



# Season Extension

Each crop in the garden has its production season when, if all goes well, gardeners enjoy abundant harvests and may have surplus to store or preserve. A number of techniques ensure continuous production of many crops beginning well before the usual production season, and extending through the normal season, into the fall, and in some cases, continuing production year-round.

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This chapter provides a brief overview of techniques that can be used for season extension, ranging from using appropriate varieties and planting dates, to selecting planting locations, to modifying the environment using materials such as mulches and floating row covers, and structures such as cold frames and high tunnels.

## Crop and Cultivar Selection

Peak production for cool season crops typically comes in the spring and fall. Warm season crops, which are frost sensitive, produce in the summer. The natural length of the harvest season varies by crop, with some crops, such as tomatoes, producing over many weeks, and others such as sweet corn, broccoli, and radishes, providing a relatively brief period of harvest from a planting. Cool season crops vary in their capacity to tolerate temperatures below freezing, but a number, including leafy greens, carrots and beets, can easily be grown throughout the winter in an unheated cold frame or high tunnel. The season for warm season crops can also be extended into the

spring, fall and winter, but these crops must be provided with the warmth they require for growth, and be protected from freezing.

Varieties (cultivars) of crops may vary in both the number of days to maturity (earliness) and tolerance to heat or cold temperatures. One way of ensuring an extended harvest, particularly of crops that tend to produce during a brief harvest period, is to plant both earlier and later maturing cultivars at the same time.

Seed catalogs and packets almost always indicate the number of days to maturity. Seed catalogs may also identify cold or heat tolerant cultivars. For example, some lettuce and spinach cultivars are identified as slower to bolt (flower and produce seed), and these would be choices for growing into the hot summer. Cold tolerant cultivars of some warm season crops, such as beans and sweet corn would be choices for an early first planting.

## Maximize Yield

**Small, successive plantings.** Sequential planting is another way to ensure a continuous harvest of many crops, particularly

those that produce only over a brief period. This works well with quick cool season crops, such as radish, lettuce and spinach, and also for warm season crops, such as bush beans and sweet corn. The first planting of sweet corn will often include both early and later maturing, main season varieties, which will then be planted successively approximately every two weeks through the planting season.

The planting season for warm season crops typically ends when there is no longer time for a crop to mature between the time of planting and the anticipated date of frost. If using structures such as cold frames or high tunnels, the planting season for cool season crops extends well beyond the normal season, but short days limit crop establishment and growth as winter approaches.

Well-established crops such as spinach, lettuce and carrots can continue to produce throughout the winter, but they need to be planted early enough to give them time to grow before days become very short from November through January.

**Harvest promptly.** A timely harvest also helps ensure a long harvest period for many crops. Harvesting crops when they are ready can stimulate continued production through thinning the stand (for example, radishes, beets, green onions, lettuce), and removal of immature fruit (summer squash). Timely harvest also improves crop health through the removal of diseased, rotting, or overly mature fruits and other plant parts, and can contribute to air flow in the crop, reducing humid conditions favorable for disease development and spread.

**Use transplants.** Using transplants is a further way to ensure early production of many crops by allowing the gardener to take relatively large, rapidly growing plants to the field when conditions are favorable. Transplants of warm season crops are produced in a controlled environment, such as a heated greenhouse, hot bed (see below), or under lights in the house so that they can be ready to plant out after danger of frost has passed. Care should be taken, particularly with the warm season crops, such as peppers, to ensure they are planted in soil that is warm enough. It is a common error to plant peppers in soils that are cold (below 55°F) and wet, resulting in root rots, which can kill the plant or delay production.

## Garden Site Selection

Various features of the garden can influence the potential for season extension. The orienta-

tion of the slope (the aspect) of land in the garden, as well as hedgerows and fences, which can act as windbreaks or sources of shade, can have effects on the earliness and productivity of crops. Gardens in low lying areas or hollows called frost pockets are likely to be more prone to frosts than those on slopes which allow for air drainage.

A garden with a northern aspect will warm up more slowly in the spring than will a southern facing garden. Western and southern facing slopes will capture the sun's warmth and may be advantageous for production early in the spring or late in the fall, but may be too hot and dry when baking under the heat of the summer sun.

Northern facing slopes are often considered desirable for fruit production, as they warm up slowly and delay flowering till danger of frost has passed. Crops that require full sunlight need at least 6 hours of direct sunlight per day, but may benefit from a bit of shade during the heat of the summer. A crop with an eastern exposure may benefit from the morning sun, but be protected somewhat from the harsh afternoon sun. Gardeners in Kansas have reported an extended rhubarb harvest with plants receiving morning sun but afternoon shade.

**Wind protection.** Wind can be very damaging to vegetable crop productivity, resulting in damaged plants, both from the physical stress of the wind and from abrasion by sand particles being blown over the land. Hedgerows and fences can serve as effective windbreaks, protecting crops from prevailing winds and allowing for an extended season of production of higher quality vegetables in windy locations. Plants in a windbreak can compete with garden plants for water, so leave space between the garden and hedgerow or trees in order to avoid this.

## Raised Beds

Raised beds or ridges can help not only with season extension, but with general crop health, contributing to good drainage and soil aeration for healthy root growth. These can be permanent or made annually, with hoes or with an implement on a tractor or rototiller. Because they are raised above the surface of the soil, beds can warm up more rapidly in the spring than the rest of the garden, helping to produce earlier crops. Just as raised beds can warm up rapidly in the spring, they may also cool off rapidly in the winter. Thus, if poor drainage, is not a concern, a flat surface or even a slight trench may help to conserve heat for crops grown in a protected structure such as a high

tunnel or cold frame (see below) during the depths of winter.

## Mulches

Mulches are materials placed in the garden to cover the soil and can help with season extension by cooling or warming the soil and by conserving soil moisture and preventing the growth of weeds that can compete with crops. Mulches may be synthetic, including plastic films and weed barrier, or natural, including paper, straw, and wood chips.

**Types.** Plastic film mulches are commonly used by commercial growers, and are increasingly available to home gardeners through catalogs and garden centers. They are also almost always used in combination with drip or micro-irrigation for efficient delivery of water to the roots of plants. Black plastic mulch is the most common type, typically coming in 3- or 4-foot widths that commercial growers lay over raised beds using specialized mulch laying equipment.

**Installation.** In the home garden, mulch can be laid by hand. For soil warming, it is important for the plastic mulch to be in direct contact with the soil so that heat can be transferred from the plastic to the soil. Warm soil under mulches can lead to earlier and extended crop production. Plastic mulch comes in a number of other colors, including clear (which can warm soil much faster, but also grows weeds), red (which tomatoes particularly like), infrared transmitting (which acts like clear mulch but won't allow weeds to grow), white (white on one side and black on the other to prevent weed growth; white mulch keeps soil cool and is often used for mid-summer plantings); and reflective, aluminized (which also cools the soil and is repellent to whiteflies and aphids).

**Disposal.** One problem with plastic mulch is clean up and waste disposal. Biodegradable mulches made out of modified starch or other bio-based polymers are also available and will probably become increasingly available in the future. These biodegradable mulches can be tilled in or left to decompose naturally after use. Natural biodegradable mulches, including paper, straw, hay and wood chips, are also well-known and excellent mulches. They help to keep the soil cool in the heat of summer, conserve moisture and control weeds. Organic mulches slow soil warm-up in the early spring, so for early plantings, they should be pulled back to allow the soil to warm up.

A further option for soil covering is the use of weed barrier fabric, which can be reused

from year to year. After preparing the soil, it can be placed in the garden where it will help warm soil for early planting while controlling weeds and conserving moisture. It is probably best to take up weed barrier from year to year, or it will likely become covered with soil and become a messy nuisance.

## Other Forms of Protection

**Row covers.** Floating row cover is fabric, which as the name implies, can be placed directly over crops to protect them. It is usually made of spun-bonded polyester or polypropylene material, and comes in various thicknesses (for example, 0.55 or 1.5 oz per square yard), rated to provide varying degrees of frost protection to crops. It comes in widths ranging from 5 to 50 feet and a range of lengths, and can be secured at the edges with weights such as sandbags, or with metal sod staples.

Floating row cover can be useful in the garden, not only for short-term frost protection, but also to provide longer-term protection for overwintering crops such as spinach or strawberry, or for providing protection from insect attack and a warm and protected environment to many crops in the garden.

While it is called floating row cover, it can be abrasive to some crops such as tomato, pepper and zucchini, particularly in windy situations. Gardeners often fashion low tunnels (see below) using bent wire or plastic hoops placed over beds to keep the floating row cover from touching the crop.

Floating row covers can be particularly valuable for exclusion of serious insect pests such as cucumber beetles on cucurbits and flea beetles on eggplant or certain cole crops. It can be left to cover crops such as zucchini until they begin to flower, but then needs to be removed to allow for pollination. Floating row cover is often used to provide additional protection to crops grown in high tunnels during the winter. Hoops or other supportive structures are used to avoid damaging leaves that can freeze to the floating row cover when temperatures drop.

**Structures.** Cold frames and hot beds are typically low wooden boxes or frames with glass (often old storm windows), polycarbonate or polyethylene film covers, which are set in the soil or over beds in the garden. Cold frames may be used for winter production of cold tolerant greens such as spinach, for late fall and early spring production of a range of cool season crops, and to harden off transplants before taking them to the open field for planting. Cold frames are often constructed

with a sloping top, and set facing the south so as to capture the most winter sun. Tops may also be peaked or arched with hoops that support a polyethylene film covering. Polyethylene film is the same thing as plastic sheeting, but for applications such as cold frames and high tunnels, special greenhouse film is used, which is typically 6 mils thick and treated with a UV blocking material so that it will last at least 4 years. Untreated polyethylene film will break down in less than a year and probably should not be used.

If the weather is at all mild and the sun is out, cold frames can heat up rapidly, and need to be vented. In the case of a cold frame with a hoop-type top, it is possible to replace the polyethylene film with floating row cover material when the season warms up, eliminating the need for manual venting, and providing a protected environment that may be used into the summer.

Fabric low tunnels can provide a warm environment while eliminating pests.



Hot beds are basically heated cold frames, which, because they stay warm, provide a favorable environment for rapid production of crops, including transplants. Traditionally, decomposing manure was used to heat beds. This is still possible, though care should be taken to avoid contact between crops and manure, which may contain human pathogens. Other methods of heating the soil include using electrical heating cable or running warm water through pipes in the soil. Hot beds are not used much any more because of their relative complexity, cost, hazard potential, and availability of more convenient alternatives such as greenhouses or lighted indoor environments.

Hot caps, cloches, and other devices are used to protect individual plants in the garden. Like cold frames, these enclosed structures can heat up rapidly and cook plants in hot weather, so they need to be vented or removed during bright days. They are typically used for protecting transplants early in the season.

Paper hot caps are commercially available. Plastic hot caps can be made by cutting the bottoms off of milk containers, and placing the hot cap over the plant, with the base pressed into the soil. Glass bell jars called cloches were used in the past. They are rarely used today because they are expensive and cumbersome to handle.

Clear plastic, double-walled protectors that provide protection from frost and a warm, protected environment for very early tomatoes are available through retail stores and garden suppliers. The space between the walls is filled with water, which provides great frost protection because it releases heat before freezing. In fact, commercial growers often use irrigation as emergency protection against unexpected freezes, particularly for fruit production.

## Low Tunnels

Low tunnels (left) are hoop-supported row covers, too low to walk in. Tunnels high enough to walk in are called high tunnels (see next section). Low tunnels may be covered with polyethylene film or floating row cover and may vary in width to span a single row or one or more beds in the garden.

Hoops to form the tunnel structure may be made of bent wire (usually 9 or 10 gauge galvanized wire), PVC (½-inch schedule 40 or flexible black pipe), galvanized electrical conduit (bent to form an arch), or other inexpensive materials. The length of hoops depends on the width of the bed, and typically varies between 5 and 10 feet. The distance between hoops can vary depending on the load tunnels



A low tunnel of polyethylene plastic held on by ropes between hoops extends a fall garden into winter. Floating row covers can also protect crops.

may be expected to bear. Hoops are pressed firmly into the soil, which anchors them. If used to support floating row cover, and in a location protected from the wind, hoops may be spaced up to 10 feet apart. If polyethylene film is placed over hoops to protect crops from ice and snow in the winter, hoops should be spaced 3 feet apart.

Vegetable farmers use special thin polyethylene row cover with slits or holes for ventilation to cover early season or winter crops in some areas. The plastic, which is slitted to allow ventilation and prevent overheating on warm, sunny days, may not be practical in the average home garden in Kansas. Edges of the plastic are typically buried using specialized equipment so the cover will not blow away, and crops can easily overheat if temperatures rise too high.

Another option is floating row cover of varying weights that can be used during much of the year and can be complemented by polyethylene film during the winter. Lighter row cover can be used during the spring and summer, and heavier row cover can be used in the late and early winter for freeze protection.

For covering in the winter, greenhouse polyethylene is preferred because it can be saved, and reused from year to year, but standard 6 mil polyethylene may be easier to obtain. Because it is not treated to resist ultraviolet radiation, it may only be expected to last one season.

The edges of row cover over low tunnels can be held in place using earth staples or similar anchors, or with sand bags, bricks, boards or other weights. Polyethylene presents

a greater challenge to keep in place, since it acts as a sail. A good approach is to secure the ends, bunching the plastic together and tying it off to a stake or t-post. Rope tie downs running from stakes on either side of the low tunnel can then be used to hold the plastic in place between hoops. The edges of the polyethylene may be further secured with sand bags or other weights. On hot days, if venting is required, the edges of the plastic may be pushed up and held in place by the ropes. This same principle is used to keep the polyethylene on some types of homemade high tunnels.

### High Tunnels

High tunnels, also called hoop houses, are essentially unheated polyethylene-covered greenhouses. They are passively heated and ventilated, and range from homemade field tunnels large enough to walk in (which distinguishes them from low tunnels), to more permanent structures, often sold by greenhouse manufacturers as high tunnels or cold frames.

Standard sizes of commercial high tunnels are typically too large for the home garden, but greenhouse manufacturers are increasingly targeting the home garden market as the benefits of high tunnels are recognized and demand for them increases. Rather expensive mini-greenhouses are commercially available to home gardeners, but do not exactly fit the description of high tunnels because crops in high tunnels are usually grown in the soil. Plans for homemade high tunnels are available from various university extension services, including Kansas State University ([www.hightunnels.org](http://www.hightunnels.org)).

Crops, including vegetables, fruit, flowers and herbs benefit in a number of ways from the protective environment provided by high tunnels and other structures. They often grow quicker, larger and produce higher quality harvests than field grown crops. During the spring fall and winter, crops benefit from daily warming of the air and soil, leading to earlier and extended harvests.

High tunnels protect crops from severe weather, including wind, rain, hail and snow. Because rain does not leach fertilizer from the soil in high tunnels, crops can make more efficient use of fertilizer. Also, sunlight reaching plants in high tunnels is diffused and lower in ultraviolet radiation, probably contributing to lush crop growth.

**Pests and diseases.** With adequate ventilation, and the exclusion of rain, fungal diseases on crops, such as foliar fungal diseases of tomatoes, tend to be reduced compared to the open field. The dry high tunnel environment can be favorable for a number of pests such as aphids, mites and whiteflies, but these may be controlled by natural enemies that may already be present, or may be purchased and introduced.

Crop spacing and other cultural practices in high tunnels are similar to those used in the open field. Gardeners should avoid the temptation to plant crops such as tomatoes too densely because crops will grow more vigorously than in the open field, which can result in an impenetrable disease-prone mass of vegetation.

**Ventilation.** Ventilation in high tunnels is typically achieved by raising the sides to allow fresh air to enter. In structures with end walls, it is beneficial to be able to ventilate at the gable peak to let the hot air out. This can be done by installing a vent or by completely removing the end wall covering during the summer. There are numerous ways side venting can be done, including rolling up the plastic on

a length of metal or pvc pipe, dropping down sides using a system developed for chicken houses, and simply tying up the sides at each hoop. For field tunnels, where the poly is held on by ropes over top of the plastic between bows, the poly can simply be propped open to vent the tunnel.

**Watering.** Because high tunnels exclude rain, crops grown in them have to be watered. A simple garden hose and sprinkler wand is one option, as is sprinkler irrigation, which works well for some crops. Drip or other micro irrigation is the most efficient way to irrigate crops and also provides moisture to the roots of crops without moistening foliage, which can contribute to disease development. Because high tunnels exclude rain, it is also possible for salts from fertilizer, animal manure or irrigation water to build up in soil. Gardeners can monitor possible salt build up in high tunnels by soil testing. If a salinity problem develops, salts can be leached through heavy irrigation or by removing the polyethylene cover for sufficient time to allow rainfall to leach out salts.

### Provide Shade

Shade cloth is an underutilized tool for keeping things cool in the Kansas garden in the middle of summer. Shade cloth comes in a range of colors and percentages of shading. It can be used as a low tunnel covering or a high tunnel covering. It is commonly used over the polyethylene cover on high tunnels, thus providing cooling shade while maintaining the rain shelter benefit of the film covering.

By limiting the amount of sunlight entering the tunnel and striking the soil, shade cloth helps to keep both the air and soil under it cool. Fifty percent shade cloth placed over a determinate tomato crop in a high tunnel when temperatures start to rise in May, stimulates the tomato crop to produce continuously throughout the summer and into the fall.