

# THE TENNESSEE VEGETABLE GARDEN

## SEASON EXTENSION METHODS

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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.*

### THE WHY AND WHAT OF SEASON EXTENSION

One of the basic facts of gardening is that crops will grow, develop and produce when temperatures are appropriate. Gardeners carefully plant cool- and warm-season crops to grow during the time of year that targets their ideal temperature range. Managing crops according to surrounding conditions can work very well and fit the needs of many gardeners. However, gardeners have the option of altering the environment around their plants (called the microclimate) to enable crops to be grown in a wider range

of conditions — thus extending the growing season.

This practice of season extension allows gardeners to have some control over the environment around their crops (roots and/or shoots) to enhance productivity or maintain survival until conditions are more appropriate for growth. Certainly there are limits, but adding an extra few days to weeks to the growing season can be quite useful in vegetable gardens. Methods are divided into two main groups: management practices that can extend growing periods and structures or materials that can be used to alter temperatures and extend seasons.



*Figure 1. A young tomato plant can be grown in a greenhouse to receive optimum conditions for growth prior to transplant.*

## **CULTURAL PRACTICES THAT CAN EXTEND SEASONS**

### **SITE SELECTION**

Vineyards often are located around lakes to allow temperatures in the area to be moderated by the water — a good example of selecting a site to take advantage of natural microclimates. Smaller scale examples include sites close to buildings that retain daytime heat, sites where plants have the benefit of a windbreak to protect from cold and drying winds, or sites near a slight slope that enables cold air to drain away from plants. Gardeners can create these season-extending sites around the residence, so pay close attention to discover where you might use microclimates to benefit the home vegetable garden.

### **RAISED BEDS**

Soil temperatures can impact speed of germination, root growth, and water and nutrient uptake — all of which affect plant growth. Raised beds have a couple of benefits in altering soil temperatures to extend seasons. In spring, water in the soil can slow down the process of soil warming because it takes more energy to raise water temperature than air. Raised beds that allow water in soil to drain more quickly can allow warmer air to enter the soil spaces and warm up the soil faster. Additionally, raised beds have more surface area that can be exposed to the warming effects of the sun. However, these factors also can lead to more rapid cooling in raised beds. Another benefit of raised beds is that they are well suited to accommodate other season extension practices. They easily can be fit with plastic mulches, row covers, low tunnels or even soil heating cables to warm the air and soil around plants and make earlier and later gardening possible.

### **TRANSPLANTS**

One of the most common methods to extend seasons is transplanting older plants into the garden rather than direct seeding (Figure 1). This simple practice enables plants to be grown when outdoor conditions would not allow or would slow growth. Additionally, conditions can be tailored for each type of plant, and early stresses that could limit growth can be avoided. Pest pressures may also be reduced by an early planting for some crops.

Some of the most commonly transplanted crops are tomatoes and peppers because these longer season crops can be harvested earlier when transplants are used. Additionally, planting can be delayed until conditions are more optimal for plant growth. These warm-season crops are frost sensitive, and their growth can be limited by cool soil temperatures even when air temperatures remain above freezing.



Cool-season crops such as cabbage and broccoli are also good candidates for spring transplanting. Transplanting these crops in spring reduces time to harvest and allows gardeners to ensure crops do not mature during hotter weather, which can deteriorate crop quality. Additionally, transplanting in the late summer can allow cool-season crops to be protected from the warmest and driest times of mid-summer to reduce stress and allow for higher quality fall-maturing crops.

Conditions after transplanting will influence how much time to harvest was gained by transplanting. The age of the transplant cannot always be directly subtracted from days to harvest because low temperatures and lack of moisture or nutrients in soil can stress transplants after planting and reduce the benefits of the practice.

## STRUCTURES AND CROP MANAGEMENT METHODS THAT CAN EXTEND SEASONS

### WHAT IS REALLY HAPPENING?

The basis for most season extension methods involves absorbing or trapping radiation from the sun to warm up the environment around crops. For instance, dark mulches absorb light (or solar radiation) and conduct this heat to the soil below. Clear plastic covers transmit and then trap light, causing the air temperature under the covering to increase.

Agricultural plastics revolutionized season extension and provided a variety of tools that work across a range of scales (Table 1). The biggest decisions for the gardener are how much money to invest in the purchase of materials and how much time to invest in installing and managing

systems to alter environmental conditions. In passive systems, growers cannot increase the temperature if there is no sunlight to provide heating, although they can temporarily capture heat that has been stored in the soil to provide warmth during cloudy periods. Also, they only have natural air movement to provide cooling. In active systems, passive heating is used, but it is combined with active heating and cooling sources to maintain more precise control, which always comes at a price. This discussion will focus on passive systems because they are the most flexible, cost efficient and applicable for home gardeners. Greenhouses will be covered in a separate publication.

**Table 1.** The range of control over growing environments provided by different types of growing

Control	← Some control → High control					
Cost	Lowest cost of production			Highest cost of production		
Method	Open field*	Mulch*	Low tunnel or row cover*	Cold frame*	High tunnel*	Greenhouse**
Details	Crops are at the mercy of the surrounding conditions.	Plastic that tightly covers soil or natural materials placed on soil surface to reduce weed growth, moderate temperatures and conserve moisture.	A thin, temporary sheet of plastic or agricultural fabric covers the crop to trap sunlight. Can be supported (typically 2 feet to 3 feet) or floating over plants.	A permanent structure often made of glass or rigid plastic to trap solar radiation. Can be closed to trap heat or vented to reduce heating.	A permanent plastic-covered structure that can be vented to manage temperatures. Typically large enough to walk in and unheated.	A permanent structure covered with glass or plastic. Features heating and cooling to manage temperatures.
Specific benefits in vegetable gardens	NA	Plastic mulch increases soil temperatures, germination, and early root growth. Organic mulches can reduce summer soil temps. Both can conserve soil moisture.	Warm-season crops can often be planted 1 to 2 weeks earlier. Cool-season crops could be planted earlier or benefit from better early or late season growth.	Benefit depends on whether heating is used. Transplants can be started several weeks before planting. Cool-season crops can also be grown early and late in the season.	Warm-season crops can be planted from 1 to 4 weeks earlier and harvested later. Cool-season crops often can be kept alive all winter.	Enables year-round growing and harvesting.

\* Passive — only solar energy for heating and air movement for cooling

\*\* Active — other energy sources used to heat and cool as well as passive

# TEMPORARY METHODS AND STRUCTURES

## MULCHES

Mulches can influence soil temperatures in two important ways. The first is through absorbing or reflecting incoming light. Dark mulches, such as solid black or woven plastic, absorb solar radiation and can transfer this energy to warm the soil below. Lighter mulches, such as white plastic or straw mulches, reflect more light and do not warm soil temperatures as much as darker mulches. Under warm summer conditions, lighter mulches can be a benefit because they may keep soil temperatures lower and less variable, which can be an advantage to plants.

The second way that mulches alter soil temperatures is by reducing heat loss. Heat can be lost from soil through the evaporation of water or when air temperatures are lower than soil temperatures (such as at night). Mulches, both plastic and natural, can retain heat by reducing both of these losses.

When choosing a mulch, pay special attention to watering needs. Irrigation is required when using impermeable plastic mulch. If using a natural mulch instead, select wisely to avoid the potential for introduction of weed seeds or herbicides. For more information on these topics, see W 346-D “The Tennessee Vegetable Garden — Plant Management Practices.”

## FLOATING ROW COVERS

Also known as direct covers, floating row covers are usually nonwoven plastic films or agricultural fabrics that can be applied directly over crops. These covers can be installed in large sections that cover many rows in the garden. The edges are usually secured with soil, wooden posts or other materials. They increase air and

also soil temperatures by trapping sunlight. Because of their light weight and permeability, they do not need structural support. However, some crops, such as tomatoes and peppers, have tender growing points that may need protection from abrasion by floating covers.

Because these covers are permeable to air and water, irrigation may not be required. Also, these covers are naturally vented due to air movement through the material. These aspects of floating row covers make them attractive to home gardeners. Additional benefits of floating row covers are their ability to protect plants and soil by reducing the speed of rain drop impact (reducing erosion and crusting) and to serve as a protective barrier from insects, such as flea beetles on eggplant.

Gardeners generally use row covers as a temporary measure in spring and fall since the covers can trap sunlight and may cause plants to overheat under the warm, sunny conditions of late spring and summer. Overheating can cause leafy crops to be lower in quality and can reduce fruit set in some warm-season crops. It is also a good practice to remove row covers when crops that require pollination by insects begin

to flower. Often this coincides with warmer temperatures when additional heating is no longer desired. Thanks to the improved climate under row covers in early and late seasons, weeds can also thrive under covers as well as crops, so proper weed control is essential to maintain benefits of row covers.

Row covers come in a variety of thicknesses, which vary in their ability to increase daytime temperatures and retain heat at night. Thicker covers retain more heat but block more incoming sunlight. It is common for gardeners to use thinner covers in the warmer seasons to retain some heat and protect crops from insects. Gardeners typically use thicker covers for fall to spring cropping of cool-season vegetables, installing them in the late afternoon and removing them in the morning. Row covers can often be reused from season to season if managed carefully and kept clean. All things considered, row covers of permeable nonwoven plastic may be the most versatile and useful, yet cost effective, tool for the home gardener seeking to extend growing seasons.

## LOW TUNNELS

Low tunnels (Figure 2) provide many of the same benefits as row covers,



**Figure 2.** Slitted plastic low tunnels supported by wire hoops. A floating row cover of agricultural fabric can be seen covering small transplants on the right.

and sometimes the terms are used interchangeably. In this discussion, we will use low tunnels to describe a temporary hoop-supported structure. Often, gardeners use polyethylene plastics over these 2- to 3-foot-tall wire or plastic hoops and stretch the plastics tight to create the appearance of a miniature greenhouse. These commercial wire hoops (pictured in Figure 2) are available for purchase, but other materials, such as electrical conduit or plastic pipes, also can be used to form tunnels.

Low tunnels are installed down the length of a row to create a distinct air space around the crops, which can provide more consistent temperature benefits. Also, the hoops protect sensitive crops from abrasion by the covering or by cold temperature damage from contact with the covering during freezing conditions. Like floating row covers, gardeners often remove these tunnels to prevent overheating when warmer late spring and summer temperatures arrive. It also is best practice to remove them when the crop outgrows the structure or when pollinating insects need access to the crop.

When using these small polyethylene tunnels, keep in mind that they can heat rapidly under bright sunlight and should be vented to prevent crop damage due to overheating. Slits along the top of the tunnels (as seen in Figure 2) or small perforations are common as a part of the manufacturing process. These slits reduce heat retention at night, but they lower the risk of daytime high temperature damage.

Polyethylene tunnels generally shed water, which can be a benefit in protecting crops. However, they usually require irrigation to be installed under the tunnel. Another limitation of polyethylene low tunnels is that the plastic is more difficult to reuse from season to season. It is common for plastic mulch, drip irrigation and polyethylene low tunnels to be installed together to achieve maximum benefit for early planting of warm-season crops. Agricultural fabrics also can

be installed over hoops to form low tunnels, which can protect sensitive crop growing points or create a larger air space to retain heat.

## SHADE STRUCTURES

Most of the season extension tools discussed so far have centered on adding and retaining heat for early and late-season garden production. However, shade structures in garden areas also can extend seasons by reducing light and temperature accumulations. In Tennessee climates, these shade structures may allow gardeners to harvest cool-season crops, such as leafy greens, for a longer period of time as spring temperatures rise or to seed or start fall cool-season crops under summer conditions. To create shaded areas, place white or black shade netting over metal or plastic hoops. These commercial materials are described by how much sunlight they block and come in a range of percentages. To extend the growing season for cool-season crops, a 30 percent to 50 percent shade is common. Make sure that shade structures are well ventilated to prevent trapping heat under the shade netting.

## PERMANENT METHODS AND STRUCTURES

### COLD FRAMES

Cold frames are familiar to many home gardeners. Often constructed of wooden frames with glass, Plexiglas, or polycarbonate panels, these structures have long been used for transplant production. It is also common to use cold frames for early or late-season root or leafy vegetable production. Cold frames can retain heat well when closed, and hinged lids on the boxes provide ventilation to prevent overheating on warm, sunny days. Some gardeners also set up a composting system under their cold frames to provide heating. This is often

referred to as a hot bed. If the frames have access to electric, then electric soil heating cables could be used to add heat.

Limitations of cold frames are their size, accessibility and construction expense. Additionally, hinged cold frames typically require close management to prevent damage to crops when bright sunlight can rapidly increase the temperature in the cold frame. Automatic opening and closing mechanisms are available as well if gardeners are willing to invest in tools to reduce management time.

### HIGH TUNNELS

High tunnels are more permanent, plastic-covered structures built over growing areas to provide warmer temperatures for crops. They also keep leaves drier, therefore potentially reducing some foliar disease. However, this exclusion of rainfall means that irrigation will be necessary. While row covers and low tunnels are generally removed after a certain period of time, crops are usually grown in high tunnels for the entire season. The sizes of high tunnels can vary greatly from smaller structures (12 feet wide x 24 feet in length) to more commercial sized units (30 feet wide x 80 feet in length). Typically, a high tunnel is tall enough for a person to comfortably work in while standing. Definitions vary, but high tunnels are commonly described as unheated greenhouses. This definition obviously limits the amount of environmental control gardeners can practice and is one of the main distinctions between high tunnels and greenhouses.

High tunnels are generally constructed of wood or steel frames and are covered with flexible or rigid plastic. Material choices depend on cost, length of productive life, and the weather conditions of the area. Snow and wind loads are one of the most common determining factors for high tunnel design and construction. Many aspects of high tunnels design are related to the crops that will be grown in them and the seasons they will be used. Most



high tunnels have doors and sidewalls that can be used for ventilation while other have vents in the end walls that can provide additional air movement. Managing these methods of ventilation is one of the most time-consuming aspects of high tunnel growing.

Venting, shading, and using multiple layers of plastic or row covers are all practices that enable gardeners to maintain more environmental control in the high tunnel. Figure 3 illustrates the use of row covers and low tunnels inside a high tunnel. When gardeners combine these methods, they can extend the growing season for cool-season crops thanks to better heat retention during the night. Likewise, sidewall venting and/or shading could extend the growing season for cool-

season crops in the warmer times of year.

### GREENHOUSES

While greenhouses use passive solar heating, the addition of active heating and often active evaporative cooling distinguishes them from other season extension practices. Because of these heating and cooling systems, the installation and operation costs of greenhouses are generally much higher than the methods discussed here. Please refer to home and commercial greenhouse publications to learn more about the design, installation and uses of greenhouses for home vegetable production.

### ADDITIONAL RESOURCES

Season extension techniques for market gardeners — ATTRA <https://attra.ncat.org/attra-pub/summaries/summary.php?pub=366>



**Figure 3.** Season extension methods can be combined to produce additive benefits. This image illustrates the use of floating row covers and hoop-supported low tunnels inside a high tunnel.



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