



# Growing in a High Tunnel

## EVALUATE YOUR PRODUCTION GOALS AND SKILLS

A high tunnel is a covered growing area that requires some hands-on management and knowledge in order to yield healthy fruit or vegetable crops safely. High tunnels are most frequently used to extend the growing season for many fruits and vegetables, and may also be used for starting transplants so that you can germinate your seeds earlier and produce viable plants early in the season.

In contrast to a greenhouse, a high tunnel is unheated, provides less climate control, and is less expensive. As a grower, however, you need to understand the production

environment your tunnel will create and how it will perform with respect to temperature, wind and snow loads, hail impacts, and relative humidity, throughout the year. Consider the size of tunnel, shape and permanence of the structure, and where you will erect it. Start by asking yourself if you can cover your tunnel purchase, construction and maintenance costs by selling or using all the produce you grow. Do you have the time to manage a high tunnel during the winter months when you may need to protect your plants from very low temperatures with row cover, or during the warm months when internal tunnel temperatures may reach well over 120 degrees?

Select the crops you will grow in your tunnel based on their suitability for covered growing conditions. This means selecting for insect and disease resistance, and some ability to tolerate the temperature extremes that may occur if your high tunnel is unheated and uncooled. Note too that crops planted in the outermost rows, along the tunnel's exterior walls, will be subject to more significant effects of temperature and you may experience some crop losses or yield reduction among those plants.

## SELECT THE BEST TUNNEL FOR YOUR CROPS

Tunnel size and shape influence not only the cost of your covered growing environment but also the conditions inside it. Smaller tunnels are less expensive but are more subject to greater temperature and humidity fluctuations compared to a larger tunnel. A small tunnel may be from 12 to 20 feet in length and from 10 to 30 feet wide (resulting in 120 to 600 square feet of space under cover).

Consider the height of your tunnel at the sidewalls and center so that you can move easily within your structure. Higher side walls will also permit you to grow taller crops and trellis them should you need to. The wider the tunnel, the more difficult it is to ventilate, so tunnels that are wider than 30 feet may accumulate too much heat during the warmest months. A larger tunnel may span 30 feet in width and run 100 feet or more in length—which will be a more appropriate structure for commercial horticultural production.

Tunnels come in two basic shapes. Quonset-shaped tunnels have rounded arches that are typically spaced 4 feet apart. The side walls are either rounded by the arches or seated upon straight sidewalls to create more growing space. Quonset shaped tunnels collect snow that may be difficult to shed and place undue stress on the structure.



*A well-constructed tunnel should last at least 10 years, although the covering will likely need to be replaced every 4-5 years as the UV protection in it deteriorates with exposure to the sun.*



*Gothic shaped tunnels have peaked roofs that result in both a taller tunnel and one that sheds snow more easily. Because they are taller, gothic shaped tunnels will require additional bracing for wind resistance.*

## COMPONENTS OF A HIGH TUNNEL

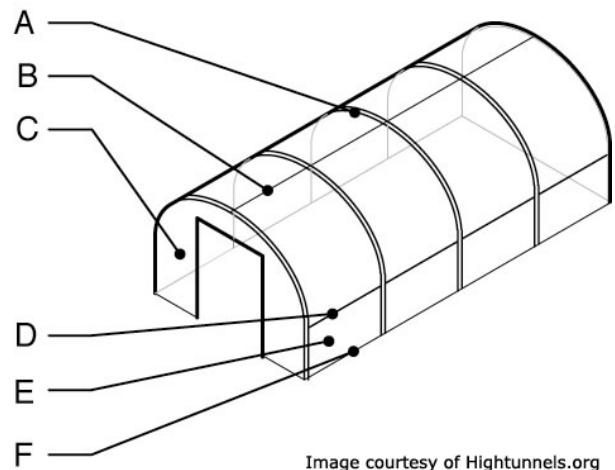


Image courtesy of Hightunnels.org

**A. Rib, Hoop, Arch, Bow:** The ribs, often made of plastic pipe, in the shape of large hoops, should be securely fastened to the ground, and are what you use to attach and support your polyethylene plastic.

**B. Purlin, Ridgepole:** Horizontal steel rods for hanging baskets and efficiently using growing space.

**C. End Wall:** Walls constructed at either end of the hoop house for support.

**D. Hip Board:** Baseboards and hip-boards secure a hoop house or greenhouse frame against weather.

**E. Side Wall:** Walls constructed the entire length of the hoop house for support and to shelter the crops planted inside.

**F. Baseboard:** Baseboards and hip-boards secure a hoop house or greenhouse frame.

**PVC Pipe:** A specific type of pipe, strong and bendable, that is often used in the construction of hoop house ribs.

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## CREATE A SAFE GROWING ENVIRONMENT

Many high tunnels are not easily movable, therefore selecting a location for your tunnel and managing the soils is very important for producing healthy crops. High tunnel orientation—based on latitude or day length—determines a site’s exposure to the sun:

- Above 40° latitude: run your high tunnel ridges from East to West to maximize light intensity and minimize exposure to Colorado’s highest winds; and
- Below 40° latitude: run high tunnel ridges from North to South to maximize solar capture.

Note that Baseline Road in Boulder, Colorado runs along 40° latitude.

**Topography and exposure.** Avoid siting your tunnel in a valley floor, basin or other low lying area that will capture cold air. Know what was grown on the site previously. Did the previous grower apply herbicides?

**Rainfall and drainage.** Evaluate how water drains on your proposed site. Do you need a drainage ditch or some other means of diverting rainfall away from your tunnel?

**Site preparation.** If possible, begin preparing your site a year in advance and cultivate to remove weeds. You can use cover crops to increase nutrient levels, and add compost and organic matter. Make sure your site is level before erecting your high tunnel—both for drainage and for the tunnel’s structural soundness.

**Structure reinforcement.** Choose the type of high tunnel you purchase based on the size you will require for production, as well as the tunnel’s ability to withstand wind, snow, and hail in your specific location. Evaluate how you can reinforce the structure by choosing a steel versus a PVC frame and adding braces to the ribs. Use anchors at the base of each rib (or every other rib) to hold the tunnel to the ground. Reinforce the endwalls to withstand prevailing winds and for ease of opening and closing them (zippers on some tunnels may break under constant strain).

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## STRATEGIES FOR SUCCESSFUL HIGH TUNNEL PRODUCTION

**Photo period.** Although high tunnels lengthen the period over which you can grow many vegetables, crops planted in December and January in Colorado, or those you would like to harvest in January or February, will grow very slowly since the day length (photo period) is very short relative to most plants’ light requirements. Consequently, your seeds will take longer to germinate and your crop yields will be lower than those planted in March.

**Temperature control.** Seasonal temperature variations will greatly impact your ability to grow food crops in your high tunnel. Because high tunnels have no temperature control mechanism to maintain appropriate growing conditions for your plants, you may need to use single or double row covering to protect plants during the coldest periods. During Colorado’s hottest periods, you may need to vent your tunnel daily to reduce heat build-up inside the tunnel.

**Pests and weeds.** Although you will experience much less predation from birds and deer, for example, you will still need to be vigilant about insects, rodents and invasive weeds that can reduce or eliminate your crop yields. Weed mat or plastic mulch may help suppress weeds that emerge during the growing season, as will regular weed removal to prevent seeding and dispersion. Due to the protected growing conditions and increased humidity, insect pests may be difficult to control or eliminate during the growing season. Strategies to address insect problems include using insect screening over your tunnel, releasing beneficial insects that will attack identified pests, applying chemical treatments (use only those labeled for greenhouse use), and heating or freezing out insects (closing your empty tunnel off in high summer for a few

weeks to allow for high heat intensity to burn out insects or opening your tunnel up in mid-winter to freeze off any insect populations). Soil-borne pathogens or those in rootstock can be just as significant an issue in a covered growing environment as in an open field situation. Regular monitoring of your crop and tunnel conditions will help you address insect, disease and pest problems before they become unmanageable and cause significant crop damage or loss.

**Soil quality.** A high tunnel area requires soil amendments similar to open fields; however, soils under tunnels are not subject to effects of weather such as rainfall, freezing or thawing. Before planting in your tunnel, have your soil tested so that you can create the best growing environment for your crops, and re-test annually. Fertility maintenance may include applying certified compost, peat and/or other fertilizers depending on your soil's nutrient composition and level of organic matter. Monitor your soil for surface mineral deposits such as salt.

**Water application and management.** Since you are growing in a covered environment, you will need to apply less water to your crops overall; however, you will need some system for regularly applying water to meet each crop's water requirements throughout the growing season. An irrigation system is highly recommended to make sure you are delivering the correct amount of water to your plants, when they need it. There are several irrigation system options, including overhead sprinklers, misters, and drip lines at the soil or subsurface level. The types of crops you will grow, and the system cost, ease of installation and management will influence choice of irrigation technology. Soil water sensors are an inexpensive way to measure soil water content and ensure you are applying the correct amount of water for your plants. If you are growing during colder months, you will need a frost-free hydrant to ensure that your irrigation water doesn't freeze in the piping or hose.

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## MANAGING THE UNEXPECTED

**Keeping your high tunnel structure safe.** Inspect your high tunnel regularly for stress or tears in the side and end walls, and look for bending in the ribs and purlins. You may need to reinforce your tunnel if you find that wear and tear are weakening it.



**Protect your new asset.** If you are a backyard producer, verify whether your high tunnel is covered by your homeowner's insurance policy. If you have a commercial operation, ensure your farm insurance policy includes coverage for your high tunnel in case it is somehow compromised or causes damage to another structure.

**Grow food safely.** Use only certified composts and amendments, and properly aged animal manures in your high tunnel soils. Irrigate with water you have determined, through laboratory testing, to be pathogen-free or use potable water. If you wash your produce, use only potable water, and keep produce cool during harvest, storage and delivery. Pick or pack produce into clean and sanitized containers. If you transport your produce, use a clean, cool vehicle and make your deliveries as early in the day as possible.

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## BE A GOOD NEIGHBOR!

- Do not situate your tunnel such that it obstructs your neighbor's view or casts a shadow on his/her growing areas. Talk to your neighbors about your tunnel before putting it up to answer any questions they may have.
- Make sure your tunnel is reinforced against wind and snow loads and well-anchored to the ground. Consult your tunnel's manufacturer if you have any questions about its structural integrity.

## IF I HAVE A FARM OR COMMUNITY GARDEN, AND WANT TO EXTEND MY GROWING SEASON, WHAT SHOULD I DO?

If you are required to have an urban agriculture license, i.e., your urban farm or community garden is the principal use on your property (visit [fcgov.com/urbanagriculture](http://fcgov.com/urbanagriculture)), then you simply need to include the information about your hoop house (proposed height, area, materials, and location on the site) with your license application. This application will be reviewed by City staff to ensure the best practices in this brochure are being followed and that any impacts to your neighbors are minimized. A hoop house must be situated five feet from any adjacent property line, and located in such a manner that it does not generate adverse impacts on adjacent uses.

## FREQUENTLY ASKED QUESTIONS ABOUT HOOP HOUSES

The City of Fort Collins welcomes food production by residents in their yards and homes using different growing strategies, including hoop houses and high tunnels. To ensure the safety and integrity of these structures—especially in preventing injuries or property damage resulting from a failure in the frame of your structure—the City will inspect all hoop houses erected after June 30, 2014.

### 1. HOW WILL THE CITY EVALUATE MY HOOP HOUSE?

- The City's Building Review Board will schedule a site visit and a review of your structure, including a visual inspection. Note that there is no formal engineering inspection of your hoop house structure.
- Call the City at 970-416-2618 to schedule a site visit and review.

### 2. DO I NEED A PERMIT FOR MY HOOP HOUSE?

- If your hoop house was constructed before June 30, 2014, then **you do not** need a permit.
- If your hoop house has a flexible frame, e.g. PVC, then **you do not** need a permit for the structure. If

agriculture is the principal use of your property, then you will need an urban agriculture license.

- If your hoop house has an inflexible frame, e.g. steel or wood frame and exceeds 120 square feet in covered area and 8 feet in height, then you will need a permit for this structure since the City classifies these as membrane structures.

### 3. ARE THERE ANY SIZE OR SHAPE RESTRICTIONS FOR A MEMBRANE STRUCTURE?

No, as long as your structure meets setback requirements of 5 feet from the side of your property and 15 feet from your rear property line.

### 4. CAN I HEAT OR COOL THE INTERIOR OF MY MEMBRANE STRUCTURE?

Yes, you may use electric, gas or water to heat or cool your structure. Remember, however, that those systems become part of the permit and, as you add utilities and equipment, your valuation will increase, as well the cost of your permit.

### 5. CAN I MOVE MY STRUCTURE ON MY PROPERTY?

Yes, you may move your structure, as long as you maintain the setback requirements stated above. If your hoop house is anchored on rails for easy mobility, then the rails and anchoring system will become part of the permit review process and will be included in your permit.

Note that all structures, both non-membrane and membrane types, should be anchored to the ground. These anchors may comprise hurricane straps tied to rebar stakes that will hold the hoop house in place against high wind conditions.

### 6. WHAT ELSE DO I NEED TO KNOW ABOUT THE CITY'S REVIEW OF HOOP HOUSES?

- You may keep your plastic covering on your structure year-round.
- You may use two layers of plastic on non-membrane structures or a double membrane on membrane structures.

- You may frame the end walls of your non-membrane structure with a rigid material (e.g. wood) for added stability.
- If your membrane structure has rigid roof panels, you will be required to have an engineering inspection.

## 7. HOW MUCH WILL A PERMIT COST?

The fee for a membrane structure permit is based on the valuation of the structure, associated materials (fans, pumps, rails) and labor costs. For example, if the value of your hoop house is \$1,000, then the cost of your one-time permit is about \$50.

## 8. HOW DO I APPLY FOR A PERMIT FOR MY MEMBRANE STRUCTURE?

First, draw up a plan showing the height and the length of your membrane structure, and the setbacks from surrounding properties. Submit your permit to the City of Fort Collins, Chief Building Official at (970) 221-6760.

Contact the Building Office at 970-416-2618 to schedule a site visit and review.

## 9. HOW LONG WILL THE PERMIT REVIEW TAKE, FOLLOWING THE SITE VISIT?

Generally less than 15 minutes at the City offices at 281 North College Avenue.

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## HIGH TUNNEL RESOURCES

Cornell University Department of Horticulture high tunnel resources: [hort.cornell.edu/hightunnel/index.html](http://hort.cornell.edu/hightunnel/index.html)

Growing for Market: [growingformarket.com](http://growingformarket.com)

High Tunnel Specialty Crop Production in Colorado webinar: [connect.extension.iastate.edu/p34276512](http://connect.extension.iastate.edu/p34276512)  
eXtension web pages on high tunnel construction and maintenance. [extension.org/pages/18358/introduction-to-high-tunnels#.UvZrq7Sro6A](http://extension.org/pages/18358/introduction-to-high-tunnels#.UvZrq7Sro6A)

NRCS Seasonal High Tunnel Initiative  
[nrcs.usda.gov/wps/portal/nrcs/detail/co/programs/?cid=nrcs144p2\\_062767](http://nrcs.usda.gov/wps/portal/nrcs/detail/co/programs/?cid=nrcs144p2_062767)

Slide show on high tunnel construction:

[njsustainingfarms.rutgers.edu/highslide/images/large/titles/ide1.jpg](http://njsustainingfarms.rutgers.edu/highslide/images/large/titles/ide1.jpg)

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## FOOD SYSTEMS RESOURCES

Building Farmers and Ranchers Program (business, planning, and management networking and mentoring for ag-businesses): [buildingfarmers.colostate.edu/about.shtml](http://buildingfarmers.colostate.edu/about.shtml)

CanDo (information on Northern Colorado's food environment): [candoonline.org](http://candoonline.org)

City of Fort Collins Planning Services (urban agriculture license):  
[fcgov.com/developmentreview/urbanagriculture.php](http://fcgov.com/developmentreview/urbanagriculture.php)

Colorado Farm to Market (Colorado State University Extension guidance and regulations for marketing food products): [cofarmtomarket.com](http://cofarmtomarket.com)

Community Gardens (public garden space for rent):  
[fcgov.com/gardens/our-gardens/community-gardens](http://fcgov.com/gardens/our-gardens/community-gardens)

Food safety for consumers and producers:  
[farmtotable.colostate.edu](http://farmtotable.colostate.edu)

Gardens on Spring Creek (general growing advice):  
[fcgov.com/gardens](http://fcgov.com/gardens)

Larimer County Food Bank (food donations):  
[foodbanklarimer.org](http://foodbanklarimer.org)

Northern Colorado Food Cluster (food system policy and project development):  
[nocofoodcluster.com/#about-1](http://nocofoodcluster.com/#about-1)  
or email [nocofoodcluster@gmail.com](mailto:nocofoodcluster@gmail.com).