

THE TENNESSEE VEGETABLE GARDEN

BUILDING AND USING RAISED BEDS

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Vegetable production is increasingly popular for Tennessee residents. Growing vegetables at home provides financial and nutritional benefits through the bounty of a fresh harvest, and the activity enhances personal health and well-being. However, a basic understanding of soils, site selection and crop maintenance is required before backyard growers can take full advantage of the benefits of home food production. To meet these needs, this series of fact sheets has been prepared by UT Extension to inform home gardeners and propel them to success in residential vegetable production.

SITE CHALLENGES FOR HOME VEGETA- BLE GARDENS

SITE CHARACTERISTICS — LIGHT, ACCESSIBILITY AND WATER

Many who are interested in vegetable gardening may not have suitable land to plant a traditional garden. Some live in apartments or condominiums where they have no access to soil, while others may have small lots or restrictions on planting in their residential areas. In these situations, raised beds can provide a great alternative. However, other site considerations are still important.

Productive vegetable crops generally require 6 to 8 hours of full sunlight per day while a few leafy crops (lettuce, spinach) may be grown with 4 to 6 hours of sunlight. The best method of estimating sunlight is to observe potential sites throughout the day and track sunlight hours. Nearby trees can block light, compete with crops for water, or even produce compounds (specifically black walnut) that are toxic to some plants. It would likely be preferable in the long run to build a raised bed and use amended soil in an area with good light but poor soil than to choose a site with good soil quality but more shade than is desirable. Additionally, a nearby, high-quality water source will enhance the productivity of your garden and reduce maintenance time.



Figure 1. Raised beds can be appropriate for a variety of crops and sites.

SOIL CHARACTERISTICS

Soil that is easily workable and allows water to soak in (infiltrate) and drain easily is best. In some residential areas, there may be a scarcity of high-quality soil. Common issues include topsoil removal or compaction during neighborhood development and soil that is high in clay or rocks or drains poorly. Be aware of any previous uses or structures on the site that may have added heavy metals, debris or other undesirable materials to the soil.

The home gardener has several choices if soil conditions are not ideal, but the first step is completing a soil test as discussed in UT Extension publication W 346-A “The Tennessee Vegetable Garden — Site Selection and Soil Testing.” This test can help determine the pH and nutrient levels of the soil as well as the organic matter content. Over time, organic matter additions, fertilizer applications, and pH management can improve the workability and productivity of native soil.

OPTIONS FOR SITES WITH POOR QUALITY OR DEGRADED NATIVE SOIL

Some home gardeners enjoy the process of improving the soil on their site over time. Soil can be brought to the site or cover crops and organic matter can be used to improve soil characteristics (see W 346-G). But many gardeners may prefer to have alternatives to provide faster return on their efforts.

Raised beds are one of the most common options to grow residential food and flower crops (Figure 1). They can be constructed to take advantage of the best lighting and water access and allow garden size to be tailored to family needs. Raised beds allow more control over substrate (a term used here to refer to the soil and/or mineral and organic material that the plants are grown in), drain more easily, and warm up faster in the spring than traditional in-ground gardens. Containers also can be used by gardeners with limited

space on balconies and patios. Raised beds and containers enable gardeners who may not be able to handle the equipment or the labor of traditional gardening to stay active and continue to produce edible crops.

POTENTIAL DRAWBACKS OF RAISED BEDS

- Mechanical tillage equipment is difficult to use in raised beds.
- Bed must be carefully constructed to withstand the weight of substrate plants and management over time.
- Close spacing can reduce air flow and increase the opportunity for disease infection or shading.
- The growing substrate will drain faster and require more frequent watering.
- Large vining plants like many squash and pumpkin selections are generally not well-suited to raised beds.



Figure 2. A raised bed that accommodates standing or seated gardeners.

INTRODUCTION TO RAISED BED GARDENING

RAISED BED MATERIALS AND CONFIGURATION

Temporary raised beds using soil can be constructed without side support, although these are mostly used in traditional gardens. A range of materials can be used to construct permanent raised beds including wood, stone, brick, block or composite materials. Prior to December 2003, chromated copper arsenate (CCA) was used as a preservative in lumber for residential uses. So, use caution because this older treated lumber as well as railroad cross-ties can contain metals that can leach into garden soil. Each gardener should select and use materials he or she is comfortable with for a home vegetable production. See additional resources listed below for more details on using treated materials.

Gardeners can line raised beds with plastic to reduce leaching concerns or chose cedar or redwood lumber that is more resistant to decay. Additionally, boards made from recycled plastic used for decking are a more expensive but long-term option for constructing raised beds. It is important to select a material that will allow construction of a stable bed that will support itself, the growing substrate and plants. Taller and longer beds will contain more substrate and weight and require more substantial construction, support and bracing. Small beds may be constructed of 1-inch-wide lumber, but it is more common to use lumber that is at least 2 inches wide.

A common bed width is 4 feet if accessed from both sides, and 2 to 3 feet if accessed from one side. Beds are generally constructed 6 inches to 12 inches in height but can be deeper. Shallow-rooted crops — such as lettuce, spinach, kale and other leafy crops — may be produced in beds that are

only 4 inches to 6 inches in depth. Taller and deeper rooted crops — such as tomatoes, peppers, okra and corn — often require deeper beds for root exploration and stability. A smaller substrate volume will retain lower amounts of water and nutrients. Since raised beds drain more rapidly than nearby level soil, deeper beds with more substrate can decrease watering frequency. An additional consideration in bed construction is the ability to accommodate those who may not be able to work at ground level (Figure 2).

RAISED BED INSTALLATION AND CONSTRUCTION

If the site has usable soil, there may be no concern with leaving the bottom of the bed open and letting the roots of plants grow into native soil. However, hand dig or till to combine the raised bed substrate with the upper layer of native soil to avoid creating an abrupt gradient between amended and native soil. If native soil is of poor quality or

the garden is on a non-soil surface, a wooden or porous ground cloth bottom can be installed under the raised bed. Newspapers or cardboard also can be used as a barrier to prevent weed or plant growth from underlying soil and sod, but they will be less effective if weed pressure is severe.

IMPORTANT CONSIDERATIONS IN RAISED BED GARDENING

GROWING SUBSTRATE

If the native soil is of high quality, raised beds can be filled with topsoil from the site. If constructing a taller (12 inches to 24 inches) raised bed, be cautious of reduced drainage when using only native soil. Often soilless mixes are used as a substrate to increase drainage, aeration and optimize nutrition. Soilless mixes usually consist of peat moss, compost, vermiculite and perlite. A common mix is equal volumes (not weight) of 1) peat moss, 2) compost and 3) vermiculite (it is best not to use older supplies of vermiculite that may be on site as they may contain asbestos).

Purchased components also can be mixed with high-quality native soil to decrease costs. A common mixture would be equal volumes of 1) garden soil, 2) peat moss or compost, and 3) vermiculite or perlite. Keep in mind that testing is important when preparing substrate for a raised bed to determine if lime or fertilizer is required. If compost is used in the substrate, it can provide plant nutrients but should still be tested to account for variation. Use caution when introducing any material into your substrate (soil, compost) that could add weed seeds. If compost heating is insufficient, weed seeds can still be viable.

CROP SELECTION

The two most important considerations in selecting crops for raised bed include seasons best suited for growth and space needed for production. The most common way to classify vegetables is according to their temperature requirements.

Cool-season crops

Cool-season crops are more productive and of higher quality when they are grown and mature under cooler spring and fall season temperatures (approximately 60-75 F). They tend to be shallower rooted and more sensitive to periods of low moisture. Many cool-season crops can be well-suited to raised beds because they can be closely spaced and sequentially planted. Raised beds, because of their potential for higher spring soil temperatures and excellent drainage, can often be planted earlier than in-ground gardens. Earlier planted cool-season crops are more likely to mature under preferred cooler temperatures. The opportunity to plant earlier is especially useful in many parts of Tennessee where spring temperatures may quickly rise to levels that are higher than ideal for cool-season crops.

Warm-season crops

Warm-season crops are damaged or killed by frost and should be planted after the threat of spring frosts and freezes are passed (see W 346-B “The Tennessee Vegetable Garden — Garden Planning, Plant Preparation and Planting”). These crops produce optimally under warmer temperatures and also tend to have a deeper root system that is better able to withstand drier, hotter conditions that are typical of Tennessee summers.

The second important consideration in selecting crops is space. Often beginning gardeners make the mistake of planting too closely, which creates competition for water, light and nutrients. Even if these factors are not limiting, close spacing can reduce air movement and increase disease risk. The chart below provides estimates of spacing for vegetable crops in typical raised beds. An increasing number of space efficient cultivars are being introduced. One of the benefits of raised beds is that no walking space is needed, so often seeds or plants are placed in a grid rather than in rows.

| Cool-season vegetables | Warm-season vegetables |
|--|---|
| Beet, broccoli, cabbage, cauliflower, carrot, kale, collard, kohlrabi, leaf and head lettuce, mustard, onion, English and snap pea, Irish potatoes, radishes, spinach, Swiss chard, turnip | Bush, pole, and lima beans, muskmelon, sweet corn, cucumber, eggplant, okra, pea (field, southern), pepper, pumpkin, Malabar spinach, squash, summer and winter, sweet potato, tomato, watermelon |

Table 1. Vegetable crops categorized by broad temperature requirements.

| 2 to 4 inches between seeds or plants | 6 to 8 inches between seeds or plants | 12 to 18 inches between seeds or plants | More than 18 inches between plants |
|---|--|--|--|
| Snap bean, beet, carrot, radish, onion, pea, turnips, garlic, spinach, leaf lettuce | Basil, Swiss chard, pak choy, small head lettuce, strawberry, kale | Cabbage, collard, broccoli, cauliflower, eggplant, pepper, compact or determinate tomato, compact cucumber and summer squash | Winter squash, watermelon, many tomatoes |

Table 2. Vegetable crops categorized by typical spacing in traditional raised beds.

CROP MANAGEMENT

Water and fertilization

Raised beds often have better drainage and aeration than traditional gardens, but usually will dry out faster due to elevation and greater substrate porosity. Close spacing in raised beds also may mean plant roots do not have as much substrate volume from which to draw water. So, water management is especially important in raised beds.

Typically garden vegetables require 1 inch to 1.5 inches or more of water per week. Raised beds would require at least this much moisture, and likely more during warm or hot weather. Overhead watering can be used, but do not allow leaves to remain wet overnight because of disease risk. It is especially important in the close spacing of raised beds to keep leaves as dry as possible to prevent infection and spread of diseases.

Irrigation involving drip tape or soaker hoses is often preferable to overhead irrigation because it keeps leaves dry and efficiently delivers water to the substrate and roots. Drip irrigation also allows more thorough watering because water can be provided slowly and has the opportunity to spread evenly through the substrate (see W 346-D “The Tennessee Vegetable Garden — Plant Management Practices”).

Fertilization in raised beds can be similar to managing nutrients in traditional gardens (see W 346-C “The Tennessee Vegetable Garden — Managing Plant Nutrition”). If using compost in preparing growing substrate (as recommended in the square foot gardening method), be sure to consider any nutrients that are contained in the compost when calculating fertilizer needs.

Weeding and mulching

One of the greatest advantages of raised beds is that the smaller growing area and close plant spacing can reduce time spent weeding compared to traditional gardens. Care in selecting a substrate without weed seeds can also prevent problems before they start.

Mulching also can be an excellent way to reduce weed issues (see W 346-D). Natural mulches — such as compost or straw — can be a good way to improve the growing substrate over time while reducing weed pressures. Black plastic mulches block light to prevent weed growth and increase soil temperatures, especially in the spring, by absorbing solar radiation and transferring heat to the soil beneath. Most plastic mulches block moisture, so drip irrigation is required under the mulch. Woven black or white ground covers are a mulch option that is permeable to water and air and can be reused. Both natural and plastic mulches reduce the rate of evaporative water loss from soil, so

they can help conserve soil moisture and reduce watering needs.

Crop rotation

It is best to cycle different types of crops in raised beds to reduce the buildup of pests and diseases. It is common to group crops in terms of fruiting (tomatoes, peppers, eggplants), vining (cucumber, squash, muskmelon, watermelon), Brassica crops (broccoli, cabbage, cauliflower, kale, radish, turnip), and root crops (beets, carrots). These different types of crops have varied nutrient needs and sometimes different pest and diseases complexes, so rotating them through your beds can increase production and reduce disease risks (see W 316 “Home Vegetable Garden Disease Control” for additional information on rotation).

Support and training

Providing support for vegetable plants can improve their ability to intercept light to support photosynthesis and make sugars needed for leaf and fruit growth. It also can improve air movement and reduce disease risk. In addition to these benefits, raised bed gardeners should consider training and supporting their crops because of space efficiency (see Figure 1).

Vertical supports can consist of trellises, stakes, cages, twine or a combination (see W 346-D). It is common to plant vining crops (cucumbers, winter squash, pole beans,

| Require support for space efficient use in raised beds | Could benefit from support | Do not need support |
|--|--|---|
| Vining cucumber, pole bean, tomato, watermelon, muskmelon, winter squash, snap and shell pea | Bush bean, compact cucumber and winter squash cultivars, pepper, eggplant, okra, compact pea | Lettuce, beet, spinach, cabbage, broccoli, cauliflower, kale, radish, carrot, Swiss chard, bush summer squash |

Table 3. Vegetable crops categorized by their need for vertical support in raised beds.

| 1 plant/2 ft ² | 1 plant/ft ² | 2 plants/ft ² | 4 plants/ft ² | 8-9 plants/ft ² | 16 plants/ft ² |
|--|---|--------------------------|--|-----------------------------------|---|
| Muskmelon, vining squash (bush types 9 ft ²) | Broccoli, cabbage, cauliflower, eggplant, okra, pepper, vine tomatoes, cilantro | Cucumber | Swiss chard, corn, lettuce, basil, parsley, potato, strawberry | Large beets, peas, beans, spinach | Small beets, carrots, onion, radish, chives |

Table 4. Spacing for crops in the SFG method (All New Square Foot Gardening, 2nd Ed. Bartholomew, 2013)



Figure 3. This image illustrates the use of agricultural fabrics both floating on the top of a raised bed crop and supported by hoops to form a low tunnel. (Photo from UT Extension Publication PB 1578 “Tennessee Master Gardener Handbook.”)

etc.) on the north side of the raised bed so that a trellis can be installed that will not shade the shorter crops. Tomatoes, peppers and eggplants are more commonly supported individually using stakes or cages. They also can be attached to twine and suspended from an overhead support. Tomatoes, especially indeterminate crops that continue to grow both from the primary growing point and side shoots, may be more manageable if some side shoots are removed (see W 346-D).

PRACTICES THAT CAN COMPLEMENT RAISED BED PRODUCTION

SQUARE FOOT GARDENING (SFG)

Square foot gardening, a concept first introduced by Mel Bartholomew, has helped introduce many to small-scale home gardening. While the principles of square foot gardening are similar to other raised bed methods, there

are some specifics. The SFG method is based on raised beds with dividers that create 1-square-foot plots within the larger raised bed. A common size is a 4-by-4-foot bed that creates 16 square foot units. Common crops are planted at set densities within each square foot unit for clarity and productivity (Table 4).

SFG typically uses a mix of equal volumes of peat moss, compost and vermiculite in a 6-inch-deep raised bed. Due to compost in the substrate, SFG gardeners are encouraged to rely on the nutrients from the compost, which is added at the end of each cropping cycle to resupply nutrients.

SEASON EXTENSION

Season extension methods combine well with raised beds. Several techniques can be used to provide increased temperatures and longer growing seasons for vegetable garden crops, and two of the most common are described below (see also W 346-F).

Floating row covers, or agricultural fabrics, form a lightweight cover that allows light, air and moisture to pass

through. These covers can be simple to install because they do not need a support system. However, for some crops with sensitive growing points, like tomatoes and peppers, floating row covers can cause abrasion under windy conditions.

There are a range of row cover weights that differentially alter temperatures. Greater temperature increase will occur during sunny days as the covers trap sunlight. The lightest covers may provide 1-2 F temperature buffer overnight while the heaviest covers can provide 4-8 F protection. Heavier covers reduce light much more than the lighter covers. While the light covers can allow around 90 percent of ambient light to reach the plants, the heaviest covers will block over 50 percent. These heavy covers often are removed in the morning and replaced in the late afternoon to provide nighttime temperature protection while still enabling light to reach the crops during the day.

Trapping heat can be detrimental under warm and sunny conditions. So, season extension methods are typically used in the spring, fall and winter and are removed when warm conditions

persist. They also block pollinating insects, so vine crops like pumpkins, squash, muskmelons and watermelons must have the covers removed when flowering begins. An added benefit is that the covers also can protect plants from some insect damage if installed early enough and tightly.

Low tunnels can be made of agricultural fabrics used for floating row covers or clear polyethylene plastic (often a lighter version of the plastic that would cover a greenhouse). Either material is stretched over wire hoops to form miniature greenhouses typically 2 to 3 feet tall (see W 346-F). Like floating row covers, they are generally applied in the spring and fall and removed during the warmest part of the growing season. Low tunnels made

of polyethylene are often perforated or vertical slits are made to allow air movement and prevent overheating in bright sunlight. The downside of polyethylene low tunnels is that they do not allow rain to reach the crops, so irrigation will probably be necessary. Low tunnels made of floating row cover material are permeable to water, so irrigation needs will depend on precipitation.

ADDITIONAL RESOURCES

Garden use of treated lumber. Penn State Extension publication.
<http://pubs.cas.psu.edu/freepubs/pdfs/uc173.pdf>

Small spaces gardens. University of Kentucky.
<http://www2.ca.uky.edu/enri/gardening/smspacegardening.pdf>

EPA information on CCA treated wood.
<http://www.epa.gov/ingredients-used-pesticide-products/chromated-copper-arsenate-cca>



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W 346-E 6/16 16-0143