# School Garden Planning and Design

As part of the design and planning process, you must choose between an in-ground garden, a raised bed garden, an alternative gardening method, such as vertical or container gardening, or a combination of methods. This will direct decisions about location, soil amendments, irrigation, and plant selection.

Raised beds are constructed above the original soil and can offer solutions to some common challenges, such as poor soil, inadequate drainage, and the presence of tree roots or rocks. The soil used to fill new raised beds can be of excellent quality from the beginning, unlike in-ground bed soil, which may require some time and skill to develop. Of course, the existing soil in some areas can be ideal from the start, but this is less common. A soil test will help guide the decision-making process on which direction to go. The best option will be specific to your needs. Table 1 provides the pros and cons to both systems:

| Raised Bed Garden | In-Ground Garden |
|---|---|
| More expensive building costs | Less expensive building costs |
| Requires some skill to build | No building skills required |
| Easily accessible for those with limitations | Less accessible for those with limitations |

| | |
|---|---|
| Less weeding | More maintenance (weeding) |
| Requires more water | Requires less water than raised beds |
| Control over soil quality from the beginning | Soil tests in the beginning and more management |
| Simplified season extenders (frost or shade cloth) | More challenging to install shade or frost cloth |
| Easier pest control | More difficult to control pests |
| More flexibility with location | More limitations with location |
| Easier to keep a tidy appearance | More challenging to keep tidy |

Table 1

Digging a garden bed in Southern Arizona requires special considerations due to the region's unique soil conditions. Southern Arizona typically has a hot, arid climate with low organic matter in sandy soils.

**No-till gardening**, also known as no-dig gardening, minimizes or eliminates the disturbance of the soil. Tilling or digging disrupts the soil structure, harms beneficial organisms, like earthworms, fungi, and microbes. Instead of tilling the soil to prepare garden beds, the no-till method focuses on building healthy soil by layering organic materials on the soil surface each season. No-till gardening creates an environment conducive to beneficial soil organisms such as earthworms, mycorrhizal fungi, bacteria, and insects. These organisms help break down organic matter, aerate the soil, fix nitrogen, and improve nutrient cycling, which leads to healthier plants.

Materials, such as compost, mulch, and wood chips decompose over time, enriching the soil with nutrients, improving soil structure, and enhancing water retention. These layers of organic material are also known as "sheet composting."

The practice of no-till gardening contributes to soil health, reduces labor, and retains moisture, making it beneficial in the arid climate of Southern Arizona.

**Double digging** is a technique used to deeply aerate the soil. Dig out a trench one shovel deep (8 – 12 inches) and set the soil aside. Loosen the soil another shovel depth below, then move to the next row, placing the topsoil from this row into the first trench. Continue this process down the entire bed. This technique improves root penetration, drainage, and soil aeration, but it's labor-intensive.

**Caliche** is a common soil issue in Southern Arizona. It is a hard, cement-like layer of soil found a few inches to several feet below the surface, formed by the accumulation of calcium carbonate (lime) and other minerals. Caliche will appear as a hardened layer that is often white or light-colored. Caliche layers can be challenging for gardening and landscaping because they create impermeable barriers that limit root growth, water penetration, and drainage.

In arid regions like Southern Arizona, caliche forms when water evaporates, leaving behind calcium carbonate and other dissolved minerals. Over time, these minerals accumulate and cement the soil particles together.

Caliche layers can vary in depth and thickness, ranging from a few inches to several feet. Sometimes, it can appear as a thin crust; other times, it forms a thick, rock-hard layer that is difficult to break through.

If caliche is present in the area intended for gardening, it may be possible to break it up. For small areas, use a pickaxe to break through the caliche layer. This is labor-intensive but can create pockets for plant roots to penetrate. In larger areas or deeper caliche layers, consider mechanical means, such as a jackhammer, auger, or rototiller to break up the caliche.

Alternatively, raised beds are an excellent solution for gardening in areas with caliche. By building raised beds and filling them with high-quality soil and compost, you bypass the hardpan and provide plants with a more suitable growing environment.

Raised beds also offer better control over soil quality, pH, and drainage, making them ideal for areas with poor native soil.

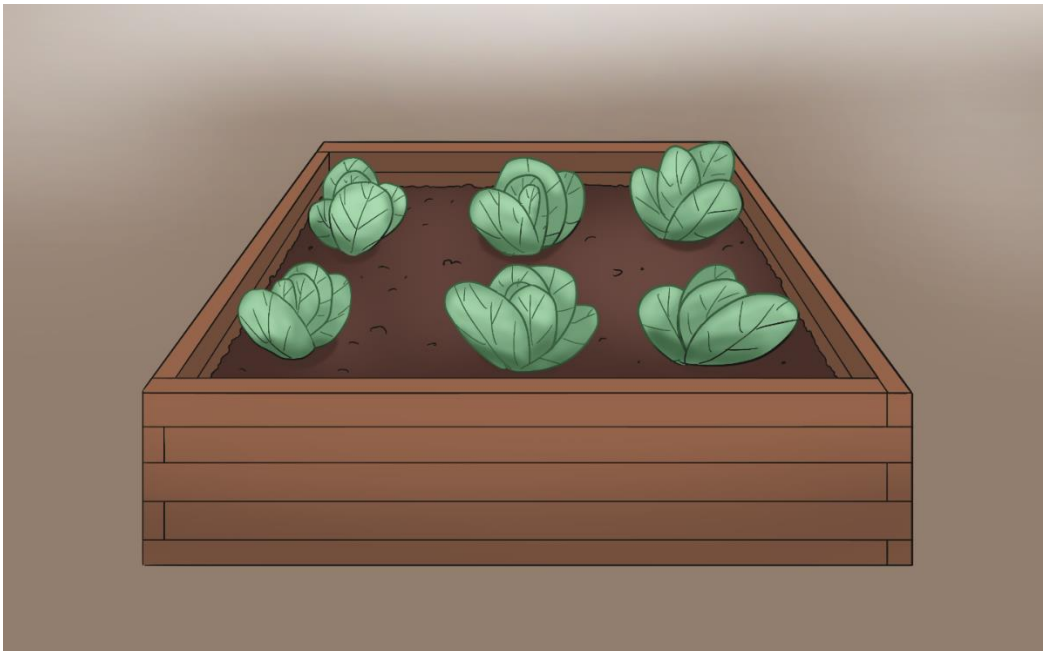
## Safe Material Options for Raised Beds

Ensure the building materials used to build raised beds are non-toxic. If wood is being considered, be aware that because it is in contact with damp soil, it will decay over time. Hardwood options, such as redwood or cedar, are more expensive, but will last longer than pine or fir. Pressure treated wood is not a good choice for edible gardens because the chemicals used pose the risk of contamination to soil and plants.

There are some new preservation treatments available, including ACQ, CA, copper-HDO, and copper naphthenate. If using wood treated with these methods, it is best to use a heavy plastic liner or a polypropylene fabric liner between the wood and the garden soil. Keep in mind that care must be taken not to damage the plastic liner when digging in the garden bed.[4]

Concrete block or metal stock tanks are alternative raised beds; however, these materials are more likely to conduct heat to the soil inside, and this increased temperature may stress the plants growing there.

## Raised Beds



## Size and Design

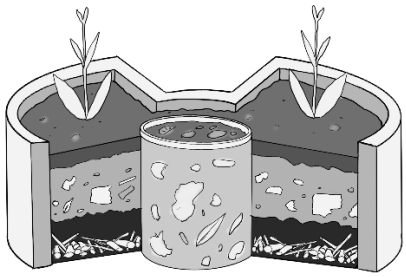
A width of no more than 4ft. is best for raised and in-ground beds. This will allow for an easier reach to the center from any side of the bed for children and adults. There is more flexibility in the length of the raised bed, depending on the space available. Generally, 8 to 10 feet will provide sufficient strength and support to the bed structure, while also giving enough space to plants. The depth should be at least 12 to 18 inches, which will accommodate most vegetable crops. This can be made higher to facilitate accessibility for individuals with physical challenges.

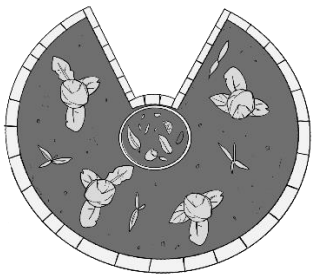
If raised beds are open in the bottom, weeds and gophers can gain access. To prevent weed penetration, lay pavers before placing the raised bed. To exclude rodents, the bottom can be set atop or lined with heavy duty hardware cloth to prevent them from chewing or digging through.

## Alternative Gardening Methods

If space is limited, alternative gardening methods can be used with great success. Intensive gardening allows the gardener to plant and harvest the most produce possible from the available space. More yield from less work is always a good thing. This is done by reducing space traditionally used for paths and rows, planting in containers, growing vertically, intercropping, and succession planting. Each of these will be explained below. Focus on the right plant for the space, consistent water, healthy soil, and plenty of sun. Having a healthy, intensive garden takes a little more careful planning at the beginning, but the reward will sure taste sweet!

## Unique Keyhole Garden Beds





The keyhole-style garden was developed in the mid-90's by the Consortium for Southern Africa Food Security Emergency (C-SAFE) to improve food security in Lesotho[25]. This circular raised bed was 6.5 feet wide with an indentation on one side. If you've ever seen an old lock – the kind a skeleton key fits into – then you understand why this style of garden was so named. Recycled hardscape materials, such as stones and bricks were used to form the outer structure, while the inside was filled with layers of branches, hay, ashes, and soil. A compost bin placed in the center was filled with plant materials to enrich the soil. Greywater from the household was poured into the compost bin to add moisture throughout the bed. At roughly 3 feet high, the deep layers of organic materials were very efficient at

retaining moisture. These garden beds grew in popularity and became common kitchen gardens in Africa, and in dry climates around the world.

## Vertical Gardening

As long as the growing container is large enough to accommodate a plant's root system, growing up rather than out can produce healthy and productive plants. Plant vining varieties, and plant alongside tall crops, such as corn, which can function as a trellis for climbing crops like beans. Trellis systems can be used to support vining plants. These can be more expensive purchased versions, or include less-expensive options like nets, posts, wire, strings, or cages. Keep in mind that plants grown vertically will cast a shadow below the growing area, which can inhibit sun-loving plants if grown below. In the Southwest, extra shade can be a good byproduct, and used as a protected seating area.

## Container Gardening

With a few suitable containers, gardening can be something for everyone to enjoy. If plants are provided with enough water, good soil, sunlight, and space, even a small, drab space can become a beautiful area for students and teachers alike. Many flowers, dwarf trees, and smaller vegetable varieties are well suited for containers. Containers can be used for themed gardens, such as for pollinators, herbs, and berries. Container garden areas can be made easily accessible for students who have physical limitation.

Many kinds of containers are suitable for use in a garden; grow bags, buckets, clay, plastic, wood, or metal pots, and even purchased bags of potting soil. Be creative! Here are a few things to consider when choosing a container:

- Container depth must be large enough to support fully mature plants
- Provide adequate drainage
- Non-toxic materials

When selecting vegetable varieties to grow in containers, consider the root depth and lateral spread at maturity. Refer to the **Table 3** for appropriate container size and plant spacing.

| Crop | Spacing (inches) | Number of Plants Per Pot | Minimum Container Depth (Inches) | Minimum Container Width (Diameter in Inches) | Crop | Spacing (Inches) | Number of Plants Per Pot | Container Depth (Inches) | Minimum Container Width (Diameter in Inches) |
|---|---|---|---|---|---|---|---|---|---|
| Asparagus | 12 - 18 | 1 | 18 - 24 | 12 | Head Lettuce | 8 - 12 | 3 - 4 | 6 - 9 | 8 - 9 |
| Bush Beans | 2 - 4 | 2 - 4 | 12 - 18 | 8 - 9 | Leaf Lettuce | 8 - 12 | 3 - 4 | 6 - 9 | 8 - 9 |
| Pole Beans | 4 - 6 | 2 - 4 | 12 - 18 | 8 - 9 | Melon | 18 - 36 | 1 - 2 | 18 - 24 | 16 - 18 |
| Beets | 3 - 4 | 3 - 4 | 12 - 18 | 8 - 9 | Mustard | 3 - 6 | 3 - 4 | 12 - 18 | 8 - 9 |
| Broccoli | 18 - 24 | 1 | 12 - 18 | 16 - 18 | Okra | 6 - 10 | 5 - 10 | 18 - 24 | 16 - 18 |
| Brussels Sprouts | 18 - 24 | 1 | 12 - 18 | 16 - 18 | Onions | 2 - 4 | 4 - 5 | 12 - 18 | 8 - 9 |
| Cabbage | 18 - 24 | 1 | 12 - 18 | 16 - 18 | Peas | 2 - 3 | 3 - 4 | 12 - 18 | 12 |
| Carrots | 2 - 3 | 3 - 4 | 12 - 18 | 8 - 9 | Peppers | 12 - 24 |  | 12 - 18 |  |
| Cauliflower | 18 - 24 | 1 | 12 - 18 | 16 - 18 | Potatoes | 8 - 12 | 4 | 18 - 24 | 16 - 18 |
| Chard | 4 - 6 | 1 - 2 | 12 - 18 | 12 | Pumpkins | 8 - 10 | 1 - 2 | 18 - 24 | 16 - 18 |
| Collard | 18 - 24 |  | 12 - 18 |  | Radish | 1 - 2 | 7 - 8 | 6 - 9 | 8 - 9 |
| Cucumber | 12 – 24 | 2 - 3 | 18 - 24 | 16 - 18 | Spinach | 3 - 6 | 3 - 4 | 6 - 9 | 8 - 9 |
| Eggplant | 18 - 24 | 1 | 12 - 18 | 12 | Squash, summer | 24 - 30 | 1 - 2 | 18 - 24 | 16 - 18 |
| Endive | 8 - 10 | 4 | 12 - 18 | 12 | Squash, winter | 24 - 36 | 1 - 2 | 18 - 24 | 16 - 18 |
| Kale | 18 - 24 | 1 - 2 | 12 - 18 | 12 | Sweet Corn | 6 - 12 | 15 plant min. | 18 - 24 | 24 - 30 |
| Kohlrabi | 8 - 12 | 1 - 2 | 12 - 18 | 16 - 18 | Tomatoes | 18 - 24 | 1 | 18 - 24 | 16 - 18 |
| Leeks | 3 - 6 | 4 - 6 | 12 - 18 | 8 - 9 | Turnips | 2 - 3 | 3 - 4 | 12 - 18 | 8 - 9 |

Table 3

## Interplanting

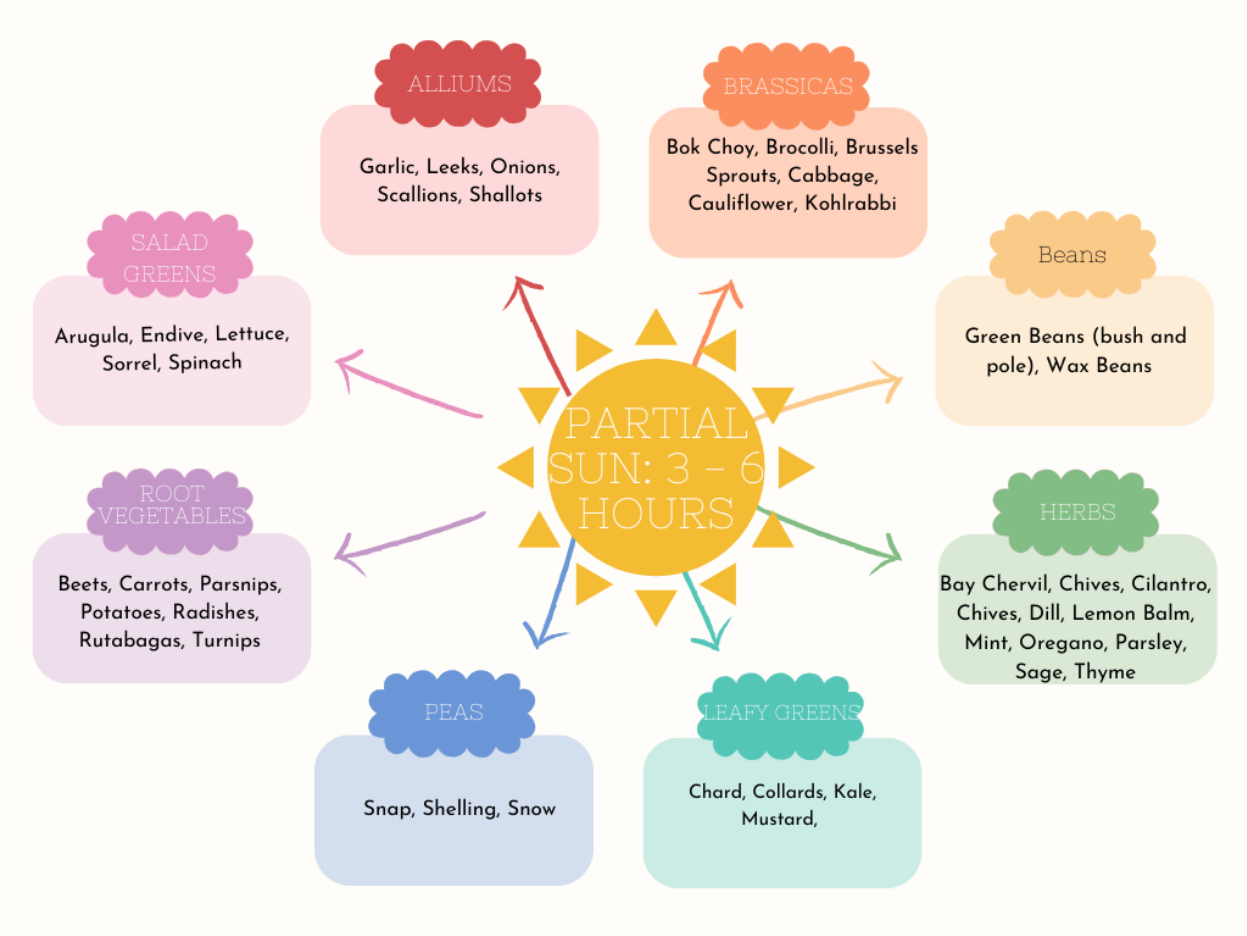
Combining two or more types of vegetables, herbs, or fruits is known as interplanting. This method requires good planning and consideration of planting times, mature size, light and water needs, and fertilization schedules to be successful. Plant combinations can maximize space and work as a deterrent of pests and diseases when done correctly.

Determining the correct spacing between two different crops planted together can be found using the formula below.

$$\frac{\text{Crop Spacing A} + \text{Crop Spacing B}}{2}$$

## Site Selection

Location is one of the most important decisions when starting a vegetable garden. Great soil and sufficient water will not make up for too little sunlight. Most vegetable varieties do best with six to eight hours of full sun, although some leafy greens and root vegetables will perform in partial shade (3 – 6 hours). Shade tolerant plants may take longer to mature and yield a little less but can still be productive. Be sure to check seed packet information for the optimal hours of sunlight needed for each variety. The chart below will guide you in some shade tolerant varieties to choose from.




Before planting, monitor the path of the sun from morning until evening to better understand the space. The position of the sun will change throughout the seasons, so observing during the year is helpful.

A good garden spot will be far enough away from trees and large shrubs to avoid the shadows they cast during certain parts of the day. Trees will compete with garden plants for water and nutrients, so it is best to avoid locating a garden near them.

Take note of the tree species growing in the area being considered for a garden. Some tree species are **allelopathic**, meaning they produce biochemicals that can inhibit the growth of other plants growing near them. Allelopathy is an example of competition between plants and can occur in a few ways:

- Biochemicals are released from the roots into the soil where they will suppress plant growth in the area.
- Biochemicals are released in a gaseous form from the leaves that negatively affect nearby plants.

- Biochemicals contained within leaves can be integrated into the soil as they fall and decompose, which can inhibit plants growing there.

Both in-ground garden beds and raised beds can be impacted by nearby allelopathic trees. Some common allelopathic species in Arizona are black walnut, tree-of-heaven, salt cedar (Tamarisk), elderberry and some pines.