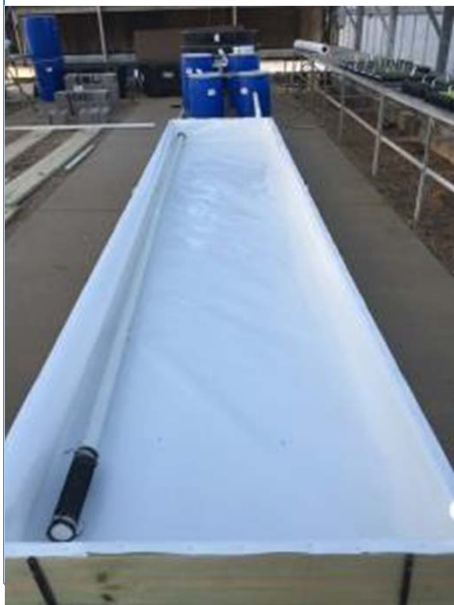
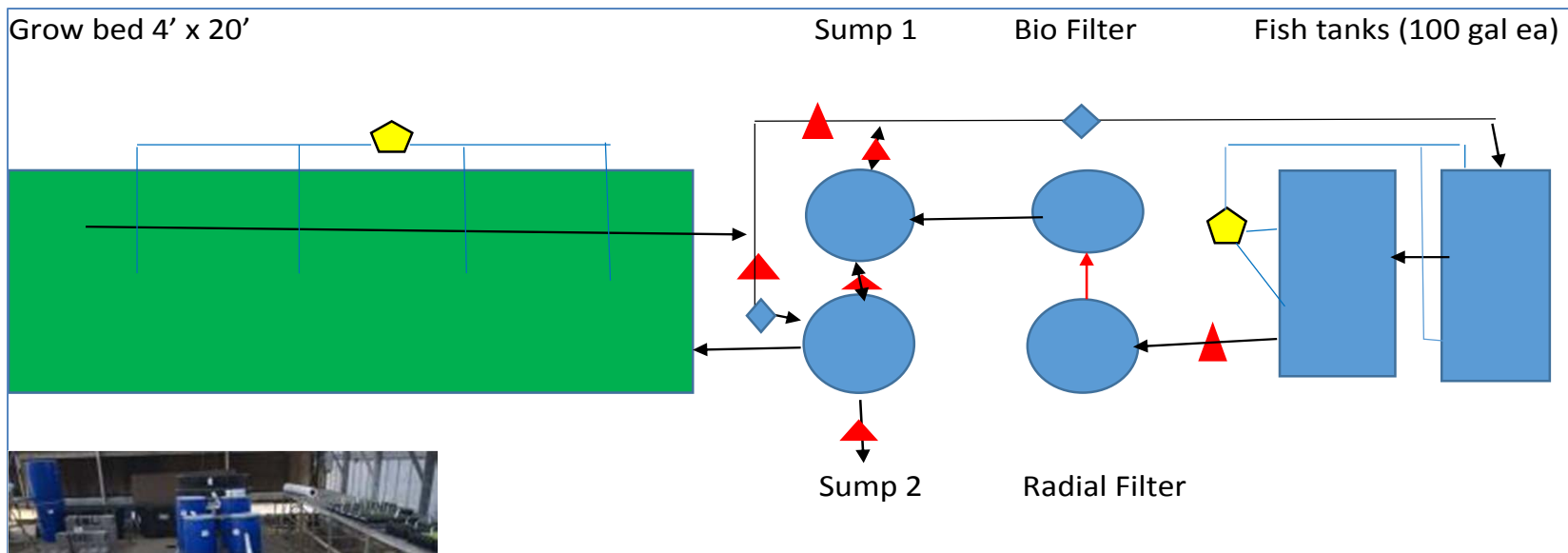


Building an Aquaponics System

- ***Building an aquaponics system is very easy once you have a sound design.***



System Overview

- *This is a dual loop system with:*
 - 2 100-gallon fish tanks
 - a radial filter
 - a bio filter
 - two sump tanks
 - 2 water pumps
 - 2 air pumps with 8 airstones
 - 4 ft x 20 ft grow bed.

System Overview

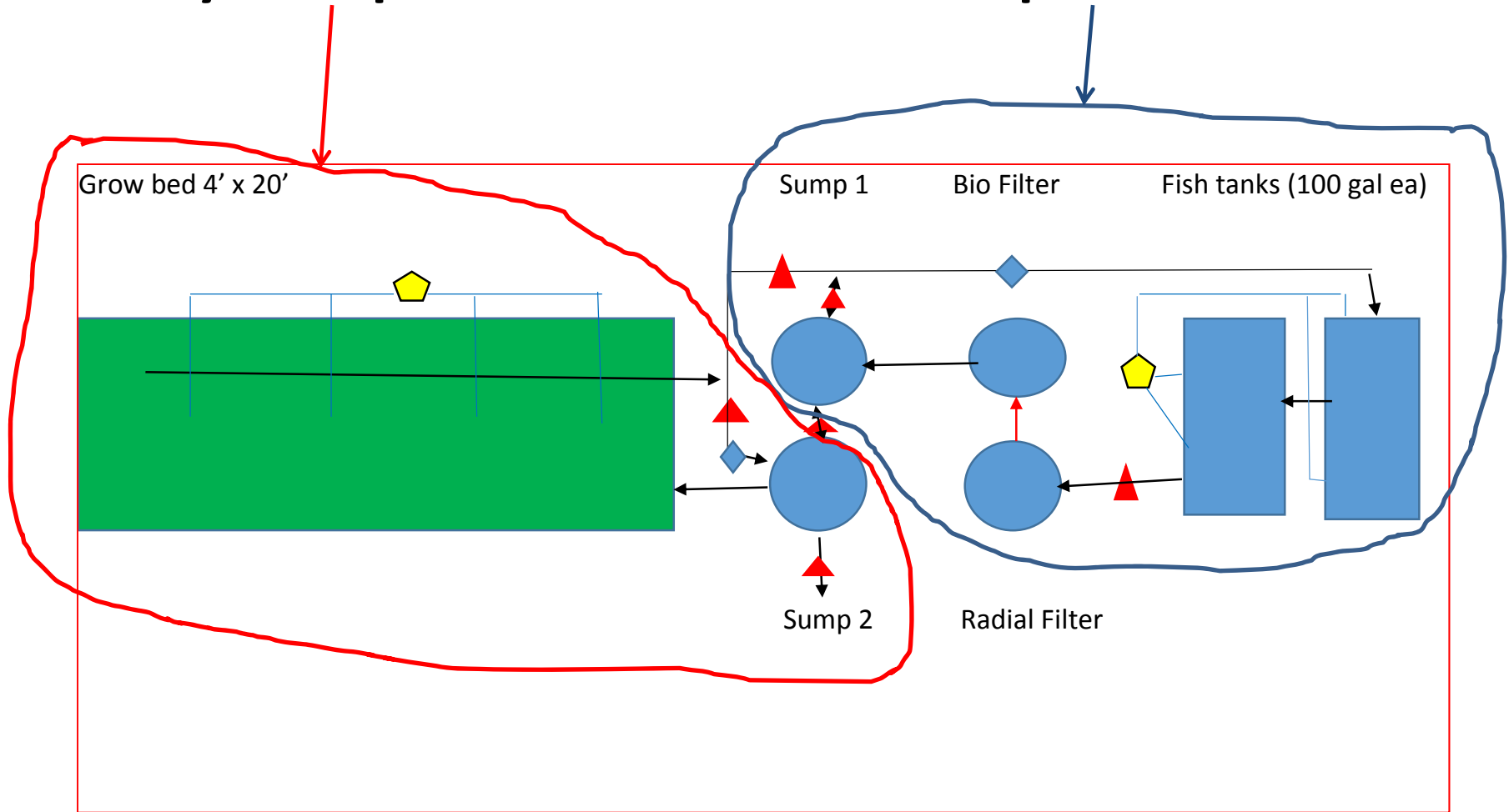
- *The complete materials list, including supplier and cost, is found in a handout.*
- *The entire system will cost about \$2,000 and is very easy to do.*
- *We built it in 4-5 hours*

Dual Loop System

- *One of the primary benefits of a dual loop system is that it enables you to separate, if need be, the hydroponics from the aquaculture systems. This is important for the following reasons:*
 1. **If you need to spray or otherwise treat the plants you can do so without killing the fish.**
 2. **If you need to treat the fish or the fish die, then you can supplement the nutrient needs of the plants while you are bringing the fish back online.**

Hydroponics

Aquaculture



Dual Loop System

- *The aquaculture loop is comprised of the two fish tanks, the radial filter, the bio filter and Sump 1.*
- *The hydroponics system is Sump 2 and the grow bed.*
- *The dual loop system requires the addition of a second water pump as well as various valves to control the direction of the water flow.*

Dual Loop

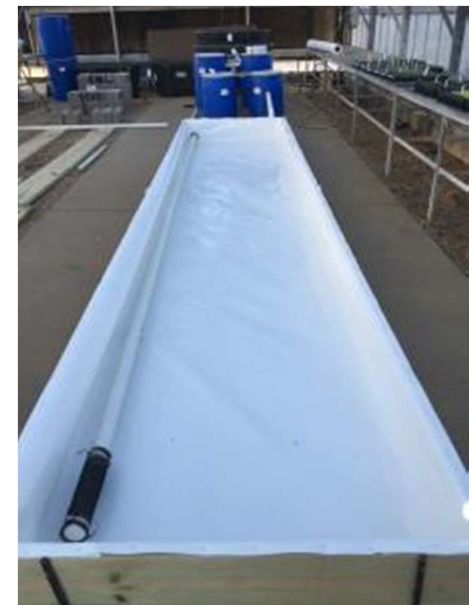
Aquaculture

- 2 fish tank
- Radial filter
- Biofilter
- Sump tank 1



Hydroponics

- Sump tank 2
- Grow Bed



Description of Components, Order of Construction and System Flow

Fish Tanks

- **Two food-grade 100-gallon Rubbermaid stock water tanks were set up on cinder blocks to be at the highest point of the entire system.**
- **Tanks were laid out and area for the grow beds measured to make sure everything is spaced properly and would fit.**



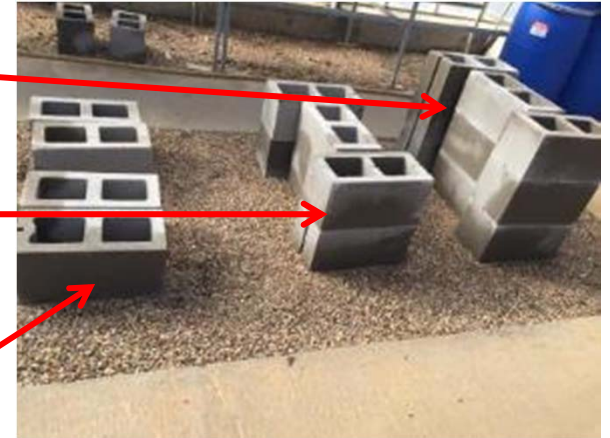
Close up



3 layers high : tank 1

2 layers high: tank 2

1 layer: sump tanks



Cascading
effect

Fish Tanks

- *One item not included in this system, but is necessary, is the cover for the fish tanks.*
- *Covers are important for at least two reasons:*
 - **First, you do not want your water exposed to the sun because it will produce algae.**
 - **Second, you do not want fish jumping from one tank to another nor do you want them getting into your raft system where they will eat the plant roots.**

Grow Bed or Trough Construction

- *The inside dimensions of the grow beds are 49.25 inches wide by a little over 20 ft long.*
 - The floating boards are 4 ft wide.
 - The extra 1.25 “ width allows for some movement of the boards. Total width (outside to outside) is 52.25”.
 - This single trough was constructed using 2x12 pressure treated lumber.
 - Treated lumber is okay to use because the food grade liner used in the trough protects the plants from any chemical leaching from the treated lumber.
 - The 2x12 sections were joined together on the interior corners using galvanized brackets and on the exterior by splicing with 1x4 treated wood.
 - The corners were reinforced using galvanized corner pieces and 1 1/4" deck screws.

Hole for return water pipe



1x4 wood splice

bracket



Grow Bed or Trough Construction

- *Once the lumber is assembled, lay down the liner and cut it to length.*



Grow Bed or Trough Construction

- *The Ultra Scrim R20WW liner comes as a roll of 6.167 ft x 100 ft and is FDA approved as food safe.*
- *Pond liner works just as well and is cheaper, but is not certified as food grade so it cannot be used if you are selling your product.*
 - **The Ultra Scrim only comes in two widths, 6.167 ft and 12 ft so that tends to determine the width of the grow beds.**
 - **The 6.167 ft width is perfect for 4 ft wide beds with sides that are under a foot high with 2x12 wood boards.**

Grow Bed or Trough Construction

- *Once laid out and cut to length, the liner was stapled to the top of the 2x12 frame.*



Grow Bed or Trough Construction

- *After the liner is installed, 1x2 treated lumber was nailed on top to further secure the liner and finish the troughs.*
- *Pre-drill the holes so that the strips don't split.*



Tips on folding the liner

- *The corners were folded over one another (think hospital bed) inside the tank and then the corner lips were cut along a 45 degree diagonal to facilitate stapling to the top of the frame.*



Bulk Head Fitting

- The bulk head fitting is installed through the liner by cutting an X in the liner and fitting it through the liner and the trough wall.***



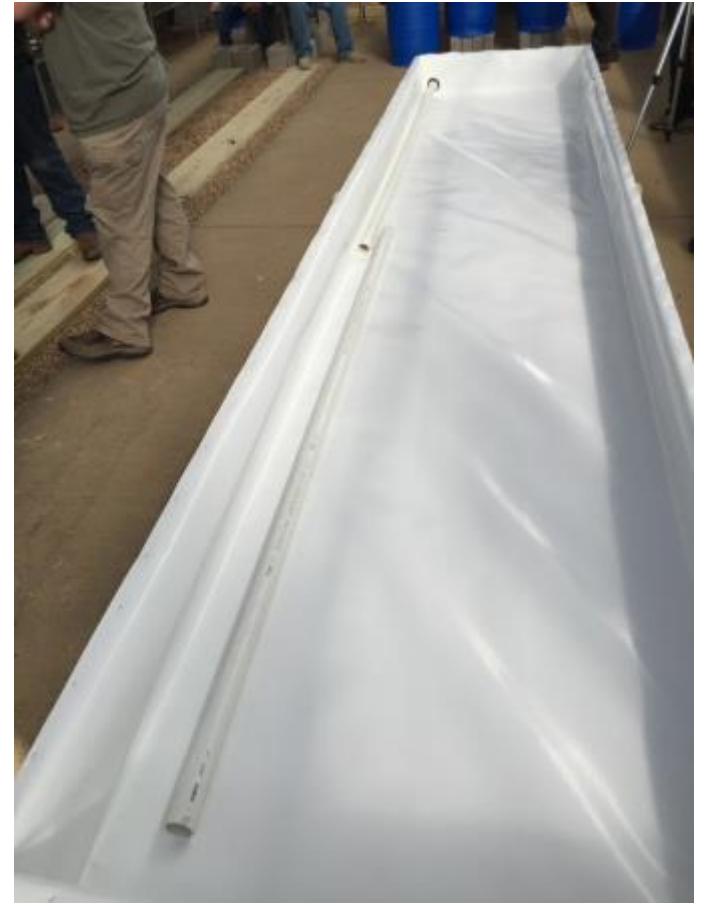
Bulk Head Fitting

- ***Tighten down as much as possible to avoid leaks and fit the PVC pipe into it using a hammer and screwdriver to tighten.***



Water Return Pipe

- The pipe is constructed of two 10 ft long, 2 inch Schedule 40 PVC pipe, cut to size using a sawzall blade and joined together with a 2 inch slip coupling.*



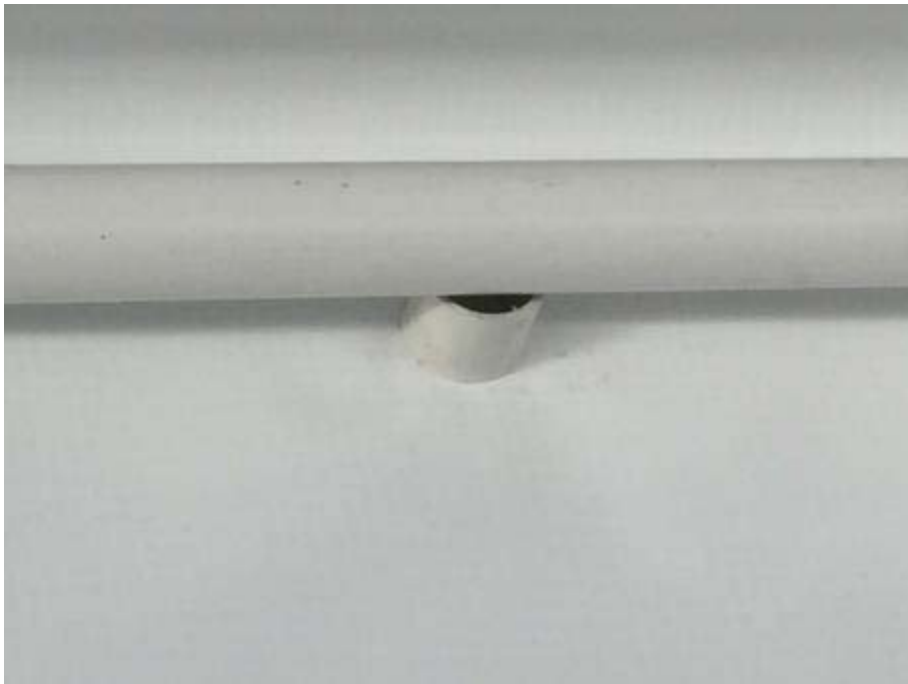
Water Return Pipe

- *The intake is at the end of the growing bed and has a filter to keep solids from recirculating.*
- *The filter is constructed of hardware net and black pet screen, 2" PVC end cap, and 2 clamps.*



Water Return Pipe

- *The completed return pipe is leveled using a couple of scrap pieces of PVC pipe.*
- **Note: plumbing fixtures in the water need not be glued together because leaking is not a concern.**



Grow Bed or Trough Construction

- The final step is to drive sixteen 3/4" x 36" round steel stakes in with a sledge hammer and secured to the outside all of the grow bed by screws to keep the walls of the grow bed from bulging when filled with water.***



End Filter

- ***All filters are constructed in the same fashion.***
- ***Lay down a PVC pipe and an end cap, spaced about 6" apart, and roll the hardware net to get the appropriate size and cut it.***
- ***Do the same with the black pet screen***
- ***Join the pieces together with clamps.***
- ***Trim excess net from end.***



Plumbing of Fish Tanks

- *The two fish tanks are plumbed to create a cascading water flow.*
- *Holes were cut through the sides using a hole saw.*



Radial Filter

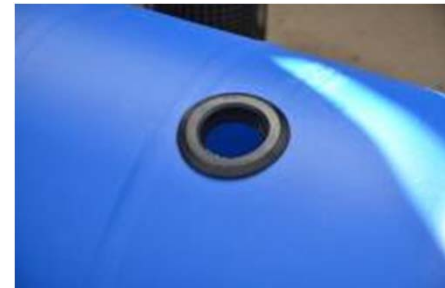
- *A hole that is the same size as the pail (excluding the lip) is then cut in the top of the 30 gallon container using a jigsaw.*
- *The pail is then fitted into the hole, the lip of the edge catching on the cover of the 30 gallon container.*



Radial Filter

- *Using a hole saw, two holes are cut in the barrel making certain to avoid seams.*
- *Install an elbow and a piece of PVC to the inlet pipe at the bottom.*

The hole closer to the top is the outlet leading to the bio filter.



The hole at the bottom is the inlet where the water enters from the fish tank.

Radial Filter

- *The top of the PVC pipe should be at a level little below the outlet line.*



Radial Filter

- *The PVC pipe from the inlet pipe should also come up in the middle of the pail.*
- *The outlet pipe is outside of the pail so that solids are forced down by gravity.*



Inlet Pipe

Radial Filter

- *This should prevent most solids from exiting the radial filter into the bio filter.*

Overview of plumbing from the outside.

Out to bio-filter



In from the fish tank

Radial Filter

- *A third hole is cut in the bottom of the tank to drain out accumulated fish waste solids.*
- *Solids can be put into worm bins for composting or wicking beds or in the vegetable garden.*



Parts consist of:
 $\frac{3}{4}$ " Bulkhead fitting
 $\frac{3}{4}$ " ball valve



Bio-filter

- *Next, water flows to the bio-filter.*
- *It is simply a 30 gallon container with a lid that contains two to three packages of bird netting scrunched up into the container.*



Bio-filter

- *The purpose of the netting is to provide a large surface area for the bacteria to colonize and transform ammonia (toxic to fish) into nitrite then nitrate which is nutritious to plants.*
- *You don't need to do anything to add the bacteria as they are all around us.*
- *If you want to speed up the process, you can spike your bio-filter with store-bought bacteria.*

Bio-filter

- *The 30 gallon container is plumbed with two 2" holes, sawed with a hole saw.*
- *The inlet brings water from the radial filter and the outlet is to sump #1.*



Bio-filter

- *The outlet is at a level that is essentially level with the top of Sump #1.*
- *This prevents backflow from the sump into the radial filter.*

Sump #1



Bio-filter

- *Similarly, to prevent backflow from the bio filter to the radial filter, the intake from the radial filter needs to be a little higher than the outlet to the sump.*

Inside View



Outside View



Bio-filter

- *The intake to the radial filter has an elbow down so that the water is forced to percolate through the bird netting.*



Sump Tanks

- *Two sumps are only necessary if you use a dual loop system.*
- *Otherwise you can run directly from the bio filter into the grow beds.*
- *It is recommended you have 1 sump tank after the bio filter which serves a dual purpose: an additional settling tank and a degassing tank.*

Sump Tanks

- In normal operation, the valve leading to sump #2 and the pump that feeds it are closed and the valve that leads back to the pump that recirculates the water to the first fish tank is open*



Floating Rafts

- *The final stage of construction is the construction of the floating rafts.*

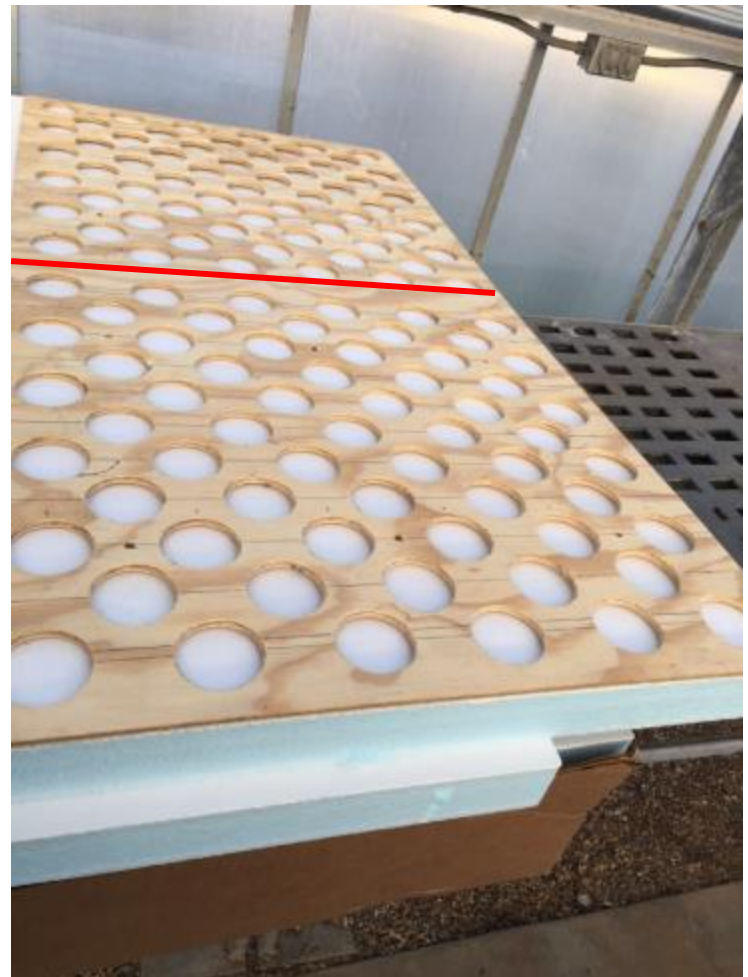
Floating Rafts

- *A template for hole spacing for the floating rafts is a 2 ft x 4 ft with 2 1/8" holes in it on a pattern with holes 4" apart.*
- *This design gives 122 holes with the 2 ft x 4 ft template.*



Floating Rafts

- *It is recommended to cut the Styrofoam board in half to make 2 ft x 2 ft pieces to make it easier to work with.*



Floating Rafts

- *Another template (2.5 ft x 4 ft) has holes of similar diameter (2 1/8") but are spaced 8" apart and therefore result in 24 holes.*



Floating Rafts

- *Holes spaced 8" apart are perfect for mature greens (lettuce).*
- *The holes spaced 4" apart are perfect for seedlings.*
- *Both the 2 ft x 4 ft with holes spaced 4" apart and the 2.5 ft x 4 ft raft with holes spaced 8" apart weigh about 30 lb when full, which is workable for most people.*

Floating Rafts

- *Some people create an intermediate spacing (6" apart) for plants that are between seedling and full maturity.*
- *Alternatively, you can use the same 4" spacing, but not fill up all of the holes.*
- *If you choose this latter course you do want some plug to put in the empty holes as any exposure of the water to light will produce algae, which you want to avoid.*
- *Also note that while the template has holes that are 2 1/8" in diameter, use a 2" hole saw blade to cut the rafts.*
- *The extra 1/8" in the template is to make it so that the 2" saw blade will fit inside the template walls, making it much easier to work with.*

Conclusion

- *From a commercial standpoint, aquaponics works if you can sell the fish to cover your costs and you can minimize your supplemental inputs and maximize your income by growing greens (lettuces, microgreens, kale, etc.) and sell to restaurants and farmers markets.*
- *Plants harvested are still alive since you harvest them roots and all so their shelf-life is much longer.*
- *For example, you can harvest lettuce, keeping the root ball in a bag, and replant it a week later and it will continue to grow.*

Conclusion

- *Generally speaking, you will not find it profitable to produce tomatoes and other fruiting plants in a floating raft bed because they take up too much space in your system (e.g. one tomato plant takes up 2 sq. ft. vs. 2 lettuces in 1 sq. ft.) relative to their price and you cannot supply the additional nutrients (potassium and phosphorous) efficiently in comparison to other methods.*

Conclusion

- *Separate the aquaculture system from the greenhouse hydroponics system so that you don't use valuable greenhouse space to raise fish that prefer a dark environment.*
- *The biggest cost to the system will be the greenhouse and the heating/cooling thereof.*

Conclusion

- *You need to decide, up front, whether you need certification of our system for the sale of fish and/or vegetables and build accordingly as it will not be profitable to take the system apart and outfit it with food safe materials later.*
- *The fish side of the aquaponics system is not very profitable so you need to determine whether the cost of the fish harvested for personal use is at a satisfactory cost.*