

TOMATOES - Hoophouse

Bethanee Wright
Winterfell Acres
Cheryl Goering-Kleinfelter
Turner Farm

Location	Brooklyn, WI	Cincinnati, Ohio
Acres in vegetables	1 acre	Between 5-10 acres, depending on rotation with livestock that year
Acres in Field Tomatoes	.05 acres (2400 SF)	less than 1/4 acre
Area in Hoophouse Tomatoes	0.03 acre	3600 SF

How these tasks are done for Hoophouse Tomatoes:

soil prep/tillage	by hand	with a walking tractor
transplanting	by hand	by hand
cultivating	by hand	by hand
spreading amendments	by hand	by hand
mulch laying	by hand	by hand
laying irrigation lines	by hand	by hand
laying row cover	by hand	do not do this task for hoophouse tomatoes
pruning	by hand	by hand
trellising	by hand	by hand
spraying for pests or diseases	by hand	by hand
harvesting	by hand	by hand
incorporating crop residues	by hand	do not do this task for hoophouse tomatoes
farming style	certified organic	certified organic

Tomatoes in Hoophouses

Pros	Extends the season by 2 months at least. Reduction in diseases that you often see in the field. Higher pack out and quality overall. Can more reliably grow larger fruited varieties. Higher production per square foot due to trellising and better growing environment compared to field.	High quality fruits; high yielding plants, esp. cherry varieties; longevity of growing period; easy to hook up systems to irrigate and fertigate consistently; coverage from rain and other elements to decrease risk of diseases; impressive system for spectators to see
Cons	Need greater attention to soil, pest and disease management. You're essentially growing in a desert so high pH soils can be an issue. There are a greater concentration of cutworms and hornworms. There is also a higher prevalence of disease issues (different than field grown diseases) so you must choose varieties accordingly.	Height/difficulty-reaching plants to prune and lower/lean on a regular basis; Height-safety-difficulty to safely reach plants and move throughout the tunnel on ladder, etc.; some difficulty perfecting the amounts of fertigation and watering needed; keeping up with the plants to prune is difficult- the grow rapidly



Propagation

Hoophouse Varieties	<u>Heirlooms</u> - CubaLibre (only purple variety I grow now- no splits or green shoulders), GinFizz, Margold <u>Cherry</u> - Sakura, Sungold, Sunpeach (later than others but lasts longer in the the fall- keeps producing heavy into 1st frost kill)	<u>Slicers</u> - chefs choice, parks whopper, big beef <u>Heirlooms</u> - brandywine, black krim, german johnson, speckled roman <u>Romas</u> - midnight roma, speckled roman, cannestrino <u>Cherry</u> - sungold, supersweet 100, blush, bumblebee, jasper
Soil Mix	Vermont Compost Fort Vee or West Star Organics potting mix	Ohio Earth Food Seed Catapult Professional Organic Growing Mix Additions: Perlite, Jumpstart II with Mycorrhizae
Seedling Trays	Seeded into 512 plugs then potted up to larger soil blocks (fit 24 per 1020 tray)	Seed into open black plastic flat, 200 per tray Potted up into black plastic 4" pots, at true leaf stage
Propagation Schedule	Seed April 1 Pot up mid April (ideally before 1st true leaves) Transplant 1st week of May (depending on weather forecast)	Seeding date - Late February Potting up date - Approx 2 weeks after seeding date (early March) Transplanting date - Early April
Germination	Germination chamber set to 75 F (anywhere 70-80F is good; I adjust temp depending on what else is sharing the germ chamber with them)	We have heated tables in our greenhouse, which run water through tubes on the tables where the trays will make direct contact. We can set the water temperature to ideally around 80F-82F degrees, until the plants have emerged. We can also set and regulate the temperature of the greenhouse with a climate controlled thermostat system, to around 70F.
Grafting	No- haven't seen the need to do it yet. Definitely interested, but feel resistant to it.	No, we haven't ventured into more advanced growing techniques because we teach beginning farmers the skills they need to be a farmer on the most basic levels. I find this to be a more advanced method of growing that I myself haven't learned yet.
Greenhouse Irrigation	Dramm waterer as needed, usually 1-2x per day (soil blocks are notoriously difficult to get moist if they dry out too much so we err on the side of plenty of water)	We irrigate 2-3 times daily, morning/afternoon/early evening as necessary. We water at the base but from above, doing our best to avoid watering the leaves and stems, into the 4" pots, which are packed into a flat, sided vented tray.
Greenhouse Conditions	We set our greenhouse at 68F set point so our geothermal and propane heat kicks in at certain points below the set point, as do all the louvers and fans for cooling. The dehumidifier has been a game changer- highly recommend one! I will rotate the trays after a few weeks of them growing once the sun really starts to shine in later April.	Optimal conditions are heated tables set to 70-72F throughout the propagation and greenhouse temps set to regulate around 70F. All tables receive direct sunlight through the greenhouse poly and are not turned or moved.
Hardening Off	N/A	We do not harden off because the plants are moving from one protected culture to another. (from a propagation greenhouse to a production greenhouse)

	Winterfell Acres	Turner Farm
Greenhouse Pests or Diseases	Since we built our new geothermal greenhouse with the full tech set up, I have seen a huge improvement in the plants being less stressed.	We have been fortunate to not have problems with pests or diseases on starts in the greenhouse (fingers crossed)

Bed Prep

Preceding Cash Crop	Cucumbers	We actually don't grow hoophouse tomatoes every year. We only have two hoophouses on the farm, the other is much smaller so we fit less in there. For our rotations to work, we grow outdoors in the field, uncovered and rotate back in at least every three years. 2021-2022 preceding crop: Spring greens - spinach, arugula, lettuce mix, large dino kale, swiss chard, Radishes
Preceding Cover Crop	We do not cover crop in the hoop house.	We haven't planted a cover crop in our hoophouse in the past few years. Since we are limited on space with only two hoophouses on the farm, we have to maximize this space for Spring greens, radishes, etc. to get an early crop
Soil Amendments	Per 96x30 hoop house: ~500 gal Compost, 50# chicken crumbles, 25# feather meal, 12.5# potassium sulfate and 5# kelp meal We also amend with a high potassium mix (Revita high K) mid-season.	Soil tests are done yearly in the fall/ winter season so we can plan for the necessary amendments prior to planting the first crop. 9lbs Sulfur - to mitigate high PH 50lbs Gypsum - to mitigate low Calcium 50lbs Kelp Meal - to mitigate low potassium 2-3 inches topped on each bed of Compost Mix
Soil Prep	1st amend and compost 2nd broad fork each bed 3rd wheel hoe and rake to clean out big debris	Prep work for the soil begins in early Spring but within a week or days prior to transplanting -We apply amendments and rake in lightly. We add the compost layer on top. -Next, we use a BSC with the rotary plow attachment to build beds. -We use a bed finishing rake to smooth the surface.
Mulching	We have dedicated tarps for each bed in the hoop house with both a black and white side. We use the black side to keep soil moist and keep down chickweed in the fall/winter/spring and then fold it up so the white side is up for the aisles in the summer	We used black landscape fabric with existing planting holes as our mulch on half of the beds this year. We first laid out drip tape lines over the beds and tacked them down with landscape staples. Next we laid out the fabric over the beds and tacked down tightly with landscape staples. We used fabric because we get a lot of weed pressure in the tunnels and wanted a way to mitigate that, keep the soil from drying out too quickly, and keep the soil warm. All of which will benefit the tomato plants
Other Notes on Hoophouse Prep		Since we grew our tomatoes with the Lower and Lean method this season, there is some prep work that needs to be done prior to transplanting. This includes hanging trellising tomahooks above the beds, hooking them onto already existing heavy wire lines running the length of the beds, which will support the weight of the plants.

Planting

Bed Width	4 feet	3 feet
Plant Spacing	1 row/bed, 18" between plants, 4' between beds	This year was a little ambitious. We had six beds with two rows each, 21" spacing between plants, with 2' between rows
Transplanting Process	<p>1st since we grow as much food in each of those beds as possible, we harvest and/or pull out the previous crop down the middle of the bed (and allow remaining crops on either side to continue growing)</p> <p>2nd lay measuring tape and set plants at 18" spacing in the middle of the bed where we just pulled the previous crop</p> <p>3rd carefully and deeply plant each plant by hand up to the first true leaves</p> <p>4th irrigate</p> <p>5th hoop and row cover (most years just to give them extra heat since we plant early and we have no supplemental heat in the hoop house)</p>	<p>1- Pop tomato plants out of pots and place them in open flat tray with holes. Remove bottom true leaves, especially if yellowing and any flower buds that are showing.</p> <p>2- Prepare transplant liquid, Jumpstart II + Mycoapply. Using a large 3 1/2x2ft tub, mix transplant liquid.</p> <p>3-Dunk flats into the liquid for a few seconds, allowing the plants to soak up thoroughly.</p> <p>4- Using a post hole digger, make wide open holes down the rows at 18" spacing. (spacing was measured by using a long open reel tape measure and marking the spots on the landscape fabric, where we cut open holes)</p> <p>5- Drop plants from trays, next to each hole. Follow behind with a hand trowel, drop the tomato in the hole, burying up to it's first set of leaves. Cover with soil and pat down a few time make good root to soil contact.</p>
Amendments at Transplanting		Transplant liquid as mentioned above in the transplant process
Water at Transplanting	Crop is watered in with drip tape immediately following transplant	Water is used when mixing the transplant liquid, Jumpstart II + Mycoapply, and acts as the application method for this
Mulch at Transplanting	Once the other crop grown in with the tomatoes are harvested/bolted, we will fold the plastic tarps white side up down the aisles to reduce weed pressure and increase light reflection for the plants	
Row Cover	Row cover is used with hoops and bags filled with compost for extra heat and protection during the those 1st few weeks	No row cover is used

Crop Maintenance

Irrigation	Hoop- Biweekly drip tape 4-8 hours	<p>We irrigate through drip tape for 2 hours, 3x weekly. During watering we fertigate 1x weekly once the plants are established.</p> <p>Fertigation starts with Neptunes Tomato & Veg 2-4-2 formula and is used during the vegging stage of the plant. Once buds begin to appear and flowering starts, we switch to Neptunes Rose & Flowering 2-6-4 formula.</p>
------------	------------------------------------	--

	Winterfell Acres	Turner Farm
Changes to Irrigation	No change	We back off to watering 2x weekly/ fertigation 1x weekly once plants have reached around 4' tall. With the use of landscape fabric on the beds, we find that the soil certainly stays moist for a longer period of time and decreases our need for watering. Fertigation starts with Neptunes Tomato & Veg 2-4-2 formula and is used during the vegging stage of the plant. Once buds begin to appear and flowering starts, we switch to Neptunes Rose & Flowering 2-6-4 formula.
Trellising	All hoop tomatoes- trellising and pruning happens weekly for ideal maintenance and ease of harvest and highest production. Each plant is trellised on 2 tomahooks with compostable tomato clips once they reach 2 main leaders. Then the plants are wound around the string until they reach the top (about 9') usually by late August/early September. By then we clip the tops to encourage ripening of the fruit they have before frost.	Johnny's tomahooks are used to trellis. Once plants are given a week to establish, we use tomato clips to attach the trellis string to the plant under it's strongest set of upper branches, one or two levels below the top of the plant so it won't slip through and off the plant. As the tomatoes continue growing, we attach additional clips to the plant, always under a strong set of upper branches. When the plant reaches within 2-3 feet of the top where the wire is supporting it, the lower and lean process begins.
Pruning	Trellising and pruning happens weekly for ideal maintenance and ease of harvest and highest production. Plants are trellised on tomahooks with compostable tomato clips once they reach 2 main leaders. All suckers on those 2 main leaders are clipped or pinched as close to the stem as possible.	Sucker pruning is done weekly (ideally), once plants are established and at least 2' tall and have their first flower cluster. Cherry and Slicers will be pruned to 2 leaders, leaving the sucker closest to the top of the plant, to act as insurance in case anything should happen to the main stem. Leaf pruning is done weekly (ideally), once the plants have approx. 15-20 leaves. Pruning is done by removing the bottom 2-4 leaves each week, or more if showing any signs of yellowing or disease. Fruits are not typically pruned, but that is something we may have time to try this year and see if it yields better results
Weed Control	Our primary weed control is the white side of our bed tarps but we also weed 2 weeks after planting and then 2-4 weeks after that. Usually we need to weed again by early August if we haven't gotten to it yet but then it's just between the plants since the tarps do their job well.	Beds covered with landscape fabric will not need as much weeding attention. Hand pulling anything coming through the hole where the tomato is planted, is all that should be necessary. Uncovered beds that are also not mulched must be weeded with hand hoes every few weeks as necessary throughout the season.
Insect Pests	Hornworms and cutworms- we pull them off and cut them in half as we prune. You can very easily see damage done by them but the tricky part is finding them! We occasionally will spray bT/dipel if it's really bad.	We had issues with the tomato fruitworm/cornworm burrowing into tomatoes, stalk borers, thrips, only light pressure of hornworms. Remove infected fruits or leaves they are damaging by hand.

Winterfell Acres		Turner Farm
Diseases	Powdery mildew- biweekly beneficial spray regime (mostly fish emulsion, beneficial microbes, seaweed extract and regalia). Also plant varieties that are resistant.	Disease doesn't show up strongly until later in the season. We haven't had any tissue testing to confirm any suspected disease, however we believe there was some presence of anthracnose (an issue we deal with across the farm), bacterial canker, powdery mildew and on the fruit, cat facing. We remove diseased plants as soon as possible, continue to sanitize tools so we don't spread more disease and we apply Serenade OMRI.
Lingering Pest/Disease Challenges		We deal with the following, pretty commonly due to tight rotations. How do farmers grow tomatoes in the same hoop house year after year without disease issues? Anthracnose (an issue we deal with across the farm) and bacterial canker, late blight (outdoors)
Environmental Control	We would like to have more ventilation and maybe even a 30% shade cloth. We mostly just open the sides and ends and have a few fans in the rafters set to turn on when it reaches 85 F in there. Ideally I would want automated end wall ventilation and more interior fans to increase air flow. It gets really hot in there in the summer.	We open and close the sidewalls for more air flow, keep the end walls and end wall fans open and even add additional large fans to move air through the tunnel and cool things down.
Heat	No	We do not heat the hoophouse
Shade Cloth	Would love to us it! 30-40% would be ideal. That is what we use on the greenhouse in which we also grow tomatoes in March through December.	We have used it in the past, however we did not use it this year.
Additional Notes on Crop Maintenance	Very important: our water and soil naturally has a high pH (7.3 or above) so we add citric acid to our irrigation water with a Dosatron to lower the water pH. This seems to have fixed most of the pH problems we had early on.	Be sure to check your crop regularly to keep up on an efficient pruning schedule, weeding and irrigation schedule that works for you. These methods may work for you but not on the same schedule depending on varieties, location, etc.

Harvest and Yields

Harvest Window	Hoop Heirloom- late June to hard frost (late Oct) Hoop Cherry- mid July to late September/early Oct. Greenhouse Hybrid- May until following January Greenhouse Cherry- May until following January	Slicers 6/27-10/3 Heirlooms 6/27-10/3 Romas-outdoors n/a Cherry-6/20-10/17
----------------	---	---

	Winterfell Acres	Turner Farm
Harvest Procedure	<p>We always harvest from the greenhouse first then the hoop house then the field tomatoes to reduce disease and pest spread on our hands, tools, boots and clothes. And besides greens harvest, we try to harvest greenhouse and hoop house tomatoes first thing in the morning before it gets too hot in there. Ideally we are harvesting only when the plants are dry.</p> <p>We harvest cherry tomatoes in wearable harvest totes so we have both hands available and we do not care about if the calyx is on or off.</p> <p>We harvest larger fruited tomatoes into thin beige stackable bins, calyx removed and calyx side down to reduce bruising. No higher than 2 layers per bin. We pull splits from the vine and throw out of the hoop house.</p>	<p>Harvest in the early morning. Harvest wearing gloves to keep from staining hands. Lift fruits from the plants removing calyx and place in 5 gal bucket. Once bucket is half full, sort tomatoes into black crates with kraft paper liners (1st/2nds and cherries), placing them bottoms up.</p>
Cleaning Procedure	<p>Fruits are not cleaned unless absolutely necessary after a heavy rain. In that case a dry cloth is used to wipe the fruits.</p>	<p>Fruits are wiped clean with a damp cloth, only if necessary and placed back in the kraft paper lined harvest crates, bottoms up.</p>
Packing Slicing, Heirloom, Roma	<p>We rough grade as we pick (only saving the splits ones for us farmers if it's July and we are hungry for tomatoes!). Then usually I will grade tomatoes myself in the pack shed as we are packing for CSA or wholesale.</p>	<p>Fruits are sorted again to ensure grading is accurate (1sts, seconds/splits or staff). Firsts and seconds are divided for separate markets and/or offered to wholesale buyers. Fruits are kept in the original crate for markets and sold that week. Wholesale are packed into cardboard boxes.</p>
Packing Cherry Tomatoes	<p>We rough grade as we pick (only saving the splits ones for us farmers if it's July and we are hungry for tomatoes!). Then usually I will grade tomatoes myself in the pack shed as we are packing for CSA (plastic bags) or wholesale (plastic pints or quart containers).</p>	<p>Fruits are sorted again to ensure grading is accurate (1sts, seconds/splits or staff). Firsts and seconds are divided for separate markets and/or offered to wholesale buyers. Fruits are packed into pint or ½ pint green berry baskets. Wholesale are packed into cardboard boxes.</p>
Storage	<p>We have 3 different cooling rooms on the farm: the cold room is kept at 34-36F, the cool room (for tomatoes mostly) is kept at 50F and the root cellar does it's own thing during the summer but stays about 40F during the winter. Since we harvest at 90%+ ripeness for flavor. We will store tomatoes for about 7-14 days before they are too far gone. We grade as we pack so it's easy to assess what need to go to the pigs.</p>	<p>Tomatoes are stored in our packhouse area which stays an average temp of 65-70F, in the lined crates, stacked up on each other. Cloth sheets are draped over the crates. Tomatoes are only kept for 2-5 days before sold or used for CSA.</p>

	Winterfell Acres	Turner Farm
Yield	<p>Greenhouse (1 leader/plant; dutch lower and lean style trellising; harvest March-Dec.): <u>Cherry</u> 5.7#/bed foot <u>Hybrid</u> 8.7#/bed foot Hoophouse (2 leaders/plant; vertical tomahook style trellising; harvest July-frost): <u>Cherry</u> 5#/bed foot <u>Heirloom</u> (only large varieties) 3.7#/bed foot Field (2 leaders/plant at beginning of season; basket weave style trellising; harvest late July-late Sept.): <u>Cherry</u> 4.7#/bed foot <u>Heirloom</u> (only small varieties) 6.5#/bed foot <u>Hybrid</u> 4.6#/bed foot <u>Paste</u> 6.5#/bed foot</p>	<p><u>Slicers & Heirlooms</u> 2250 lbs (3 beds, total of 6 rows) <u>Cherry</u> 1536 lbs (3 beds, total of 6 rows) <u>Splits</u> (total for all types) 643lbs</p>

Equipment

General	Nothing super expensive except the hoop house and greenhouse themselves	Tomahooks \$336 Tomato Clips \$60 Tomato pruners \$33 each x 6 = \$198
Biggest Impact		All of the equipment combined has the biggest impact on profitability because they are the tools we need to use the Lower and Lean method. This significantly extends the longevity and health of our plants (indeterminate varieties) vs planting outside (mostly determinate varieties)

Marketing

Markets	CSA, direct to restaurant, direct to school districts; online ordering through Market Wagon	CSA, farmers market, on-site farm stand, direct to restaurant
CSA	4-8 pints cherry tomatoes; up to 20# heirlooms; 2-5# paste and 10# hybrids	Slicers (firsts) - 2lbs per share weekly from late June-Oct Cherry 1/4pt - 1 pint cherry per share weekly from late June- Oct
Farmers Market		Slicer (firsts) - \$4/lb Slicer (seconds)- \$2/lb Cherry (½ pint) \$3 Cherry (1 pint) \$5 Cherry (quart) \$8
Direct to Restaurant	\$4.50/# early greenhouse slicing tomatoes \$7/quart cherry tomatoes mid-sized heirlooms \$3.75/# large-only heirlooms \$4.40/# hybrids- \$3.50/# paste- \$3.30/# green- \$3.30/#	Slicer (firsts) - \$3/lb Slicer (seconds)- \$1.50/lb Cherry - \$6/lb