

Chapter 9

High Tunnels an Excellent Tool for Organic Production

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A high tunnel is a temporary structure similar to a greenhouse that may be the most versatile of all the season extenders. High tunnels are an excellent method to produce high quality organic fruits and vegetables in Maryland. These structures have the potential to extend the growing season and reduce the need for control strategies for many diseases and insects. High tunnels are a low cost, low maintenance, and highly flexible tool that can be placed on any property site, provided that it is suitable and has an adequate source of water. Electricity is generally not required. Ventilation is passive, as the high tunnel sides are manually rolled up to allow air flow across the tunnel. This ventilation process cools the structure and removes humid air that can accumulate in the tunnel at night as the plants respire. High tunnels allow the grower to plant early in the season, continue production later in the season, and possibly produce additional crops, such as greens, throughout the winter.

In Maryland, the possibilities for crops are almost unlimited. As with any enterprise, high tunnel crop selection depends on the marketing plan of the operation. Whether the crops can be sold for profit often hinges on the marketing ingenuity of the operation. With good planning, variety selection, and close management, a low-cost high tunnel system can add another profitable opportunity for a vegetable or small fruit operation.

During a three year research project, farmer cooperators found that high tunnel production offers significant advantages to field production, such as in increased yield and improved fruit quality. High tunnel design keeps crop foliage dry, thereby reducing disease. Moisture is further controlled through drip irrigation, which contributes to the potential for high production and excellent produce quality. Producers have noted that heirloom tomatoes grown in high tunnels cracked less, had fewer blemishes, and showed increased yields, compared with field-grown tomatoes. Study cooperators also noted improved quality and increased yields from supplemental crops, including pea shoots, carrots, rapini, strawberries, beans, and salad greens. Strawberries, especially, had less disease, increased yields, and an earlier harvest date, compared with field-grown strawberries. High tunnels also extended the season of salad greens, compared with field-grown greens.

High Tunnel Basics

High tunnels are management-intensive and may not be appropriate for part-time growers who are unable to invest the necessary time and effort or whose location is too rural or out of the way. Tunnels may not be the best choice when the only good location is far away from the farmhouse because of winter management such as brushing snow

off. Putting the high tunnel away from the center of the farm may not be wise because you don't want to drive out frequently to roll up the sides. Within the first year of operation, growers willing to closely monitor temperature, soil moisture, plant health, fertility, as well as follow an effective integrated pest management (IPM) program should be able to absorb the cost of the tunnel. Prior to purchasing a tunnel, serious considerations must be made regarding commitment, time management, and marketing. When growers devote increased time to managing their high tunnel, crop quality and yields increase, as well as profitability.

Effective high tunnel management includes:

- Rolling the sides up and down for maximum heating and cooling.
- Monitoring the crops for disease and pest problems.
- Developing an irrigation schedule.
- Fertility management.
- Timely harvesting of crops.

Productive high tunnel management involves a significant amount of time and dedication. Surprisingly, it requires more effort than simply spending 10 minutes in the morning to turn on the irrigation system, walk through the tunnel, and then returning three hours later to shut down the irrigation system, until eventually harvesting the crop. As the growing season progresses, growers must allocate additional time for field production and potential management conflicts that may arise between high tunnel and field production. Time is limited; therefore, it can be challenging to achieve a successful balance between high tunnel and field production.

A high tunnel system is large enough for the grower to plant, monitor, and harvest the crop from inside the structure. Standard tunnels are 14 - 30 feet wide, 36 - 200 feet long, and 7.5 - 13.5 feet tall at the center. Tunnels less than 30 feet wide create more effective cross ventilation and also reduce snow accumulation on the roof during the winter season. The sides should be vertical and the plastic rolled up at least five feet off the ground. Higher side openings improve air flow; however, great care must be taken to ensure that the plastic covers the plants and prevents rain from wetting the foliage. The Gothic A Frame consists of metal bows made by bending steel pipe or tubing. Potential stresses caused by the weight of snow or heavy wind also must be considered. Metal pipes are driven into the ground approximately two feet deep every four feet of the high tunnel length to provide support for the Gothic A Frame. The bows fit into the ground pipes and are attached by bolts. The ends of the structure can be plastic or wood on a wood stud frame; however, it should be removable to allow access for tillage equipment and to increase ventilation during the summer.

The structure is typically covered with a single layer of 6-mil polyethylene with provisions for rolling up the sidewalls. The polyethylene is secured onto a batten board on each side of the high tunnel about 5 - 6 feet above the soil line. A vertical sidewall helps to prevent rain from entering the tunnel, and when rolled up it provides ventilation. A pipe is then attached to the loose bottom end of the plastic along the length of the

structure. A “T” handle on the end of the pipe is used to roll the plastic onto the pipe to open the sides.

Cross ventilation is assisted by the wind and has proved to be very efficient. The site and productivity can be maintained into or beyond the conventional growing season as long as the side vents are carefully managed.

The key to successful use of the high tunnel is to plan and prepare the site for construction. Crops are grown directly in the soil inside the high tunnel, therefore, the site should be well drained and in an area where water will not collect. The site does not have to be perfectly level; however, slopes with more than one foot grade change over 100 feet may require some grading. Remember that crop production is better suited for less-disturbed soils. Also, soil will benefit from amendment with compost. Plants can be grown on raised beds covered with plastic or landscape fabric with the rows in between bare soil or the entire floor can be covered with landscape fabric.

During periods of cold weather, the sides are lowered in the afternoon to retain heat and then raised in the morning to vent before the internal temperature rises too high. The floor of the structure may be covered with a layer of black landscape fabric, which (1) helps raise the temperature inside the tunnel (which extends the season), (2) controls weeds, and (3) prevents evaporation of soil moisture. The structure also will provide a foundation for the use of plastic netting for support, shade cloth, and row covers for increased plant protection on cold nights. Excess moisture raises humidity in the tunnel and often leads to disease problems. Humidity typically increases at night as temperatures drop. Venting in the morning allows the moist air to escape. High tunnels can reduce the incidence of some diseases--particularly if trickle-irrigation tubing is used underneath the black plastic mulch. Due to the fact that water does not hit the foliage, disease development is slowed.

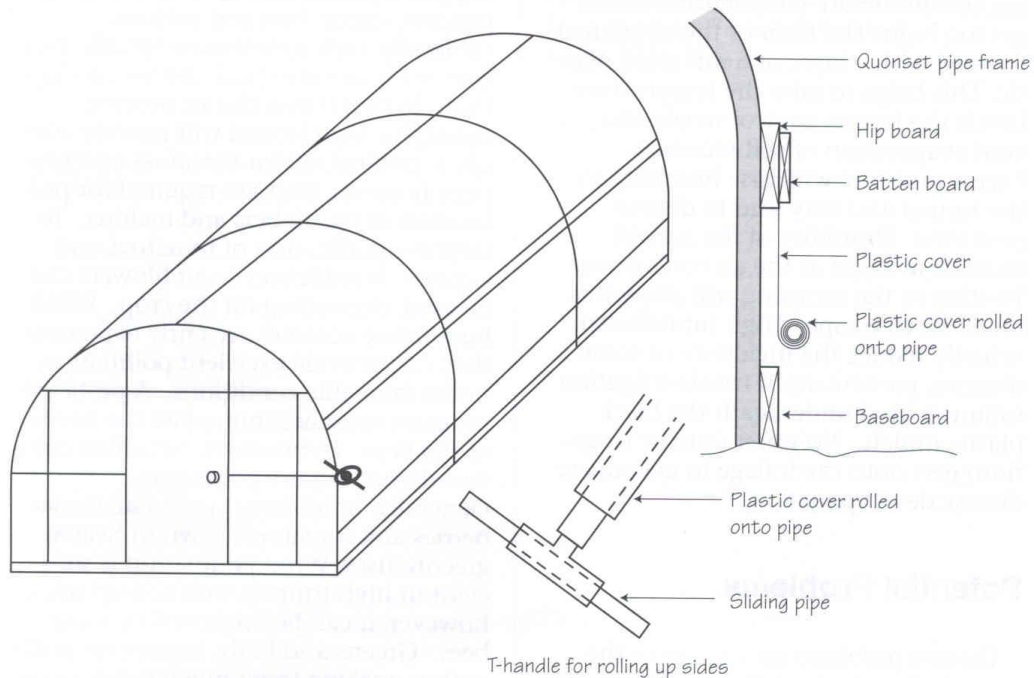


Figure 1. Typical high tunnel (cold frame) with roll-up sides using a T-handle on a pipe.

High Tunnel Benefits

High tunnel crop production is rapidly expanding throughout the Northeastern U.S., as well as internationally. Vegetables, small fruits, and cut flowers may benefit from the season extension and weather protection provided by a high tunnel. High tunnels create a microclimate that may increase flower quality. Foliage and flowers do not become wet, which reduces the incidence of many diseases. Soils do not become excessively wet, since the only water supply in the tunnel is trickle irrigation which reduces the incidence of certain root rotting diseases. As an added benefit, the area between the beds will become too dry for weeds to germinate provided that irrigation is installed correctly and the floor receives no rainfall.

The single layer plastic reduces light levels about 10%, compared with growing outside. Temperatures inside the tunnel are usually warmer than outside temperatures, thus encouraging season extension. The floor in the tunnel will not freeze during most Maryland winters; this allows winter tasks such as soil amendment incorporation, growing during cool weather, or covering crops during the coldest part of the winter. The roll-up sides provide passive ventilation to cool the structure and dry the foliage, once again reducing the incidence of disease. The sides can be lowered in the evening to hold in heat and can protect cut flower plants from windy and inclement conditions that may flatten flowers grown outside.

Crop options for high tunnels in Maryland are limited only by the producer's imagination and potential markets. Ginger, raspberries, greens, tomatoes, cucumbers, peppers, onions, potatoes, beets, and even dwarf fruit trees can be grown in structures. It is important to consider the market potential as well as the amount of space that can be

devoted to high tunnel crops. Timing is also a consideration. For example, crops that offer potential for premium prices early or late in the season may be the most profitable. Rotations must be considered--at times many growers discover that they need three or more tunnels to allow maximum flexibility and space for trial.

Currently, projects conducted at the University of Maryland are examining the practicality of a mobile high tunnel. This type of tunnel is 18 feet wide by 48 feet long; it is on wheels and rolls on a 150 foot track. Many growers have shown an interest in the movable structure. Ongoing research is focusing on the effect of covering various crops at different times of the year. Annual strawberries planted in the fall will be covered throughout the winter months, while heirloom tomatoes will be covered during the summer. In October, the tunnel will be moved to cover primocane red raspberries that are scheduled to be harvested sometime in late November or December. After the raspberry harvest has been completed, the tunnel will be moved to cover the strawberries during the winter months.

High Tunnel Disadvantages

High tunnels require an increase in the level and the amount of management needed to grow crops. The sides must be raised and lowered to regulate temperature and humidity. Plants must be irrigated regularly and fertigated as needed. Unless supplemental heat is provided, the tunnel may not be able to provide adequate protection to the plants after November/ December, depending on the weather during a given year.

Disease problems may occur, even in the protected environment; therefore, management of the environment is critical. The high tunnel climate potentially may increase the incidence of powdery mildew, and should be monitored closely. Ventilation to avoid high temperatures or high humidity also is very important. Maryland's unpredictable weather during the spring and fall may increase management needs during those seasons.

The microclimate created by high tunnel encourages insect growth as well as plant growth. IPM strategies and pest scouting must begin when the plants are set out. Insect thresholds appear to be lower than in open field production and research is ongoing to provide better guidelines for action thresholds. The use of beneficial insects is a practical way to deal with many insect and mite problems. Season extenders, like row covers, may be used as physical barriers to prevent insects from nesting on the plants. For example, floating row covers with edges secured by soil, will prevent many insects from reaching the crop while screen door material installed on the roll-up sides will exclude larger pests.

Many growers use insect management strategies that minimize or eliminate pesticide use in field production. These strategies frequently focus on over-planting for yield compensation and allowing the natural insect predator/prey cycles to occur, crop rotations, and acceptance of low levels of pressure from pests. These strategies reduce

crop loss from insect damage to a tolerable level, thus a marketable product is produced. Unfortunately, this approach will not work within a high tunnel. Observation has shown the tolerable insect threshold level for a high tunnel is lower than in the field, possibly due to the high tunnel's semi-enclosed environment.

A three year project conducted at five sites has proven that growers who took early action to minimize insect damage were ultimately able to produce healthier plants that continued to yield high quality fruit during the growing season for a longer period of time. While growers who did not take action in a timely manner or chose no action produced stressed plants with significantly reduced yields and decreased plant longevity. Beneficial insects were present in all of the high tunnels at most times during the warmer growing season; however, the beneficials did not increase as fast as the insect pests when pest numbers increased past threshold level. Producers who take swift action to halt insect infestation in high tunnels will be rewarded with increased profits.

The Numbers

- A basic 21 x 48 feet, single layer of poly tunnel with Ends, Flooring, and Irrigation will cost approximately \$3000.

Actual data collected from a Maryland organic grower using a 21 x 48 feet tunnel

2005

- Tomatoes as a primary crop produced 1249.55 lbs @ \$3.00/lb = \$3748.65
- Date Planted: 4/1/05.

2006

- Tomatoes produced 878.32 lbs @ \$3.00/lb = \$2634.93
- Other Crops: Rapini, Pac Choi, Pea Shoots, Carrots, Tat Soi grossed \$712.00
- Date Planted: 3/23/06.

2007

- Tomatoes produced 907.91 lbs @ \$3.00/lb = \$2723.73
- Other crop: Chard grossed \$750.00
- Date Planted: 3/24/07.

Total: \$10,569.31 gross income over three years.

High Tunnel Source List

A.M. Leonard, Inc., 1-800-543-8955 <http://www.amleo.com/index/help-desk/subcat.cgi?Cat=D>

E. C. Geiger, Inc., Box 285, Rt. 63, Harleysville PA 19438-0332, 1-800-4GEIGER.

FarmTek – Growers Supply, 1-800-245-9881,
http://www.farmtek.com/farm/supplies/cat1a:ft1_coldframes_hightunnels.html

Four Season Tools, 1-816-444-7330, <http://www.fourseasontools.com>

Haygrove Tunnels, <http://www.haygrove.com>

Ledgewood Farm, 1-603-476-8829, <http://www.ledgewoodfarm.com/>

Maryland Plants and Supplies Inc., 1-800-248-2818,
<http://www.mdplantsandsupplies.com/>

Nolt's Produce Supply, 1-717-656-9764

Penn State Seed Co., Inc. 1-570-675-8585, <http://www.pennstateseed.com/>

Rimol Greenhouse Systems, 1-877-RIMOL-GH, <http://www.rimolgreenhouses.com/>

Walker Plants, 1-856-358-2548, <http://www.walkerplants.com/>

REFERENCES:

The Hoophouse Handbook: Growing Produce and Flowers in Hoophouses and High Tunnels, www.growingformarket.com

2003 High Tunnel Production Manual Penn State Center for Plasticulture,
<http://plasticulture.cas.psu.edu/manual.htm>

High Tunnel Vegetable Growing, www.hort.cornell.edu/hightunnel

HighTunnels.org, www.hightunnels.org

Hoop House Production Methods and Economics,
www.noble.org/Ag/Research/Horticulture.htm

Warm-Season Vegetable Production in High Tunnels,
www.kerrcenter.com/publications/2002_proceedings/warm-season_veggies.pdf

Four Season Farm, www.fourseasonfarm.com