

## *Production and Economics of High Tunnel Vegetables and Strawberries*

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High tunnels are minimally-heated, low cost, plastic-covered greenhouses which use little or no energy from fossil fuels to heat or ventilate the structure. Crops are grown directly in soil with out the use of artificial media. High tunnels are solar energy units. Solar energy is trapped within the structure and used to warm the air and soil. High tunnels provide the following benefits to horticulture crop producers:

1. High tunnels lengthen the growing season of many high value crops such as melons, peppers, tomatoes and strawberries.
2. High tunnels protect the growing crop from extremes in temperature, sunlight, strong winds, driving rain and destructive hail.
3. High tunnels protect the growing crop from many harmful insects, wildlife and diseases that can lower marketable yield.
4. High tunnels can be used to intercrop many vegetable species. On a small plot of land, high tunnels permit intensive production of food crops.

Since most crops have a higher marketable yield within a high tunnel coupled with a longer harvest period, crop production within a high tunnel can be very profitable. However, the level of profit varies with crop choice, market outlet, and high tunnel design. The economics of high tunnel crop production systems have not been extensively evaluated. In this paper, production and economic information for high tunnel vegetables and small fruits is discussed.

A commercial, single-bay, high tunnel averages 2500-3000 ft<sup>2</sup> per unit, although many growers have high tunnels with smaller dimensions. Small high tunnels have a greater fluctuation in temperature and humidity and don't provide an even growing environment. Larger dimension high tunnels are easier to manage and are more energy efficient. On average, high tunnels cost approximately \$1-1.50 USD per ft<sup>2</sup> of structure. Thus, a single bay, free-standing high tunnel can cost \$2500-4500 USD. Most high tunnels have a useful life of at least 10 years, and these costs can be prorated over time. High tunnels can be constructed from many materials including steel, plastic or wood. Steel-framed structures have the longest useful life.

Fixed costs are costs that do not change regardless of the level of production. Additional high tunnel fixed costs include polyethylene plastic, shade cloth, end wall framing material, drip irrigation components, and row covers. Other fixed costs such as land charges, depreciation, insurance and taxes must be considered. Our estimates are that a typical high tunnel can have fixed costs in the range of \$150-300 USD per 1000 ft<sup>2</sup>. Tomatoes are one of the most popular crops grown within high tunnels in the U.S. There is a premium price for early and late tomatoes. In addition, most crops which have a vertical growth habit are very well suited for high tunnel production since all dimensions

of the high tunnel are used. Tomatoes within a high tunnel have a very good rate of return on investment. Both determinate and indeterminate tomatoes can be grown within a high tunnel. However, determinate tomatoes have a higher, earlier yield and larger fruit size relative to indeterminate tomatoes, and may be a better crop choice for high tunnels. Determinate tomatoes can yield approximately 8-12 pounds of marketable tomatoes per plant. Thus, a high tunnel with approximately 400 tomato plants will yield as much as 6000 pounds of marketable tomatoes per high tunnel.

Indeterminate (greenhouse type) tomatoes will continue to produce fruit well into the fall, but average fruit size will be smaller than tomatoes from determinate plants. Thus, if a grower is selling in a market outlet where a continuous supply of tomatoes is important, indeterminate tomatoes are a good choice. Tomatoes are also amenable to intercropping with many shade-tolerant vegetables or small fruits such as leafy salad greens or strawberries.

High tunnels are vented primarily by rolling-up the sidewall. The sidewalls of the high tunnel should be rolled-up higher than the height of the crop canopy, since tomatoes require flower vibration for efficient pollination. Our research has shown that sidewalls should be able to be rolled-up to at least a height of 5 ft for effective cross ventilation. The high tunnel structure itself should be oriented in a north-south direction for maximal year-around light interception but should be oriented parallel to prevailing winds for good passive ventilation. If light intensity or temperatures become too much for good color development of tomatoes, a 50% shade cloth can be used over the outside of the high tunnel. Adequate potassium fertilization is also important for good color development in tomatoes.

Black, embossed mulch or IRT (infrared transmissible) mulch is very effective for warming the root zone which is crucial for early-season tomato production. Plastic mulch also reduces soil evaporation and any weed emergence. Plastic mulch costs approximately \$0.02 per ft<sup>2</sup> and is an excellent investment. Reflective or white mulch can be used for summer-planted crops in the high tunnel.

High tunnels significantly reduce pests on tomatoes. However, it is important to prevent the relative humidity from getting too high. Roof vents can significantly reduce humidity and are very effective for preventing excessive temperatures.

Insect exclusion screen can be used, but should not restrict air flow within the high tunnel. The breakeven price for tomatoes within a high tunnel is approximately \$0.50 USD per pound. Most growers receive \$1.50-\$2.50 USD per pound for early season, and late-season, vine-ripe tomatoes.

While tomatoes are one profitable crop choice for a high tunnel, there are many other cropping systems which are enhanced by high tunnels. If a high tunnel is to be most profitable, it should be used for year around cropping. Usually, a grower can have 2 crops of a warm season vegetable and 1 crop of a cool season vegetable or fruit within one calendar year. Most warm season crops are established in the high tunnel as early as soil temperatures reach the optimal level. Transplants will reach maturity faster than direct seeding.

Row covers or portable heaters may be used to provide supplemental heat to the high tunnels. Row covers are an excellent investment, costing about \$0.09/ft<sup>2</sup> and usable for several years. Row covers are 4x more effective in retaining heat in the high tunnel relative to the field.

Peppers are an excellent rotation crop for many other warm season crops within a high tunnel. We have averaged approximately 8 pounds of bell peppers per plant in our research trials. Many colored bell and specialty peppers can be grown within a high tunnel. Sunburn during the warm, summer months can be reduced by using shade cloth similar to what is used for tomatoes.

Cucumbers are an excellent spring and Fall season crop for high tunnels. Both slicing and “hothouse-type” cucumbers can yield very well within a high tunnel, although we have had greater success with slicing types. Hothouse cucumbers can develop powdery mildew within a high tunnel and don’t seem to grow well in the fluctuating temperatures within a high tunnel.

High tunnels can be used to harvest early cantaloupes, honeydews, watermelons or other specialty melons. For higher yields, the cantaloupes and other specialty melons are trellised. Unlike cucumbers which are self-fruitful, melons require bees for cross pollination. Our research with melons in a high tunnel has indicated that they can be grown for early markets but may be marginally profitable. Three to four marketable melons per vine is a typical yield. The return on investment is relatively low on high tunnel melon production. Melons are more profitably produced using low tunnels. Strawberries are a potentially profitable crop for high tunnel production. It is very important to use annual, short day or perhaps day neutral types for high tunnels. Matted row production of June-bearing strawberries has a very high opportunity cost. A commercial high tunnel can accommodate approximately 2200-2500 strawberry plants. One of the most significant costs associated with high tunnel strawberry production is cost of the planting material. Rooted plugs can cost approximately \$0.25 USD per plug. Thus, it is important to buy runner tips from a certified nursery and root the tips in plug trays. Four weeks later, the plugs are ready to transplant within the high tunnel.

Strawberries can yield 1.25-1.5 pounds per plant within a high tunnel. The key to success is to have efficient pollination. Bumblebees may be used, and with our research we have discovered that bumblebees did not increase the number of high tunnel strawberries, but did increase the average fruit weight per strawberry.

High tunnel strawberries are ready to harvest approximately 5 weeks earlier than field-grown strawberries. Exclusion of rainfall by the high tunnel will prevent many foliar and fruit diseases, but gray mold (*Botrytis*) and powdery mildew can be potential problems. Packaging costs can be a significant cost associated with strawberries. I recommend marketing strawberries in small volumes (pints).

The breakeven price for high tunnel strawberries was calculated to be approximately \$1.28 USD per pound. Our test marketing revealed that consumers are willing to pay 3-4 times that amount for early, vine-ripened berries.

#### **References:**

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