

## High Tunnel Construction and Internal Environment and Pest Management

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### High Tunnel Construction:

Farmer Decisions Impacting High Tunnel Structures:

**High Tunnel Site:** The first and foremost decision that you will make related to your high tunnel is where to position it on your farm. If you are interested in season extension, or even think that you might like to build a high tunnel at some point on your farm, it is important to start thinking about this as far in advance as possible. Things to watch for include how the **shadows** from trees and other outbuildings change throughout the year. Short shadows in June and July will be long in December and January and could impact production if you are thinking about producing year-round. It is also important to think about **access** to the structure. You might be able to drive a truck back to a location on the farm in the summer that will be difficult to reach in the colder months. The third consideration for the site is **orientation**. We have enough sunlight in the lower 48 states in the summer months to grow in high tunnels, but conventional knowledge tells us that if we want to grow year-round and are above 40N latitude we should orient the house East-West. While East-West orientation will maximize light and is preferable, there are an increasing number of farmers who produced year-round in high tunnels oriented North-South. From their experiences we have seen that clearly it is possible to produce year-round in high tunnels with North-South orientation. Lastly, a major consideration for positioning your high tunnel is proximity to water and electric sources. Clearly water is required, and we will discuss some considerations that might make electricity necessary.

**Kit or Homemade:** There are a number of decisions that should be made prior to constructing a high tunnel. The first that should be made related to the structure is whether to purchase a high tunnel “kit” or to construct a homemade one. For the most part we recommend purchasing a kit, especially if you have limited experience with high tunnel structures. The inclusion of the hardware and nearly all the required materials in the kit can save time and money, not to mention multiple trips to the hardware store for additional materials.

**Shape:** In the past most high tunnels were Quonset shaped as they were structures commonly used for overwintering nursery stock. In recent years as high tunnels have grown in popularity the structures have switched to being more gothic shaped than Quonset. This has allowed for improvements in venting as well as working environment and comfort levels.

**Covering and Venting:** The polyethylene covering commonly used on high tunnels is usually 6-mil and can be applied as either a single or double layer. If a single layer is used there is no need for electricity to run the small inflation fan that is necessary for a double layer covering. A double layer tends to be approximately 4-5F warmer than a single layer. Year-round production is possible with a single layer. Venting in high tunnels is done passively and is usually achieved by the use of either roll-up or drop down sides at a minimum, although some farmers build large doors that can be opened wide in the warm months for ventilation. Ventilation may also be achieved using butterfly or louvered vents in the ends or even a ridge vent. All of these, as well as the side ventilation can be either manual or thermostatically controlled.

**Construction:** When we build high tunnels we usually use a 13 or 14 step process. This includes: squaring the site, pounding the ground posts, assembling bows, standing bows, attaching purlins, plumbing the structure, attaching the hipboards and baseboards, installing the windbracing, building the endwalls, hanging the doors, attaching the plastic, and installing ventilation.

### **Internal Environmental/Pest Management**

It is impossible to cover environmental and pest management in detail in a short time but we can talk generally about both the root zone (soil) and shoot zone (air) in terms of management. For the **root zone** we are mostly talking about managing soil organic matter, fertility and moisture. We tend to manage our organic matter with compost applications. In the first few years of production at the SOF after initial soil prep we applied ~5 cubic feet of compost/100 square feet of production area in the fall each year. More recently we have moved to this application rate between each crop, which is between 3 and 5 times annually. We do not use cover crops in the stationary high tunnels because it takes time out of our cash crop production in a very premium space. The compost application also has the potential to help suppress soil-borne diseases. Compost application is also our chosen method for fertility in the high tunnels. In the past we have also used some alfalfa-based fertilizer that provided the fertility and resulted in similar yields as the compost application but did not provide the soil building benefits of the compost.

We apply around one acre inch equivalent/week in the high tunnels in the summer months. In the winter this can drop dramatically, although we do water occasionally in the winter. We have observed that soil moisture headed in to the fall is important for good winter crop production. In the fall we generally increase our soil moisture and then water in the winter when it is sunny. This could be as often as every seven to ten days, like at the SOF, or as few as five or six as was the case at our home farm in Winter 08-09. So that we can water in the colder months we install frost free hydrants and bury our water line below 40 inches. In the Midwest we have seen an increase in pH over time in the high tunnels. This is linked to a lack of leaching and the fact that we have limestone aquifers that cause our well water to have high amounts of dissolved calcium. In a way, when we water from a well we are liming our soils. To counteract this we have started to apply elemental sulfur in the high tunnels.

For the **shoot zone** we manage differently in summer and winter. In the summer we are venting with both roll-up sides and louvered peak vents to keep it fairly cool. In the winter we are covering the crops in two different ways. The first is with polyethylene supported by EMT conduit. It is very durable and for places like the SOF, where there are a number of volunteers and students in and out of the tunnels the more heavy duty polyethylene stands up to the various levels of pushing and pulling. We also cover with row-cover (0.55 oz weight) supported on high tensile wire. For our 34 X 96 ft house we use four runs of wire to support the rowcover, which is 3 pieces each at 40 X 30 ft turned sideways so that the overlaps run the width of the house. This allows us to access the area in the middle of the house without having to move the covering from one of the ends.

For **pest management** we utilize certified organic approaches at both the SOF and Ten Hens. The main pests we have in the hoopouses are aphids, loopers, winter cutworms, and

occasionally flea beetles. Above all else we try to ensure that any transplants we bring into the hightunnels are clean of both diseases and pests. For aphids we often utilize insecticidal soaps. For the loopers in the fall we utilize bT. For the winter cutworms we utilize a combination of bT, soil applied nematodes, and Spinosad applications. In an extreme case in 2007 we removed all plant material from one of the houses at the SOF and allowed chickens to access the house. The flea beetle damage often occurs on the early brassicas, especially arugula. For this we try to have the row cover in place and leave it there as much as possible to exclude any of the flea beetles.

In general we try to practice good sanitation techniques as well as **good crop rotation** to decrease the probability of disease and insect outbreaks.