Building A Floating Raft Bed (no words)

Author	Message
urbanfarmer	**Post subject:** Building A Floating Raft Bed (no words) **Posted:** Fri May 06, 2011 2:58 pm

offline

Joined: Wed Sep 01, 2010 9:13 am
Posts: 1843
Location: Zone 9b


SAKRETE
JOINTS

The raft bed ended up being 16 feet x 4 feet x 15 inches height and weighed around 6,000 pounds when full.

The inside was then lined with 6 mil black polyethylene and filled with water. I have no pictures of the styrofoam rafts, but I drilled holes and placed seedlings in there.

A storm subsequently destroyed the raft bed (actually someone moved a brick after the storm moved the foundation some, but it was still standing until the brick was moved, F#@%). I dream of rebuilding it one day if time and budget allow me to...

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Next time I would put it closer to the ground. It was a bit high up, but still comfortable for my height.

Material cost, $1.97 per 2x4x8 treated lumber whereas anything larger went up drastically. BUT, where would using thicker would come in handy? I felt the 2x4's on the top were MORE than strong enough to hold the water. The 4x8 sheet I have is 7/16 OSB Exposure 1; so, I painted it with self-priming outdoor acrylic paint. I painted the edges several times and the rest of it twice to make sure it was sealed. Those pieces are still outside looking good, LOL!

What joints do I stagger?? Please tell me how to build it better because I have to rebuild it anyway!!! I'm not a construction person. This was actually my first time using a power saw, nail gun, leveling ground, etc. I suck at this stuff, but I'm willing to do and learn!

I honestly think my material cost was around $115, but I threw in a few more bucks to round it off in case I forgot something, but I don't think I did. I'm putting away money to give it another try. It's hard since I'm a student and gas, food, and books are my primary expenses.

OH, I did use 16 gauge finishing nails as framing nails... I know this was probably a terrible idea, but I jumped on it and kicked stuff, and it didn't budge. I may do this again because I can't afford a framing nailer and regular nails tend to split the wood.

Utah Aquaponics System Construction and Early Startup

Attached are a few photos of our Utah Aquaponic System in construction and in early production. Detailed aquaponic system design information and plant and fish selection decisions can be found in our thread at AquaponicsHQ here:
http://www.aquaponicshq.com/forums/showthread.php/831-Utah-System-Part-1-Beginnings

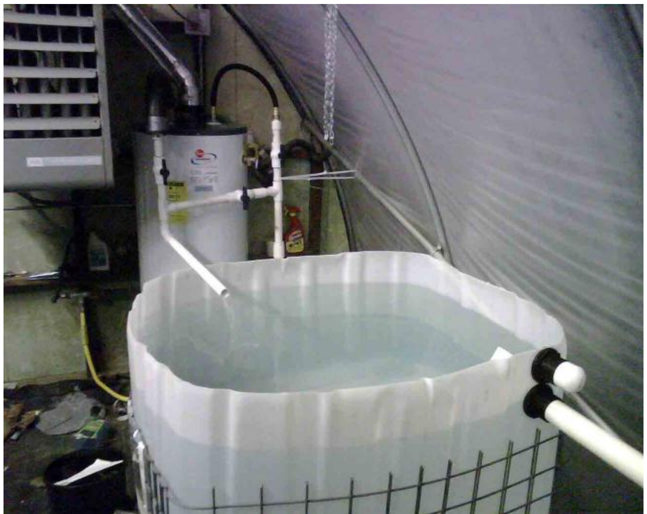
Aquaponic system under construction: (In mid-February 2009):

18' x 32' double poly greenhouse - - - - - - - - - - - - - Grow Bed Tank on supports

275 Gallon IBC Tote, top cut off for the fish tank - - - Propane Water Heater to heat water

Utelite Expanded Shale for the Gravel - - - - - - - - - - Bell Siphon installed

Beds filled (leveled first) - - - - - - - - - - - - - - - - - Base for Floating Raft System- dump tank below



Fish Tank - New and Full of Water - - - - - - - - - - Gravel grow beds, water flowing in

Bell Siphon drain tube - - which flows down and - - empties into the sump tank

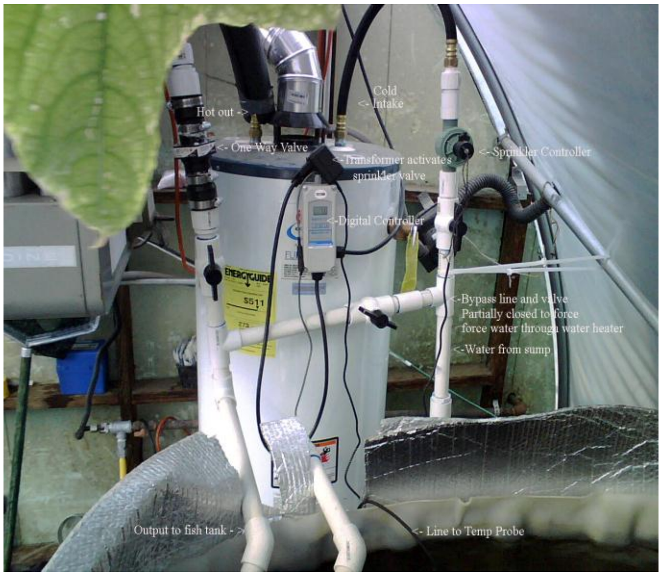
Floating Raft Construction Detail - covered with used vinyl sign material (hmmm, I wonder where that came from!).


March 14 - Just 2 Weeks after planting seeds - - - May 1st 8 Weeks after planting

Lettuce 4 weeks old from seed (except large plants) - Lettuce 8 weeks old - salad time!

May 19 - 10 weeks after planting - - - - - - - - - - - - - - Betterboy Tomato - 10 weeks

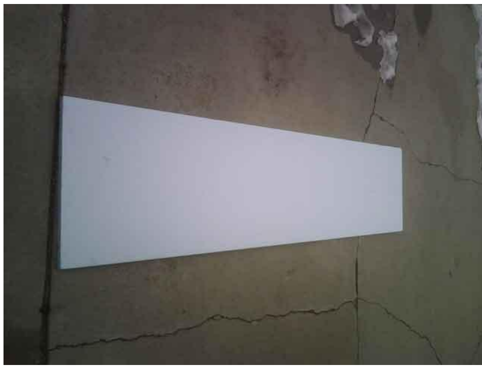
Cherry Tomato's - more tomatoes than leaves - - - Greenhouse Cucumbers, ready to harvest



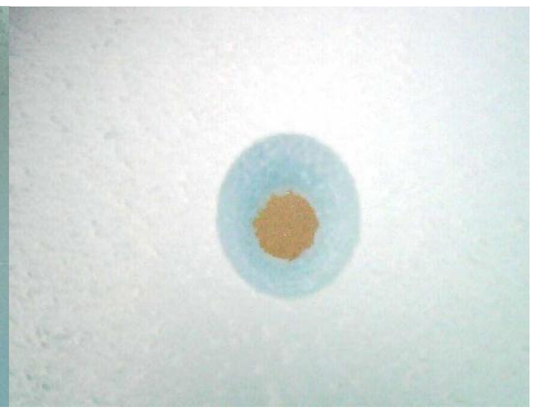
Water heater details, click on picture for large view. Details on the components are in the aquaponicshq forum linked below.

Got a phone call the other day and picked up a third tank for free!

Aquaponics Floating Raft Upgrade




After seeing the system at Nelson and Pade in Wisconsin, I resolved to upgrade my system. I found these 2 x 8 feet x 1" building foam on sale and picked up a couple of lengths. Any type will do, pink or blue 4 x 8 or smaller. This was what was on sale.



They use a tapered bit to drill the hole. This bit is a 1 1/8" and it makes a nice large opening at the top for the plant, but narrow at the bottom for the roots. Best of all, I don't have to shim the plant cubes to get them to stay in the hole. Previously I used 2" foam and cut square holes with a knife. The holes are uneven sizes, sometimes the cubes fall through. Using the tapered bit is nice and simple.

First I cut the sheet to fit tightly into the raft tank. Any gap around the edges and the light gets in and promotes algae and moss growth. Then I marked out the hole spacing. 8" on center. My old system was 6" on center and it was to close. Eight inch spacing is what was recommended at the seminar. Then I rough drilled the holes to about 3/4 depth. The I finish drilled more carefully, running the drill on it's highest speed, allowing it to "polish" or slightly "melt" the edges to give the smooth finish you saw in the previous pictures.


I'm also switching to these rock wool cubes, rather than the horticubes. Notice how these taper to a point. The horticubes are the opposite, with big bases and narrow tops, making them difficult to keep in the holes. These cubes are tapered to fit in the tapered holes, as can be seen by the two I have inserted. Then finally, 2 new sheets installed in the raft system, along side an old sheet. I'll replace the old sheet as soon as the plants on it mature.

1. Utah System Part 1 - Beginnings

For 10 years I have had an 18 x 32' foot (5.5 x 9.75 meters) greenhouse that was moved from our last house, It was never fully setup till this summer, when the plastic finally gave out (10 years was pretty good). So I added new poly, then when my Giant Pumpkins contracted Fuserium Oxysporum and died (I had 200lb (90kgs) baby pumpkins by then, my personal best is 580lbs(265kgs)). I was in a sorry state.

With lots of extra time on my hands, I finally repaired the greenhouse controller, Put Polycarbonate on the end wall, added power vents and thrip screen, leveled the floor, sunk the 50 gallon pond, leveled the floor by adding 2" of sand, and covered it with heavy duty black weed guard. Then filled it up with tropical fruit trees.

Summer and Fall went by with good success, Lemons, Figs, Pineapples, Birds of Paradise and more. Bugs were low, a few fungus gnats, easy to control. Winter came, I filled the propane tank and wired up the propane space heater, keeping the temps above 50F degrees (10C). As our winters get cold and we had a meter of snow piled up, it cost $200 a month during the coldest season to keep the greenhouse going! That's very expensive lemons.

In December, my 10 year old son announced that he needed a science project for school. Having looked at Hydroponics, Aeroponics, Aquaponics, Aquaculture for years, We decide to hook up a floating raft system to the small pond with its 10 Koi and Goldfish. We bought a plastic tote, rerouted the pump line, added an overflow, cut some foam and started some lettuce.

The lettuce is still growing very very slow (the water averages 45-50F degrees (8-10C) the daylight is to short. But it continues to grow. In the meantime, Dad (me) decides its time to join the big time. So the search began for tanks, pumps, fish and information. My system is still not complete, but I thought I would document my searching's for others to learn from, and for others to comment on. I'll add more posts with my progression.

First item, when growing lettuce in raft, don't fill the net pots with miracle grow. The day we moved them from the nursery to the floating raft, the air bubbles from the airstones, eroded away the media in 1/2 the pots. Now I have 1" by 1" Horticubes, and will just forget the net pots, starting the plants in these, then putting the horticubes directly into the foam board in the floating raft.

New Domestic System Design Tool

At Aquaponic Solutions we have developed a new domestic aquaponic system design model for all those people who wish to design and build their own backyard/hobby/domestic media bed aquaponic systems. This model allows you to size the media bed (gravel bed) of your system based on three important requirements: the fishfeed to plant use ratio requirment (we use the UVI ratio model for this), the biofiltration requirment (this is for people who wish to use a gravel bed as a filter and want a majority system using another hydroponic approach, like deep flow or NFT) and the solids mineralisation requirment (to make sure that solids that enter the gravel bed are broken down and mineralised).

There are many different sizing approaches for media bed aquaponic systems, but none of them are actually based on the use of sound or established scientific or technical principles. Our new sizing model uses established and well known associations for gravel bed biofilter sizing, fish feed input to plant use ratios and gravel bed solids mineralisation ratios.

The model is provided as an excel spreadhseet for ease of use and we also provide a document that explains the model and explains how to use the model. We hope this assists you with designing your backyard or hobby scale aquaponic systems. Happy aquaponicing!

Aquaponics Nugget #18:
Types of Aquaponics Systems (Part 2)

Today we'll cover several types of aquaponics systems, hopefully explaining their differences well enough so you can understand and make an intelligent choice for your own system.

Deep-Water Culture (often also called Raft Aquaponics). DWC in its simplest form is a fish tank and a hydroponics trough or water container of some sort. There's a pump that circulates water through the system, and usually an air pump or blower that supplies aeration to the fish and plants in the system. This is the kind of aquaponic systems we use on our farm, because they are the least expensive to build and operate, and the most productive for the least labor. They are also currently the ONLY systems that are certified organic.

Gravel-Bed Aquaponics: These systems grow vegetables by running the system water through beds or tanks filled with different sizes and types of gravel, with the plants planted directly into the gravel. These systems also have a pump, but have differing methods of aerating and circulating the water; some have what are called autosiphons, and are set up to operate in flood-and-drain mode where at times the gravel dries out and at times is flooded; other systems simply flow the water through the gravel, just below the surface of the gravel.

We have reports of gravel bed hydroponics working for a few months in the tropics, then the bacteria associated with aquaponics clogging the interstitial spaces between the gravel bits, not only gluing them together, but also creating anaerobic decomposition zones that generate all kinds of nasty stuff that gets back into the system and uses up all the oxygen. As the system clogs it gets less efficient at growing plants and keeping fish alive, and the gravel eventually has to be removed and washed or replaced. Gravel beds seem to work much better in temperate climates, i.e. Australia, but they may still have the following drawbacks:

Planting into and harvesting out of gravel beds is a LOT more work than working with deep-bed raft hydroponics, where you can pick up a lightweight raft and move it to a couple of sawhorses at waist level to do your harvesting and replanting. Gravel beds are heavy, and are either on the ground (making your work harder because you need to bend over for planting and harvesting), or are up at waist level on a really strong frame that costs a lot of money and labor to build. It takes work to pull a plant's roots out of the gravel, and work to dig a seedling cube or a 2" net pot with a seedling in it into the gravel. In some systems there are issues with algae growing at the surface of the gravel. Some people solve these with ebb-and-flow systems, which we think are a recipe for a disaster (see Ebb-And-Flow in this section).

To be fair here, we also have a report from a guy who designed a gravel bed system that has good drainage and aeration that seems to work just fine, in Texas in a climate similar to ours in Hawaii. To be even more fair, we have another report from someone who put in a good-sized commercial gravel bed system who has now removed the gravel and is using rafts in the system. We feel the labor involved makes these systems inapplicable to a commercial situation, and they may be more work for the backyard aquaponic gardener.

Nutrient-Film Technology (NFT) systems usually have narrow plastic troughs or pipes with a very shallow film of water flowing along the bottom of the trough/pipe (hence the name). Although a standard in the hydroponics industry, and well-suited for a bacteria-free chemical hydroponic environment, they can have a few problem areas:

The small-size water delivery lines that deliver water to the hydroponic channels tend to clog badly with the bacteria and crud that thrives in an aquaponics system. If the water supply is interrupted by a pump failure or a clog that is not caught right away, the system can lose its plants very quickly as they dry out rapidly with no water reservoir below to draw on. This is prevented in a raft system which always has deep water below the plants. Also, NFT systems usually involve more than one pump which creates more potential failure points than a one-pump system.

The infrastructure for NFT, with all the racks, movable troughs, and greenhouses (which are required so this stuff doesn't blow away in a big wind) is expensive, much more expensive by our estimates than the aquaponics systems we use. We are thinking of trying a modified test NFT system that we call a "thick" NFT system, with 2" of water in the troughs, and a vertical rack system. We should have this information available to put in our course manuals within six months or so.

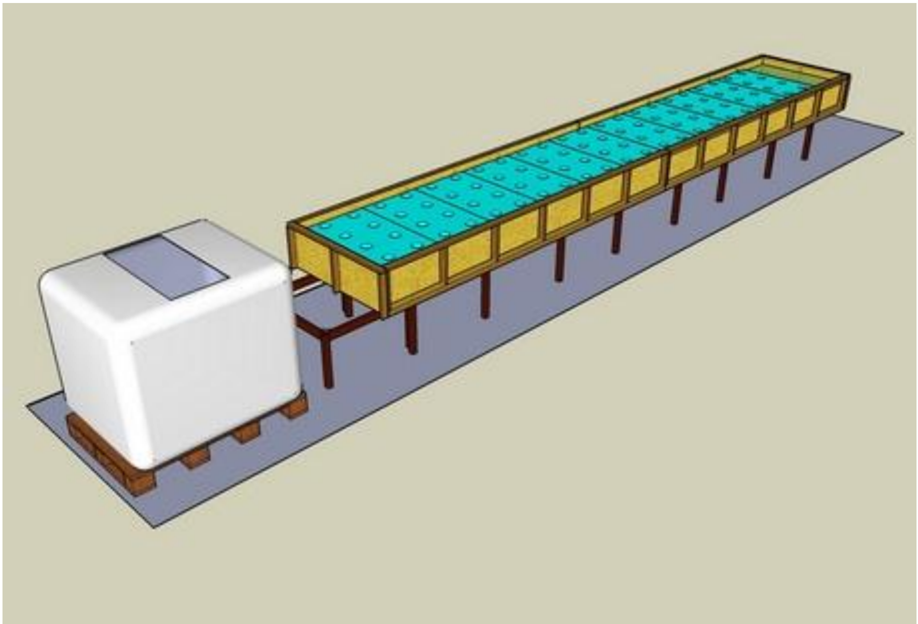
"System Kits", and "Complete Systems": We can't use trade names or refer to specific companies doing aquaponics business. However, there's a bewildering variety of systems out there that are built with old used plastic barrels (or even more expensive brand-new ones), fiberglass planting trays, plastic and fiberglass fish tanks, tank stands, custom greenhouses, special biofilters, “trademarked” this and that; it goes on and on.

We’re sure the people selling these systems are good people. But we've seen websites offering aquaponics systems for sale that cost three to ten times as much as if you just bought the parts yourself from the same places they buy them. These inflated prices often do not include all the materials necessary to build the system, nor shipping, nor construction and assembly.

There's nothing magical about the equipment these people sell. If you have someone to show you the way, you can build and operate the most economical, productive, efficient, and durable aquaponics systems yourself, from parts and materials you buy locally. If you take the time to acquire the knowledge, you will save a ton of money, have more fun, and you will have the understanding to be able to solve problems yourself instead of having to call on the "experts" and pay them more money.

Most important, anyone can build an aquaponics system, but operating one without good <u>and</u> easily-understood information can be frustrating. Part of the information in our manuals is given in the form of a "Daily Operations Manual" where you simply use the checklist and follow the step-by-step instructions on your way to success with aquaponics.

(We realized that we needed a "Part 2" of "Types of Aquaponics Systems", and promise that we will put the twice-delayed "Water Quality" Nugget in this newsletter next week).



Floating Rafts

View the slideshow to see the evolution of the construction of my system.

Floating rafts or Deep Water Culture (DWC) is another AquaPonics technique, developed and promoted by the University of the Virgin Islands (UVI).
UVI is one of the pioneers of AquaPonics.

see the links page for more info on UVI.

DWC uses tanks or ponds to grow plants in on floating rafts.

Plants are grown in small pots filled with media that are inserted in holes in the rafts that keep them floatin on the water surface.

The main advantage of this system is the ease of planning, sowing and harvesting of one particular fast growing crop, i.e. lettuce and herbs: very long "raceway" ponds are calculated so that the harvesting of one or more rafts coincides with the sowing of new ones.
These raceways can be as long as 100 and 200 m.

The main drawback of this system is the difficulty of bringing enough oxygen to the plant's roots.
It is doubtful if this can be reached by passive aeration if the whole water surface is covered with rafts.

This calls for extra investment in aeration, both in hardware (air pump, tubing and diffusers) and in energy consumption.

Another problem with DWC is plant support: the small pots do not give much stability. This is no problem for low plants like lettuce and herbs.

Higher growing plants need a support to grow against, especially if outside a greenhouse and exposed to wind.

A challenge to meet.

I have built a small pilot DWC system in my greenhouse to study and compare the advantages of this system to NFT and growbeds.
I intend to build longer raceways outside.

The bottom and sides of the tank are constructed out of a 5 mm multiplex board stapled to a frame made of 45 x 20 mm ribs.

The bottom of my DWC tank is made of two panels measuring 3 m x 1 m , the sides are 30 mm high.

On the inside, 90° bookshelf supports are screwed to both bottom and sides for strengthening.

A thick polyethylene foil (leftover from my greenhouse covering) is then spread over the tank and carefully folded into the corners.
Takes a bit of adjustment and patience, but the rectangular form of the tank is a big help.
Kind of wrapping a birthday present inside out. Not really difficult, just make sure the folds in the corners always take the foil up to the rim of the tank, else it will be leaking.

The rims of the foil are folded over the sides and stapled to the frame.

A 50 mm tank drain fitting is installed in each growbed.
For that I use a guide made of a 20 mm piece of board with a hole drilled in it with the corresponding hole saw. I weigh that down to hold it in place.

With an exacto knife I then first cut the corresponding hole out of the foil,

helped by the guide. This is important, lest the teeth of your hole saw wrap up the foil while drilling (been there, done that).

After that, cutting the hole through the bottom with the hole saw is childs play.

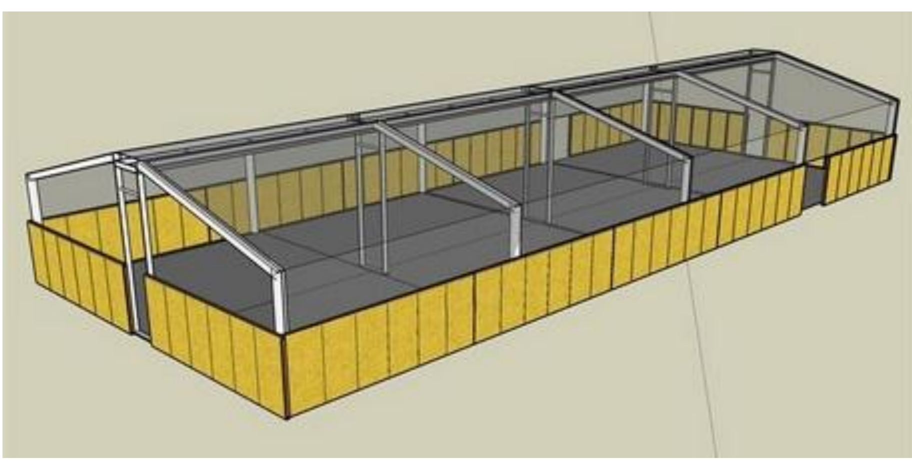
The drain fitting is connected to the fish tank solids lifting overflow drain, so the DWC side is not really a drain but a fill.

The pump is located in the DWC tank and pumps the water back to the fish tank.
The fish tank (CHIFT -see the "definitions and acronyms" page) overflows into a pond type filter which then overflows into the DWC tank, from which it is pumped back to the fish tank, which then overflows ... etc ...etc ...

<u>Insulation.</u>

I have the intention of filling the gaps between the frame ribs with insulation and staple a second 5 mm board against them to close up, then screw a plastic or aluminum L-profile all around the rim and on the corners for finishing touch.

see more pictures of the construction principle on the "rectangular growbeds" page.



I have built my own 16 x 7 m greenhouse.

View the slideshow to see the evolution of the construction.

First I had the terrain leveled.

The central gangway is built out of custom made aluminium ladders.

Then I made the rafters which lean against this central gangway and are fastened to it.
Each rafter is also anchored to the ground.

Being particularily charmed by foam as insulation technique, like presented in the the Solaroof concept (a double sided foil in which foam is injected both for heat and cold insulation - see the Solaroof Wiki and forum), I decided to use square PVC drain pipes 100 x 100 mm, standard length 4 m for the rafters.
This will allow me to have a double sided greenhouse.
One word of warning: beware of the price information on both the Solaroof forum and Wiki.
I participated in some discussions there.
I have 25 years of experience with foaming applications for cleaning in the food industry.
When I posted some prices on what an industrial foaming product might actually cost, I was inadvertently and without warning banned from the forum.
The people who run the forum are obviously protecting their commercial interests (which is fine with me, I am not against honest commerce, but I do oppose against hypocrisy as these people pretend to be open while they are not. Very little useful information is given on either site, but the contributors ideas are no doubt milked out).

back to my greenhouse (excuse the rant):

The bottom part of the vertical side walls is made of 1 m high panels of 5 mm multiplex stapled to a wooden frame of 45 x 20 mm planks.
To isolate the panels from the humid soil, they stand on strips of 50 x 100 mm Floormate insulation.
I cut a 100 x 100 mm x 4 m PVC drain pipe lengthwise, which left me with two 100 x 50 mm x 4 m gutters which I screwed to the top of the panels for rain collection.

North, east and west sides, the hollow part of the panels is facing inwards for insulating later on, south (sunny) side the hollow part is facing outwards for incorporating thermal solar collectors.
The panels need painting as soon as the weather permits.

At this moment only the outer foil is installed as I wanted to first test a new method for fixing the foil to the frame.
For that I used 3M VHD (4952) acryl double sided sticking tape, as standard available in 12 and 19 mm width.

This seems to be a wonderful solution: where applied under the right circumstances and preparation, the foil sticks very well to both PVC and aluminum profiles.
Right circumstances are low humidity and temperatures above 15°C, and thorough degreasing of both supports and foil.
I was late in the season, so the circumstances of humidity and temperature were far from ideal (<10°C and humid).
Still most parts stick extremely well (they resisted an autumn storm), and I am convinced of the method.

The foil was 8 m wide, so the covering was done in two phases.

The 100 x 100 mm square drains also allow for the incorporation of electric cables and fixtures.

What would I change?
-Next time I will use 19 mm tape. Unfortunately at the time only the 12 mm width was in stock.
-I will choose a dry warm windless day.
-Distance between rafters is now 4 m. Next build will be maximum 3, preferably 2.5 or 2 m, certainly for a higher greenhouse (height is now limited to 2.5 m for building permit reasons).

-And, most of all, I will ask for some help. Alone is but alone. One does a lot of walking from one side to another.
Vanity, O Vanity.
(Still I am quite proud of myself ;-)).

Biofiltration

Food for the fish is the only external input to an AquaPonics system.

Fish transform most of this food into muscle tissue.

But like all animals, fish also produce waste.

Just like in a Recirculated Aquaculture System (RAS), in AquaPonics the waste produced by the fish consisting of settled and dissolved solids is pumped to a bio-filter system.

In this bio-filter, high surface, often porous media through which the water is pumped are colonised by beneficial bacteria.
These natural bacteria convert the waste from the fish tanks, largely ammonia (toxic to fish), first to nitrite (higly toxic to fish) and then to nitrate (not toxic to fish) with the help of oxygen.

It is essential to evacuate these solids from the fish tank as fast as possible to remove ammonia and nitrite (toxic to fish).
If not, they will be colonised by these bacteria, who will also compete with the fish for the oxygen.
Once the full biofiltring cycle is finished, toxicity is reduced to acceptable quantities for the fish.

While not toxic, the accumulation of nitrates causes stress with the fish. For this reason, RAS systems daily renew part of the water, about 10%.

In aquaculture, this highly charged water goes down the drain.

Not so in AquaPonics: here the "charged" water is considered a resource and the connotation turns from negative to positive: the water is no more considered as "charged", but as "rich in nutrients".

These nutrients are then pumped to the hydroponic part where they are absorbed by the plants for their growth.

Both the aquaculture and the hydroponic component complement each other as a single unit.

Most AquaPonics systems use the media in the grow beds as biofilter. The clean water is then recycled to the fish tank.

Some, however, incorporate a separate biofilter.

Other systems allow the nutrients to accumulate in the aquaculture component and only feed the plants the nutrient rich water necessary for their growth.

Here no water is returned to te fish.

This allows to add micronutrients and other products beneficial to plants growth that might endanger the fish. Or to influence the pH so that it is more to the liking of the plants.

It also allows for the addition of chemicals.

Personally I believe these systems to be incompatible with the spirit of AquaPonics which aims to be ecologic, organic and sustainable.

Pumping and aeration are of the utmost importance in AquaPonics.
Not only are they vital to fish, plants and bacteria, this is also where your energy consumption goes to.
A well designed system will keep the energy bill low.
Even small errors can easily make you waste 30, 50, 100% or more.

But don't let this deter you:
The key is to keep your system as simple as possible as you will quicly understand after reading this page.

PUMPING

The pump is literally the heart of an AquaPonics system.

Just like the heart in the human body, it provides transport for both the elimination of waste and the providing of oxygen.

The pump in AquaPonics is meant to transport water from one point to another. That is it's purpose. It's performance must be directed to maximal

volume (flow).

There are two forces the pump must overcome:
gravity and the friction in pipes and appendages.

While designing a system, it is very important to keep both the height to which is pumped as the friction in pipes and appendages to the strictest minimum for best pump performance and least energy consumption.

It is easy to understand that if you need to pump the water to a height of 1 meter, pumping it to 1.2 meter will mean an energy waste of 20%.
So keep the height to where you pump as low as possible: just over the rim of your tank is enough.

How to limit friction?
By eliminating all unnecessary piping and appendages.
This is easy to do and means a simplification of the setup.
The only length of pipe that is unavoidable is the standpipe on your pump to bring the water to the necessary height.
From there on the work is done. You have overcome gravity.
Let gravity do the rest of the work by using wide horizontal pipes or gutters (better) that are never completely filled.
Dimension the standpipe one size bigger than the connections on your pump: 3/4" pipe for 1/2" connections, 1" pipe for 3/4" connections, and so on.

These four simple measures will ensure best performance of your pump:
-pump straight up,
-the lowest necessary,
-in a slightly overdimensioned standpipe.
-from then let gravity work for you in wide horizontal pipes or gutters (better) that are never completely filled.

Most used in aquaculture and Aquaponics are centrifugal pumps as these are reliable, readily available and cheap through mass production.

The performance of a centrifugal pump is directly related to the hight to which it must pump (pump head): the higher to pump, the lower the flow, the lower to pump, the higher the flow.
This performance can be set in a table or in a curve on a chart.
Centrifugal pumps perform best in the middle of their curve. That is what they are designed for.

Here is the bad news:
99% of the pumps we use are designed for much higher heads than we need.

Most pumps can pump to 30-40 meters, while we mostly only need 1 to 1.5 meter.

... to be continued.

AERATION

Aeration is about exposing water surface to air srface so that the water can absorb oxygen out of the air

... to be continued.

What plants can be grown in an AquaPonics system?

Most green leafy vegetables grow well in all AquaPonics systems.

Even in the most simple AquaPonics system there seem to be almost no limits to what plants you can grow.

Tomatoes, cucumbers, peppers, beans, carrots, potatoes, herbs,strawberries ...
All have been successfully grown in Aquaponics.

But there have been failures too.

In reality different plants require very different circumstances to feel "happy".

Some plants need constant moisture and lots of nutrients i.e. watercress and duckweed.

Other plants prefer more dry media and meager soil to thrive i.e. thyme.

That is why I advocate a better control on flood and drain frequency as this frequency decides about both soil dryness and nutrients availability.

See the "flood & drain" page in the menu for more info.

Although sometimes selected minerals or nutrients such as iron are added, the main source of nutrients for the plants is the fish waste.

Another intriguing factor, not enough discussed, is the growbed surface needed for each of these plants.

See the download section for a surface calculator.

Thanks to the constant apport of nutrients, plants need much less surface in an AquaPonics system than in traditional agriculture.

It is my intention to post here a list of plants with their moisture, nutrients and growbed surface demands.

<u>What fish can be bred in an Aquaponics system?</u>

Even in the most simple AquaPonics system there seem to be almost no limits to what fish you can breed.

At least that is what is advocated and mostly true.

In reality different species may require very different circumstances.
Most fish species need their appropriate water quality and surroundings to feel "happy".

Animal welfare is most important to me and to most AquaPonics adepts.

Some fish need a lot of oxygen, others need less.
Some need warm water i.e. tilapia, other cold wate i.e. trout.
Some will stand high densities, others need hides and territory.

In practice, Tilapia (most commonly nile tilapia, Oreochromis niloticus) are the most popular fish chosen for home and commercial projects that are intended to raise edible fish. In Australia, "land of AquaPonics", native species are the most popular fish, including Silver Perch, Jade Perch, Sleepy Cod, Murray cod and Barramundi. Rainbow and brown trout while not native

to Australia are also in use - along with fresh water crayfish such as yabby and redclaw.

I plan to raise carp (Carpa) and European perch (Perca Fluviatilis) along with freshwater crayfish (Astacus Leptodactylus). These fish like to swim around in schools, so fish density is not a real issue.

I might have a go at pike (Esox) and perchpike (Zander, Lucioperca lucioperca) too. These fish are higly predatory and territorial.
Designing fish tanks which incorporate many hides so these fish feel comfortable is a challenge.

It is my intention to post here a list of fish with their demands for best animal wellfare, which will reflect on growth results.

AQUAPONICS

Tomatoes grow through the roof.

LETTUCE IN FRONT-TOMATOES IN BACK


STRAWBERRIES IN GRAVEL BED


A COMPLETE SALAD BAR

YES! EVEN SNAP BEANS AND PEAS
From garden salads to fruits and herbs. Everything grows using the natural fertilizer properties of fish waste

AQUAPONICS

In recent years there has been a lot of interest in aquaponics. Prior to 2006 if you had googled the word "AQUAPONICS" you would have found perhaps 4 sites with information about aquaponics, including this one. Today, everyone looking for a new career has suddenly become experts in the subject. This is because, aquaponics, by itself, is relatively easy. I say, "By itself" because the hard part is the fish rearing system. This is where we separate the hobbyist from the more serious fish farmer and aquaponics operation.

Some may find what I am about to say here is a but harsh but I truly believe it. The folks who tell you that the aquaponics is the most profitable side are only telling you part of the story. When you figure that you can get about 15 pounds of produce for each pound of fish you grow and that the profit per pound of tomatoes is about the same as the profit per pound of fish, then yes, the veggies are more profitable when you look at it that way. The part you are not hearing from them is the fact most of the people who claim to be experts in the aquaponics know little or nothing about building fish culture systems or raising fish. So when they try to use the little inefficient fish culture tanks they provide you will grow some fish, enough to get some fish waste, but you will loose money on the fish side of things because that part of the overall operation will cost more to operate than the product is worth.

My focus has always been and continues to be concentrated on quality fish growing systems with the aquaponics being the secondary profit center. Aquaponics was started to have a place to dispose of the fish waste in a profitable manner. Some of these new comers to

the business seem to think aquaponics came first and the fish were the after thought.

My opinion is this, if one wants to grow fish, then by all means do it. It can be an enjoyable and profitable business and while you are at it, use the fish waste to increase your profits. If all you want to do is to grow produce, then leave the fish out of the business plan. There are other ways to grow organic vegetables.

Like anything else in a series of events, a chain is only as strong as it's weakest link. In almost every aquaponics system I see on the internet today they are still trying to do things using the very first method we, at Global Aquatics, used for our very first experiments. All we did was run the water from the fish tanks through some beds with a gravel media and then return it to the fish tanks. In the gravel media we had placed various plants from tomatoes, to lettuce and peppers. It was our theory, just as it is with many today, that the gravel would capture the fish waste and allow it to decompose and go through the de-nitrification process to become plant food nutrients and in the process also become a bio-filter and remove all of the ammonia and nitrites that were so harmful to the fish.

At the time we were operating an 8 tank version of our S-92 unit. After doing some adjustments, namely keeping the water levels in the growing beds low to keep from drowning the tomato plants, we found that the plants did indeed flourish. However, after a couple of months we began to have problems with both the fish and the plants. For one thing, the amount of fish waste coming into the beds from this many tanks was far more than the gravel beds could hold. The amount of ammonia and nitrites generated by the solid waste could not possible be broken down by the vegetable plants or the gravel filters. By the 3rd month the water returning from the plants beds to the fish tanks was toxic with ammonia and nitrite. This not only destroyed the water quality in the fish tanks it was damaging the plants as well.

We had to step back and think about this for awhile and then learn how nature handles this problem.

In order to explain how aquaponics work, let's first explain how nature works. I am sure there will be comments on my explanation here, but few of us are biologists, so I will take a layman's approach to make it easier to get the idea without a lot of long Latin words no one will remember tomorrow.

One of the biggest concerns in modern times is the environmental impact from farmers spreading raw animal manure on fields for crop fertilization. In many areas of the world this "Over fertilization" has contaminated under ground well water, rivers and lakes. Generally speaking it is not so much a matter of the amount of manure that is placed on the fields, as it is the form in which it is put there in the first place. In order to understand this we must first understand the process in which nature converts solid animal waste into a form that plants can use.

Unlike chewing animals with a mouth and teeth, plants can not consume solids. Instead they absorb their foods either through their roots or leaves. In order for this to happen the solids must be reduced to their chemical foundations. We call this the "de-nitrification process". Although the process is a bit more complex, the easiest way to explain it is something like this: First the solids must be exposed to water to feed certain bacteria which begin to break them down. Like all living animals, these bacteria also excrete waste, ammonia. This excretion now leaves a food source for another type of bacteria that feed on the ammonia. Once again there is excretion involved. It is called Nitrite. It is at this point that most run off pollution occurs. Manure placed on the surface of a field will gather enough moisture in time for bacteria to convert most of it to Nitrite. However, since this process can take several days, should enough rain fall occur, this chemical, Nitrite, can be now diluted with rain water and carried deep into the ground to well water, or can be carried to rivers and lakes, thereby causing nitrite pollution. Also at this time many other chemicals are being released such as Phosphorus. For the most part most plants cannot consume nitrites, and once they dissipate into the ground or waterways the next step in the process can not happen very quickly.

Since Mother Nature wastes nothing she has provided us with still another bacteria. This group now consumes nitrite. The resulting excretion from this group is Nitrate. For my explanation nitrate is a fairly loose term for the forms of nutrients released at this point, however, the point is, this is the stage of the process that supplies plant food. Once again however, these nutrients are also a problem when washed in to lakes and rivers, for it is these groups of chemicals which encourage and feed algae.

In a fish culture system we have waste in two forms. First we have discharged water. This water in itself already contains a lot of nutrients and small solid particulate. The other form of waste is solid matter. Either of these two turned loose in a river or lake will cause a problem. They can be sprayed on a field and they will break down much faster than normal farm animal manure because of the fact that it is already very wet and there are bacteria working on it when discharged. However, this is still not the final form for plant food. It still must go through this process. SOLID WASTE AMMONIA NITRITE NITRATE = PLANT FOOD

After considering how nature works and recognizing the time involved for complete break down of the solid matter we determined that what we needed to separate the solids long before they got to the aquaponics. We then built a massive clarifier prior to the plant growing area that would allow for the solids to filter out before they got to the gravel bed. (**See S-92 filtration****) The effluent would now pass through the clarifier's, then through the plant beds and then back to the fish system. After operating this system for several months we did find that we were able to keep the gravel beds from clogging but the down side was, we had to clean the clarifier's every three or four days. This took a lot of time and effort and now we had another problem, what to do with all of this solid waste. Wasn't the purpose of all of this to get rid of the fish waste by having the plants eat it?**

Within a month we found there were other problems with this new system. While the gravel plant media was staying clean, the media and the plant roots were a poor bio-filter. We were still getting too much ammonia and nitrites back to the fish tanks and the plants were being stressed from this as well. We also found another issue that concerns me to this day when people use this method. We found several bacteria, including e-coli, in the growing beds. What made this such a concern to me was the fact that I did not want e-coli in my fish tanks and I also recognized that if someone were put their hand in the gravel media before picking a tomato there would be a good chance the tomato would be contaminated with the bacteria. After a discussion with several knowledgeable folks at the University of Delaware they stated that this should not be unexpected since this would be prevalent in any septic tank where solid animal waste was being broken down and the gravel media beds were acting just like a septic tank in that they were capturing enough solid waste to encourage the present of these bacteria. When we inquired as to how to deal with this we were told that one method would be to break the solids down with both anaerobic and aerobic digestion, just like they do in a municipal waste water facility, before the waste was used for plant crops or returned to the system. They were also uneasy with returning the water to the fish system in the first place. Their

analogy was, if you were to somehow treat the waste in your septic tank in a primitive manner and then return it to be used in your house you would be in jeopardy. Since no animal can do well living in his own waste, why would you expect a fish to be any different?

Now it was back to the drawing board. We knew two things after all of these trials. We needed to completely remove the fish waste from the fish system in a positive manner and never bring this back to the fish system once any of it was removed. We needed to clean the water of all ammonia and nitrites. This was easily done with solids filtration and bio-filtration. We also knew from the trials that the fish waste made great fertilizer when properly prepared. There was only on solution. It would require two recirculating systems. One for the fish and the other for the plants. The follow up research would treat each one as its own entity.

Building better fish filtering system has always been the main focus at our research facility, so nothing would change there. Developing a method to utilize the waste from these fish would be a new focus. Drawing on the science of treating waste in a tertiary, or three stage process like used in waste water treatment, we designed a small, inexpensive unit that could be build from common materials found in the construction industry. In our system we call this the digester. All of the waste from the fish system goes here. Once it enters this point it is never allowed to go back to the fish system, The digester, using aerobic (ambient air) and anaerobic digestion will break the solids down to a clear liquid nutrient in a matter of days. From here the pure nutrient is circulated to the plant beds and back to the digester using a flood and drain method.

At Global Aquatics we have incorporated in all of our S-series fish systems devises to totally digest the solids by means of an aerobic digester vessel and then coupled that to special plants production trays. The nutrients are then delivered to plants by a timered pump. Unlike Hydro-ponics, our plants are not growing in standing water, but rather in porous media which traps the nutrients around the plant roots.

SOME INTERESTING FACTS

Global Aquatics developed the first true commercial aquaponics system in 1986 as a part of an experiment in conjunction with the Food and Economic Department at the University of Delaware. The original scope of the experiment had nothing to do with what we know today as aquaponics, but rather was an experiment to build a better biological filter to provide pollution free aquaculture discharge. The experiment started in April of 1984 and over 100 different plants were used to see which ones would work best to remove all of the nutrients from the water. By the end of 1986 we had discovered a whole new agriculture science. We had developed equipment and methods that not only consumed the nutrients, we had figured out how to grow vegetable crops that were far superior to normal hydroponics crops in both texture and taste.

NUTRIENT LOAD IN FOODS

While this may sound a little simplistic, the reason foods grown using organic fertilizers are so superior to those using chemical fertilizers is because it is just natures way of doing things. If an orange is suppose to be chocked full of vitamin "C" the elements to cause this to occur have to be found in the food the plant takes in. When someone is using liquid nitrogen, a very good plant fertilizer, to grow the parent plant, where are the elements needed to add the food benefit of the fruit? The answer is, it is not there. This is why hydroponic tomatoes have no flavor. In order to get the full nutrient load in any vegetable or fruit you must be able to provide all of the bases chemicals in the plant food. Nature has given us the way to achieve this by using nature animal waste and plant compost. Using this method is just a continuation of the natural recycling system.

WHY IS THE FLOOD AND DRAIN SYSTEM SO EFFECTIVE FOR PLANT GROWING?

Before I explain this I need to say, not all plants need to use this method. Some plants like lettuce do very well in aquaponics using the raft system. In the raft system a pool of water is used. The lettuce seedlings are then inserted into small holes punched in thin foam boards and the boards are floated on the water. The lettuce plant will send it's roots into the water and get its nutrient from there. For many stalk plants such as tomatoes and peppers the flood and drain works the best. Here is why.

First lets look at how Mother Nature does things. We all know the benefit of worms. Among the many things they do is they drill holes on the ground. So why is this a big deal? It is because of the way a plant root system works. First of all, the roots need water. When it rains what is the best way to get water to the root? Yep! Down the worm hole. The second thing is aeration. While the plant leaves take in carbon dioxide and expel oxygen, the roots do the opposite. They take in oxygen and put out carbon dioxide. In order for the plant roots to get oxygen it has to be able to get into the ground. In order for the carbon dioxide to leave the soil it has to have an escape path. Hence, the worm hole.

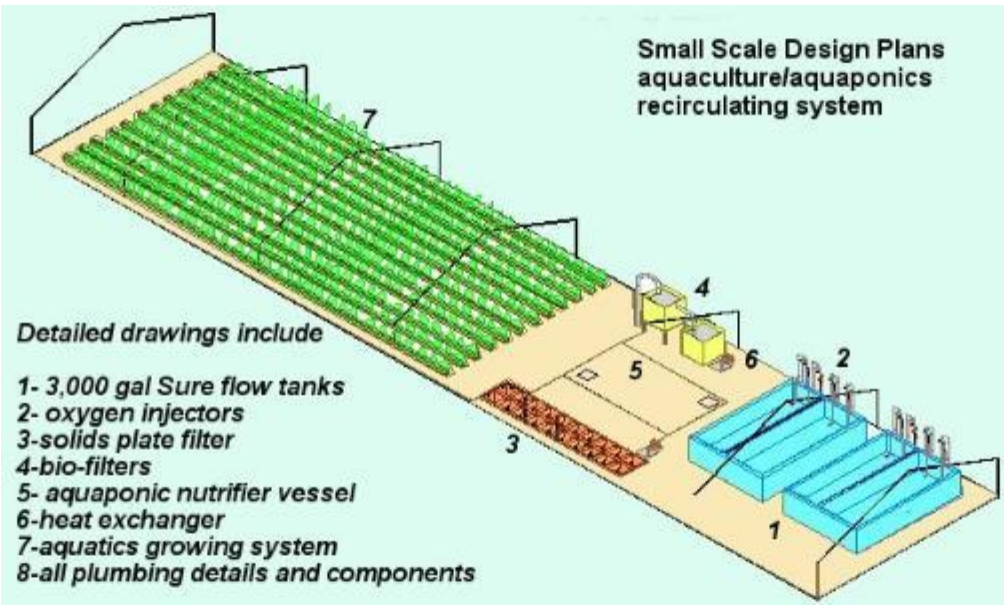
When we grow plants in a loose gravel bed we can easily manipulate things to copy nature with the root system. For one thing, we all know that too much water around the roots will kill the plant. This is for several reasons. One is the root can not breath to expel the CO_2 or bring in the O_2. The second thing is, with even a little too much water keeping the roots real wet, the CO_2 will eventually become an acid that will cause root rot. This is a problem sometimes with the drip method of feeding plants and a lot of times with those using the plants as bio filters. The gravel does two main things. First of all it is the media which holds the plant in place. The second thing is it is a place for moisture to cling to feed the plants. After the plant is set in place, the water to the trough containing the plant and gravel is turned on and fills the vessel to the top soaking all of the stones. Once this occurs the water is shut off and the water is allowed to drain out. In the Global Aquatics systems this drained water just returns to the digester to be used again during the next cycle.

Once the water has been removed the empty spaces between the stones load up with fresh ambient air. The plant begins to do go through the life process. The roots are supplying the plant with the nutrient it gathers from the moist stones, they are being supplied with oxygen from the trapped air and of course they are putting CO_2 into the spaces. About 12 hours later the water is once again turned on. As the water fills the voids in the stone the CO_2 is flushed out and a new supply of nutrient coats the rocks. Once again the water is drained away, new oxygen comes in and the process begins all over again.

THE RATIO BETWEEN PLANTS CROPS AND FISH

I get asked all the time how much produce will you get from one pound of fish. Although this is difficult to measure most people who have knowledge in this will give you a number of about 15 to 25 pounds of veggies per pound of fish. Of course this will vary depending on the crop. It is a safe bet that you will get more pounds of tomatoes per pound of fish waste than you will from lettuce crops. This is because a large part of the weight of a tomato comes from water content.

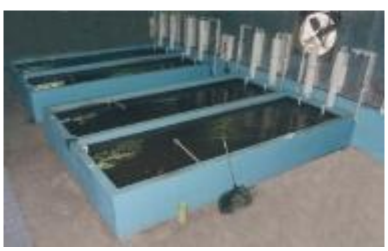
BUILD IT YOURSELF

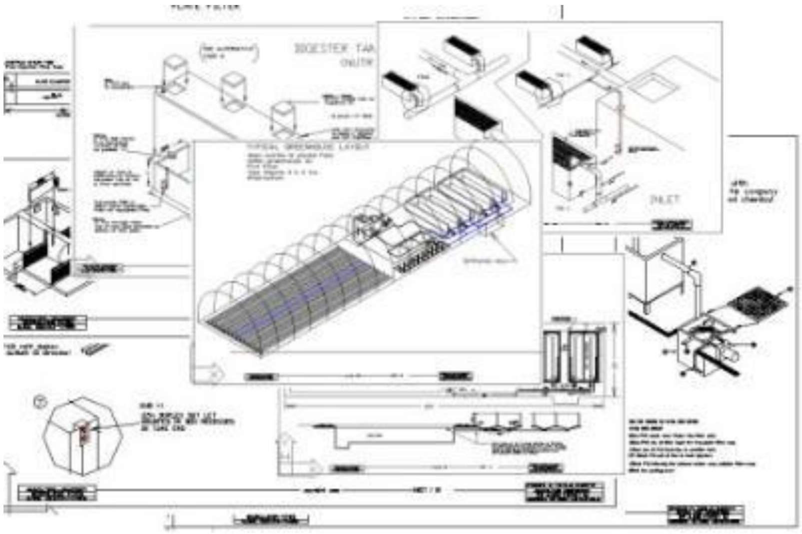


Small scale aquaculture/aquaponics systems designed specifically for the first time fish farn

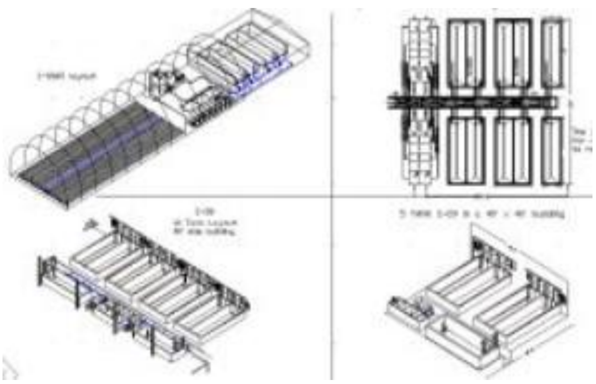
Introducing the S-2005 system.

A professional system you can build yourself at a very low cost





A complete set of blue print size design plans showing in great detail all of the components and how to build them.



Many different layouts to fit your needs.

Expanded layouts to help you plan for future growth

build it with poured concrete

build it with concrete blocks

build it with plywood

build your aquaponics garden

Now, you can build a state of the art aquaculture system on your property without paying the hourly cost for a design engineer or consultant. All you do is buy the blueprints.

The S-2005 system has been designed at the request of many farmers and small land owners who just want the blueprints and details they need to build a small start up system that can be easily expanded at a later time.

This is no toy or gimmick. The design comes from 40 years experience as an aquaculture engineer. All of the components are of proven reliability as are shown on other pages within this website. All of the components can be built from the things you can purchase at Home Depot or other building supply company. In most cases the components are drawn in several different ways to demonstrate different materials they can be constructed of, from plywood, to concrete, to concrete blocks to PVC fittings.

What makes this design so unique is, I have taken you back to the prototype. Anything that is manufactured in a factory started out as a prototype. That prototype was usually hand made from basic, readily available materials. After the prototype was proven successful, machine tools were made to reproduce the part in mass quantities and sold at a high retail cost. For instance, the original prototype for our oxygen injector was made completely from PVC fittings. Later special molding was created to reproduce it for the market at a price of about $250.00 per copy. In these drawings I show you how to build the original prototype in your garage for less than $50.00 per copy. It is the same with all of the other components including the bio-filters, plate filters, tanks, and aquaponic growing layout.

Ideally the S-2005 fish growing system would be put in a pole barn or other building to protect it from the elements. However, this complete system, including aquaponics, will fit inside a greenhouse measuring 35 feet wide and 150 feet long with sidewalls 8 feet high. However, if you already have a greenhouse that is not quite this size you can scale the design layout to better fit your conditions. If you are a farmer with an empty chicken house or barn, you can rearrange the design layout to fit these needs as well.

One other important thing to note:

I do not just sell you the plans and then disappear. I am available via phone call or e-mail at anytime to answer any questions you have while under construction at no charge. For a small fee and travel expenses I can even go to your location and assist with the initial layout and can come to you to get the system up and running at the end of construction.

WHAT YOU GET WHEN YOU PURCHASE THESE PLANS

This is a complete professionally prepared package containing 24 full size blue print sheets and construction manual. The packages contains not just the S-2005 package but also our latest, more advanced S-09 system design. With this complete package you can build now inexpensively while planning to upgrade in the future.