CARROTS

	Erik Heimark Maple Ridge Produce	Janaki Fisher-Merritt Food Farm	Ben Doherty Open Hands Farm
Location	Aitkin, MN	Wrenshall, MN	Northfield, MN
Acres in vegetables	5	17	17
Acres in carrots	5% of an acre	3.2	5
Area in hoophouse carrots	a double 80' row		
How these tasks are done for Carrots:			
field prep/tillage	with a tractor	with a tractor	with a tractor
hoophouse prep/tillage	with a walking tractor	with a walking tractor	do not do this task for carrots
creating stale beds	with a tractor	with a tractor	with a tractor
direct seeding	by hand	with a tractor	with a tractor
cultivating	with a walking tractor	with a tractor	with a tractor
laying irrigation lines	with a tractor	do not do this task for carrots	by hand
laying row cover	by hand	do not do this task for carrots	do not do this task for carrots
spraying for pests & diseases	by hand	with a tractor	do not do this task for carrots
harvesting	by hand	with a tractor	with a tractor
topping	do not do this task for carrots	with a tractor	with a tractor
farming style	organic practices, not certified	certified organic	certified organic

Propagation

FIELD Varieties SPRING	Mokum (germination and growth a little slower than expected, tops can have weak attachments)	Spring: Napoli, Calibra	Spring: Mokum (quick and tasty), Naval (better yielding and flavor fine, tops strong for harvest)
FIELD Varieties SUMMER	Bolero (see below); Yellowstone (strong tops, large, good looking roots, more susceptible to Aster Yellows than others,vdo not sell as well at market despite good flavor and looks); Manpukuji (slow to maturity, good flavor, very strong tops, doesn't grow as long as hoped)	Napoli, Calibra	Naval - back to trialing others for better flavor

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FIELD Varieties FALL	Fall: Bolero (excellent storage, good flavor, hardy, slow to maturity, some tops don't attach well)	Bolero, Purple Elite	Bolero
HOOPHOUSE Varieties	Bolero	Yaya. Tops don't hold up in the field, but they do great in the hoophouse. I prefer their color to Napoli.	
Planting Schedule	**Field:** May 14th or after first frost in May- early planting & late planting May 28th- early planting June 25th- early planting July 23rd- Harvest 1st planting early carrots August 4th- Harvest 2nd Planting early carrots August 19th- Harvest 3rd Planting early carrots Sept. 10th- Harvest late Planting carrots (first planting) **Hoophouse:** After cucumber rotation (August 15th-ish) or after lettuce rotation (July 1st - 15th)	**Field:** 5/10, 6/10, 6/26 **Hoophouse:** 4/19, 5/7	**Field:** First spring planting goal is late April, soon after plowing and smoothing. From there, 2nd and 3rd are 3 weeks apart. (We might skip the 3rd planting from now on due to yield issues.) Storage planting goal is June 20s -- early enough to get large carrots and have time to replant if there's low germination . We try to make that decision by July 1 so replant harvest sizes are still good, but we avoid replanting and have only done sections or small fields a couple times.

Bed Prep

Preceding Cash Crop	**Field:** Typically we plant sweet corn, followed by pumpkins/squash, followed by brassicas, followed by onions, lettuce and carrots/root veg. Typically, carrots beds have broccoli, cauliflower, cabbage, etc planted in them prior to carrots, and these crops are typically proceeded by pumpkins/squash. **Hoophouse:** We will follow a lettuce planting with a carrot planting. Sometimes a cucumber planting with a carrot planting or an intercropping of carrots with tomatoes once the tomatoes are fully grown. The proceeding crops would be tomatoes, peppers, eggplant or cucumbers.	**Field:** My rotation doesn't necessarily specify a preceding cash crop, but I don't follow beets and keep four years in between carrots, beets, and parsnips. **Hoophouse:** It varies, tomatoes, cucumbers, spinach, basil, green onions, and spring mix are all grown in rotation in the hoophouse.	**Field:** No set rotation. We try to plant carrots after brassicas , winter squash or another crop we know had very little weed seed set the year (or two) before.

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Preceding Cover Crop	**Field:** Proceeding carrots, we planted cauliflower and broccoli in a double row, 18 in on center in black plastic with drip tape irrigation. Some rows have low-Dutch white clover planted in them. **Hoophouse:** The proceeding crops would be tomatoes, peppers, eggplant or cucumbers.	**Field:** Winter-killed barley and crimson clover early, red clover or crimson clover for storage planting **Hoophouse:** winter rye killed by tarping	**Field:** Winter wheat or winter rye. We now do field prep in early May for the final storage planting, to maximize stale bedding. Long dry periods in May and June have made stale bedding less effective - not enough rain for weed germination, then more than average germ later once irrigation starts.
Soil Amendments	**Field:** We practice organic growing. One year prior to the carrot planting we spread 2 truckloads about 14 yards a truck load) of (non-certified) organic turkey manure over the field. The field is then worked and raised beds are formed with plastic mulch and irrigation. The following year, the carrots are planted in the plastic mulch spaces left from the previous crop. With straight planting of carrots, the field is worked and then carrots planted. **Hoophouse:** We apply turkey manure (~6 yards), homemade compost (~4 yards), cow manure (~4 yards), biochar (~5 yards), lime (~200lbs applied to a 30x96 tunnel) and borax (1 lb) to our high tunnel.	**Field:** It depends on the soil test and what the previous cash crop was, but often 1000 lb composted poultry manure, and 100 lb Sulfate of Potash before planting, and sandier fields get 5 tons or so of compost added the fall before. **Hoophouse:** Before planting we apply 250 lb sulfate of potash, 500 lb feathermeal, and 1500 lb alfalfa meal before planting with the idea that this will provide enough fertility for other subsequent crops when carrots are harvested by mid-July.	**Field:** Our typical farm-wide fertility: Pre tillage: Gypsum 300-400#/acre plus zinc, boron and copper often called for by soil test. Calcium and sulphur are important for vegetable quality and pest/disease resistance. This rate is recommended to us to replace annual removal and to keep available levels high. Composted turkey litter (not dry pelletized), 3-4 tons per acre. Very good NPK source. Carrots also get a light application of Sustane 4-6-4 (dry pelletized turkey litter) worked in 2-3" a couple weeks before planting . 450#/ac. Probably unnecessary.
Soil Prep	**Field:** Soil in the plastic mulch rows are worked the previous year. Soil is tilled twice with a 4' tiller or once with a disk, followed by the tiller. For the plastic mulch beds, soil needs to be worked very well. For hand planting in rows without plastic much, sometimes a hand tiller is needed to further till the soil prior to planting and often the rows are raked smooth. Ideally, all or most of the fertilizing, tillage, and mulch laying is done in the fall of the previous year. **Hoophouse:** The hoop house is worked with a hand tiller every two years.	**Field:** One pass with the spader, or using a keyline plow about 14" deep followed by a pass with a power harrow. The spader works better when the soil is wet or if I need to bury residue, but the power harrow is faster. If the field has a living cover crop rather than winter-killed, I will do a shallow pass with the rotovator first. I try to complete primary tillage three weeks before planting so I have time for stale bedding. **Hoophouse:** Tarp the area to kill the cover crop for two weeks, broadfork and power harrow.	**Field:** If cover crop is over 8-12", we disc quickly for better incorporation. Then moldboard (3 bottom with a buster bar, on JD 2940), followed same day by 15' Perfecta with JD 5320. The buster bar smooths ridges, breaks chunks, and separates dirt from rootballs. The perfecta does the smoothing, and in our soil is best done before the chunks dry down, often within a couple hours of plowing. Then every week or two we follow with the perfecta as needed for weeds - looking for just right timing after rains. Often we'll perfecta each field twice on plowing day so we don't need perfect conditions later, that's been especially helpful with more sporadic rainfall. We have medium silt loam and seed into chunkier soil, to avoid pulverizing soil and crusting issues.

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Stale Bedding	**Field:** The black plastic mulch bed from the previous year is kind of like a "stale bed." The beds are created with a shaper-mulch bed layer. The mulch bed tends to be around 2' wide with between rows of 4'. The rows are created 6' on center. **Hoophouse:** Kind of a stale bed, black plastic mulch is laid in rows and the between rows are also covered in black plastic. Carrots are planted into holes in the mulch.	**Field:** I do field prep three weeks prior to planting and then use an Einboch tined weeder to kill the first few flushes of weeds before planting. I usually use it once a week prior to planting. In dry weather, I will try to irrigate at least once to ensure that there's enough moisture to germinate the weed seeds. **Hoophouse:** We try to shallow cultivate with a wheel hoe a couple of times before planting. Make sure there is good soil moisture to germinate weed seeds.	**Field:** 15' Perfecta with JD 5320, at 5-6 mph. Average 2 - 2.5" deep.
Additional Notes		**Field:** I still get pretty good stands of carrots even when there's a fair amount of residue, after a rye cover crop for example, but planting is a lot more stressful and it's more difficult to use the tined weeder with residue so I try to have as little residue as possible.	

Planting

Bed Width	**Field:** Unmulched beds are planted 36" on center in rows 250' long. Plastic mulched beds are planted 9" apart, staggered in a double row 150' long to 250' long and typically 2' wide. **Hoophouse:** Same as in the plastic mulch in the field.	**Field:** Our wheel tracks are set at 72", and three rows of carrots are planted per bed at 18" apart. **Hoophouse:** We don't have a set bed width for carrots in the hoophouse, it depends on which house is being used and the available space.	**Field:** Beds are 40" wide on center, with room for up to 12" wide tires..
Plant Spacing	**Field:** Unmulched beds are planted in rows 36" on center, with about 2" spacing between seeds. Each row has a double planting of carrots, a row on either side of the drip tape. Plastic mulched are planted in pods. Each pod is roughly 9" apart and staggered in a double row. **Hoophouse:** Same as in the plastic mulch in the field.	**Field:** Three 18" rows per bed. The goal is to have 1" between carrots. **Hoophouse:** We plant hoophouse carrots a lot closer--three lines of seed about 3/4" apart, spaced 12" apart from each other.	**Field:** Rows are 18" apart, 2 rows per bed. Goal for in-row spacing is about 20-25 seeds per foot, and 15-22 plants per foot after germination, though 12 plants is acceptable too. I would aim a little higher if our main markets were grocery or direct, to get less bulky carrots and more slender ones.

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Seeding Process	**Field:** Unmulched beds are planted in rows 36" on center from pelleted seeds from a Hoss walk behind seeder using the #3 disk. The seeder is walked up and down the row on either side of the drip tape (6" spacings on drip tape emitters). The hopper is filled about once a row. Plastic mulched beds are planted in pods. The pods are widened to about a 5" diameter, and a handful of pelleted or non-pelleted seeds are planted by hand. The previous crop was planted at 18" on center, these holes are widened and new holes are made in between these holes. About10-12 seeds per pod. **Hoophouse:** We use a Japanese hoe or our hands to create and widen the holes for planting. Seeds are planted by hand from either regular or pelleted seeds.	**Field:** I use a three-row Stanhay S870 belt planter with a 13.0x90 hole belt on setting AL for an in-row spacing of 1". I usually have the depth set at 6 notches, and use the S2 base plate. I have someone walk behind the planter to make sure seed is always dropping and the seed is being covered consistently. **Hoophouse:** We use a Stanhay Robin push seeder with a 13.0x90 hole belt. Make three passes as close as you can without disturbing the row just seeded, then move over 12" and plant three more until we have as many row feet as needed.	**Field:** Seeding is done 4 rows/2 beds at a time, with Planet Junior seeder on belly of Oggun II tractor, which has tires set at 80" on center. We can also use a wide Hefty G, or 2 rows/1 bed at a time with Allis G or smaller Hefty G.
Water at Planting	**Field:** Crops are watered with drip tape in both the field and plastic mulch row applications. We prefer a good rain after planting but that doesn't always happen. We try to run the irrigation prior to planting in the plastic mulch row, otherwise planting can be difficult in the dry soil. **Hoophouse:** Irrigation in the high tunnel is drip tape with 6" emitters.	**Field:** Depending on how much soil moisture is in the ground, I want it to rain or be irrigated sometime within a few days of planting. If it's really dry I'll irrigate right away, but I try to have good soil moisture for stale bedding, so the field generally isn't really dry at planting. Water is applied with a Bauer water reel attached to a 100' boom. **Hoophouse:** The hoophouse soil is generally kept moist for stale bedding, but the carrots are usually irrigated within a week or so of planting as well.	**Field:** If no rain, irrigation starts by the following evening. If soil and air are hot, dry and/or windy, we start the same evening or following morning.
Row Cover	None	None	None

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Germination	**Field:** If we time it out correctly, carrot and beet rows are planted close by in the field planting. When the beets first emerge, we take the flame weeder to the carrot row to burn out the weeds while the dormant seeds are protected. We have never done this successfully. **Hoophouse:** Carrots tend to germinate extremely fast for us in the high tunnel.	**Field:** Consistent seeding depth and making sure the seed doesn't dry out. **Hoophouse:** Consistent seeding depth and moisture.	**Field:** Good bed prep and seed depth is key, then just right irrigation until we've germinated our in-row spacing goal. That's 4-12 days depending on soil and air temps, and seed depth. We aim to avoid any drying soil below 1/4", and typically water a planting each morning or evening, 2-4 hours or 0.2-0.4 inches, pausing for rain. Carrot seeds don't like to dry out, but overwatering increases weed germ. If it's been very dry and the soil is dry for several inches down, the first watering of seeds will be an inch or so, and 1-2 waterings of the next couple days may be 0.5-0.75; otherwise the surface dries out too early in the day. After that smaller amounts usually suffice.
Thinning	**Field:** Carrots in the field planting are thinned mostly by accident while hoeing or weeding. These seems to sufficiently thin the carrots for us. In the mulch rows, carrots are not thinned until some have reach usable size. Pulling the market ready carrots makes room for the rest of the carrots and the cycle continues for about 4-5 weeks.		We don't thin.
Additional Notes	**Field:** In the beds without plastic mulch, after the carrots are large enough (4th or 5th leaf) occasionally rice hulls are used to mulch the carrots. Mulching isn't necessary in the plastic mulch beds.		**Field:** We've found that watering between one true leaf stage and about 2" tall can cause widespread forking. We typically let them dry out during this period, once the in-row germination is sufficient, which is when we usually get in our first cultivation.

Crop Maintenance

Irrigation	**Field:** We shoot for 1" a week. If we do not have enough rain in the rain gauge we will turn on the irrigation for a day or two until the moisture is adequate in the soil. **Hoophouse:** Irrigation is often left on overnight in the greenhouse.	**Field:** It really depends on the field and the weather, but I generally figure they need between 3.4 to 1 1/2 inches per week, after germination. **Hoophouse:** We use NDS Hydro-flo 180 degree fan mist sprayers on 16" risers spaced 4' apart for about two hours once or twice per week, depending on the temperature and size of the crop	**Field:** After 2" tall, our goal is 1-1.25" per week in one watering, accounting for rain of course. The first watering after any period longer than a week, or if excessively dry, should be light and cautious to avoid splitting -- give 1/3-1/2", then come back 2-3 days later with an inch or so. In hot and dry conditions, they seem to grow best and split least with 1" every 5 or so days.

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Changes to Irrigation	**Field:** We try to irrigate more as the carrots approach pickable size. It is not done scientifically. **Hoophouse:** No changes	**Field:** When carrots are germinating or just emerging, I will irrigate smaller amounts more often to make sure that the soil doesn't dry out in the seed zone. **Hoophouse:** We irrigate heavier and more often later in the growth stage because the hoophouse is warmer at that time and the plants are larger.	**Field:** If sizing up period (roughly 2-4 weeks before harvest) is hot, dry and/or windy, we sometimes give 2" per week. We avoid watering in the 7-10 days before a harvest, unless excessively dry and we need them to gain size. We're still learning how to time the pausing of irrigation to avoid mud buildup on the flamer tires.
Weed Control	**Field:** See earlier comments. Field carrots flame weeded before germination (right when beets have germinated). Then carrots are hand weeded until their tops begin to canopy. Sometimes mulch is applied if we have time and mulch available. **Hoophouse:** carrots are hand weeded in the high tunnel. The weeding is very minimal because they germinate so quickly.	**Field:** I flame weed the first two plantings just before emergence, the fall planting germinates so fast that flaming is beneficial. As soon as small weeds are visible, I use a basket weeder to cultivate close to the row, 1/2-3/4" is the goal. I modified the weeder with a steel plate along one side of the baskets to keep soil from falling into the row and covering the seedlings. I make two passes per bed to get as close as possible to the row. On subsequent cultivations I put the basket side toward the row in order to move soil into the row to disturb weeds closer to the carrots. We usually hand weed carefully when the carrots are between 1-1.5" tall using small bent knives to flick out the tiny weeds. Early plantings usually have more weed pressure and usually require a second time weeding. Otherwise, we usually get by without any more hand work in the field other than scouting for big weeds just before harvest. Once carrots are about 2 1/2" tall I use the finger weeder to cultivate. After that I use the tined weeder to blind cultivate and knock down the ridge made by the fingers. I use the finger weeder or just the A-blades for the final cultivation so that the ridge protects the crown of the carrot. **Hoophouse:** We generally flame weed prior to emergence, then hand weed once or twice depending on the weed pressure. We use a wheel hoe with an 8" stirrup to cultivate between rows.	**Field:** Flame weeding right before germination with a 3pt, 8 ft flame weeder OR a walk behind/hand push, five-torch Red Dragon (if tractor operators are too busy at the right time, as nearly anyone can use the Red Dragon.) First cultivation is Buddingh basket weeder, on Hefty G if no flaming, it's slow and around first leaf stage. With flaming, it can be delayed til 2-3 leaf stage and can drive a little faster. Second cultivation is 1-2 weeks later, with basket weeders, at a faster speed. Hand weeding goal is at about 4" tall, roughly 4 weeks after seeding. Can be up to 30 labor hours per acre, or half that when stale bed period has enough rain for good weed germination. Flaming can also cut the weeding hours by 1/3 - 1/2. Later cultivations, 1-2 times as needed -- we've used shanks on an Allis G, s-tines and other knives on a custom toolbar on a Farmall Cub, and are fine-tuning a s-tine cultivator (with floating row units off an old row crop cultivator) to use under the Oggun or bigger Hefty (both hi-crop) A later hand weeding is often necessary in spring and early summer plantings, and sometimes in the storage planting (for about 1/4 the time of the first weeding). But with better stale bed germination, flaming, and more effective cultivators, will hopefully be less or not necessary. We've seen easy weed control before when the rain and dry timings have worked out perfectly!

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Insect Pests	**Field:** We have not had many insect problems in our carrots. Occasionally we have black swallowtail caterpillars eat down some vegetation and we remove them by hand. **Hoophouse:** We have not had any pest problems with the greenhouse carrots	**Field:** We have some impact from carrot fly in the early plantings, but it hasn't been enough of an issue for me to do much about it, and they don't seem to bother the fall Boleros.	
Diseases	**Field:** Yellow asters can be a problem some years. We don't really do much for it. Just harvest those infected carrots. **Hoophouse:** None	**Field:** We've eliminated Yaya from our outside plantings because the tops don't hold up to what I think is Cercospora. Other varieties seem to be able to withstand it, though. We always have some Aster Yellows, but most years it affects less than 1% of the crop.	**Field:** Alternaria in summer carrots , can spread to Bolero if adjacent so we separate those plantings.
Hoophouse Environmental Control	No controls, just manually rolling the sides up and down	We don't do anything special for carrots, just try to open it up early enough in the morning so that we don't get excess humidity, and keep the temperature below 80 degrees during the day if possible.	
Hoophouse Supplemental Heat OR Shade Cloth	None	No	

Harvest and Yields

Harvest Window	**Field:** Carrots are harvested when their tops are the diameter of a quarter. The same bed will be harvested over a 4 to 5 week period. Typically carrots start to get harvested the last week in July and continue on until the end of September or early October. **Hoophouse:** Same strategy as in the field. Often we harvest a little earlier to help thin the pods.	**Field:** We begin harvesting the first planting in early August. We take the Napoli's first, and then the other varieties. If they're sized up nicely, we often will harvest the whole variety at once and store in the cooler for 3 weeks or so. We generally harvest the storage planting the last week of October. **Hoophouse:** Our goal is to start sending carrots to the summer CSA shares the beginning of July. Sometimes they are still a little smaller than usual at that time (1/2-3/4" diameter and 5-6" long), so we harvest more and send them bunched with tops on the first few weeks. We manage the harvest so the hoophouse crop ends when the field crop is ready in the beginning of August.	**Field:** Naval and Bolero we're looking for a decent percentage of hefty, thick carrots, for our foodservice markets. One of us walks the field with a pitchfork and a bucket and checks in different areas and areas of average density. We try to pick a full planting at once, but sometimes split it up if we're tight on cooler space or harvest time, or if we want them to grow a little more while we work through the first harvest. Mokum / spring carrots are more slender, we just do a very small planting of them and expect lower yields.

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Harvest Procedure	**Field:** We harvest carrots at any time of the day. We pick and bunch them as we go, then drop them into cold water. We typically put 5 nice carrots in a bunch, more if they are small. Ugly carrots are topped and then dropped into the water by themselves. **Hoophouse:** Same as field	**Field:** If the stand is good, I generally wait to harvest until the yield is about 1 lb/row foot. The carrots are usually about 1" in diameter and 7-8" long. We try to harvest carrots early in the day during the summer, if possible, and try to choose a day when the weather is overcast so they don't dry out waiting to be brought down to the pack shed. In the fall, we harvest all day. We use an FMC/Scott Viner harvester. **Hoophouse:** Carrots are always harvested in the morning, for the CSA. We use a digging fork to loosen the soil, then pull the carrots and bunch them by hand.	**Field:** For Mokum we use an undercutter and pick by hand. For Naval and Bolero we use a 1970s Scott Viner harvester, pulled by a 2940 JD tractor, and a JD 5320 with wagon and bins to catch the carrots. It takes 3 people - one person driving each tractor and one person operating the harvester. For bigger plantings or fields farther from the cooler, we'll use two wagons hooked together, with 4 bins per wagon. The bins are 18-20 bushel bins, plastic, Decade brand, sanitized before each use. On storage harvest days, we average 12 bins per hour -- picking 8 bins per load and with all of us returning with each load to forklift them into the cooler and reload with empty bins (and quick bathroom breaks). The smaller summer plantings tend to go slower depending on turnarounds, yields, etc. If the soil is too wet or the carrot tops are too weak from alternaria, excessive cold, or snow, the harvester doesn't pick up carrots as well and we may have people follow behind to glean. If it frosted overnight, the tops are usually stronger and more upright after thawwing a few hours. All bins are numbered, and anytime a bin enters or leaves the cooler, its number, contents, the date, and activity (harvest, wash etc) are recorded on a clipboard. For winter storage, a cooler location is recorded (A11, B24, etc), and all winter storage bins are entered in a google sheets inventory. That inventory is updated at key sales/budgeting points throughout the winter.

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Grading	Seconds sometimes bagged and sold by the lb; the really ugly seconds are sometimes peeled and chopped and mixed with other root veggies and sold in a variety back by the lb. Most of the time, second carrots are kept for the household.	We cull carrots with Aster Yellows, small broken pieces, worm damage, deep splits, and those that are badly forked. Those that have a few large forks, are broken but decent sized (over 3" or so), have small splits that aren't open to the core, or are just ugly or knobby go to CSA juicing shares, or for processing carrots. The CSA gets straight run of what's left. When we do wholesale deliveries, we sort out the biggest ones for restaurant customers, the most perfect for retail bulk, and everything in the middle gets bagged for retail.	Firsts, for grocery, we use carrots roughly less than 2" at crown and 5-8" long; straight or with minor curves, with maybe 1 cosmetic defect, preferably none. Seconds, for foodservice, are thicker, longer or shorter, can be forked (which we sometimes snap into 2 separate carrots), and can have 1-2 cosmetic defects, especially if those don't require peeling. Thirds, "Nubs and Stubs", usually go to a soup company for stock and are the broken bits and funkier, but clean and sound, carrots.
GREEN TOP	**Bunching:** We put 5 to 6 good sized carrots in a bunch and tie them with a MN grown twist tie. **Cleaning:** The bunched carrots are picked into water. They are drained and rinsed in the pack shed and dunked into SaniDate water for 40 seconds. If they need additional scrubbing we do so before the SaniDate soak. Often they don't require any scrubbing. **Packing:** Carrots are allowed to dry and then packed on icepacks in large Costco tote for market. **Storage:** Carrots are picked the day before market so the storage time in minimal. We pack the carrots on icepacks. **Max Storage:** We have never gone more than a day of storage before selling them. Some times we will take the carrots that didn't sell and chop them up for mixed root veggie packs and place them in our retail refrigerator. They can store like this for a week or more.	**Bunching:** These only go to the CSA, so the size of the bunch and the size of the carrots in the bunch varies. After loosening, we pull up the desired number, reject any that aren't nice enough, strip any leaves that aren't attached well, and tie with a twist tie. **Cleaning:** We have an expanded metal screen table that we spray them off on using a handheld sprayer. **Packing:** They go into large gray vented stack and nest harvest crates, 12-20 per container, depending on the size of the bunch/tops. **Storage:** We put them on a pallet in the cooler, which is about 37 degrees in the summer. Shares are generally sent out that afternoon, but if they need to be kept in the cooler longer the pallet will be covered with a plastic bag (pallet cover). **Max Storage:** We almost always send them out the day of harvest, but I think we could probably keep them a week without a problem.	We don't bunch carrots.
BULK Topping	By hand	The harvester tops the carrots.	The harvester removes the tops. When it works perfect we smile. Otherwise we cry and get out the wrenches.

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BULK Cleaning.	Bulk topped carrots are picked into cold water in the field. Carrot tops are left in the field. In the pack shed they are rinsed under heavy pressure from a hose and sometimes scrubbed. Then they are soaked in a SaniDate solution for 40 seconds before being drained and packed.	Carrots are harvested into 800 lb. Macro bulk bins. We bring those to the pack shed with the skidsteer or on a hay wagon. A bin dumper dumps the carrots onto a conveyor, where we can sort culls, tops, and weeds before the carrots go into a barrel washer. When they come out of the barrel washer, they fall onto a rolling inspection conveyor which allows for sorting out culls and juice carrots. The remainder run off the end into a clean pallet box. We put one layer of burlap on the bottom of the bin so that the carrots on the bottom aren't sitting in water. We use a boogie board to help break their fall as they come off the wash line so we don't end up with so many broken pieces. If the carrots have been stored dirty for more than a day or so, we attach a brush washer to the end of the inspection conveyor to further scrub and shine up the carrots. If they are intended for long-term storage, we have a sprayer at the outlet of the last washer to apply a Sanidate solution.	The forklift retrieves a bin from the cooler, and loads it on the bin dumper. Once fully lifted, the carrots are sprayed with a hose to encourage them to slide down into the barrel washer. Some hand pushing is necessary -- a taller ceiling with a bin dumper tipping the bin further over would be nice. We wash half a bin per barrel washer load, then unload with a long homemade hoe (wide plastic head) to refill the conveyors. There's a slanted conveyor, which brings the carrots up to a level conveyor that's at waist/working height. At the second conveyor, 2-3 people hand sort into categories/grades -- one category goes over a divider to land in a bag when the conveyor is run, and other categories are put into bins or buckets close nearby.
BULK Bagging	Carrots are weight out into 1 lb clear plastic bags. Bags are twist tied and packed on icepacks in large containers for market.	We pull a bin out of the cooler and lift up with our forklift. A few people pre-fill bags by standing next to the bin while one or two others check the weight on scales, tie the bags, and put them in delivery containers.	We use a red head bagger to hold our custom-printed 25 lb bags. They are filled one at a time by running the conveyor. Then removed from the bagger / bag holder, weighed on a scale, closed with a steel wire tie, then either stacked on a pallet (for an existing order) or in a bin (if for backstock). For labeling - all our info is printed on the bag - existing orders get a small white sticker from a sticker gun which has a customer code and delivery date. Backstock gets a colored sticker dot, indicating what category/grade the bag is, and the wash date is written in sharpie on the colored sticker. Backstock bins are tracked in the cooler by bin number, contents and location, all recorded on a clipboard.

	Maple Ridge Produce	Food Farm	Open Hands Farm
BULK Storage	Same as green topped carrots, although we have been able to store them in a refrigerator for 3 days before the next market.	After washing, we leave the bins uncovered in a 33 degree cooler overnight. The following day, plastic pallet covers are placed over the bins and they are stacked.	See below
BULK Storage Open Hands Farm	We use ventilated plastic 18-20 bushel bins, with carrots harvested into them from the harvester, and stored dirty until washed. Most washing is done to order, though we keep some clean carrots in bags on hand to meet last minute orders. Our summer cooler is 15x30 ft with a 15' ceiling, and a 10x10' door for the forklift. It has a humidifer running much of the time in carrot season, and a 10" shuttered exhaust fan to bring in fresh air occasionally. Our winter cooler is 26 x 30', with 20' ceiling, and a couple 10x10' doors. It has two refrigeration units, to cool the harvest in warm times, but in winter is primarily cooled with outside air. The outdoor air system was designed and installed by Ron's Refrigeration in Wisconsin Rapids, with components from IVI in Idaho. They are common systems for potato storage. On the north wall of the cooler there is a 4 ft door, about 8' off the ground. This is controlled by computer panel (a 90s era analog style computer, we didn't upgrade to the touchscreen). The panel opens and closes the door based on input from temperature sensors located inside and outside the cooler. We keep the temperature setpoint at 34.5. When the outdoor temp is 34 or lower, the door opens proportionately to the outside air temp and we are cooling with outside air. The door opens only enough to get the perfect temperature air , when mixed with the cooler's inside air. So when it's , say, -10 outside, we aren't blasting the carrots directly with -10 degree air. When the outdoor temp is above 34, the panel closes the door and turns on the refrigeration units. Winter air is dry, and so is refrigerated air. We run a humidifer full time to keep carrots crisp, flavorful and juicy, and unstained. Inside the IVI door is a 4 ft fan, pulling "warm" air from inside the cooler, and (when the IVI door is open) also pulling cold outdoor air, all being pushed past the humidifier. Both inside and outside air are well mixed with the humidity in a 4 ft wide "plenum", or back room, before being pushed out through slats in the wall. The slats, or openings, in the wall line up with the forklift access holes of the bins. This way, air of the perfect temperature and humidity is blown over and under every bin, all winter long. This is different than in a typical cooler setup , when bins stacked several rows deep and high, sometimes will never fully cool down in the center, and storage life can be decreased significantly. There are temp sensors, on long leads, that can be buried in a couple bins, so we can monitor temperatures in the center of a couple bins. There are also passive exhaust shutters, which open when outside air is being pulled in, so the fan can push stale and warmer air out of the cooler. That's a lot of moving parts and several machines. We've had more issues than we hoped for, but the carrot quality and flavor has been very, very good.		
BULK Max Storage	A week.	7 months	After five months the cosmetic appearance is likely to go down, usually with some staining. Sometimes we see staining sooner than that, but usually acceptable. Flavor is usually great til April, when we switch to our smaller cooler, which isn't as ventilated with fresh air. We like to sell out by March 10-15, but have sold as late as May 10 with good quality.

	Maple Ridge Produce	Food Farm	Open Hands Farm
Yields	**Field:** We pick ~10 to 20 bunches/wk for the first two weeks and then ~30 to 50 bunches/wk for another 4 to 5 weeks. Then bunch yields decrease down to ~10 to 20 bunches/wk, but the 1 lb topless carrot bags start coming in around 10 - 20 bags a week until the end of the season, about 4 weeks. I estimate we are getting ~370 lbs of carrots off 400 ft. About 1 lb/sq ft **Hoophouse:** We estimate ~ 1.2 lbs per ft.	**Field:** 4-6 lb per bed foot **Hoophouse:** 2 lb pounds per bed foot, mostly green top bunches, 1.6 bunches per bed foot.	**Field:** Not including the "nubs and stubs" grade, the storage planting is often over 30,000 lb per acre marketable yield, or 1.3 lb per bed foot if my math is right. Summer yields tend to be around 20,000 lb per acre.

Equipment

General	Planter ($300), hand cart ($150), totes ($100), pack shed materials ($50), hand tools ($100)	Bin dumper new, $5500; Barrel washer new, $4450; infeed conveyor used, $250; Rolling inspection table new $2000; stanhay s870 planter used, $2500; Basket weeder new, $2500; Finger weeders new, $4000; Flame weeder used, $1500; Tined weeder new, $3500; FMC harvester used, $13000.	1970s Scott Viner Carrot/Beet Combine, $8000 JD 2940 tractor, $13,000 JD 5320 Tractor, $25,000 Wagons, $1500 each when add new deck and tires Forklift, 2010 Toyota 3,000 lb four-wheel propane, $13,000 Barrel Washer, purchased for $1500? and modified with another $2500 over the years Bin Dumper, $2000 used plus repairs (new $5000) Conveyors, 2, about $1000 each Bagger / Bag holder, $500 Plastic pallet bins, own 330, about $100 each when bought semi load (sometimes with friends) and with USDA Value Added Grant 2" Irrigation pipes, $30-40 each, about 100 pipes used for carrots Planet Junior 4 row seeder, $1500 Oggun II tractor, modified for hi crop and 80" on center, $20,000 Buddingh Basket Weeder, $2500 Hefty G, $6000 S-tine cultivator homemade, $750 Perfecta Cultivator 15ft, $4500 Flame weeder, used 3 pt, $900 Flame Weeder, Red Dragon Hand Push 5 torch, $1000

	Maple Ridge Produce	Food Farm	Open Hands Farm
Biggest Impact	Labor more than equipment has an impact on our profitability.	That's like making me choose my favorite child! Probably the basket weeder. Being able to cultivate so close when the carrots are small has really reduced the amount of weeding time needed.	Harvester saves us the most, turning a large crew week long job (or longer) into a 3 person, 3 day job. The forklift, bins, bin dumper and conveyors save huge amounts of lifting and bending. Irrigation makes carrots possible in our soil, germination especially but also adequate water for sizing up.

Marketing

Markets	farmers market, on-site farm stand, direct to restaurant, Food Hubs	direct to grocery, direct to restaurant, broken carrots to a kimchi maker and soup company	CSA, wholesale through a distributor, Farm to School delivered to their distributor, Colleges delivered direct
CSA		One 1-1.5 pound bunch per share per week in July, 2 lb bags in August, September, and October.	CSA members get to mix and match to make their own shares. Carrots are an option every week once they're ready. Average use per customer per week, in regular case season is about 1 lb. Many customers buy extra around holidays and through the winter via a 1-time storage share or pre-order/pre-bagged "store", once a month.
Farmers Market	We start the season at $5 per bunch and $5 per lb and can generally keep that price throughout the season. We may drop the price to $4 per lb on the bagged carrots toward the end of the season.		
Direct to Grocery	In the past I have sold carrots to grocery stores at a bulk price of 1.79 per lb. I don't sell bulk anymore.	5 lb bag, $5.85; 2 lb bag, $2.50; bulk $1.40	Bulk in 25 lb bag. $1.10-1.20
Direct to Restaurant	we only sell our carrots at farmers markets now	bulk $1.45/lb	
Wholesale to Distributor			Bulk in 25 lb bag. Typically $1.10 lb for firsts/retail, $0.95-1 for seconds/jumbo No. 2.
Seconds		$.55 per pound for juice and broken carrots for processing. We also sell them to CSA members as add-ons for $.68/lb	We call our seconds "foodservice", since that's long been our main market, since other markets were saturated and we made connections in foodservice and farm to school. They use our largest carrots and some chunky, some funky ones. $0.95-1 for distributor delivery, a little more for direct delivery. After that there's only small "nubs and stubs" left, we sell to a soup company for stock for $0.45 lb.