C. High-Density Planting Strategies And Specialized Techniques For All "Greens" Crops

1. High Density Technique Number One

- **It took us an embarrassingly long** time to notice that tiny seedlings have completely different space requirements than fully-grown plants, and to figure out how to make this fact useful to maximize our system "real estate". In our April 2010 training, while Tim was doing a segment of the training that I probably should have been paying attention to, I was instead cruising around the internet doing a Google image search for "aquaponics", just to see what was going in through pictures. I found an intriguing photo that took me to a website about Cornell University's Controlled Environment Agriculture (CEA) experiments growing lettuce hydroponically in greenhouses. Clearly this growing method required tremendous funding for both start-up and on-going operational expense, and in addition was very labor-intensive, but it still had some valuable information about spacing requirements from seedling stage to five-ounce harvest-sized heads of lettuce.

- **Their method involved seeding into tiny cells** in a seeding tray that held 128 in the same area that we had been using 32 cells of 2" slit pots! This got me thinking – what would be the maximum number of seeds to sprout into the minimum amount of space? We experimented with trays that held 72 cells and trays that held 98 cells. This involved moving the sprouts into 2" slit pots, and I was concerned that they would experience some sort of transplant shock, as plants do when they are planted in pots, then moved out into the ground.

- **Often, this transplant shock is so severe** that most of the leaves of the plant must be removed to avoid loss of moisture from the plant, as transpiration continues before the roots are established enough to take up enough water to keep the plant alive.Transplant shock did not seem to be a problem, and since October of 2010, we have been seeding in this manner. The following series of photos demonstrates this process pictorially.

Seeding into the 92-cell trays, using a soilless mixture of coir and vermiculite. This coir is extremely course, and not very easy to work with. It has the advantage of being harder to wash out of the slit pots, but overall, the more fine grade is actually my preference, particularly when I include the fact that the finer grade also holds water better. As a result, germination is better with the finer coir, unless great care is taken to not let the seed dry out during germination.

The coir is soaked in aquaponics water (note the bin in the back-ground, to the left), overnight if possible. This allows the large chunks to break down. Vermiculite is mixed in to a rough ratio of 60% coir/40% vermiculite. This allows for greater retention of water, as without vermiculite, the coir has a tendency to dry out too rapidly.

Next, the wet coir/vermiculite mixture is loaded into all the cells of the trays. We do 12-15 trays at a time, laid out on a table, filling them until they're slightly overflowing with the potting mix, then tapping the whole tray a couple of times down onto the table to "settle" the potting mix.

Then, we put the seeds right on top of the potting mix in the tray "cells'. The "assembly line" technique works the best, doing one entire step, then the next, and then the next, etc. If more than one person is working together, have each person do one job until completion.

Below are two photos of the lettuce seeds. We use pelleted seed, from Johnny's because the unpelleted lettuce seeds are extremely small and difficult to work with, and the clay coating both improves germination AND makes them easier to handle. Seeds are dropped in by hand, one seed per cell.

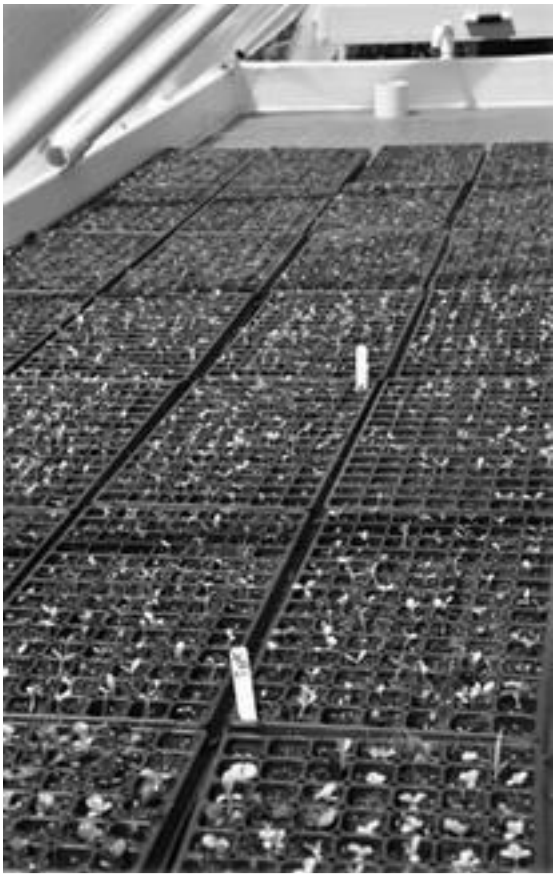
To the left are the mixed seeds, in a 12-quart pot (we use a lot of seeds!) This is about $1300 worth of seeds, for a mix that we custom order, that is adjusted and changed, depending upon the time of year. We order seeds from Johnny's, and then mix them ourselves, in a large pot. Seeds are then stored in a dark cabinet, sealed in airtight plastic bags or jars.

In the foreground of the top photo, Andrew, one of our wonderful Interns from Richmond, VA, is watering the seeds, while in the background, two interns can be seen seeding. **There are two correct ways to take care of your seedlings after they are seeded:**

<u>The first way</u> you use in the wintertime, or in cold weather: you <u>must</u> get your seeded trays out of the weather and keep them warm so they will germinate! In the photo on the bottom, Andrew is placing the finished trays on a set of gorilla racks, where they are kept warm for three to four days, until the seed has germinated; then it is transferred to the sprouting tables, where the conditions might be colder and less conducive to seed germination. The trays are watered by hand daily with system water, with a garden watering can (as in above photo). **This is <u>the method</u> you use on a <u>heated</u> germination table in cold weather to ensure the germination of your seeds.**

<u>The second</u> way you use when it's relatively warm: cover the newly seeded trays with a thin (scant 1/8 inch) layer of vermiculite and put them **directly** into the sprouting tables; the vermiculite layer keeps the new seeds from drying out and dying. **This is <u>the method</u> you use in regular warm weather, and the vermiculite keeps the seeds moist.**

Seeded trays are placed in sprouting tables, which are covered with greenhouse film over PVC frames, to keep the seedlings protected from rain. We date trays by section, with date seeded, and when transferred out to the Nursery System, and again when they go into the main system (explanation follows).



The photo to the left shows the entire sprouting table, not quite full of trays (there is some empty space up at the far end of the table). We have 12 of these, and we run system water through them in an "ebb and flow" method to provide the seedlings with both moisture and some nutrients.

To the far upper left of the photo, you can see the PVC frame, and the greenhouse film covering it. At the top of the photo is the PVC faucet that turns on to water the table. The piece of 3" PVC sitting to the left of the fitting is to provide a splashguard, so the seedlings in the trays closest to the faucet (that area is empty in this photo, at the far end of the sprouting table) are not damaged or displaced by the water flow.

At the very top of the photo is another sprouting table, barely visible in this photo. The seedlings in the foreground are one week old, and in the background (top of photo) are four days old.

This is the process our interns have named "forking". The goal of forking is to carefully move the seedlings from the 92 cell trays into 2" slit pots.

We tried all sorts of tools, chopsticks, popsicle sticks, spoons, everything we could think of that might be a good tool to get out the root mass inside the small amount of the coir/ vermiculite mix. Turns out, the best tool we could find were salad forks. Here the fork is just being inserted into the cell, with the 2" slit pot ready to drop it into. Make sure the root mass is at the bottom, and the seedling is pointed up – it's easy for it to fall over sideways, or even go in upside down, at which point it has no hope of survival.

The photo above on the left shows the small root ball of the seedling, and the photo on the right shows the careful placement of the seedling in the 2" slit pot. The pot is now ready for placement into the raft, shown on the following page.

During this stage, expect to pick and choose the largest, most vigorous seedlings, discarding the smaller ones. **You will probably discard 20-30%** at this point of the process. **It is very important to not try to use every sprout, as this will negatively affect your growth rate during the following grow out stage, sometimes dramatically!**

Here Jack is placing the 2'x4' raft of 32 small lettuce plants into the main (uncovered) system, and below is the entire system, planted out with the 2'x4' rafts filled with lettuces of varying sizes.

Note the 2" PVC in the foreground, which is the return line from the sprouting tables to the deep-water troughs.

Above, Susanne is holding a full-grown head of lettuce, after two weeks in the main system. Above to the left is the entire harvest crew, working at waist-height, under a shade structure. 2'x4' rafts are picked up and carried over from the troughs, effectively making harvesting as easy as possible. Note the pile of rafts over to the left of the photo, that have been stacked up after the lettuce has been cut off of them. This pile will be emptied of slit pots, with the root mass, cut lettuce stems, and whatever growing medium is left in them (usually not much, if any at all) emptied out of each pot, then taken to the compost pile, and the slit pots are reused. Rafts are washed thoroughly, and if there is any indication of disease (powdery mildew is the worst we've ever had), rafts can be rinsed with bleach or hydrogen peroxide.

Here an intern is washing and scrubbing off the rafts. We use long-handled scrub brushes purchased from a restaurant supply store. This is the only water intensive part of our entire growing operation, as we use water to spray off the rafts. We fill a pump spray bottle with a low-concentration hydrogen peroxide mix if we have evidence of disease, but otherwise, we use plain water. If you are not certified organic, you can use a low concentration bleach solution.

Below, the main system grow out process begins again, with the just washed 2'x4' 32-hole rafts being loaded with seedlings from the 2'x2' 55-hole nursery rafts (this is the same step that Jack is doing in a previous photo). This part of the cycle only takes two weeks until they are harvest sized, if the seedlings go in large enough. This maximizes yield from our main system, and therefore maximizes the food we can grow and (in a commercial operation) the money we can make with our system. **The combination of all these space-intensive methods of planting has <u>doubled</u> the yield of our commercial systems compared to the first three years of our operation, without adding any troughs!**

Tim's First Reaction To The High-Density Planting Technique:

- **Susanne invented this high-density planting technology.** When I first saw the little lettuces after being "forked" into the pots in the rafts, I was certain they were all going to die! They leaned this way and that, and there was hardly any coir in the pot with the pathetic little mass of roots and tiny leaves. But they all survived and did incredibly well!

- **I needn't have worried:** Susanne had already gone through this herself: the little plants looked wrong at first, so she tried putting some coir in the bottom of the pot before forking in the sprout, and "tucking it in" with more coir around the sides, so it didn't fall over and slump so badly. All this work was unnecessary, as the technique worked just fine without it. The only caveat is that you need to cover the baby plants if they're in outdoors "nursery troughs" to keep cold heavy rain off them; or you can lose 30% to 50% of them. Try it, it works great!