



# High Tunnel Leafy Greens & Herbs

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## Introduction

High tunnels, also known as hoop houses, are simple polyethylene-covered unheated structures. They can be covered with one or two sheets of plastic; those covered with two have an air layer in between, thus offering better insulation and, consequently, more cold protection.

While they are often used to extend the growing season earlier into spring and later into fall, high tunnels can be used in the mid-Atlantic region for winter production of a wide variety of leafy greens and herbs. “Leafy greens” is a broad term that includes vegetables such as lettuce, spinach, and leafy plants in the Brassicaceae family. In addition to winter production, shaded and well-vented high tunnels can be used to grow some of these cool-season crops into early summer, when it would otherwise be too hot for production.

## Marketing

High tunnels and other season extension techniques allow producers to extend the time period over which cash flows are generated from produce crops. High tunnel production is expanding to supply the increasing demand for locally grown produce, as well as policy and grant programs favoring high tunnel production. High tunnel production of leafy greens and herbs can also enable producers to market products at higher prices, before the start of a traditional local season. High tunnel leafy greens and herbs are typically added by producers already selling through direct markets: farmers markets, CSAs (community supported agriculture programs), and direct to local restaurants and groceries. Farmers market producers entering winter might



generate a subscription list and establish a pickup location or delivery service for leafy greens and herbs grown in high tunnels. Social media and/or email distribution lists are great ways to notify customers of product availability and the order deadline for the week. Orders can then be received via return email or by phone.

Greens produced by extending the season into early summer can be sold retail via roadside stands and farmers markets. Bagged leaf lettuce mixes (sometimes called “mesclun mix”) are popular at these markets. Wholesale marketing avenues include restaurants and locally owned grocers. Other local and regional marketing opportunities may be available for bagged salad and greens mixes, especially if they are certified organically grown. If offering bagged greens, herbs, or salad mixes, producers should always confirm they are meeting Best Handling Practices and food safety regulations applying to their product.



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## Market Outlook

Consumer use of fresh leafy greens and herbs increased during the early 2000s as consumers demanded a more diverse selection of leafy greens and decreased their average consumption of head lettuces, especially iceberg. The shift toward leaf lettuces continued from 2010 to 2015. High tunnel production of greens and herbs often targets a specific type of customer, one willing to pay for certain products or product quality during the off-season. Since this demand can vary between local areas, producers should identify what other high tunnel production is nearby. High tunnel production may command a price premium if high quality and steady supply are maintained to meet local demand. A good marketing plan can help the producer identify nuances in the local market and adjust planning and production accordingly.

Some growers have found winter greens to be the most profitable use of high tunnels on the farm. Additionally, growers may benefit financially from producing cool-season greens in shaded tunnels during late spring and early summer, when Kentucky field production is winding down but consumer demand persists. Providing fresh off-season greens retains existing customers and helps attract new customers.

## Production considerations

### *Growing environment*

High tunnels can provide the protective environment necessary for growing greens throughout the winter months. Tunnels are passively solar-heated, and nighttime low temperatures within a high tunnel can be a few degrees warmer than outside temperatures. Row covers used in conjunction with the high tunnel will provide additional cold and frost protection. Because row covers also block sunlight, they should not be left on for prolonged periods during the winter. Placing the row covers over hoops will help to keep tender leaves from freezing to the fabric. As an alternative, a heater can be used when unexpected drops in temperature occur. However, due to rising energy costs, the use of heaters should generally be limited to short durations. Often these extra precautions against cold are not necessary, as many greens will recover from an overnight freeze and continue to grow with warming temperatures the following day. A grower who has received NRCS EQIP funds to purchase a high tunnel should check his/her state's NRCS High Tunnel System Conservation Practice Standard to

make sure heaters are allowed. NRCS allows the permanent installation of heaters in Kentucky. Such additions should be included in the manufacturer's design and recommendations.

Opening the sidewalls is imperative for good air circulation and temperature control, even in winter. During sunny days, temperatures in the tunnels can be 30 to 40 °F higher than outside temperatures, necessitating that the tunnels be adequately vented. Lacking the automated ventilation system of more elaborate greenhouses, high tunnels are ventilated by manually rolling up the sidewalls in the morning and closing them at night. Orienting the houses perpendicular to the prevailing wind on the farm will help facilitate air movement.

Because tunnels prevent natural rainfall from reaching plants, drip irrigation is essential. The irrigation system can also be used to provide fertilization during the season. Watering will need to be carefully managed during the winter. Very turgid plants may not recover as well from freezes, so it is best not to water immediately before temperatures drop below freezing. Plants should be irrigated only when tunnel temperatures are expected to remain above 32 °F for a few days. Growers, therefore, will need to closely monitor both air temperature forecasts and soil moisture.

High tunnel production of leaf lettuce into early summer will require shade cloth. One experienced Kentucky grower uses 60% shade cloth, while 39% shade has been used successfully in Missouri and Kansas trials growing leaf lettuce and spinach. The combination of shade and irrigation keeps soils cooler, thus improving plant establishment and reducing bolting (flowering) problems. In spite of these successes, however, summer greens production in Kentucky is quite risky. Not only is the chance of bolting especially high, but greens often develop a bitter taste in very hot weather if they are not adequately watered.

### *Site selection*

Although stand-alone greenhouses are normally oriented in a north-south direction in Kentucky, orienting a high tunnel in an east-west direction will maximize the amount of low winter sunlight reaching plants. Select a level, well-drained, fertile location for greens production. Site selection is more critical when

the high tunnel is built to be a permanent structure. Once permanent tunnels are in place, amending the soil each year could present a challenge. A small tractor with a tiller can be driven into tunnels with hinged endwalls. However, if the endwalls are fixed, soil preparation will need to be accomplished by hand or with a small power tiller.

Moveable high tunnels can be relocated to a new site each season to facilitate crop rotation and to avoid nutrient depletion of the soil. Another benefit to moveable tunnels is the ability to rotate the high tunnel to different locations in the field to prevent the buildup of soil-borne diseases. Often tunnels that remain in the same location, producing the same crop for a number of years, will have high levels of soil pathogens. This leads to progressively high disease loads and crop losses. The soil in moveable tunnels should be worked prior to erecting the structure.

#### *Plant selection*

Greens producers will need to diversify their crop offerings with an assortment of colors, textures, and leaf shapes to appeal to consumers. Select crops that are both marketable and winter hardy. Winter greens that have a history of success in Kentucky high tunnels include: arugula, Chinese cabbage, endive, Mizuna (Japanese mustard), mustard greens, Pak Choi, Russian kale, spinach, and Tat Soi (Asian mustard). Lettuces include Bibb (Boston), leaf, and romaine (cos). The following herbs could potentially be grown in high tunnels: cilantro, chives, dill, garlic chives (Chinese leeks), oregano, parsley, sweet marjoram, and thyme. For early summer production, select crops and cultivars that are bolt-resistant. Growers will need to experiment with crops and cultivars to determine what works for their production system at their particular location.

#### *Planting*

Winter greens are either direct-seeded or transplanted into ground beds. In general, plants that are harvested as heads are transplanted, while those harvested as individual leaves are seeded. Transplants should be 4 to 6 weeks old, depending on the crop. Greens can be re-seeded or transplanted every three to six weeks for a continuous harvest. Early fall plantings of spinach may require pre-germinating seed for one week in a cold room or refrigerator. Once soils cool, pre-germination is no longer necessary.

Raised beds, which enhance soil warming in the spring, may actually be a detriment to winter crop production; soils in raised beds do not stay as warm as soil-level beds.

Leaf lettuces for early summer production require extra attention. Plants will grow quickly and need to be harvested in a timely manner. Because plant regrowth usually suffers from a loss in quality, a planting may only yield a single cutting. After harvest, plants are turned under and the area seeded for the next crop.

#### *Pest management*

Due to the unique environment within tunnels, growers may encounter different disease problems within the tunnel than in the field. Because the tunnel excludes rainfall, the foliage tends to stay dry, resulting in fewer disease problems due to those pathogens that are spread by rain splash or require leaf-wetness for infection. However, due to the limited movement of air in a tunnel, diseases favored by high humidity could increase in severity. These include gray mold, leaf mold and powdery mildew.

Insect pests in tunnels differ as well. While the high tunnel presents a barrier to some insects, it is an ideal environment for others, particularly whiteflies and aphids. Typically any insect that is a problem in a greenhouse environment will be a problem in a high tunnel. Additionally, grasshopper feeding can occur throughout the winter since the ground within the tunnel does not freeze. Without natural predators, such as birds, to help keep insects in check, serious infestations may develop very quickly.

Due to the relatively high density of plants in tunnels, pests and diseases tend to spread rapidly. Frequent scouting to monitor insect populations and disease is essential to keeping these problems manageable.

#### *Harvest*

Leafy greens are hand-harvested as whole plants (once over harvest) or as individual leaves (multiple harvests). Because the harvested products are leaves (which rapidly lose water), care must be taken to cool, pack, and sell them promptly.

Romaine, Boston lettuce, Chinese cabbage, and Tat Soi are harvested as whole plants. They are cut at the



base with a knife once heads have reached the desired size and density.

Crops sold in bunches include herbs, arugula, and other greens. The leaves are cut with a knife or scissors, leaving sufficient plant material for regrowth (about an inch above the soil surface to protect the growing point). Many growers harvest a set number of leaves per plant to maximize the number of harvest weeks. Endive must be harvested before a strong bitter taste and toughness develops that makes it unmarketable. Leaves are bound with rubber bands or produce ties. Some plants wilt quickly and may need to be stored in water until packed or delivered.

Greens to be sold in bags as a mesclun mix or braising mix are either hand-picked or cut with sharp scissors to minimize cell damage and prolong quality, and then placed in bins.

#### *Labor requirements*

High tunnel greens production for 20 weeks from a single 96-foot by 20-foot house requires labor for site preparation (10 to 15 hours), planting (three to six hours), production (10 hours), and harvest/packing/marketing (40 to 100 hours). Harvest times are highly variable depending on crop mix and selection. Crops that include greens, Bibb (Boston), and romaine lettuce can be harvested and packed in considerably less time (40 to 60 hours) for the season than herbs and leaf lettuces (50 to 100 hours). In addition, high tunnels will require daily labor to manually raise and lower sidewalls (15 to 20 hours). These structures could also require monitoring during heavy storms. Additional labor may be required for producers marketing their own greens.

#### **Economic considerations**

Initial investments include high tunnel construction, land preparation, purchase of seed or transplants, and installation of an irrigation system. Additional start-up costs could include black plastic mulch, row covers, and an inflation fan. Seed costs for specialty greens and herbs may be higher than more common crops.

High tunnels are a relatively inexpensive way to extend the growing season. Excluding labor, the approximate materials cost of high tunnel construction is \$1.30 to \$1.50 per square foot. Site preparation and high tunnel systems, like ventilation fans and heating,

can add about the same amount per square foot. High tunnel operators in Kentucky reported high tunnel construction costs during winter 2017 at \$2.50 to \$3 per square foot, plus the value of some operator labor. Compared to the cost of a traditional production-ready greenhouse (\$8 to \$30 per square foot), the high tunnel requires little capital investment. High tunnel production, however, does represent a much greater investment than growing produce in the field.

The following 2016 budget estimate is based on specialty lettuce production in a 96-foot by 20-foot high tunnel. Costs will be similar for other crops; higher value greens and herbs could result in potentially greater returns. Production costs for mixed greens are estimated at \$440, with harvest and marketing costs at \$500. Total annual expenses per tunnel are estimated at \$1,440, which includes an annual fixed cost representing tunnel construction costs depreciated over 10 years.

Gross returns will vary widely according to local market conditions; presuming a conservative gross return estimate of \$3,000, returns to land, capital, and management would be approximately \$1,600. This estimate includes the cost of \$10 per hour for all labor needs. Actual returns from high tunnel production of leafy greens may far exceed this estimate based on market demand and price.

A variety of greens and herbs can be grown in high tunnels in the winter months. Producers should formulate their own budget estimates based on what they know their potential markets are demanding. For example, members of a CSA might be surveyed as to whether they would prefer to receive early or late-season romaine lettuce, mesclun salad mix, herbs, or a combination of all three. While production costs for different varieties may be similar, good estimates before planting will allow the producer to accurately price their crop.

#### **Selected Resources**

- How to Build a High Tunnel (University of Kentucky) <http://www.uky.edu/hort/sites/www.uky.edu/hort/files/documents/hightunnel.pdf>
- An IPM Scouting Guide for Common Problems of High Tunnel and Greenhouse Vegetable Crops in Kentucky (University of Kentucky, 2016) <http://www2.ca.uky.edu/agcomm/pubs/ID/ID235/ID235.pdf>

- Cornell High Tunnels - Greens (Cornell University) <http://blogs.cornell.edu/hightunnels/vegetables/greens/>
- High Tunnel Winter Cropping Systems (West Virginia University, SARE) <http://www.sare.org/Learning-Center/SARE-Project-Products/Northeast-SARE-Project-Products/High-Tunnel-Winter-Cropping-Systems>
- Organic & Sustainable Crop Production Grower Resources: High Tunnels (University of Tennessee) <http://organics.utk.edu/growers.htm#HighTunnels>
- Sample Budgets and Spreadsheets (Winter Greens) (Cornell University, 2009) <http://blogs.cornell.edu/hightunnels/economics/sample-budgets-spreadsheets/>

- Specialty Lettuce and Greens: Organic Production (ATTRA, 2002) <https://attra.ncat.org/attra-pub/summaries/summary.php?pub=375>

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*Photo courtesy of Tim Coolong, University of Georgia Associate Vegetable Professor*

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