High Tunnel Production

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High tunnel systems, commonly called "hoop houses," are an increasingly popular practice being adopted by farmers. The USDA High Tunnels System Initiative through the Environmental Quality Incentives Program (EQIP) has incentivized their use to 1) extend the growing season; 2) improve plant quality and soil quality; 3) reduce nutrient and pesticide transportation; and 4) improve air quality through reduced transportation inputs.

High tunnels are simple structures consisting of plastic-covered, tubular steel structures relying mainly on the sun's energy to warm the soil and air. Wind circulation and ventilation allows the high tunnel to be passively cooled. Typically, high tunnels are not equipped with concrete foundations and footings, mechanical heaters, exhaust fans, or supplemental lighting. This is what differentiates them from greenhouses, although some farms modify high tunnels to include these.

High tunnels can be semi-permanent, temporary, or movable structures. Moveable high tunnels are built on skids or wheels, allowing them to be moved for crop and field rotation purposes. High tunnels are built in a variety of shapes and sizes including Quonset, gothic, narrow or wide, short or long, and single bay or multi-bay. Four-season high tunnels are built to withstand snow and ice loads, whereas three-season high tunnels have a lighter frame design and the poly covers are removed during winter months to prevent snow and ice loads.

High tunnels, being high enough for a person to stand up inside of or allow for the use of small-sized tractors and equipment, are passively heated and cooled structures, designed to extend the growing season by increasing average temperature, and protecting crops from potentially damaging weather conditions including freeze and frost events, temperature fluctuations, precipitation, wind, or excess moisture. High tunnels can reduce production risks and may enhance crop quality. High tunnels provide growers an opportunity to lengthen their production, harvest, and marketing season.

Other benefits of high tunnels include better timeliness of production operations and utilization of labor by providing work in any type of weather conditions and potentially creating year-round harvest opportunities. The protected microclimate inside a high tunnel can produce crops of a higher quality and higher yields compared to their field-grown counterparts.

High tunnels are another tool in the toolbox for farmers wishing to extend their growing and marketing seasons, but they are not for everyone. High tunnel adoption requires additional costs, risks, and management and must align with the farm's business goals, objectives, and resources in order to be a profitable option.

Production Methods

In general, using the soil in a high tunnel is not too unlike field production, but rates of fertilizer and pesticides can be lower or less frequent because rain does not wash them out of soils or off plants. However, irrigation usage is more intensive without rain feeding the system. Vertical production with trellising materials, and combining hanging pots with soil-level plants are common methods for making use of the entire space.

Certain pests and diseases are more common in these environments than they are in the field. For example, *Botrytis* and spider mites. Ventilation, air circulation, and rapid heating in the morning are important features to reduce leaf wetness time for disease management and maintain temperatures that are not as conducive for pest issues.

Over time, with continuous in-soil production in a high tunnel, you may begin noticing lack of vigor, short plants, canopy collapse at fruit set, lower yields, and shorter yielding windows All are signs of vascular compromise or root damage by plant pathogenic fungi and nematodes that build up in protected high tunnel soils after growing the same plant species year in and year out. A concurrent trend is also a slow increase in soil pH and salinity if one is not checking on water quality, leaving nutrients unavailable to plants outside their suitable pH range or burning roots and reducing seed germination from salt levels.

What can one do to prevent this and ensure the long-term sustainability of the high tunnel?

1. Use a standard crop rotation in your high tunnel. It is tempting to grow tomatoes every year, but that selects for and enhances a soil microbiome that enjoys feeding on tomatoes.
2. Check your water pH and alkalinity and consider acidifying if your pH is over 7 and alkalinity is over 100 mg/L. These are normal values for standard field production and human consumption, but when water of this quality is the only water ever added to a system due to plastic keeping rain out, then the pH of the soil at the root zone increases over time. It is not uncommon to create a soil pH over 8.0 in high tunnels.

3. Pick a fall to change your plastic and leave it open to the sky until spring, and make a schedule of this every three or four years. This allows rain and snow percolate through the move some of the built-up fertilizer salts (organic and conventional) down and out, while also staving off pH increases because rainwater and snow have a naturally low pH and alkalinity.

Grafting

Grafting is a tool that some growers have adopted with great success in tomato hoophouses that were declining after 4 years of continuous production. There are several rootstock varieties to choose from, and the process is relatively easy to learn. However, it is more expensive and labor intensive if performing your own grafting. If the same rootstocks are chosen year in and year out, and no other preventative measures are taken, then pathogen and nematode pressure can continue to increase and in the next 3-8 years, you may find production declining again.

Soil Treatments

Chemical fumigation, high pressure steam, and biofumigation are techniques that can be deployed in high tunnels to sterilize soils. There is also a special technique developed for high tunnel growers to reduce the pathogen load in their soils while conserving beneficial soil organisms, called Anaerobic Soil Disinfestation (ASD). This technique encourages a special group of microbes, called anaerobes, to destroy air-breathing soil pathogens. For most growers, soil treatments can be applied every 3 to 5 years to keep soilborne diseases in check.

Container Culture

Container culture using pots or bags of potting mix is a great alternative to in-ground production, with plants in containers filled with potting media and the floor covered with landscape fabric. In hoophouses with compromised soils, it can be important to elevate containers off the ground to create an air gap. The main difference in production is dialing-in the irrigation and fertility program and finding time to pack the containers and dispose of old potting media.

Hydroponics

Hydroponic production removes the potting mix from container culture and replaces it with an inert material like rockwool, or perlite. Two commonly used methods are Nutrient Film Technique (NFT) with one or more layers of plant-holding rails or gutters nutrient-rich water moves through, and Deep Water Culture (DWC) with plant-holding rafts on troughs of nutrient-rich water. Water flow (in NFT) or level (in DWC) are constantly maintained with pump systems, and monitored daily for pH and nutrient content.

More information about using high tunnels in the Midwest can be found in the *Indiana High Tunnel Handbook* (HO-296), *Scheduling Fall and Winter Vegetable Production in High Tunnels* (HO-330), *Managing the Environment in High Tunnels for Cool Season Vegetable Production* (HO-297), and *High Tunnel Cucumber Production Guide* (ID-521-W) at edustore.purdue.edu. In addition, Michigan State University created a *Hoophouse Production and Marketing Guide* at canr.msu.edu, and Iowa State University maintains *Vegetable Production Budgets for a High Tunnel* at the extension.iastate.edu.