CUCUMBERS - Hoophouse

	John Dindia Lakeview Hill Farm	Christa Alexander Jericho Settlers Farm
Location	Traverse City, MI	Jericho, VT
Acres in vegetables	2.5	30
Acres in FIELD cucumbers	0	0
Area in HOOP cucumbers	5000 SF	0.3 acre
How these tasks are done for Hoophouse Cucumbers:		
hoophouse prep/tillage	with a walking tractor	with a tractor
transplanting	by hand	by hand
direct seeding	do not do this task for cucumbers	do not do this task for cucumbers
cultivating	by hand	do not do this task for cucumbers
spreading amendments	by hand	by hand
mulch laying	by hand	by hand
laying irrigation lines	by hand	by hand
laying row cover	do not do this task for cucumbers	do not do this task for cucumbers
pruning	by hand	by hand
trellising	by hand	by hand
spraying for pests or diseaes	by hand	by hand
harvesting	by hand	by hand
incorporating crop residues	with a tractor	do not do this task for cucumbers
farming style	certified organic	certified organic

Propagation

Hoophouse Varieties	Socrates- does well in spring and early summer, nice size fruit highly productive and uniform, thin skin sensitive to scratching Picolino- does well in all seasons, somewhat smaller fruit, not as uniform, very productive Katriana- does well in the summer, large fruit, very uniform, but tends to be more sensitive to disease than others Quirk- Highly productive small snacking cucumber, cute, quality flavor, highly disease resistant, longer harvest time due to small size	Corinto - american slicer type, gynoecious and parthenocarpic Katrina - persian type, gynoecious and parthenocarpic, tolerates heat stress well
Soil Mix	morgans 101 seed starter, we add rootshield +, actinovate, and mycostop	Vermont Compost Company: Fort V potting mix
Seedling Trays	3.5" square pots	started in Winstrip 72's on heat mat, pot up to 3.5" plastic pots

	Lakeview Hill Farm	Jericho Settlers Farm
Propagation Schedule	we start our first transplants on week 8 with a 4 week transplant production period, we then succession plant every 5-6 weeks through week 35. We do not pot up, seed directly into 3.5" pots	March 6 seeding, pot up March 16 to pots, transplant to hoophouses April 8 April 25 seeding, pot up May 4, transplant to hoophouses May 25 sometimes we do a third planting with targeted transplant date of June 10
Greenhouse Seeding	We use the dinky flat filling machine, to fill 18- 3.5" square pot shuttle trays. The machine will mix the potting mix with the rootshield+, actinovate, and warm water.	seed by hand, cover lightly with potting soil, saturate soil
Germination	We usually germ the cucumbers in the greenhouse on heat mats set to 85 with a dome on top of them. In the early spring the greenhouse is usually set to 70 degree day and 67 degree night. Lights are set to achieve, roughly 16 hrs of light.	Place seeded trays on heat mat and cover each tray with plastic dome (or cover whole bench with sheet of clean greenhouse plastic), target soil temp 80-85 F (heat mats controlled with theromostat), germinate in a few days, grow out to 2 full cotyledons and start of first true leaf and then pot up into plastic pots (18 pots per 1020 trays)
Greenhouse Irrigation	we irrigate as needed both overhead and via flood table. We use heated irrigation water at 70 degree, also use citric acid to adjust ph to 6.2 and remove bicarbonates.	bottom water seedling trays on long metal trays that are fitted to rolling benches with recirculating water system, typically water once per day at mid morning, less frequently during cloudy stretches of weather, more frequently later in season when sun more intense
Greenhouse Conditions	70 degree days, 67 degree nights, heated irrigation water at 70 degree, manage humidity to achieve about max 80% humidity. Use LED grow lights to achieve a rough DLI of 7.1 or greater. At first we have all the trays as close together as possible, at the last 1.5 weeks we usually rotate the trays and space them so there is 4" between trays on all sides, we only bottom water for the last 1.5 weeks. We use multiple pieces of equipment to maintain these conditions including, Maximus environmental controls, grow lights, fans, heaters, infloor heat, heated irrigation water, etc,	Cucumber seedlings are located near middle of house where there are fewer drafts from ventilation louvres, nighttime temps low 60's, daytime temps not above 85 F ideally, no additional light used, passive ventilation used to control humidity and daytime temps
Hardening Off	We do not harden off our cucumbers because we are transplanting into greenhouses with the same environmental conditions as the prop house. We do a treatment of Mycostop a couple days before transplanting for the first 2 or 3 successions to help with dampening off after transplanting. It should also be noted that the first two successions are always transplanted into a greenhouse with heated soil and heated irrigation water as cucumbers are very sensitive to cold soil. Soil is heated to 70 degree.	Reduce watering the week before transplant, but no other hardening used as they are moving from one greenhouse to another for transplanting (into hoophouses)
Greenhouse Pests or Diseases	no major issues with pests or diseases for propagation, for early spring production you need to be cautious of dampening off after transplanting until soil has reached 70 degree.	no

	Lakeview Hill Farm	Jericho Settlers Farm
Bed Prep		
Preceding Cash Crop	nothing specific most likely greens, tomatoes, peppers, more cucumbers	tomatoes or peppers grown in the house the year before, winter salad greens grown the spring before cucumbers are planted (winter salad greens include spinach, lettuce, arugula, mustards)
Preceding Cover Crop	I wish we could financially afford to cover crop in tunnels but we do not.	NA
Soil Amendments	we always add 1.6 cubic yards of compressed peat moss per 1000 sq ft of greenhouse space every fall. We used to apply compost until soil phosphorus levels became too high. The peat moss seems to not burn off as quickly as the compost, is purchased in large 2 yd compressed bales. We preplant fertilize with 100-125# N with 10-0-4 fertlizer.	peanut meal used for nitrogen, potassium sulfate used for potassium, and sometimes Azomite used if some trace minerals need amendment. Additional phosphorous usually not needed, but if it is we use bone char. We do not use animal manure based compost or fertilizers to avoid salt accumulation in soils. We soil test all our hoophouses every spring with a saturated media test (University of Maine Soil testing service) and amend specifically for the crop for that season, so levels of amendments vary. Goal for available nutrients per 1000 square feet is : 7# N, 9# K, and 2# P pre-planting. We also monitor calcium, boron, and manganese. Our other trace minerals rarely need adjustment. We fertigate weekly during peak fruit production periods with chilean nitrate and potassium sulfate through the driplines. Target is to water-in .25# N and .25# K per 1000 square feet each week.
Soil Prep	we usually just flail mow, hand spread fertilizer, and shallow power harrow with walk behind previous crop residue.	We do our final harvest of winter greens, and then apply fertilizer amendments directly on top of the harvested bed, we then spade the bed lightly (just a few inches deep) to incorporate fertilizer and greens residue, and lay driplines and irrigate. Meanwhile we are heating the soil with underground hot water lines to bring soil temp up to 60F (soil heating done for the early season plantings, not the May/June transplants). Ideally there are two weeks between fertilizing and transplanting, but often it is more like one week given our spring workload.
Mulching	we use woven landscape fabric between the rows.	We use white on black plastic for our earliest planted houses (April transplant) and black woven ground fabric for our later planted houses (ground fabric can be reused many seasons).
Planting		
Bed Width	5' betwen rows	6 feet on center
Plant Spacing	12" between plants	1 row per bed, 9" between plants

	Lakeview Hill Farm	Jericho Settlers Farm
Transplanting Process	lay down tape measure, use 4" soil auger on battery powered drill to auger small hole, pop transplant into holes, lay down 2 rows of drip tape 6" off each side of row, lay down landscape fabric between rows, hang 6x6 jute or coconut trellis netting for Quirk cucumbers, 1 trellis string or qlipr hook for all other cucumbers.	Once driplines and mulch plastic or fabric are in place, we lay tape measure down middle of bed (plastic mulch has no holes yet, fabric has pre-cut holes) and poke holes in plastic at desired interval (9"). We run the driplines during transplanting to moisten soil and ensure placement of drip line near seedlings as we plant. We carefully remove plants from pots (so as not to damage stems) and place them into a hand dug hole, being sure to cover root ball completely and angle stem such that plant does not break. If possible we plant during a cloudy stretch of weather so plants can lay on plastic for a few days before being clipped to trellis strings. Inevitably we get a wind storm in April that shakes the hoophouse frames and will uproot and break newly planted cucumbers. If weather is sunny then we stake up plants with small wooden stakes (a little bigger than a chopstick) so leaves are not laying on hot plastic, but we do not clip them to trellis strings until roots are established and transplants are through period of transplant shock.
Amendments at Transplanting		NA, all amendments are incorporated preplanting
Water at Transplanting	crop is watered in with drip tape and heated irrigation water immediately after transplanting.	drip tape is running while we are transplanting until bed is thoroughly saturated
Mulch at Transplanting	6' wide black woven landscape fabric	NA
Row Cover		none used, houses have heat systems if weather is too cold

Crop Maintenance

Irrigation	Generally speaking we would irrigate to accomplish 1 inch per week before established fruit load and 1.5 inches per week with a fruit load under ideal sunny and warm conditions. The environmental controller will automatically dial back the irrigation cycle based upon outdoor conditions (how sunny vs cloudy). We are on sandy soils so we irrigate 4 shorter cycles per day. Our irrigation water is heated to 70 degree in the earlier season, injected with citric acid to bring down the Ph and bicarbonate levels. We also inject fertilizers though a dosatron once we have an established fruit load.	Irrigation done via drip tape, 4 lines per bed so entire bed width gets saturated, typically we irrigate every other day for 1 hour to maintain even soil moisture, sometimes we water every day if in a stretch of very hot sunny weather. We check soil moisture levels (by hand, feeling soil in beds at a few places in house) every day in each house and adjust water schedule accordingly.
Changes to Irrigation	yes it is mentioned above	Plants demand more water as they get larger and produce more fruit, so we often do daily irrigations when in peak production, especially if weather is hot and sunny. We reduce watering in early planted houses if weather is cloudy and plants are young. Though it would be ideal to have soil moisture measuring devices in place for all houses, we have not invested in this technology.

	Lakeview Hill Farm	Jericho Settlers Farm
Trellising	Yes, quirk cucumbers are trellised onto a biodegradable jute or coconut netting, all other varieties are trellised onto a single tomahook or qlipr hook.	We have fitted all our hoophouses with high tensile wires supported by the cross bars and end walls. End walls are braced with angled bars at all four corners to prevent crop weight pulling them in. Wires have tensioners on them to tighten as needed. We use roller hooks spooled with trellis twine and plastic tomato clips to keep plants attached to the strings.
Pruning	We train the plants to have a single leader, we remove all fruit for the first 2' of growth, at about head height we leave the first set of fruit on each sucker. Once the plants have reached the top wire, we hang over the top wire, completely leave the next 3 suckers, topping the lead at the fourth. We remove suckers weekly, and clip up using biodegradable clips and twine at the same time.	Each plant has one leader and one trellis line to which it is clipped. When plants reach the top of the trellis wire and start coming back down we keep two leaders (umbrella method) for that stage of plant growth. Plants are first clipped to trellis line when they are a few feet long and well established from transplanting. We then sucker and prune at least once per week (sometimes twice if growing fast in hot weather) and wrap the leader of each plant onto its trellis string, using tomato clips to keep plant attached to string in a few key places (under strong leaf branches). Some varieties set a lot of fruits very early on the plant and we prune these off for the first 2 feet of the plant. From there on up we keep 2 fruit per node (for american slicer types) and 3 to 4 fruit per node (for persian types). We remove leaves as the fruit are harvested, removing to just above the lowest fruit on the plant.
Weed Control	no, landscape fabric takes care of that	Little weeding needed, we scuffle hoe edges of houses once or twice per season and hand weed the planted holes if weeds pop up there.
Insect Pests	Yes, Aphids are relatively easily controlled with parasitic wasp, aphidius colemani, lady bugs, also beauveria baussiana has been quite effective with aphids, all three do not have immediate results and take about 2 weeks to be effective so scouting and quick response is necessary. We also have recently been dealing with spider mites and thrips, beginning around August, I do not have great experience managing them, we are currently using Amblyseius swirskii to help, along with applications of Grandevo and Venerate. It should be noted that we completely net the sides of the greenhouses with 47G Protek Net insect netting, this has been very effective with cucumber beetles, we do not have any issues anymore, but it does not seem to be effective with spider mites, aphids, and thrips.	We exclude most (though not 100%) of striped cucumber beetles by using netting on the hoophouses. All sides, doors and louvres are netted. Netting is in place from time of transplant until we remove the crop. We also have frequent infestations of spider mites. We are getting better at monitoring these and controlling with IPM, but we are not yet satisifed with our level of control on these.

	Lakeview Hill Farm	Jericho Settlers Farm
Diseases	Yes, we have recently been dealing with Ulocladium leaf spot, I do not know much about it, apparently it is quite rare. We have purchased a soil steamer which should eliminate the problem as it is a soil born disease. We used to deal with bacterial wilt, but since we have excluded cucumber beetles with the netting we no longer have that issue. We also used to deal with significant loss of transplants due to dampening off post transplanting but since we have started using mycostop prior to transplanting and ensuring our soil was 70 degree, it has not been a major issue. We still lose maybe 5% off our plants to this in the early spring, but we plan for it and have backup replacements. Powdery mildew is also a frequent issue in later summer. We try to fog almost weekly with mil-stop and oxidate, which significantly helps.	In late season we often getting powdery mildew but usually do not treat for it as we are near the end of the plants' production anyway. We have also been seeing a scab-like disease (on scab resistant varieties) that is stumping our experts here. Current thought is that it is abiotic and perhaps nutrient related, but we are not yet sure what is causing it. There are large area of necrosis on leaf tissue in the absence of any identifiable fungal or viral pathogens. Seems to occur in areas with high soil moisture (poorer drained areas of hoophouses) hence our thought that perhaps nutrient uptake is compromised and causing the symptoms.
Lingering Pest/Disease Challenges	Yes, as mentioned above, control of thrips and spider mites has been an issue that I can not seem to dial in.	The above noted condition, and we're also wondering if plant nutrient levels can make plants more/less attractive to spider mites (does high N attract them?) and whether screening houses is eliminating some native predators of spider mites. Also interested in any tips/tricks for successful IPM management of two-spotted spider mites.
Environmental Control	75 degree day/night for 1 week post planting to promote growth. After 1 week 75 day and 65 night. A prenight treatment of 60 degree once fruit production begins will help promote fruit growth. As mentioned earlier heated soil and irrigation water are a must for early spring production. We do our best to maintain humidity below the dew point especially at dusk and dawn to prevent condensation on the leaves. This is best done by power venting, raising the indoor temp by 5 degree, then opening peak vents and cracking roll ups till temp drops back down, then closing vents and repeating cycle till humidity drops to ideal conditions or at least outdoor ambient levels. Grow lights are on for early spring production and transplant production.	We do not use any additional lighting. We do use white plastic on beds in early planted houses to help reflect light back into plant canopy. Early planting are in heated hoophouses that have both ground heat and air heat systems. We have four hoophouses with ground heat, two that share a biomass furnace (wood pellet fuel) and two that have propane on-demand water heaters. All of them have water lines buried 16" underground with a loop in each bed. Three of these four houses also have automatic controllers to regulate heating and ventilation (peak vents and roll up sides) to achieve set parameters for temperature and humidity. We aim to for night temps 60-65 F and 60-70% humidity, and day temps 75-80 F.
Shade Cloth	Yes, It makes a significant difference, we use knitted 30% black shade applied to the entire exterior roof, usually applied 1st week of june and removed mid september. it is attached with clip-its to the batten cordage for the roll-up sides.	no

	Lakeview Hill Farm	Jericho Settlers Farm
Heat	Yes, I would not plan on growing hoophouse or greenhouse cucumbers without supplemental heat. Use primarily use a large wood boiler with a natural gas backup boiler to run our in ground soil heat, which is just like a heated slab, except the pex tubing is buried 1' in the soil. We use the same boiler water and run a plate heat exchanger to heat our irrigation water to 70 degree. We also have a fan coil to also heat air and use convection tubing to evenly distribute that heat through the greenhouse. Our Maximus environmental control system operates all of the pumps and fans to distribute this heat within the parameters we set.	A Maxim 250K BTU biomass furnace (by Central Boiler) powers ground heat for two large hoophouses. Takagi on-demand water heaters (100K BTU, propane fuel) power ground heat in two other houses. We have various models of Modine propane furnaces to supply air heat. We use Igrow 800 environmental controllers by Link4. These allow us to set specific humidity and temperature parameters and programs and to monitor and control the houses remotely.
Additional Notes on Crop Maintenance	It is a lot of maintance, we generally follow the standard "umbrella" style production system. One thing we did not talk to much about was fertilization. Cucumbers have the highest demand for N of any greenhouse crop we grow. But we have to spoon feed the fertilizer as we have noticed that more than 125#N applied as a preplant fertilizer will often lead to a large flush of aphids. Therefore around the setting of the first fruit we start injecting fertilizer via dosatron. We try to start with 2.1#/N/acre/day applied via chilean nitrate and 3.37#/acre/day if K20 via water soluble potassium sulfate. We are constantly trying to find an alternative source for nitrogen that is water soluble and can be tank mixed and stay in suspension for about 2 weeks without growing algae causing dipper clogging.	

Harvest and Yields

Harvest Window	Mid April- Mid Sept when they would be removed for winter greens. Under grow lights we can grow though thanksgiving	Harvest begins on May 1 and extends through September 15. Earliest plantings are typically cleared out end of July and later plantings go until mid September when plants are removed for winter greens seedings.
Harvest Procedure	hand harvest, M-W-F usually in the morning, pinching on the stem, into bulb crates onto harvest carts with pneumatic tires use aluminum two step ladders when harvest gets above head height.	Hoophouse - harvest mid morning after plants have dried. Cukes are snapped from the vine with fingers and placed in a flip-top tote (about 40# per tote). Bottom of tote is lined with a new absorbent (disposable) towel. Full totes are loaded on ATV with trailer and driven to packbarn where harvest is weighed, recorded and totes are placed in walk-in cooler (temp 50-52"F). Totes are stacked with tops open for first 24 hours and then closed if to be stored a few more days.
Cleaning Procedure	We use a brusher washer with sponge water remover and rotary packing table to wash all the cukes and sort for packaging.	Cucumbers are not washed or wiped at time of harvest. After cooling and during packout for sale cucumbers are wiped with a clean cloth if necessary.

	Lakeview Hill Farm	Jericho Settlers Farm
Packing	Orders are packed directly into waxed boxes with plastic liner, excess is stored to plastic totes with lids.	Cucumbers are graded and weighed for orders as we pack (retail bags for farmstand, into CSA shares, or cases for wholesale accounts). Wholesale accounts are packed either in 20# 1/2 bushel wax boxes or 40# fliptop totes for customers that return our totes.
Storage	just in the walk in cooler, usually set to 36ish	Cucumbers are stored in a walk-in cooler (temp 50-52"F). Totes are stacked with tops open for first 24 hours and then closed if cukes are to be stored a few more days to maintain humidity. Maximum storage time is ten days.
Yields	$31,3824 total gross for 2022. Beit Alpha lebanese cukes at $2.60/# Quirks at $3.5/# wholesale and $5/pint at farmers market and farm store. There was a total 1050 bed ft planted (or 1050 plants) roughly in the ground for 10-12 weeks each over 4 successions. We lost probably half of our yield potential in the last two successions due to disease and insect pressure, probaly $10k+	American slicer types: 21#/bed ft early season, 25#/bed ft. main season Persian types: 17#/bed ft. early season, 19#/bed ft. main season
Additional Notes on Harvest & Yields	I think the potential is there for even larger yields with better crop management	

Equipment

General	5000 sq ft greenhouse with all the gizmos and gadgets I mentioned minus the lights. $40-45K Brusher washer, maybe $8k? don't remember.	inground heat system for hoophouses - $1200, $800, $1500 (heater, piping, installation) air heat system - $1500 to $2500 (heater plus propane hookup) hoophouses - $15,000 to $30,000 depending on size
Biggest Impact	the greenhouse with all the environmental controls	In ground heating is crucial to the success of our early season cucumber plantings. The warm soil greatly improves transplant sucess and early plant growth. The cost of this system is off-set by the higher prices we can demand for early season production. And once we have our customers buying from us early they tend to stay with us throughout the season, even when others have cucumbers during the main season - so we can hold onto market share throughout the growing season.

Marketing

Markets	farmers market, on-site farm stand, direct to grocery, direct to restaurant	CSA, on-site farm stand, direct to grocery, direct to restaurant, wholesale through a distributor
CSA		2 to 3 cucumbers per week May through September
Farmers Market	$5/pint with 3 large cukes or 6-7 quirks	$5/pound (prebagged)
Direct to Grocery	$3.50/# quirks $2.6/# beit aplha lebanese bulk	retail bags $4.45/pound early season, and $3.50/pound main season bulk cases $3.95/pound early season and $2.65/pound main season

	Lakeview Hill Farm	Jericho Settlers Farm
Direct to Restaurant	same as above	Persian types: bulk cases $3.95/pound early season and $2.65/pound main season, 20# cases American slicer types: bulk cases $3.95/pound early season and $2.15/pound main season, 20# cases
Wholesale		Persian types: bulk cases $3.95/pound early season and $2.65/pound main season, 20# cases American slicer types: bulk cases $3.95/pound early season and $2.15/pound main season, 20# cases