Nelson and Pade Workshop
Part 2

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Disclaimer – These notes are my own, they may not reflect what was actually said or intended, nor are they complete, as I recorded what I was thinking based on my own experiences. Verify any claims before acting upon them. The workshop is highly recommended, both for those considering aquaponics for the first time, as well as those with established systems. Nelson and Pade have 20+ years in commercial hydroponics construction and operation and almost as much experience in aquaponics research, design, and operation.

Friday, November 13, 2009 – **Afternoon session – introduction to the greenhouse**

- Aquaponic Systems and Components
- Plant Growing Systems
- RAS
- Fish and Plant Nurseries

After a quick lunch we traveled about 30 min. to a new demonstration greenhouse. Here is the link to the interior web cam. http://www.aquaponics.com/infoMontelloGreenhousewebcam.htm.

The Greenhouse is approx. 60-80' long by 24' (my guess). The sidewalls are 7-8' tall and composed of a double poly inflated covering with insect screen on the inside. The sidewalls lower for ventilation control. There is no swamp wall (evaporative cooling system) as in traditional hoop type greenhouses, just one small exhaust fan mounted high up in the gable on one end. Apparently, open venting all along the side wall vents out the heat and keeps the greenhouse sufficiently cool without the need for evaporative cooling, and reduces costs, humidity and provides a more natural ventilation and while we were there it was often lowered 6-12" inches which kept the greenhouse at a comfortable temperature.

The plumbing to the tanks, rafts and filters was all underground. The floor was covered in 4x8' sheets of wafer boards (plywood) and non-mortared bricks, primarily to keep the greenhouse clean and allow access to the plumbing if needed. The end where the fish tanks and filters were located was covered and shaded. The top covering was also double poly plastic with air inflation. The end walls and entrances are all polycarbonate sheeting. The greenhouse humidity was not noticeable; there was no accumulation of moisture on the walls or roof (unlike mine which is always wet.) The high arched roof and open sidewalls really make a difference. The question was asked about the increased costs of heating a higher building and it was reported that it's only a little more and the benefits of the reduced humidity, increased ventilation, which translates into greater crop yields, more than offsets any increase. There are air circulation fans around the interior as well as several gas heaters mounted from the rafters.

There are two aquaponic systems in the greenhouse, a nursery system and the main system.

Main Production Aquaponic System

This system is modeled after the University of Virgin Islands (UVI) setup, with a few additional improvements. The flow is as follows:

1. First, 4 - 500 gallon conical bottom fish tanks. Stocking is staggered with new 50 gram fry going in every 6 weeks, allowing for harvest of one every 6 months. There are approx. 200 tilapia per tank. Each tank has 9 - 6" air stones spaced around the inside of each tank and they are net covered.

2. The water flows (not pumped) from the 4 Fish Tanks to 2 large clarifiers (settling tanks to remove the settleable solids). The clarifiers have very large inlet pipes to create a very slow flow to allow the solids to settle out. The tank is divided in half by a divider that goes ¾ of the way down the middle of the tank, forcing the flow down and under, the outlet is also high on the opposite side of the tank. This large volume, slow flow allows a large part of the heavy solids to settle into the conical bottom of the tank. These tanks as with all the tanks are deeply recessed into the floor. Note: In our home systems, the gravel beds act as the filtration system. In this system there are no gravel beds, only rafts. Raft water needs to be free of solids, or they will attach to the roots of the plants, blocking the uptake of nutrients and creating mineralization pockets that will kill the roots. Many home systems that have a mix of rafts and beds use the output of the gravel beds into the raft system, others have added filtration of the tank water, before it goes into the raft, either way, the water going into the raft system needs to be filtered to remove solids.

3. The water then flows out of the Clarifiers, into two mineralization tanks. These tanks are connected in series, so that the flow from the first tank moves into the second tank. The inlets are high and the outlets are low. These smaller tanks are full of bird netting. The netting gives a place for the solids that are in suspension (not settleable) a place to catch on to. Both the mineralization tanks and the clarifiers' are dumped and flushed 2-3 times daily. (This is why we like gravel beds in home systems, lower maintenance). The time in between cleanings can change the mix of nitrates to other elements, as UVI found that cleaning the netting every few days or more, rather than daily, creates pockets de-nitrification that convert nitrates into other gases, reducing the nitrates in the system, while leaving the other minerals. This was found helpful for fruiting crops.

Mineralization Tank

Low Space Bio-Reactor

4. Then the water flows out of the last mineralization tank, into a Low Space Bio-Reactor (nitrification and off-gas tank). This tank is full of plastic parts that have lots of spaces in them, the tank is well aerated and here a lot of the ammonia is converted to nitrites and then nitrates. Also the boiling action of heavy aeration causes other gases to come out of solution and to vent to the atmosphere. (Lots of Carbon Dioxide is good for plants – another benefit of aquaponics in an enclosed space). This picture is of the smaller nursery system bio-reactor, but gives you the picture of the plastic beads.

5. From here the water flows into a Sump and then is Pumped into a Bubble Bead Filter, (the green filter in the picture), this is an additional filter step not found in the UVI system, and John Pade stated that there are rarely any solids when they back flush the filter and it's probably not needed.

Bead Filter

6. Then it flows through a UV Sterilizer, which kills any pathogens in the water (and the nitrifying bacteria as well). When asked about losing nitrification, John stated that in an established system, the majority of the bacteria is on the walls of the tanks, rafts, in the netting and other places in the system, that the bacteria in the water was not critical, once a system was established.

Sump and Base Addition Tank

7. From the UV Sterilizer it flows into another sump which includes a Base Addition tank that contains the Calcium or Potassium Hydroxide that is added to bring pH up. In this picture, the down arrow is the output from the bead filter, which then flows into the horizontal UV sterlizer, which outputs in the square sump. The sump is well aerated to mix any additions well.

8. Then part of the water flows via gravity into the raft system, which returns to the prior sump. The other part of the water is pumped back into the fish tanks to start the cycle over again.

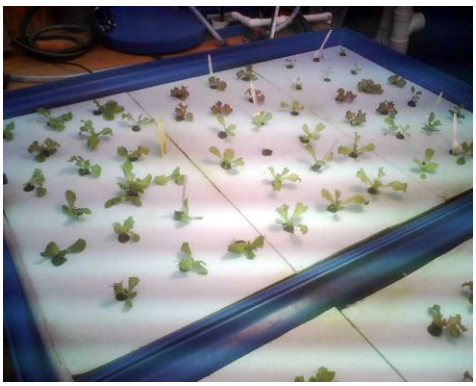
Nelson and Pade have trademarked the name ***Clear Flow Aquaponic Systems™*** for this ultra-pure water that flows through the raft system. While this extreme filtration is not needed, it does have some benefits in commercial applications. First, when harvesting and packaging produce as live produce with the roots intact, the roots are cleaner and whiter than they might be without the filtration. Second, when the city health inspector comes around, having no knowledge of fish pathogens, and having severe issues with crops grown in animal waste, you can get around some of his arguments by showing the extreme level of filtration and sterilization. Let's face it; most health inspectors have no understanding that fish do not carry pathogens that affect humans. With this system, you don't try and fight the system.

The Raft system is a downsized version of what you would do commercially. Each leg of the raft is 3' wide by 36' long. Unlike what I think UVI model does, where the water flows from one end to the other and is piped back to the fish tanks, they have divided the raft tank in half the long way, forcing the water to flow to one end, around the bend and back to the start. This eliminates extra piping. They have 2 raceways so the total dimension is 12' wide by 36' long. There are no walkways in between, utilizing the space to its fullest. Rafts are added at one end and removed from the other. The tank itself is framed and covered with heavy white vinyl. The water is 12-14" deep. Their rafts are made from 1" polystyrene foam boards approx. 2' x 3' cut down to fit the size of their reduced raft tank. The foam is drilled on 8" centers with a tapered/stepped bit. The entire system is heated hydronically (hot water heat coils) under the raft systems. The system is maintained between 73-75 degrees. A separate small gas boiler circulates hot water under the raft liner when the system temperature falls to low. There is a 3" fine pore air stone every 3' with .3 cfm of air per stone. Also overhead are the supplemental lighting fixtures, both Metal Halide and LED panels. There are also overhead fans. Basically a commercial version of what you would have in your house hanging from the ceiling. John says the crops do better with air movement between the leaves.

Air Blower

The nursery system is a separate scaled down system, with 4 – 50

gallon fish tanks and corresponding filtration (minus the bead filter and UV Sterilizer) hooked to small 3 x 6' raft system. Heating is with a 5 gallon bucket heater in one of the sumps. John said originally it was not enough heating, then they insulated all the pipes and it was more than enough. The air for both systems is supplied by a large blower that pressurizes a 2" line that steps down to a 1" and then to the flex tubing into the various air stones in all the systems. In the nursery tanks, each tank has 4 – 3" air stones.



Side-Stream Mineralization™

The waste water that is flushed from the clarifiers and mineralization tanks is pumped into a temporary conical holding tank, where it is aerated heavily, it is then allowed to flow through a hydroponic pot system, watering fruiting crops. After one pass it flows into a sump and is pumped outside into a drainages system among some fruit trees. Nelson and Pade have trademarked this as "Side Stream Mineralization." The ultimate goal is to have zero discharge. (Sounds like were going full circle and ending up with modified gravel beds.)

The last part of the system is the purge tanks. As each batch of Tilapia is finished, they are transferred into the purge tanks. The tanks are salted to 5ppt. The system has a basic solids filter system and uses Zeolite to absorb ammonia as there is no nitrification system. Over a 3 day period the temperatures are dropped to 60 degrees, and then the last day, the fish are netted out live and put on ice to ship to the processor.

Purge Tanks

It was good for me to see how a commercial system is configured. In later classes, the use of Nutrient Film Technique (NFT) was discussed. In NFT the single biggest issue is the clogging of the tray inlet tubes. It was stated that an NFT system the size of an equivalent Raft system (by area) only uses 25% of the nutrients, so you can have 4 times as many NFT production spaces. However, there are no known commercial operations using NFT.

(And several commercial ventures that tried and failed). In our home production systems, we are going for stability, ease of use, and variety of production, without real regard to maximizing production and minimizing expenses (at least in the general sense). We trade off filters for gravel beds, single crop systems to multi-crop systems, perfected-optimized production to acceptable-general production. It is interesting to note that with Side-Stream Mineralization there is an attempt to capture and use the nutrients that our backyard systems capture and use inherently.

Next Installment – Saturday Morning Session

- Aquaponics: History, Methods, Designs
- Water Quality
- Environmental Control Requirements and Equipment

Saturday Afternoon Session

- Water Quality Testing
- Greenhouse and Aquaponic Systems Construction Basics