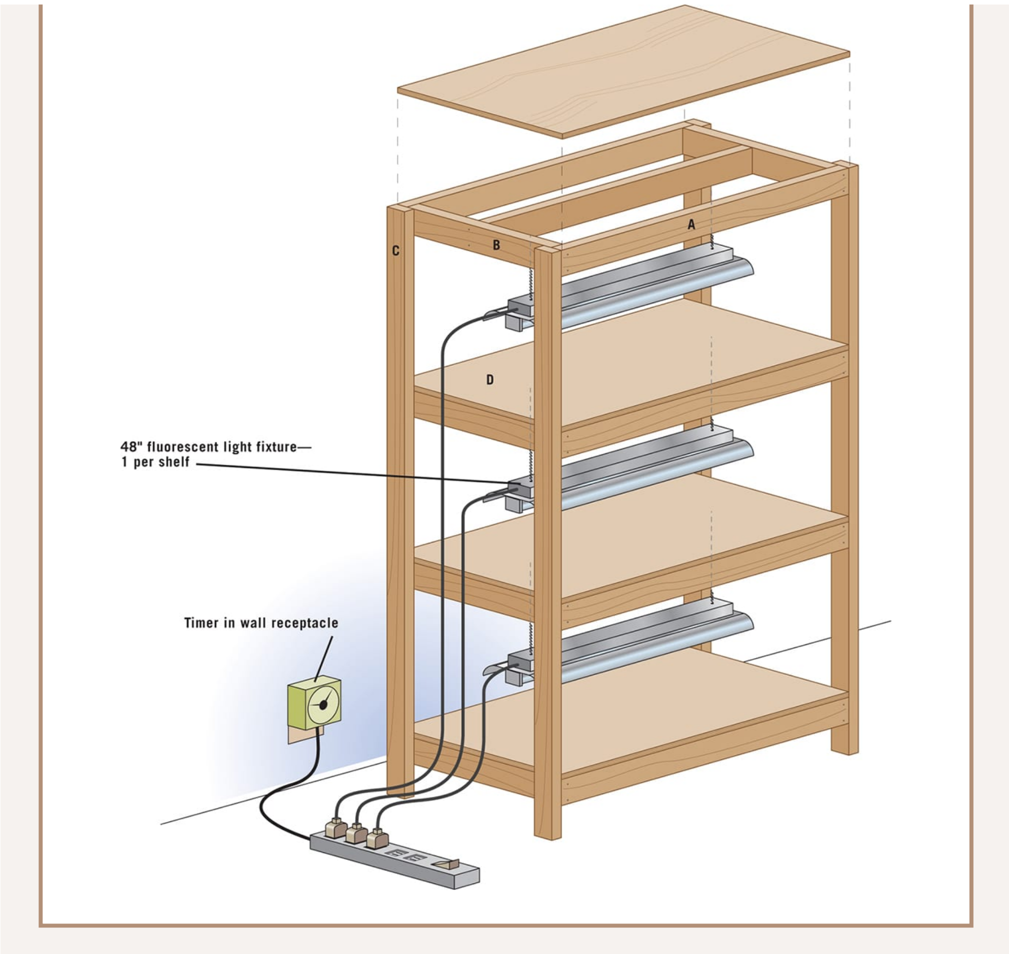
Grounded automatic timer

Eye protection

Work gloves

CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
A	Shelf frame side	8	1½ × 3½ × 50”	2 × 4
B	Shelf frame end	8	1½ × 3½ × 21”	2 × 4
C	Leg	4	1½ × 3½ × 79½”	2 × 4
D	Shelf	4	½ × 24 × 48”	Plywood

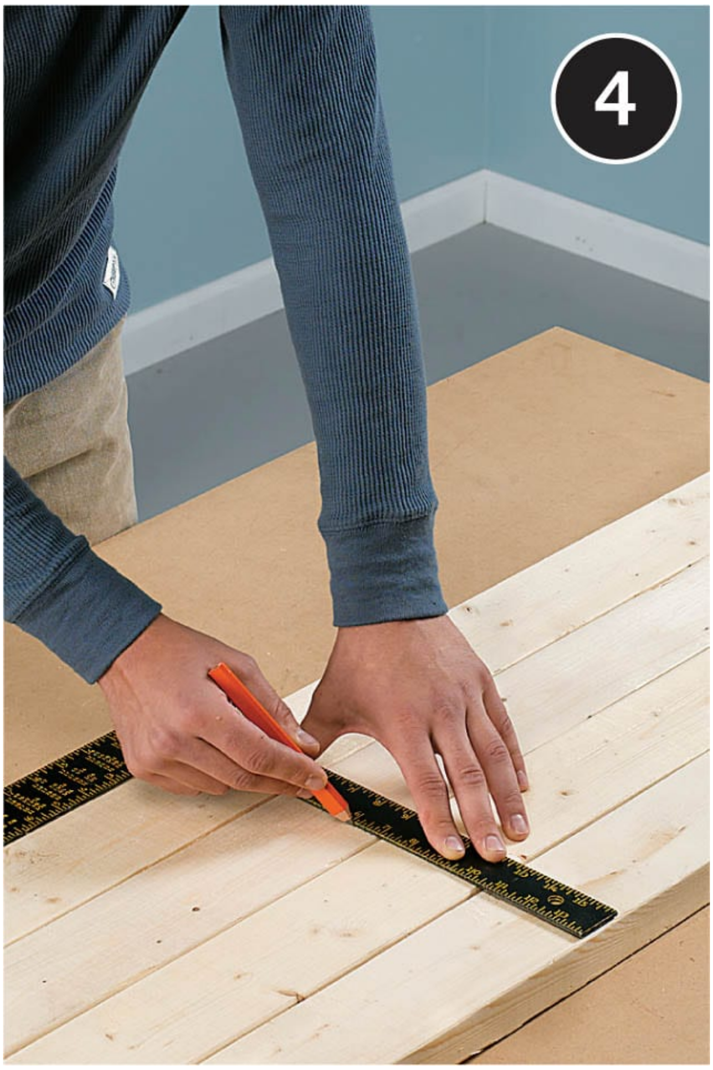

A
B
C
D
48" fluorescent light fixture—
1 per shelf
Timer in wall receptacle

How to Build a Seed Starter Rack

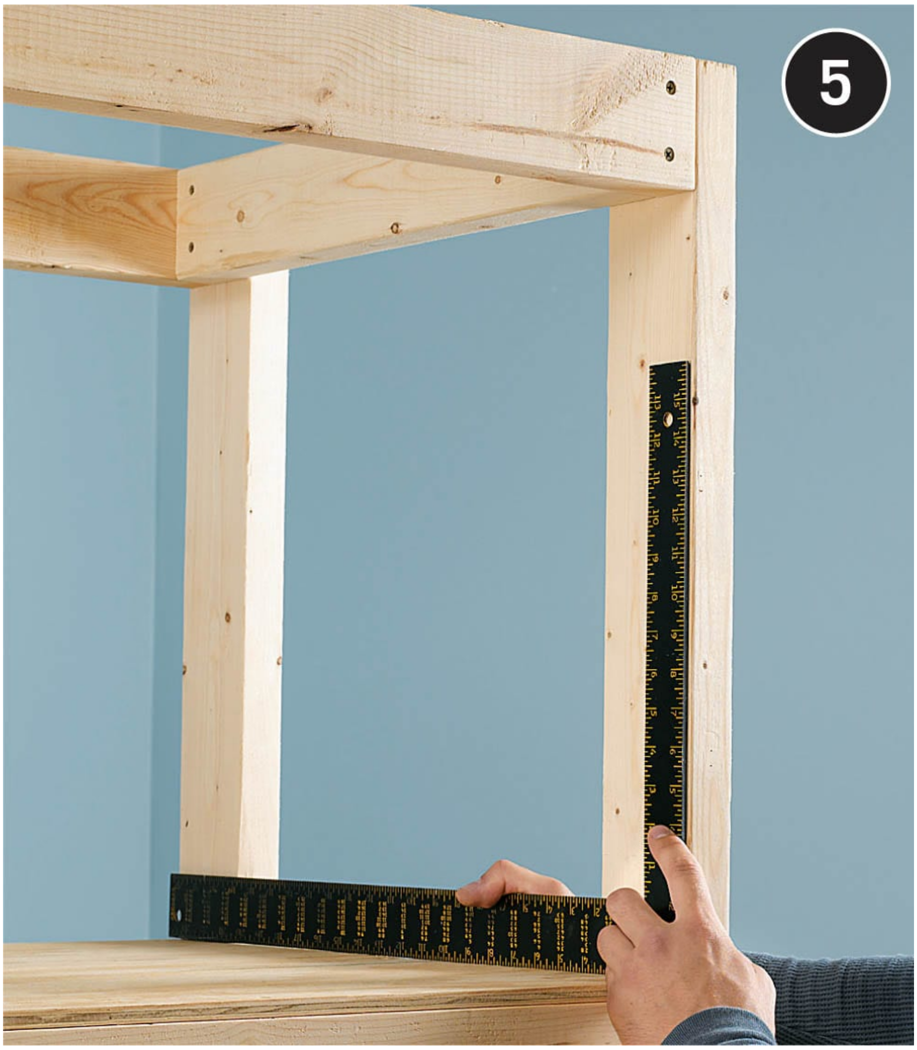
Cut all of the wood for the shelf frames, using a circular saw or power miter saw. Cut one shelf frame side and two shelf frame ends from each of four 8' 2 × 4s, and cut the remaining four shelf frame sides from two 10' 2 × 4s. Cut each of the four legs from an 8' 2 × 4.

Assemble the shelf frames with 3½” deck screws. Position the side pieces of each frame over the ends of the end pieces and so their top edges are flush. Drive two screws through the sides and into the ends. Complete all four shelf frames using the same technique.

Add the shelves. Cut four shelves 24 × 48", using a circular saw and straightedge cutting guide. Check each shelf frame with a framing square, then lay the shelf over the frame so it's centered side-to-side and end-to-end. Fasten the shelf to the frame with 1⅝" deck screws.



Mark the shelf locations onto the legs. Measuring from the bottom of one leg, make marks at 7½", 31½", and 55½". These marks represent the top edges of the shelves; the top shelf is installed flush with the top ends of the legs. Use the framing square to transfer the layout marks to the remaining three legs.



Fasten the shelves to each leg with two 2½" deck screws driven through the shelf ends and into the legs. The top edges of each shelf should be on its layout marks (or flush with the ends of the legs), and the front and rear sides should be flush with the outside edges of the legs. Use a square to make sure the shelf and legs are perpendicular before fastening.

Hang the light fixtures, using chain and S-hooks. Cut the chain into 18” lengths, using wire cutters, and attach each to one end of each fixture, using S-hooks or wire, as applicable. Attach the other end of the chains to the plywood shelf above, using S-hooks.

Route the fixture cords to the nearest leg of the rack and secure them with zip ties or insulated cable staples. Be sure to leave enough slack in the cord to allow for moving the fixture up and down. If necessary, use an approved extension cord to extend a fixture cord to the power strip location.

Plug the light fixtures into an approved (grounded) power strip, and plug the power strip into a 24-hour timer installed in a GFCI-protected wall receptacle. If the circuit or receptacle is not GFCI-protected, replace the existing receptacle with a GFCI receptacle, following the manufacturer's directions.

Greenhouse Workbench

Good, sturdy worktables are indispensable tools for most greenhouse gardeners. That's why almost any sizable greenhouse is furnished with some kind of workbench running down both long sides of the building. Benches hold plants at a comfortable level, saving your back and your knees during those many hours of tending and watering. They also make for healthier plants, keeping them above the cooler air near the floor and, with permeable bench tops, allowing airflow.

In this project, you'll learn how to build a basic, easily adaptable worktable, to which you can add the top and shelf surfaces of your choice. Made with 2 × 4 lumber, the bench frame is simple, inexpensive, and durable. And because it's put together with screws, you can easily disassemble the main parts for compact off-season storage (a great feature for temporary hoophouse gardeners).

Regarding adaptability, you might want to change the dimensions of the bench as shown to suit your needs and/or fit the available space in your greenhouse. Simply add or subtract whatever you need to modify the bench width, length, or height. You can also add a second shelf to double the storage space for seedling flats and other short items, or to keep garden tools conveniently close to the bench top.

A greenhouse bench should be practical, lightweight, and space-efficient. This simple bench is highly adaptable and easy to move around. The ample lower shelf provides maximum storage area without taking up unnecessary floor space.

GREENHOUSE WORKBENCH

TOOLS + MATERIALS

Tape measure

Hammer

Circular saw or power miter saw

Clamps

Drill/driver

Framing square

Aviation snips

Metal file

(8) 8’ cedar or PT 2 × 4

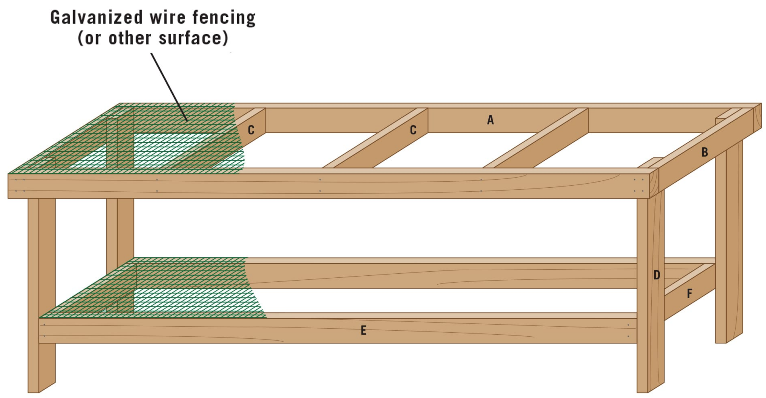
Deck screws (2½”, 3½”)

24”-wide steel mesh (or other tabletop material)

1½” galvanized horseshoe nails

Eye protection

Work gloves



CUTTING LIST

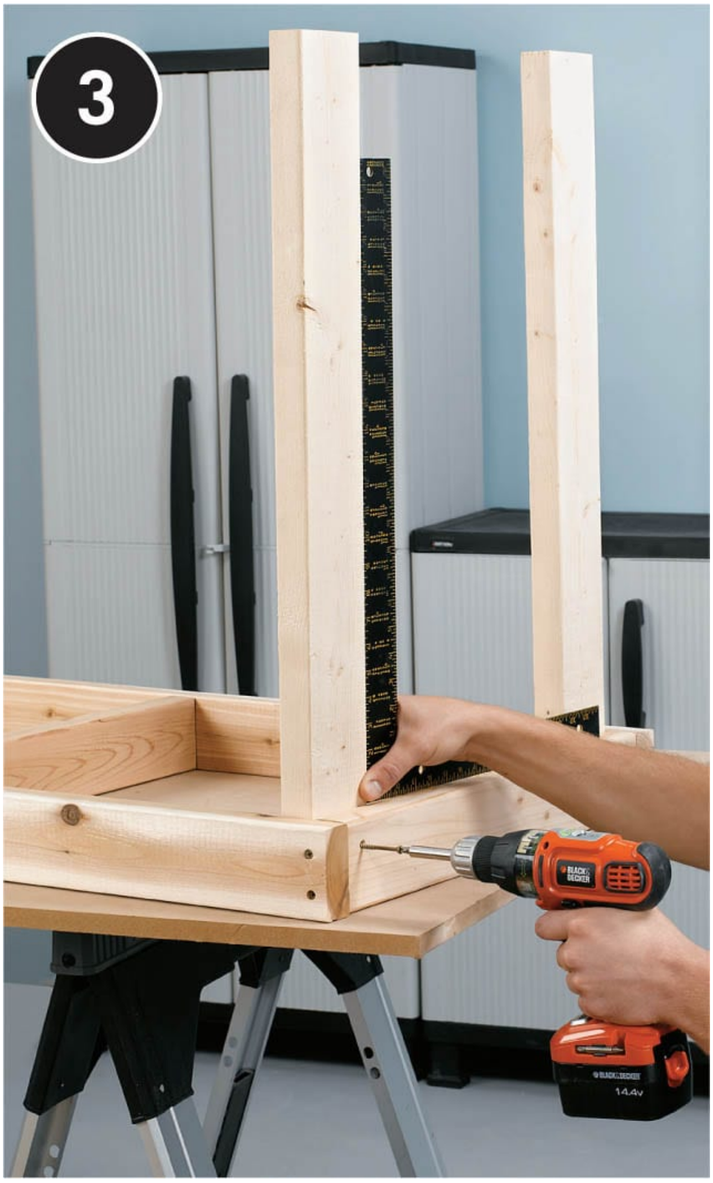
KEY	PART	NO.	DIMENSION	MATERIAL
A	Top frame side	2	1½ × 3½ × 96”	2 × 4
B	Top frame end	2	1½ × 3½ × 22”	2 × 4
C	Top supports	3	1½ × 3½ × 22”	2 × 4

D	Leg	4	1½ × 3½ × 32”	2 × 4
E	Shelf frame side	2	1½ × 3½ × 90”	2 × 4
F	Shelf frame end	2	1½ × 3½ × 19”	2 × 4

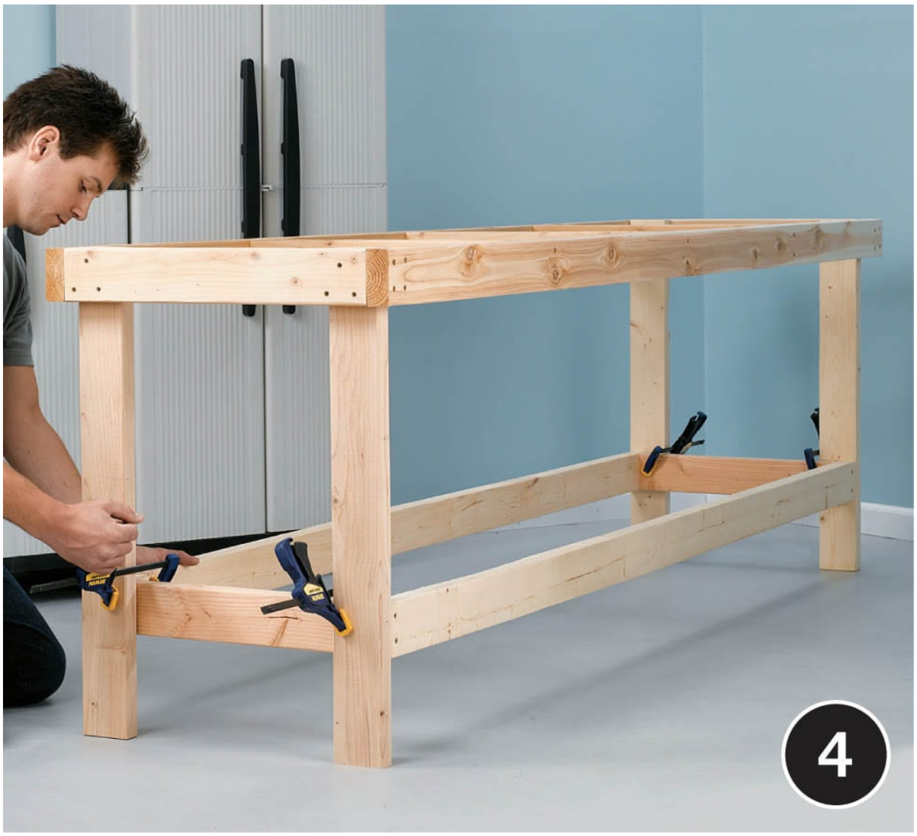
How to Build a Greenhouse Workbench

Assemble the top frame by clamping the side pieces over the ends of the end pieces so they're flush along the top edges. Fasten each corner with two 3½" deck screws.

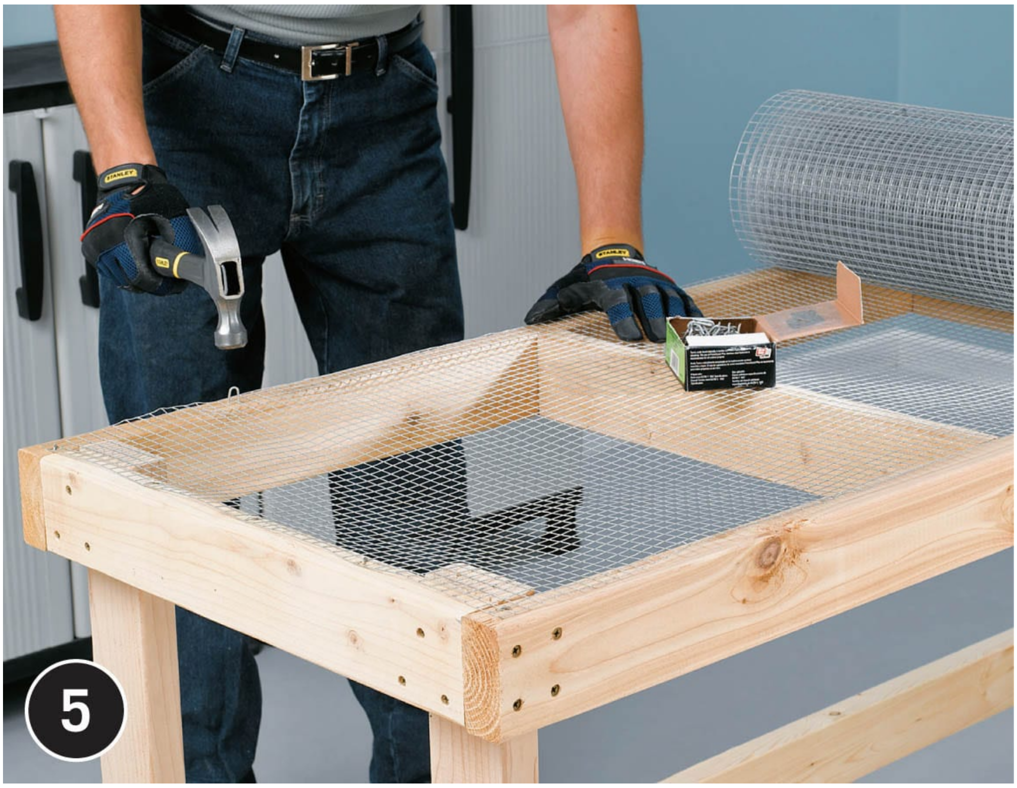
Install the top supports between the side pieces, spacing them 24" apart on center. First, mark layout lines onto both side pieces, then square the frame by measuring diagonally between opposing corners; the frame is square when the measurements are equal. Fasten the supports with pairs of 3½" deck screws.



Attach the legs to the inside corners of the top frame, using 2½" deck screws. The top ends of the legs should be flush with the top edges of the frame. Use a framing square to make sure each leg is perpendicular to the frame before fastening.



Assemble the shelf frame in the same manner as the top frame. Mark the inside face of each leg 10” up from the bottom end. Position the shelf frame with its top edges on the marks, and fasten it to the legs with 2½” deck screws driven through the frame ends. The side frame pieces should be flush with the outside edges of the legs.



Add the top and shelf surface material. Galvanized wire mesh fencing is shown here (see next page for other options). Cut the 24"-tall fencing to length at 95", using aviation snips. Round over any sharp cut ends of wire with a metal file. Center the mesh over the top frame, leaving a ½" margin at all sides. Fasten the mesh with 1½" horseshoe nails. Trim and install the shelf mesh in the same fashion.

Options for Bench Top + Shelf Surfaces

Expanded steel mesh is stiffer and has smaller holes than metal wire fencing, offering a more solid surface while maintaining permeability. Fasten steel mesh to the frame parts with heavy-duty staples or horseshoe nails. Do not use stucco lath, which has a rough surface and sharp steel edges.

Exterior plywood offers a smooth, continuous surface for a bench top or shelf. One full 4 × 8' sheet of ¾"-thick plywood will cover a full-size bench top and shelf. Fasten plywood to the frame parts with 1½" deck screws. Keep in mind that a plywood surface won't drain like a permeable material; you may want to pitch the bench slightly to one side for drainage. Coat it with deck stain or paint to make it easier to clean and more stain resistant.

1 × 4 or 1 × 6 cedar boards or decking boards make an attractive top surface and offer some runoff, depending on how widely the boards are gapped. For the bench top, run boards parallel to the length of the top frame; for the shelf, run them perpendicular to the length of the shelf frame.

Protect stored items from draining water with a simple "roof" made with a single panel of corrugated plastic or fiberglass roofing. Use 2 × 4s between the leg pairs to support the panel, sloping the panel down toward one end at ¼" per foot. Secure the panel at the top end with a couple of screws.

Built-In Potting Bench

Any greenhouse of reasonable size and structural integrity is a candidate for a useful and beautiful built-in workbench. A bench like the one in this project is a streamlined greenhouse addition that makes best use of the least amount of materials and fits in seamlessly with the greenhouse interior. It can also be easily adapted to different gardeners—made lower or higher, longer, or deeper as need dictates. That makes it much more valuable than any prefab potting bench you can buy. The design includes a handy lower shelf to keep potting materials off the greenhouse floor and a wonderful compartment beneath removable slats where you can blend your own batches of potting mix.

This is made of standard construction grade 2 × 4s and pressure-treated 1 × 6 deck boards. Because it is covered by a roof, leaving the bench unpainted will not materially affect its longevity. But greenhouses and gardening sheds usually aren’t simple utility areas. Investing a little time and money in painting the bench is well worth it (the potting bench seen here is coated with semi-transparent deck stain).

This potting bench uses the structural members of a greenhouse kneewall for support. The five slats at the right end can be removed to access a shelf for buckets and planters.

BUILT-IN POTTING BENCH

TOOLS + MATERIALS

Tape measure

Deck screws (2½”, 3”)

Lag screws (⅜ × 3”)

Carriage bolts (½ × 3½”)

Level

Exterior-rated wood glue

Drill

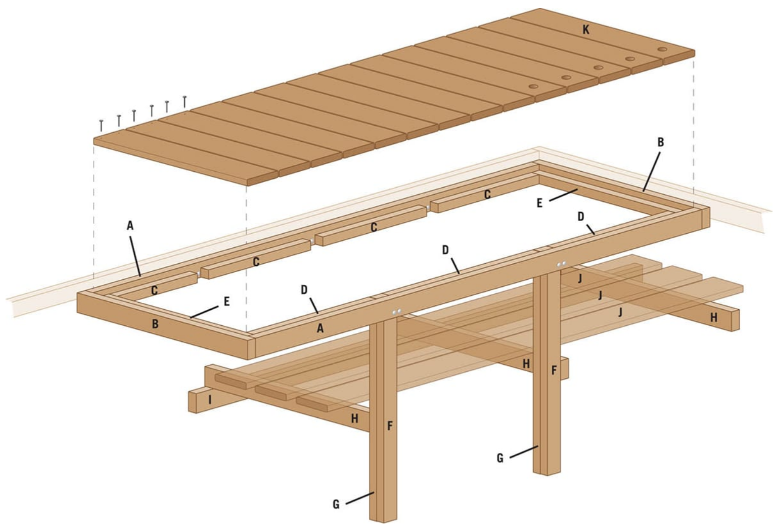
Circular saw or power miter saw

Clamps

(6) 2 × 4” × 8’

(3) 2 × 2” × 8’

Eye protection



CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
A	Front/back frame	2	1½ × 3½ × 81”	2 × 4
B	Frame ends	2	1½ × 3½ × 22”	2 × 4
C	Cleats-back	4	1½ × 1½ × 16”	2 × 2

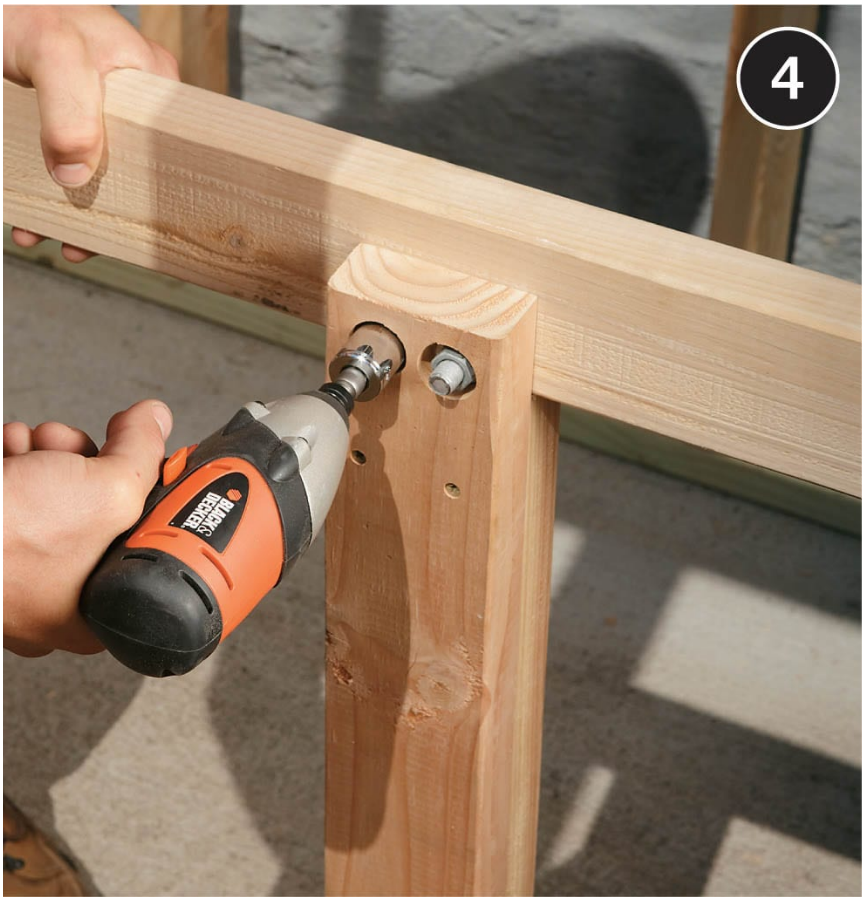
D	Cleats-front	3	1½ × 1½ × 22”	2 × 2
E	Cleats-side	2	1½ × 1½ × 19”	2 × 2
F	Leg half	2	1½ × 3½ × 31½”	2 × 4
G	Leg half	2	1½ × 3½ × 33½”	2 × 4
H	Shelf support	3	1½ × 3½ × 20½”	2 × 4
I	Back wall ledger	1	1½ × 3½ × 32”	2 × 4
J	Shelf board	3	4/4 × 5½ × 60”	Deckboard
K	Top slat	14	4/4 × 5½ × 18½”	Deckboard

How to Build a Built-In Potting Bench

Pre-assemble the frame that is the benchtop support. Cut the 2 × 4 front, back, and ends to length and then join them with 3" deck screws and exterior-rated wood glue.

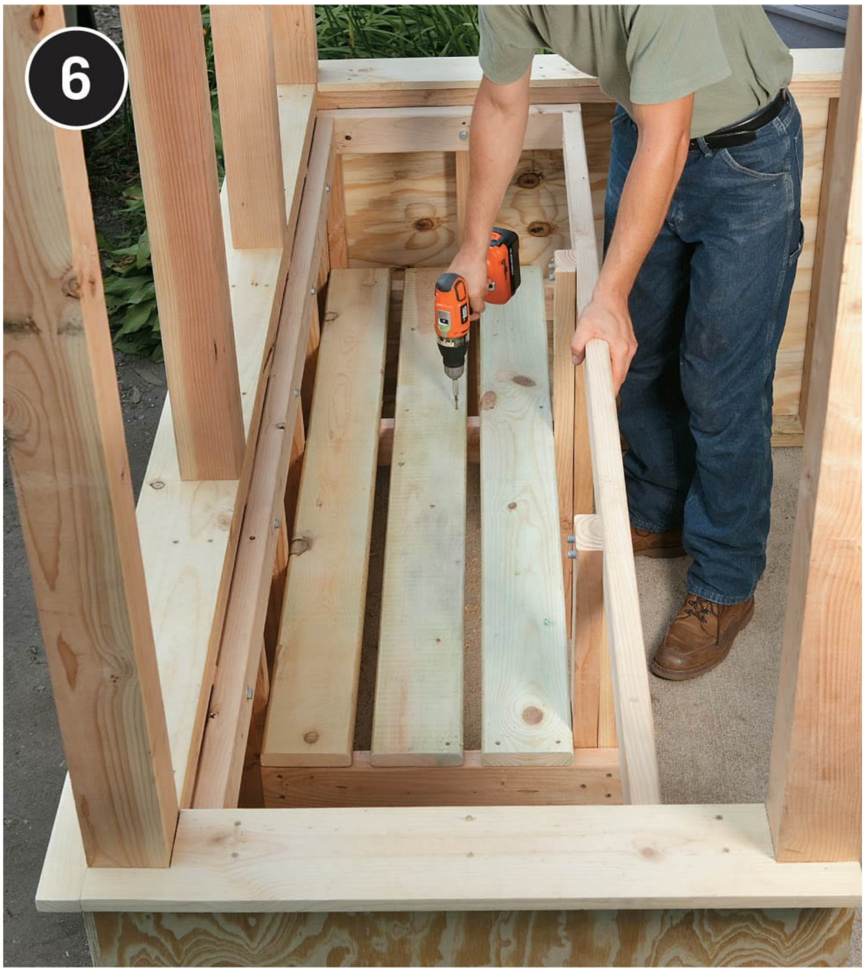
Attach the benchtop frame to the greenhouse wall studs using ⅜ × 3" lag screws. Before driving the lag screws, tack the back of the frame to the long wall with deck screws. The tops should be 36" above the floor. Then, clamp a 2 × 4 brace to the front rail of the frame and adjust it until level. Drill guide holes and drive one lag screw per wall stud at the back rail and on the ends.

Install the front legs. Each leg is created with a pair of 2 × 4s face-nailed or screwed together. The front 2 × 4 in each pair should fit between the frame and the floor. The back 2 × 4 in each pair is 2½" longer to provide a surface for attaching the frame and legs. Join the leg halves with glue and 2½" deck screws.

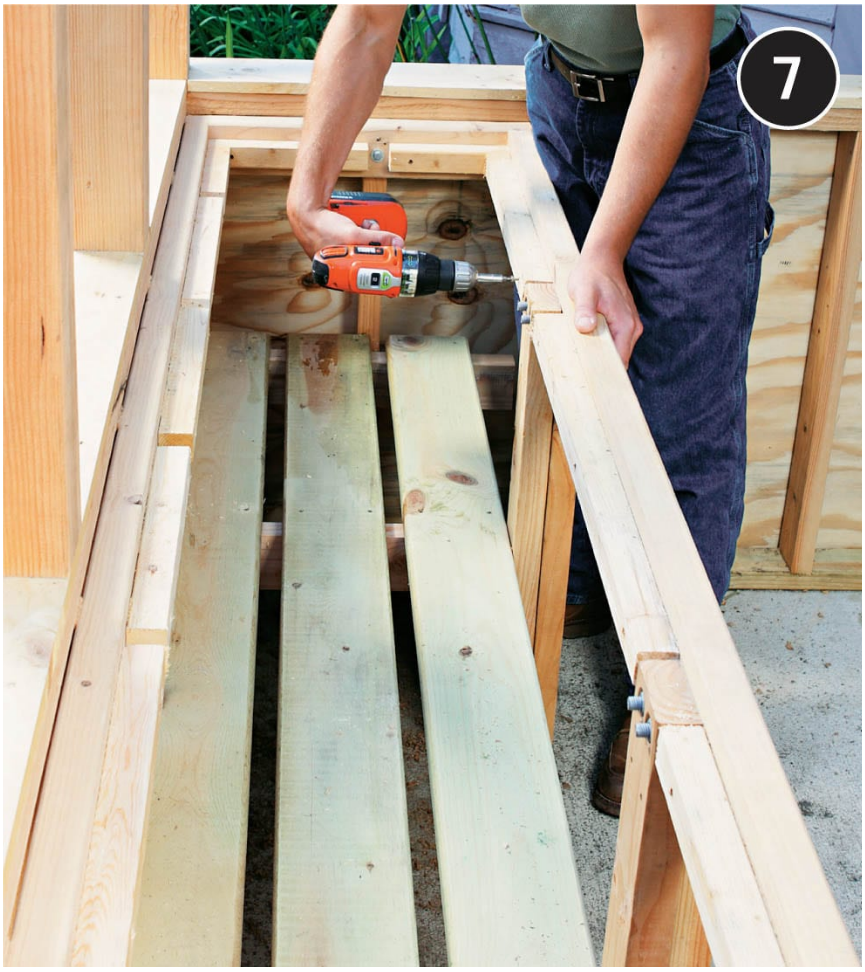


Attach each leg to the frame with a pair of ½ × 3½" carriage bolts. Drill guide holes for the bolt and counterbores for the nuts and washers in the back face of the frame. Do not use washers behind carriage bolt heads.

Attach a 2 × 4 ledger to the front wall studs to support the 2 × 4 shelf supports that run from the front of the bench to the wall. Use 3” deck screws driven at kneewall stud locations.



Attach 2 × 4 shelf supports to the legs and attach a 2 × 4 shelf support to the endwall. Then, fasten the shelving material to the tops of the supports. The best height for the shelf depends on the height of the containers you plan to set on the shelves beneath the removable section of the top.



Glue and screw 2 × 2 cleats around the inside perimeter of the benchtop frame. The cleats should be positioned so they are level and the top faces of the deckboard slats will be about ⅛" above the frame tops when they rest on the cleats. Install a full-length cleat along the back wall and fill in between the legs at the front.

Cut the benchtop slats from treated or cedar decking (or composite if you prefer). Attach the slats over the first two bays by driving a pair of deck screws into each slat end and the cleat below. Do not fasten the deckboards over the right end bay. Drill 1” finger holes near the end of each board and simply set them on the cleats so they can be removed to access the shelf below. If you wish, finish the bench with stain, sealant, or paint.

Simple Potting Bench

A multi-functional workstation, like the High-Low Potting Bench, offers great versatility that makes it useful in just about any greenhouse. But sometimes, all you really want from your work area is a big, broad surface with plenty of room to spread out and get busy. This workhorse of a bench is modeled after the most-used workspace in any home: the kitchen countertop. At 36 inches tall, the bench is the same height as most kitchen counters, and at 28 inches wide, it's slightly deeper than standard countertops—but not so deep that you can't easily reach across to the other side. The symmetrical configuration allows you to push any part of the bench against a greenhouse wall and still get plenty of light penetration.

There's also no need to worry about a moisture-laden greenhouse environment. The understructure is made with moisture-resistant, pressure-treated lumber, and the top is made up of composite decking boards that won't split, rot, or splinter and require no protective finish.

Of course, if you've always wished your kitchen counters were a bit higher or lower, you can simply add or subtract a few inches from the given dimension for the bench legs. You can also change the length of the bench to fit a small greenhouse, if necessary. Shortening the whole thing by 2 feet allows you to build it with standard 8-foot lumber and decking instead of 12-foot and 10-foot pieces.

This potting bench has a 28 × 71” top and is built with four 2 × 4s and three standard-size decking boards. The handy pot shelf below the bench top is made with a cutoff from one of the deck boards.

SIMPLE POTTING BENCH

TOOLS + MATERIALS

Tape measure

Circular saw

Drill

Piloting-countersink bit

Framing square

Clamps

(3) 12’ pressure-treated 2 × 4s

Deck screws (2½”, 3½”)

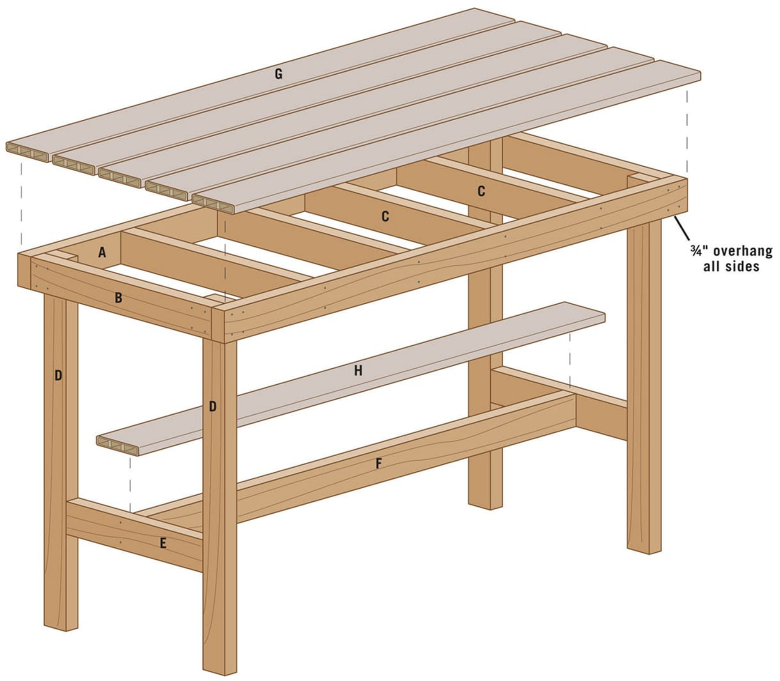
(1) 10’ pressure-treated 2 × 4

(3) 12’ 1 × 6 composite decking boards

Sandpaper

Eye protection

Work gloves



CUTTING LIST

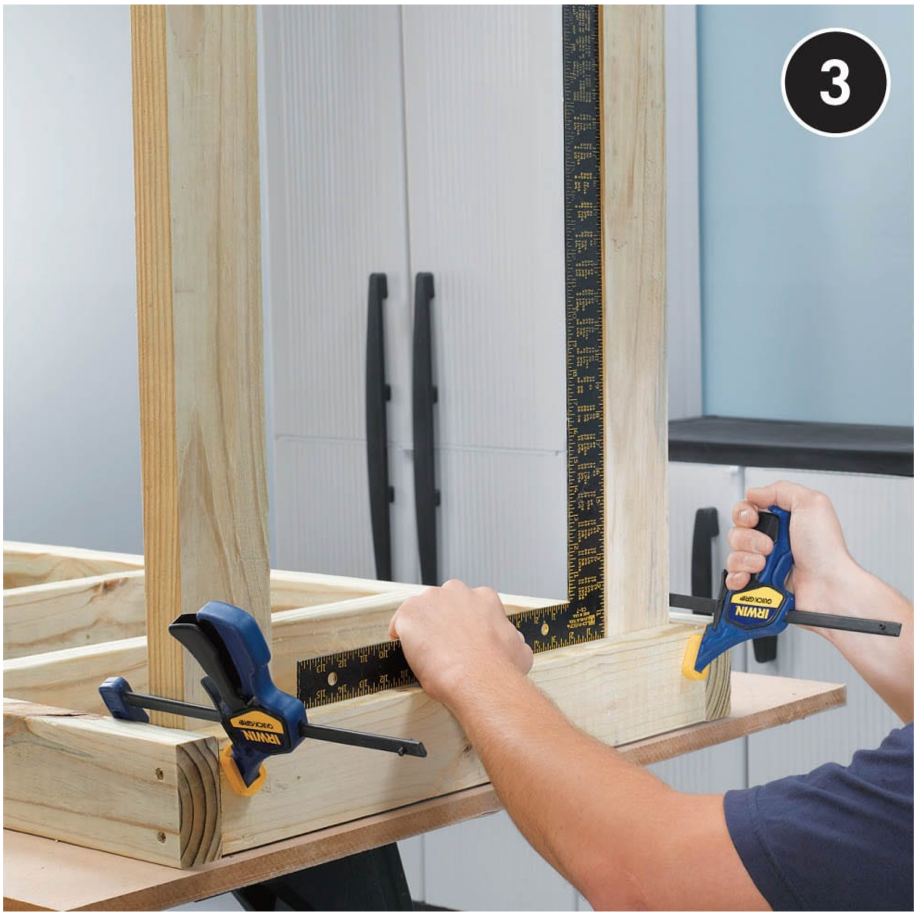
KEY	PART	NO.	DIMENSION	MATERIAL

A	Top frame side	2	1½ × 3½ × 69½”	2 × 4
B	Top frame end	2	1½ × 3½ × 23½”	2 × 4
C	Top supports	4	1½ × 3½ × 23½”	2 × 4
D	Leg	4	1½ × 3½ × 35”	2 × 4
E	Leg support	2	1½ × 3½ × 16½” (field measure)	2 × 4
F	Stretcher	1	1½ × 3½ × 63½” (field measure)	2 × 4
G	Top decking	5	1 × 5½ × 71”	1 × 6 decking
H	Pot shelf	1	1 × 5½ × 68”	1 × 6 decking

How to Build a Simple Potting Bench

Cut the two top frame sides from one 12' 2 × 4, using a circular saw or power miter saw. Cut the two top frame ends and the four top supports from another 12' 2 × 4. Fit the side pieces over the ends of the end pieces so all top edges are flush. Fasten the pieces together with two 3½" deck screws at each joint.

Mark the layout for the top supports. Measuring from one end of the top frame, mark both frame sides every 13⅝". Check the top frame for square, using a framing square. Install the top supports between the frame sides with 3½" deck screws driven through the frame sides and into the supports. Make sure the supports and frame sides are flush across the top.



Cut the four legs from one 12’ 2 × 4. Round-over the edges on the bottom end of each leg, using sandpaper, a file, or a router and roundover bit; this prevents splintering if the table is slid around. Install the legs at the inside corners of the top frame, driving 2½” deck screws through the legs and into the top frame ends. Also screw through the top frame sides and into the legs. Make sure the legs are square to the frame before fastening.

Mark the inside edge of each leg, 10” up from its bottom end. Measure the distance between each leg pair and cut a leg support to fit snugly between the legs, using the 10’ 2 × 4. Install the leg supports with their bottom edges on the marks; drive 3½” screws toenail style through the top and bottom edges of the supports and into the legs.

Cut the 2 × 4 stretcher to fit snugly between the leg supports, using the remainder of the 10' 2 × 4. Install the stretcher so it's centered side-to-side on each support, with the top edges flush. Drive 3½" screws through the outsides of the leg supports and into the stretcher ends.

Cut the top decking boards to length. Clamp the first board in place so it overhangs the front and ends of the top frame by ¾”. If the deck boards are crowned (slightly curved across the face), make sure the convex side faces up. Drill two pilot holes at the center of each top frame end and top support location, countersinking the holes slightly. Fasten the board with 2½” deck screws.

Install the remaining deck boards so all of their ends are perfectly aligned and each board is gapped ⅛" from the next (without gaps, the joints would trap dirt). Use pieces of ⅛"-thick hardboard or two ⅛"-diameter drill bits to set the gaps. The last board should overhang the rear frame side by ¾".

Complete the pot shelf by cutting the remaining half-piece of deck board to length. Position the board so it is centered side-to-side over the stretcher and overhangs both leg supports by ¾". Fasten the board to the stretcher and leg supports with 2½" deck screws driven through pilot holes.

High-Low Potting Bench

A workbench like this can be absolutely ideal against the back (north) wall of a greenhouse. It actually combines two work benches in one: a regular waist-level bench to fill seed trays or pots and a longer, lower bench that can hold supplies or plants while still allowing a maximum of sunlight to reflect back and penetrate deeply into the greenhouse. As a plus, it's constructed of materials that are ideal for the moisture-heavy environment and temperature fluctuations common to any greenhouse.

What makes this potting bench different from most other potting benches is that the work surfaces are at appropriate heights for gardening tasks. The work surface is 30 inches high, making it easier to reach down into pots. The low work surface is just over a foot high, so you won't have to lift heavy objects such as large pots or bags of soil. In addition to the high-low work surfaces, this bench also features a shelf and hook rail to keep small supplies and tools within reach, yet still off the main work area.

A potting bench gets wet and it gets dirty, so rot- and moisture-resistant materials were chosen to build this bench. The frame is made with pressure-treated pine lumber, and the work surfaces are composite deck boards. The composite material provides a smooth surface that will not splinter and is easy to clean.

Not all pots are the same height. With two different working heights, this bench is comfortable to use whether you're planting seeds in starter trays or planting a 5-gallon planter with tomatoes.

TOOLS + MATERIALS

Tape measure

Cup hooks

Clamps

Sandpaper

Drill

Bandsaw or jigsaw

Work gloves

Eye protection

(1) 1 × 2” × 8’ pine

(2) 1 × 4” × 8’ pine

(4) 2 × 4” × 8’ pine

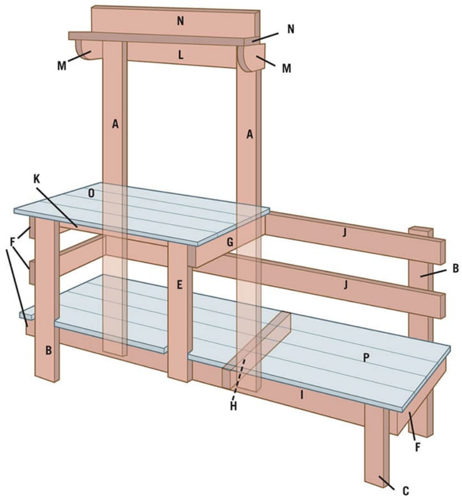
(1) 1¼ × 5½” × 6’ pine

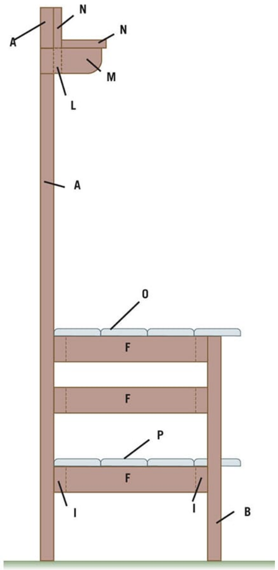
(4) 5/4” × 8’ deck boards

Exterior-rated screws (1¼”, 2”, 2½”)

Solid-color exterior paint or stain

HIGH-LOW POTTING BENCH





CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
A	Long leg	2	1½ × 3½ × 62¾”	Treated pine
B	Mid-length leg	2	1½ × 3½ × 29”	Treated pine
C	Short leg	1	1½ × 3½ × 12”	Treated pine
D	Back strut*	1	1½ × 3½ × 54¼”	Treated pine
E	Front strut	1	1½ × 3½ × 20½”	Treated pine
F	Outside cross supports	4	¾ × 3½ × 22”	Treated pine
G	Middle top cross support	1	1½ × 3½ × 19¾”	Treated pine
H	Middle bottom cross support	1	1½ × 3½ × 16”	Treated pine
I	Bottom rails	2	1½ × 3½ × 60”	Treated pine
J	Back rails	2	¾ × 3½ × 60”	Treated pine

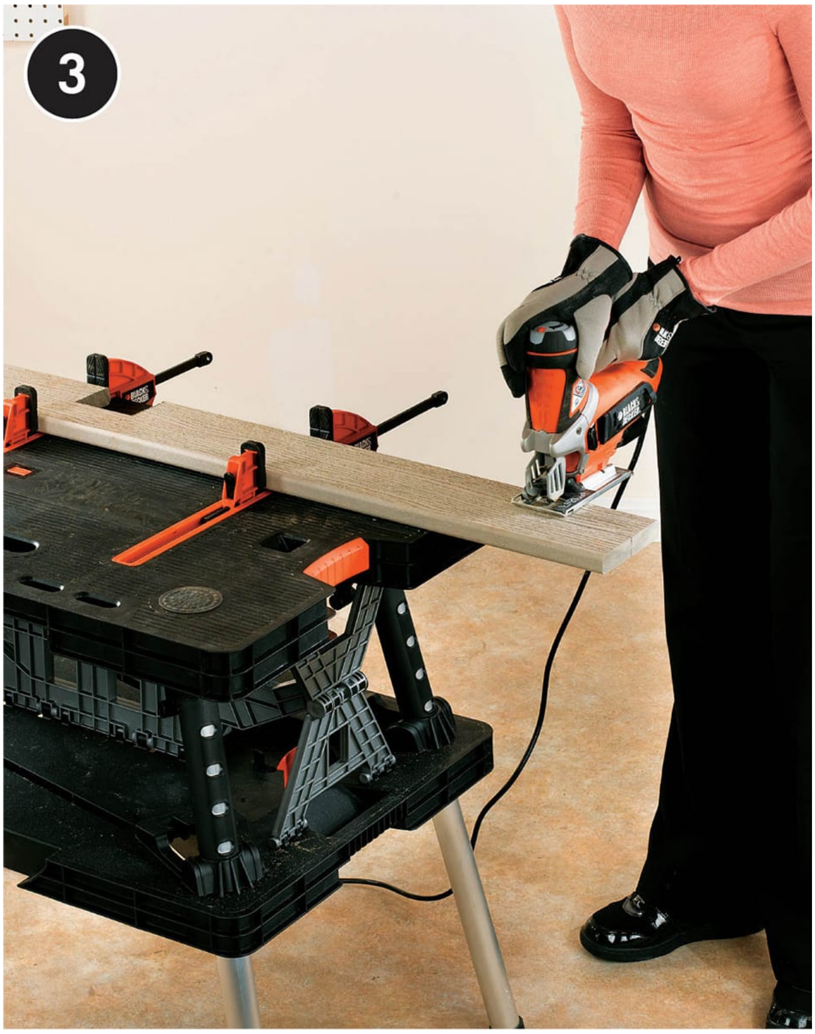
K	Front rail	1	¾ × 1½ × 30”	Treated pine
L	Hook rail	1	¾ × 3½ × 30”	Treated pine
M	Shelf supports	2	¾ × 3½ × 7”	Treated pine
N	Shelf/shelf back	2	1¼ × 5½ × 31½”	Treated pine
O	High worktop	4	1¼ × 5½ × 33½”	Deck boards
P	Low worktop	4	1¼ × 5½ × 62½”	Deck boards

**Not shown*

How to Build a High-Low Potting Bench

Cut all of the frame and shelf parts to length. Draw a 3½-inch radius on the front bottom corner of each shelf support. Cut along the radius lines with a jigsaw or bandsaw. Sand the profiles smooth.

Attach two back rails and one bottom rail to the long leg, back strut, and back right mid-length leg with 2” deck screws. Check that all of the parts intersect at 90° angles. Attach the front rail and one bottom rail to the left front mid-length leg, front strut, and short leg. Connect the back assembly and front assembly by attaching them to the cross supports.



Cut the composite deck boards for the work surfaces. Place the front deck board for the lower work surface against the backside of the front left leg and front strut. Mark the point where the front leg and strut intersect the deck board. Using these marks, draw the 3¾" deep notch outlines and cut out the notches with a jigsaw.

Place the top and bottom deck boards on the cross supports, leaving a ¼-inch space between the boards. Attach the deck boards with 2-inch deck screws. If you are using composite deck boards, use the recommended decking screws.

Attach the shelf back, shelf hook rail, and shelf supports to the long leg and back strut with 2½-inch deck screws. Attach the shelf to the shelf supports with 2-inch deck screws. Fasten the hooks to the shelf hook rail.

Lettuce Table

The lettuce table solves a number of gardening problems that home gardeners confront when growing tasty vegetables and herbs. First, and most important, it moves the crop up and out of the way of rabbits, slugs, and other destructive pests. Second, it's portable, so it can be moved to follow or avoid the sun, or brought into the garage on frosty nights. Third, it can be set up on convenient but barren spots like decks, patios, and driveways. Fourth, it allows you to garden at a comfortable height, saving wear and tear on knees and backs. Fifth, you can easily replace the growing media every year and precisely control moisture and fertilizer, giving you better, more predictable yields. And finally, it provides accessible gardening for those in wheelchairs.

The frame of this lettuce table, which will be in contact with the soil, can be made from cedar, redwood, or any other naturally rot-resistant wood. It is left unfinished on the inside. Pressure-treated wood is used for the rest of the framework because it's less expensive and will resist decay for decades.

The galvanized hardware cloth across the bottom is an inexpensive way to support the weight of the soil; you can substitute cedar boards, galvanized metal flashing, or any other rot-resistant, nontoxic material that can hold the weight. No matter what you use to hold the weight, the soil is held in place with heavy-duty landscape fabric or aluminum screen mesh.

The lettuce table can be used to grow more than lettuce. It simply draws its name from its original purpose, which is to provide a shallow bed for growing lettuces in an easy-to-reach spot that can be moved easily around your yard. This interpretation is on the large side to allow you to grow several varieties, but you can easily modify the simple plan to build a more compact version.

TOOLS + MATERIALS

2 × 4” × 8’ cedar (1)

2 × 4” × 12’ cedar (1)

2 × 4” × 8’ pressure-treated (1)

2 × 4” × 12’ pressure-treated (3)

1 × 2” × 8’ pressure-treated (3)

¼” galvanized hardware cloth

Stapler with 5/16” stainless steel staples

Landscape fabric

Construction adhesive

2½” deck screws (1 lb.)

Countersink bit

Framing square

Leather gloves

Drill

Miter saw

Tin snips

Hammer

Caulk gun

Clamps

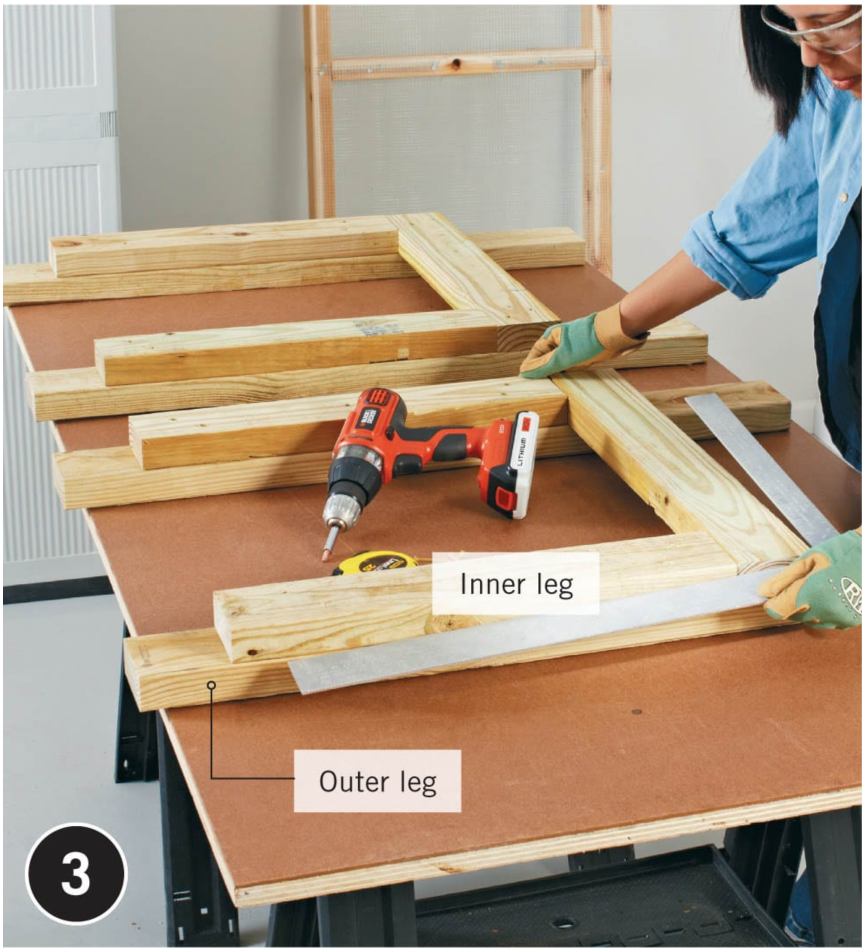
CUTTING LIST

PART	NO.	DIMENSION	MATERIAL
Tray side	2	2 × 4 × 72”	Cedar
Tray ends and divider	3	2 × 4 × 21”	Cedar
Outer leg	4	2 × 4 × 36”	Pressure-treated
Inner leg	4	2 × 4 × 20½”	Pressure-treated
Bottom leg	4	2 × 4 × 8½”	Pressure-treated
Stretcher	1	2 × 4 × 69”	Pressure-treated
Top stretcher	1	2 × 4 × 72”	Pressure-treated
Center support	1	2 × 4 × 19”	Pressure-treated
Side rail	2	2 × 4 × 24”	Pressure-treated
Side trim	2	1 × 2 × 71”	Pressure-treated
End trim	2	1 × 2 × 17”	Pressure-treated

How to Build a Lettuce Table

Cut the parts for the table frame to length and assemble the cedar top tray with the center divider. Predrill all screw holes to avoid splits, and use two screws at each corner. Use 2½” (or 3”) deck screws. This design is for a 2 × 6 ft. tray, but you can make it larger or smaller.

Wearing leather gloves, cut the hardware cloth to size. Cut out a 2 × 4" section at each corner for the legs. Center it on the underside of the cedar frame—it should be about ¼" in from the edge on all sides. Nail it every 6" on the center divider, but first mark and cut out a 2 × 4" slot at the center of the divider. Pull the cloth flat and nail it several times on each side and the ends. No need to overdo it—the edges of the cloth will be covered and secured with 1 × 2s later.



Cut the legs from the pressure-treated wood and assemble them into two leg pairs. Screw the inner and outer legs together, leaving a 3½” gap at the top. The top frame will sit on the ledges created at the top. Leave the bottom legs off for now. Make sure the legs are parallel to each other, then join them together with the side rails. Spread a bead of construction adhesive before attaching the two pieces. Set the legs down parallel to each other and join them with the side rails.

With the tray turned upside down, fit the legs onto the ends. Check that they're square to the frame and sitting flat underneath it—if you see daylight between the inner leg and the tray, trim the outer leg a little so the gap disappears. Screw each leg to both parts of the cedar frame.

Attach the stretcher with 2½” screws. Use clamps to hold the wood in place while you predrill and fasten. Also measure and cut the bottoms of the legs, and fasten with adhesive and screws.

Place the tray on the ground, right-side up. Screw the top stretcher to the rails and lower stretcher. Measure the distance from the stretchers to the center divider and cut and fasten the support. Add $^{1}/_{16}$" to your measurement just to make sure you have a snug fit.

Predrill the 1 × 2s every 8 to 10". Flip the tray over then screw the 1 × 2s to the bottom of the tray, flush with the outside edges and covering the hardware cloth.

Finally, staple on landscape fabric or aluminum screen on the inside of the tray to hold the soil in. Fill the tray with a soilless growing media and fertilizer—not ordinary topsoil. For best results, replace the soilless mix every year, as it becomes compressed over time.

Trellis Planter

This simple, very stable planter-and-trellis combo exploits the durable nature of cedar to create a greenhouse feature ideally suited to the rigors, sun exposure, and moisture ever present in any greenhouse structure. The design showcases the wood in an incredibly useful greenhouse planter perfect for training edibles to grow vertically.

Because the 2 × 2 lattice trellis is attached to the planter, not permanently fastened to a wall or railing, it can be moved easily to follow changing sunlight patterns within the greenhouse or even shuttled outside in warmer months to make room for other plants or just to give the planter’s occupants some outside exposure. You may even want to consider installing wheels or casters on the base for greater mobility.

Building the trellis planter is a very simple job. The trellis portion is made entirely of strips of 2 × 2 cedar, fashioned together in a crosshatch pattern. The planter bin is a basic wood box, with panel sides and a two-board bottom with drainage holes that rests on a scalloped base. The trellis is screwed permanently to the back of the planter bin.

All manner of plants can be grown vertically in a greenhouse environment, including some surprising candidates, such as tomatoes, zucchini, and even miniature melon varieties. By training edibles that normally sprawl to climb up the more orderly surface of a trellis like this, you’ll free up room in your greenhouse, make it easier to tend the growing plants, and increase airflow—preventing disease in the process.

TOOLS + MATERIALS

(1) 2 × 6” × 8’ cedar

(1) 2 × 4” × 6’ cedar

(4) 2 × 2” × 8’ cedar

(3) 1 × 6” × 8’ cedar

(1) 1 × 2” × 6’ cedar

Tape measure

Drill

1”-dia. spade bit

Counterbore bit

Jigsaw

Compass

Square

Moisture-resistant glue

Deck screws (1⅝”, 2½”)

Circular saw

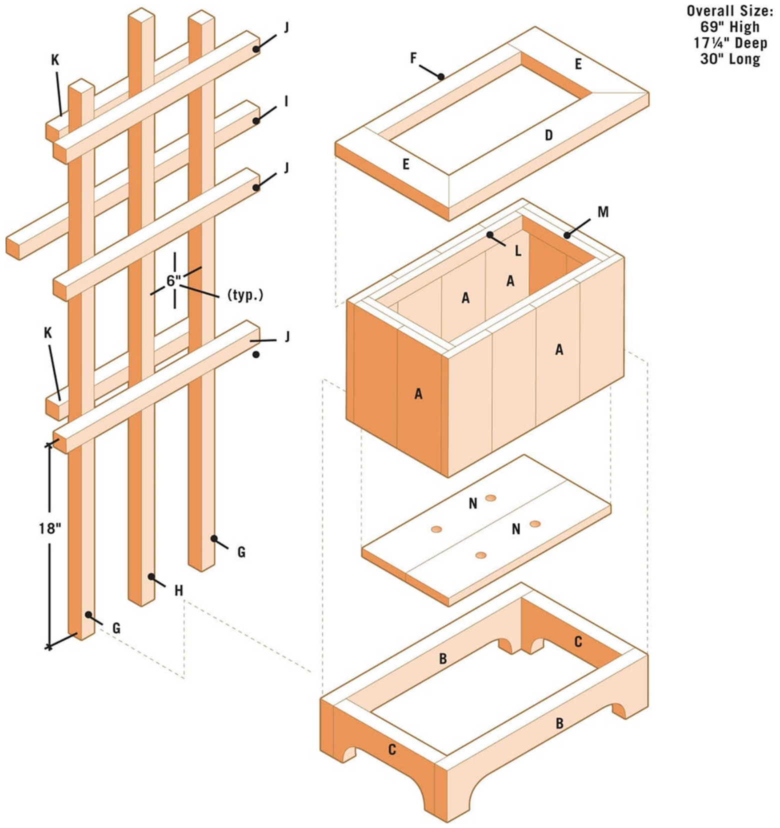
Miter saw

Finishing materials

Eye protection

Work gloves

TRELLIS PLANTER



CUTTING LIST

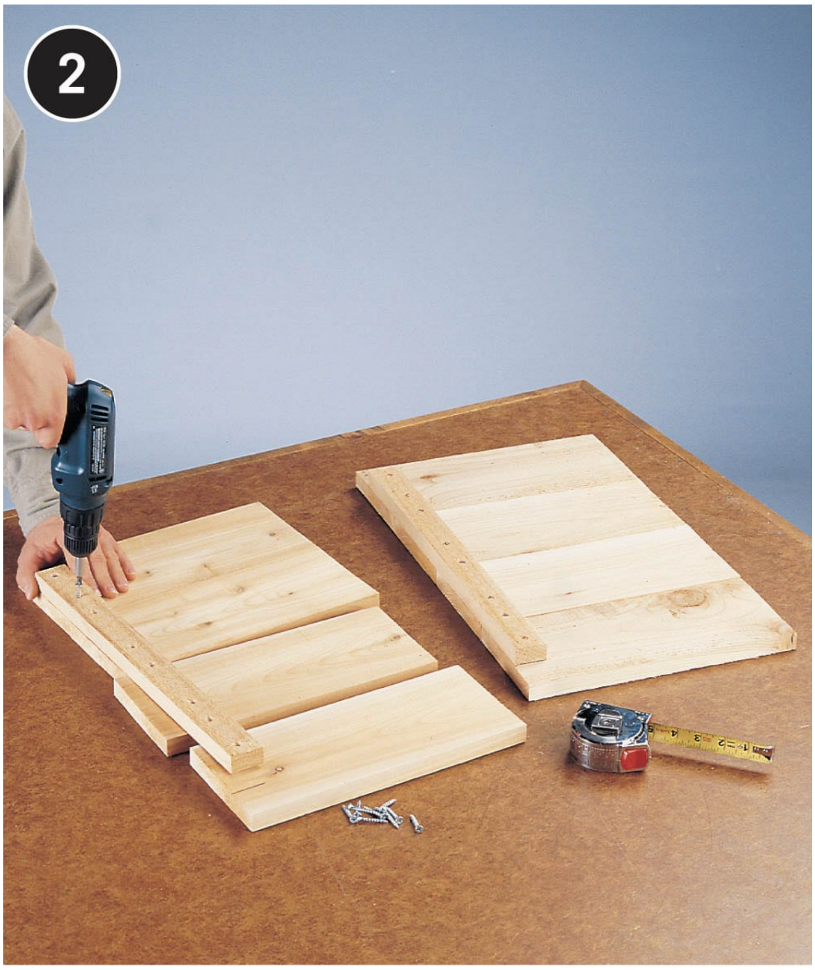
KEY	PART	NO.	DIMENSION	MATERIAL
A	Box slats	12	⅞ × 5½ × 13”	Cedar
B	Base front and back	2	1½ × 5½ × 25”	Cedar
C	Base ends	2	1½ × 5½ × 12¾”	Cedar
D	Cap front	1	1½ × 3½ × 25”	Cedar
E	Cap ends	2	1½ × 3½ × 14¼”	Cedar
F	Cap back	1	1½ × 1½ × 18”	Cedar
G	End posts	2	1½ × 1½ × 59½”	Cedar
H	Center post	1	1½ × 1½ × 63½”	Cedar
I	Long rail	1	1½ × 1½ × 30”	Cedar
J	Medium rails	3	1½ × 1½ × 24”	Cedar
K	Short rails	2	1½ × 1½ × 18”	Cedar
L	Long cleats	2	⅞ × 1½ × 18½”	Cedar

M	Short cleats	2	⅞ × 1½ × 11”	Cedar
N	Bottom boards	2	⅞ × 5½ × 20¼”	Cedar

How to Build a Trellis Planter

1. Cut the box slats (A) and cleats (L, M) to length. Arrange the slats edge-to-edge in two groups of four and two groups of two, with tops and bottoms flush.

2. Center a long cleat (L) at the top of each set of four slats, so the distance from each end of the cleat to the end of the panel is the same. Attach the cleats to the four-slat panels by driving 1⅝" deck screws through the cleats and into the slats. Lay the short cleats (M) at the tops of the two-slat panels. Attach them to the slats the same way.



3. Arrange all four panels into a box shape and apply moisture-resistant wood glue to the joints. Attach

the panels by driving 1⅝" deck screws through the four-slat panels and into the ends of the two-slat panels.

4. Cut the bottom boards (N) to length. Set the bin upside down on your work surface, and mark reference lines on the inside faces of the panels, ⅞" in from the bottom of the bin. Insert the bottom boards into the bin, aligned with the reference lines to create a ⅞" recess. Scraps of 1× cedar can be put beneath the bottom boards as spacers.

5. Drill ⅛" pilot holes through the panels. Counterbore the holes slightly with a counterbore bit. Fasten the bottom boards by driving 1⅝" deck screws through the panels and into the edges and ends of the bottom boards.

6. Cut the base front and back (B) and the base ends (C) to length. To draw the contours for the scallops on the front and back boards, set the point of a compass at the bottom edge of the base front, 5" in from one end. Set the compass to a 2½" radius and draw a curve to mark the curved end of the cutout. Draw a straight line to connect the tops of the curves, 2" up from the bottom of the board, to complete the scalloped cutout.

7. Make the cutout with a jigsaw, then sand any rough spots. Use the board as a template for marking a matching cutout on the base back. Draw a similar cutout on one base end, except with the point of the compass 3½" in from the ends. Cut out both end pieces with a jigsaw.

8. Draw reference lines for wood screws ¾" from the ends of the base front and back. Drill three evenly spaced pilot holes through the lines. Counterbore the holes. Fasten the base ends between the base

front and back by driving three evenly spaced deck screws at each joint.

9. Set the base frame and planter bin on their backs. Position the planter bin inside the base so it extends ⅞” past the top of the base. Drive 1⅝” deck screws through the planter bin and into the base to secure the parts. Cut the cap front (D), cap ends (E), and cap back (F) to length. Cut 45° miters at one end of each cap end and at both ends of the cap front.

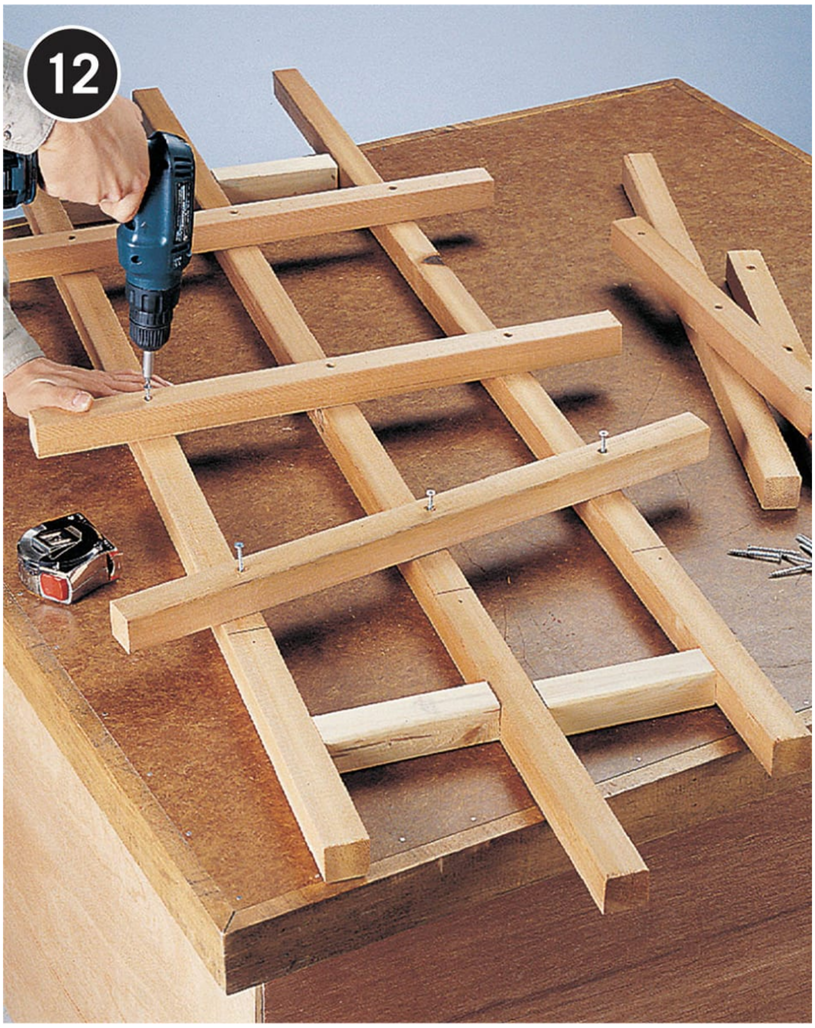
10. Join the mitered corners by drilling pilot holes through the joints. Counterbore the holes. Fasten the pieces with glue and 2½” deck screws. Clamp the cap front and cap ends to the front of your worktable to hold them while you drive the screws. Fasten the cap back between the cap ends with deck screws, making sure the back edges are flush. Set the cap

frame on the planter bin so the back edges are flush. Drill pilot holes and counterbore them. Drive 2½" deck screws through the cap frame and into the side and end cleats.

11. Cut the end posts (G), center post (H) and rails (I, J, K) to length. Lay the end posts and center post together side by side with their bottom edges flush so you can gang-mark the rail positions. Use a square as a guide for drawing lines across all three posts, 18" up from the bottom. Draw the next line 7½" up from the first. Draw additional lines across the posts, spaced 7½" apart.

12. Cut two 7"-wide scrap blocks and use them to separate the posts as you assemble the trellis. Attach the rails to the posts in the sequence shown in the

diagram, using 2½" screws. Alternate from the fronts to the backs of the posts when installing the rails.



13. Fasten the trellis to the back so the bottoms of the posts rest on the top edge of the base. Drill countersunk pilot holes. Drive 2½" deck screws through the posts and into the cap frame. With a 1"-diameter spade bit, drill a pair of drainage holes in each bottom board. Stain the project with an exterior wood stain.

Planter with Hanging Trellis

You don't need a large yard—or any yard at all for that matter—to have a garden. Planting in containers makes it possible to cultivate a garden just about anywhere. A container garden can be as simple as a small flowering annual planted in a single 4-inch pot or as elaborate as a variety of shrubs, flowering plants, and ornamental grasses planted in a large stationary planter.

This planter project combines a couple of different container options to create a larger garden in a relatively small space. The base is an 18 × 30-inch planter box that is large enough to hold several small plants, a couple of medium-sized plants, or one large plant. It features a trellis back that can be covered by climbing plants.

In addition to the planter and trellis, this project features two plant hangers that extend out from the back posts. Adding a couple of hanging plant baskets further extends the garden display without increasing the space taken up by the planter.

This project is easiest to build with a table saw, miter saw, and jigsaw. If you don't have access to a table saw, use a circular saw or jigsaw and straightedge to rip the 1 × 6 siding boards. An even easier option is to replace the 2¾-inchwide siding boards with 3½-inchwide 1 × 4s. This modification makes the planter 4½ inches taller, so you also have to make the front posts 24½ inches long instead of 20 inches long and add 4½ inches to the front posts trim.

This efficient planter combines a box for container gardening with a climbing trellis and a pair of profiled arms for hanging potted plants.

TOOLS + MATERIALS

(3) 1 × 2” × 8’ cedar

(3) 1 × 6” × 8’ cedar

(1) 2 × 4” × 10’ cedar

(2) 4 × 4” × 8’ cedar

(1) 2 × 2” × 6’ cedar

(2) ⅜” locknuts

Deck screws (2”, 3”)

(4) ⅜” flat washers

(1) ¾ × 4” × 4’ ext. plywood

(2) ⅜ × 2-½” eyebolts

Straightedge cutting guide

Brad nails or finish nails

Circular saw or table saw

Tape measure

Jigsaw

Miter saw

Clamps

Compass

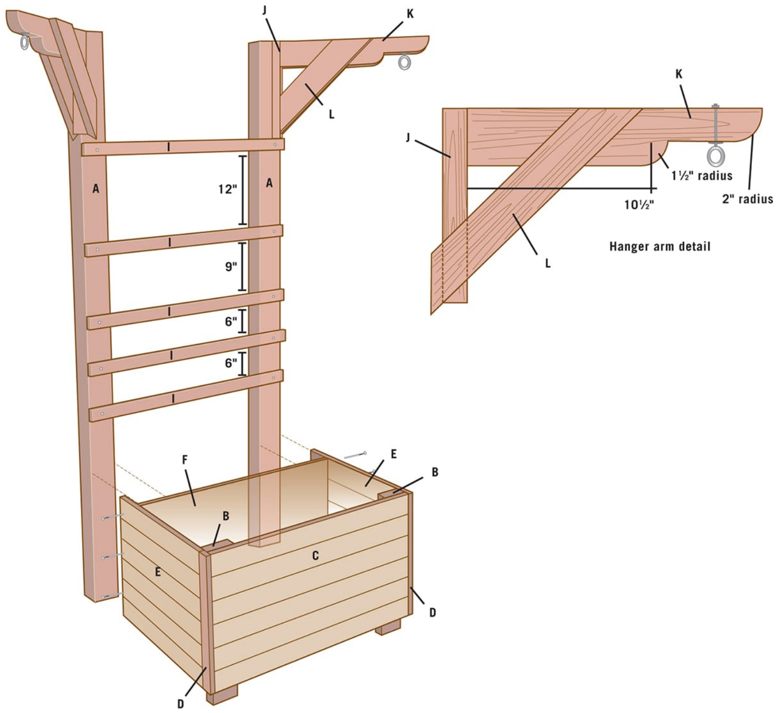
Drill

Handsaw

Eye protection

Work gloves

TRELLIS PLANTER



CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
A	Back posts	2	3½ × 3½ × 72”	Cedar
B	Front posts	2	1½ × 3½ × 20”	Cedar
C	Front siding	6	¾ × 2¾ × 30”	Cedar
D	Front post trim	2	¾ × 1½ × 18”	Cedar
E	Side siding	12	¾ × 2¾ × 21½”	Cedar
F	Back panel	1	¾ × 18 × 30”	Ext. plywood
G	Bottom supports*	2	¾ × 1½ × 22¼”	Cedar
H	Bottom panel*	1	¾ × 22¼ × 30”	Ext. plywood
I	Climbing rails	5	¾ × 1½ × 30”	Cedar
J	Hanger backs	2	1½ × 1½ × 12”	Cedar
K	Hanger arms	2	1½ × 3½ × 18”	Cedar
L	Hanger braces	4	1½ × 3½ × 18”	Cedar

**Not shown*

How to Build a Planter with Hanging Trellis

1. Mark the bevel cut lines on the outside and front faces of the posts drawn 1" out from the corner and running down the post for 12".

2. Tilt the shoe of a jigsaw to 45-degree and bevel-cut along the layout lines.

3. Use a handsaw to make a stop cut that meets the bottom of the bevel cut in each back post, forming a shoulder.

4. Rip-cut 1 × 6 stock to 2¾ inches wide using a table saw or a circular saw and a straightedge cutting guide. Cut six 30-inch-long pieces and twelve 21½-inch-long pieces to make the siding strips. Also use a circular saw or table saw to cut the bottom and back panels to length and width. Cut 1½-inch-long, 3½-inch-wide notches out of the front corners of the bottom panel. Cut the front post trim, bottom supports, and back climbing rails to length from 1 × 2 boards.

5. Attach the front siding strips to the front posts with 2-inch deck screws. Align the ends of the siding pieces flush with the sides of the front legs. Leave a ¼-inch space between the siding boards.

6. Drive one screw through each end of each siding board and into the front legs. Drill a countersunk pilot hole for each screw. Attach the front post trim pieces to the front posts with three or four 2-inch brad nails or finish nails. Align the front edge of the trim pieces flush with the front face of the front

siding. Attach the back panel to the back posts with six 2-inch screws.

7. Attach the back lattice rails to the back posts. Drive one screw through each end of each climbing rail. Refer to the construction drawing on this page for lattice spacing. Place the front and back assemblies on their sides and install siding on the side that's facing up. The siding boards should be positioned against the front post trim board and flush with the back edge of the back post, spaced ¼ inch apart.

8. Attach the siding with 2-inch screws. Flip the project over and repeat the process to attach siding to the other side.

9. Attach the bottom supports to the front and back legs. The bottom of the front end of the bottom support should be flush with the bottom of the siding. The bottom of the back end of the bottom support should be positioned 2 inches up from the bottom of the back post. Drive one screw through the front end of the support and into the front leg and two screws into the back legs. Attach the bottom to the bottom supports with four 2-inch screws—two into each support.

10. Cut the hanger backs, hanger arms, and hanger braces to length. Draw the hanger arm profile onto the side of each hanger arm, and use a compass to draw the radius profiles.

11. Use a jigsaw to cut along the profile layout lines on the hanger arms. Both ends of the hanger brace are mitered at 45 degrees, but the back or bottom end is a compound miter cut, meaning that it has both a miter and a bevel component. Cut the top-end 45-degree miters on all four braces. Then, make compound cuts at the bottom ends of the hanger braces. Make the cuts so the beveled end faces the post when it is attached.

12. Drill a ⅜-inch-diameter hole through the top of each hanger arm. Locate the hole 3 inches in from the end of the hanger arm. Fasten one eyebolt, two flat washers, and a locknut through each hanger arm. Attach the hanger back to the back end of the hanger arm with two 3-inch screws. Position a 2 × 2 hanger

back and a 2 × 4 hanger arm against the beveled corner of each back post.

13. Drive two 3-inch screws through the hanger back and into the back posts. Attach the hanger braces to the hanger back and hanger arm with 2-inch screws. Make sure the hanger arms remain perpendicular to the posts when you attach the braces.

14. Cut 4-mil black plastic sheeting to cover the sides, front, and bottom several inches oversized so they overlap in the corners. Cut the back sheeting the same size as the back panel. Attach the plastic to the inside faces of the planter with staples Start with the bottom sheet, overlap the sides on the bottom, and then overlap the front over the sides and bottom. Finally overlap the back over the sides, leaving a small gap between the bottom of the back sheet and

the bottom sheet to allow water to drain out. Fill the planter with potting soil and add your plants.

TIP: Adding a few inches of gravel to the bottom of the planting compartment allows for better drainage.

Solar Produce Dryer

A solar dryer is a drying tool that makes it possible to air-dry produce even when conditions are less than ideal. This dryer is easy to make, lightweight, and is space efficient. The dryer makes a great addition to your greenhouse.

The dryer, which is made of cedar, utilizes a salvaged window for completion. But you will have to adjust the dimensions given here for the size window that you find. The key to successful solar drying is to check the dryer frequently to make sure that it stays in the sun. If the air becomes cool and damp, the food will become a haven for bacteria. In a sunny area, your produce will dry in a couple days. Add a thermometer to the inside of your dryer box, and check on the temperature frequently—it should stay between 95 and 145°F.

Based on the cold frame platform seen on these pages, this solar dryer lets you dry fruit and vegetables quickly, naturally, and in a more sanitary fashion than simply air-drying.

SOLAR PRODUCE DRYER

TOOLS + MATERIALS

Stapler

Scissors

(2) 1 × 4” × 8’

Tape measure

Drill

Deck screws (1½”, 2”)

Brad nails

Hole saw bit

Staples

Circular saw

Screen retainer strip

Insect mesh

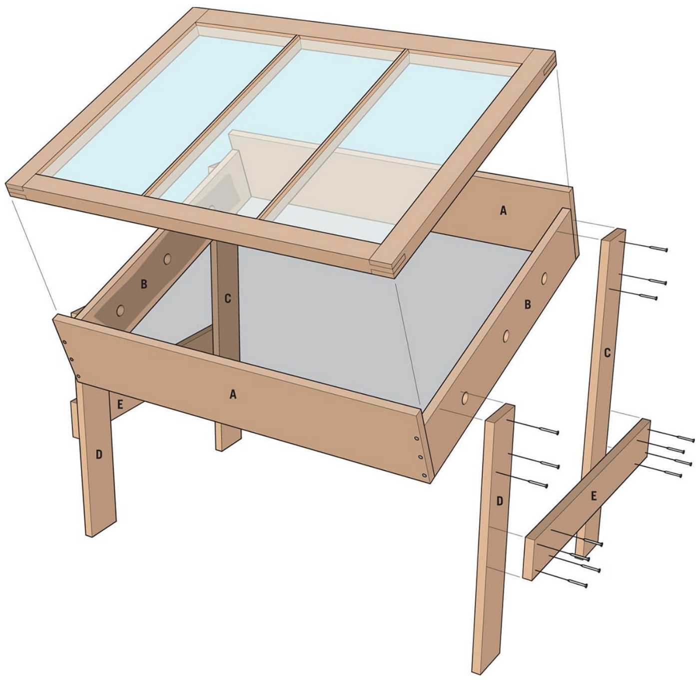
(1) 1 × 8” × 8’

Window sash

(1) 1 × 6” × 8’

Eye protection

Work gloves



CUTTING LIST

KEY	PART	NO.	DIMENSION	MATERIAL
A	Front/back	2	⅞ × 7½ × 34¾”	Cedar
B	Side	2	⅞ × 5½ × 27⅛”	Cedar
C	Leg (tall)	2	⅞ × 3½ × 30”	Cedar
D	Leg (short)	2	⅞ × 3½ × 22”	Cedar
E	Brace	2	⅞ × 3½ × 24”	Cedar

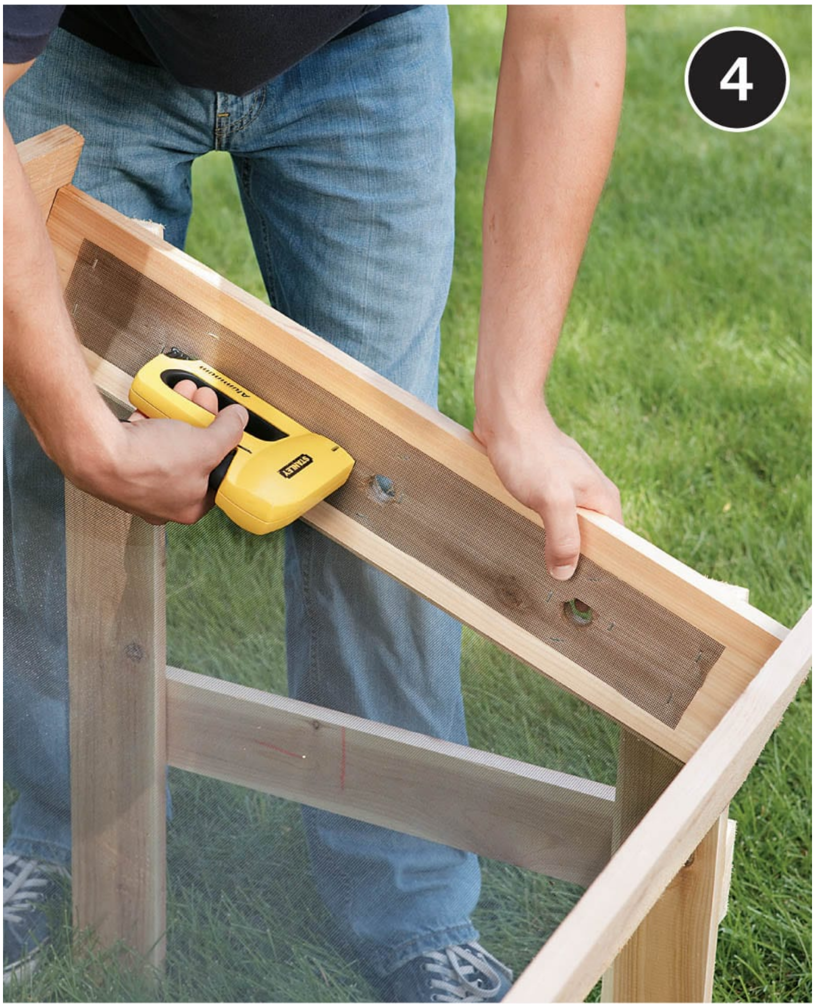
Insect mesh–fiberglass 28⅞ × 34¾”

How to Build a Solar Dryer

Assemble the box. Attach the wider boards for the frame by driving 2” screws through the faces of the 1 × 8” boards into the ends of the 1 × 6” boards. There will be a difference in height between these pairs of boards so that the window sash can sit flush in the recess created.

Install the mesh. Staple the screen to the frame. Then tack the retainer strips over the screen to the frame with 3 to 4 brad nails per side. Trim off the excess mesh.

Build the stand. Attach each 24” board to a 30” board (in the back) and a 22” board (in the front) with 1½” deck screws. Then attach the finished posts to the frame with three 1½” deck screws in each post.



Drill three 1” holes for ventilation in each 1 × 6” board equally spaced along the length of the board, leaving 5” of room on each end for the posts. Staple leftover insect mesh behind the ventilation holes on the inside of the frame.

Finish the project by sliding the window sash into place.

Resources

BC Greenhouse Builders

www.bcgreenhouses.com

(888) 391-4433

Black + Decker

www.blackanddecker.com

Charley's Greenhouse + Garden

www.charleysgh.com

(800) 322-4707

ePlastics

www.eplastics.com

(800) 474-3688

Grandio Greenhouses

www.grandiogreenhouses.com

(866) 448-8231

Growers Supply

www.growerssupply.com

(800) 476-9715

Growing Spaces Growing Domes

geodesic-greenhouse-kits.com

(970) 731-2120

Juliana Greenhouses

www.julianagreenhouses.com

(877) 628-9571

Outdoor Living Today

www.outdoorlivingtoday.com

(888) 658-1658

Solexx Greenhouse + Greenhouse Covering

www.solexx.com

(877) 476-5399

Studio Shed

www.studio-shed.com

(888) 900-3933

Sturdi-Built Greenhouse Manufacturing Company

www.sturdi-built.com

(800) 334-4115

Sunglo Greenhouses

www.sunglogreenhouses.com

(425) 251-8005

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8, 11, 18, 23 (bottom left), 55 (bottom), 65 (bottom)

Photo courtesy of Charley's Greenhouse & Garden, charleysgh.com, (800) 322-4707

37 (top left), 59, 62 (bottom), 64 (top)

Clive Nichols

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Dreamstime

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Photo courtesy of ePlastics, www.eplastics.com, (858) 560-1551

25 (left)

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30 (Magnus Persson)

Photo courtesy of Grandio Greenhouses, www.grandiogreenhouses.com

62 (top), 64 (bottom), 65 (top)

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57 (top)

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41 (top), 56, 58 (bottom), 63 (bottom),

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28 (left)

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28 (right)

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3, 20 (top right, Ivan_Sabo), 21 (bottom left, Frank L Junior), 21 (top right, Sylvie Bouchard), 21 (bottom right, www.sandatlas.org), 42 (Evannovostro), 52 (Rawpixel.com), 53 (bottom, Arina Trapeznikova), 134, 143 (Jourdan Laik), 156, 160 (Sveten), 168 (Alex Yeung)

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31 (left)

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37 (top right), 55 (top), 58 (top), 63 (top right)

Photo courtesy of Studio Shed, www.studio-shed.com, (888) 900-3933

53 (top)

Photo courtesy of Sturdi-Built Greenhouse Manufacturing Co., sturdi-built.com, (503) 244-4100

15, 22 (bottom), 24, 31 (right), 32, 33, 60 (top), 61

Photo courtesy of Sunglo Greenhouses, www.sunglogreenhouses.com, (720) 443-6711

35 (right), 37 (bottom), 39 (top), 40, 57 (bottom left), 57 (bottom right)

Metric Conversion Charts

METRIC CONVERSIONS

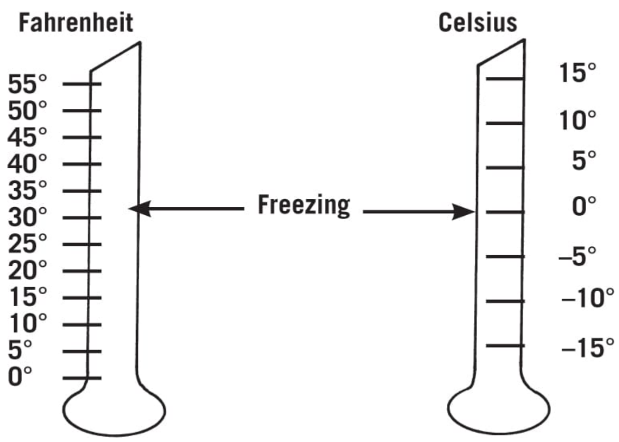
TO CONVERT:	TO:	MULTIPLY BY:
Inches	Millimeters	25.4
Inches	Centimeters	25.4
Feet	Meters	0.305
Yards	Meters	0.914
Square inches	Square centimeters	6.45
Square feet	Square meters	0.093
Square yards	Square meters	0.836
Ounces	Milliliters	30.0
Pints (U.S.)	Liters	0.473 (lmp. 0.568)
Quarts (U.S.)	Liters	0.946 (lmp. 1.136)
Gallons (U.S.)	Liters	3.785 (lmp. 4.546)
Ounces	Grams	28.4
Pounds	Kilograms	0.454
Millimeters	Inches	0.039
Centimeters	Inches	0.394
Meters	Feet	3.28
Meters	Yards	1.09
Square centimeters	Square inches	0.155
Square meters	Square feet	10.8
Square meters	Square yards	1.2
Milliliters	Ounces	.033

TO CONVERT:	TO:	MULTIPLY BY:
Liters	Pints (U.S.)	2.114 (lmp. 1.76)
Liters	Quarts (U.S.)	1.057 (lmp. 0.88)
Liters	Gallons (U.S.)	0.264 (lmp. 0.22)
Grams	Ounces	0.035
Kilograms	Pounds	2.2

CONVERTING TEMPERATURES

Convert degrees Fahrenheit (F) to degrees Celsius (C) by following this simple formula: Subtract 32 from the Fahrenheit temperature reading. Then, multiply that number by 5/9. For example, 77°F – 32 = 45. 45 × 5/9 = 25°C.

To convert degrees Celsius to degrees Fahrenheit, multiply the Celsius temperature reading by 9/5. Then, add 32. For example, 25°C × 9/5 = 45. 45 + 32 = 77°F.



METRIC PLYWOOD PANELS

Metric plywood panels are commonly available in two sizes: 1,200 mm × 2,400 mm and 1,220 mm × 2,400 mm, which is roughly equivalent to a 4 × 8-ft. sheet. Standard and Select sheathing panels come in standard thicknesses, while Sanded grade panels are available in special thicknesses.

STANDARD SHEATHING GRADE		SANDED GRADE	
7.5 mm	($^{5}/_{16}$ in.)	6 mm	($^{4}/_{17}$ in.)
9.5 mm	(⅜ in.)	8 mm	($^{5}/_{16}$ in.)
12.5 mm	(½ in.)	11 mm	($^{7}/_{16}$ in.)
15.5 mm	(⅝ in.)	14 mm	($^{9}/_{16}$ in.)
18.5 mm	(¾ in.)	17 mm	(⅔ in.)
20.5 mm	($^{13}/_{16}$ in.)	19 mm	(¾ in.)
22.5 mm	(⅞ in.)	21 mm	($^{13}/_{16}$ in.)
25.5 mm	(1 in.)	24 mm	($^{15}/_{16}$ in.)

LUMBER DIMENSIONS

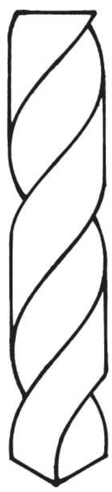
NOMINAL — U.S.	ACTUAL — U.S. (IN INCHES)	METRIC
1 × 2	¾ × 1½	19 × 38 mm
1 × 3	¾ × 2½	19 × 64 mm
1 × 4	¾ × 3½	19 × 89 mm
1 × 5	¾ × 4½	19 × 114 mm
1 × 6	¾ × 5½	19 × 140 mm
1 × 7	¾ × 6¼	19 × 159 mm
1 × 8	¾ × 7¼	19 × 184 mm
1 × 10	¾ × 9¼	19 × 235 mm
1 × 12	¾ × 11¼	19 × 286 mm
1¼ × 4	1 × 3½	25 × 89 mm
1¼ × 6	1 × 5½	25 × 140 mm
1¼ × 8	1 × 7¼	25 × 184 mm
1¼ × 10	1 × 9¼	25 × 235 mm
1¼ × 12	1 × 11¼	25 × 286 mm
1½ × 4	1¼ × 3½	32 × 89 mm
1½ × 6	1¼ × 5½	32 × 140 mm
1½ × 8	1¼ × 7¼	32 × 184 mm
1½ × 10	1¼ × 9¼	32 × 235 mm
1½ × 12	1¼ × 11¼	32 × 286 mm
2 × 4	1½ × 3½	38 × 89 mm
2 × 6	1½× 5½	38 × 140 mm
2 × 8	1½ × 7¼	38 × 184 mm

NOMINAL — U.S.	ACTUAL — U.S. (IN INCHES)	METRIC
2 × 10	1½ × 9¼	38 × 235 mm
2 × 12	1½ × 11¼	38 × 286 mm
3 × 6	2½ × 5½	64 × 140 mm
4 × 4	3½ × 3½	89 × 89 mm
4 × 6	3½ × 5½	89 × 140 mm

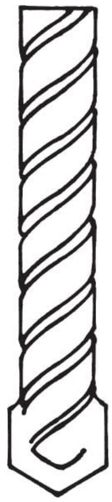
LIQUID MEASUREMENT EQUIVALENTS

1 Pint	= 16 Fluid Ounces	= 2 Cups
1 Quart	= 32 Fluid Ounces	= 2 Pints
1 Gallon	= 128 Fluid Ounces	= 4 Quarts

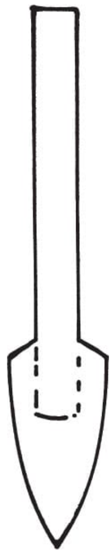
DRILL BIT GUIDE



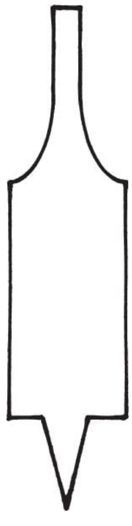
Twist Bit



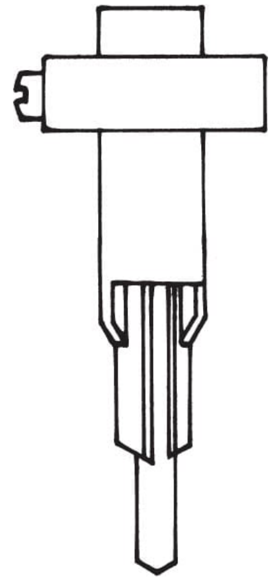
Carbide-tipped Masonry



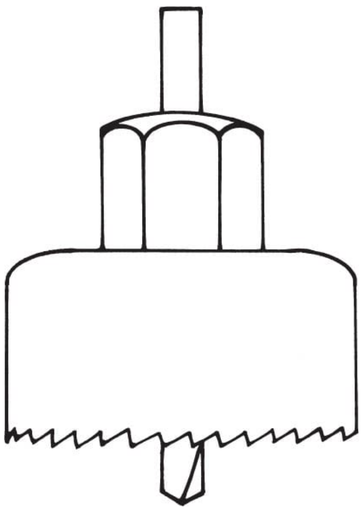
Glass + Tile



Spade Bit



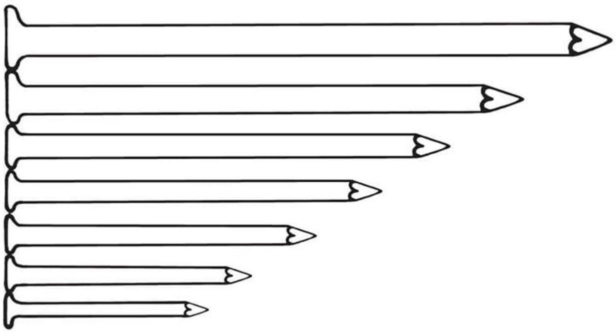
Adjustable Counterbore



Hole Saw

NAILS

Nail lengths are identified by numbers from 4 to 60 followed by the letter “d,” which stands for “penny.” For general framing and repair work, use common or box nails. Common nails are best suited to framing work where strength is important. Box nails are smaller in diameter than common nails, which makes them easier to drive and less likely to split wood. Use box nails for light work and thin materials. Most common and box nails have a cement or vinyl coating that improves their holding power.



LBS.	MM	IN.
20d	102 mm	4"
16d	89 mm	3½"
10d	76 mm	3"
8d	64 mm	2½"
6d	51 mm	2"
5d	44 mm	1¾"
4d	38 mm	1½"

COUNTERBORE, SHANK + PILOT HOLE DIAMETERSSCREW

SCREW	COUNTERBORE DIAMETER FOR SCREW	CLEARANCE HOLE FOR	PILOT HOLE DIAMETER	
SIZE	HEAD (IN INCHES)	SCREW SHANK (IN INCHES)	HARD WOOD (IN INCHES)	SOFT WOOD (IN INCHES)
#1	.146 (9/64)	5/64	3/64	1/32
#2	1/4	3/32	3/64	1/32
#3	1/4	7/64	1/16	3/64
#4	1/4	1/8	1/16	3/64
#5	1/4	1/8	5/64	1/16
#6	5/16	9/64	3/32	5/64
#7	5/16	5/32	3/32	5/64
#8	3/8	11/64	1/8	3/32
#9	3/8	11/64	1/8	3/32
#10	3/8	3/16	1/8	7/64
#11	1/2	3/16	5/32	9/64
#12	1/2	7/32	9/64	1/8

Index

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H

Brimming with creative inspiration, how-to projects, and useful information to enrich your everyday life, quarto.com is a favorite destination for those pursuing their interests and passions.

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Created by: The Editors of Cool Springs Press, in cooperation with BLACK+DECKER.

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For safety, use caution, care, and good judgment when following the procedures described in this book. The publisher and BLACK+DECKER cannot assume responsibility for any damage to property or injury to persons as a result of misuse of the information provided.

The techniques shown in this book are general techniques for various applications. In some instances, additional techniques not shown in this book may be required. Always follow manufacturers' instructions included with products, since deviating from the directions may void warranties. The projects in this book vary widely as to skill levels required: some may not be appropriate for all do-it-yourselfers, and some may require professional help.

Consult your local building department for information on building permits, codes, and other laws as they apply to your project.