AQUAPONIC SYSTEM

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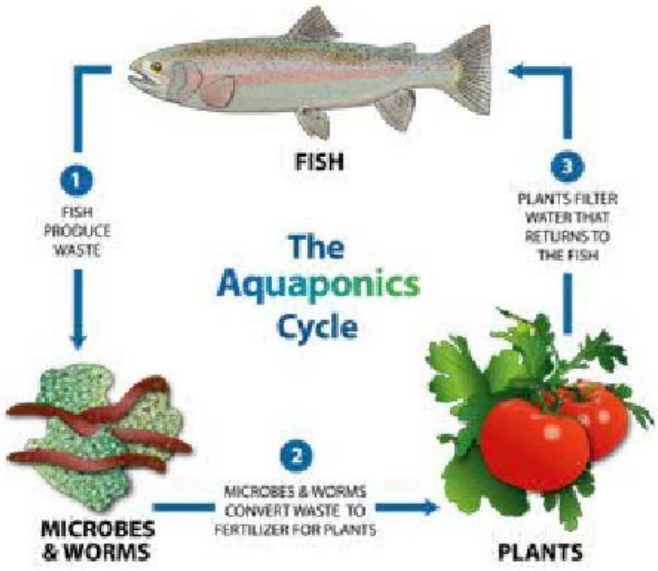


PRESENTATION

Aquaponics is a food production system that sustains itself combining traditional aquaculture (raising aquatic animals such as fish, crayfish or prawns in tanks) with hydroponics (cultivating plants in water) in a symbiotic environment. In the aquaculture, effluents accumulate in the water, increasing toxicity for the fish. This water is pumped into a plant grow bed where the by-products from the aquaculture are filtered out by the plants as vital nutrients, after which the cleansed water is recirculated back to the animals. The word *aquaponics* is a combination of the words *aquaculture* and *hydroponic*.

Aquaponic systems vary in size from small indoor or outdoor units to large commercial units, using the same technology. The systems usually contain fresh water, but salt water systems are plausible depending on the type of aquatic animal and plants are needed to be grown. Aquaponic science may still be considered to be at an early stage, even though we can find it's trails back to the time of the Maya population in Central America.

Large Scale Aquaponic System

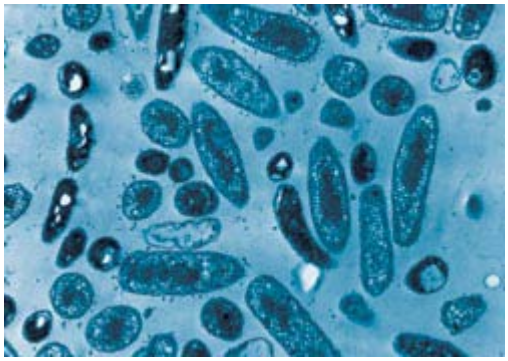
The aquaponic system consists of two parts: the aquaculture part for raising fish or other aquatic animals and the hydroponics part for growing plants. Aquatic effluents resulting from uneaten feed or raising animals like fish, accumulates in water due to the closed system recirculation of most aquaculture systems.

1. Fish tank; 2. Plants grow bed;

The effluent-rich water becomes toxic to the aquatic animal in high concentrations but these effluents are nutrients essential for plant growth. Although consisting primarily of these two parts, aquaponics system are usually grouped into several components or subsystems responsible for the effective removal of solid wastes, for adding bases to neutralize acids, or for maintaining water oxygenation. Here are some typical components used on large scale systems:

- *Rearing tank*: the tanks for raising and feeding the fish;
- *Solids removal*: a unit for catching uneaten food and detached biofilms, and for settling out fine particulates;
- *Biofilter*: a place where the nitrification bacteria can grow and convert ammonia into nitrates, which are usable by the plants;
- *Hydroponics subsystem*: the portion of the system where plants are grown by absorbing excess nutrients from the water;
- *Sump*: the lowest point in the system where the water flows to and from which it is pumped back to the rearing tanks.

Nitrification, the aerobic conversion of ammonia into nitrates, is one of the most important functions in an aquaponics system as it reduces the toxicity of the water for fish, and allows the resulting nitrate compounds to be removed by the plants for nourishment. Ammonia is steadily released into the water through the excreta and gills of fish as a product of their metabolism, but must be filtered out of the water since higher concentrations of ammonia (commonly between 0.5 and 1 ppm) can kill fish. Although plants can absorb ammonia from the water to some degree, nitrates are assimilated more easily, thereby efficiently reducing the toxicity of the water for fish. Ammonia can be converted into other nitrogenous compounds through healthy populations of:



- *Nitrosomonas*: bacteria that convert ammonia into nitrites, and
- *Nitrobacter*: bacteria that convert nitrites into nitrates.

In an aquaponics system, the bacteria responsible for this process form a biofilm on all solid surfaces throughout the system that are in constant contact with the water. The submerged roots of the vegetables combined have a large surface area, so that many bacteria can accumulate there. Together with the saliency of ammonia and nitrites in the water, the surface area determines the speed with which nitrification takes place. Care for these bacterial colonies is important as to regulate the full assimilation of ammonia and nitrite. This is why most aquaponics systems include a biofiltering unit, which helps facilitate growth of these

microorganisms. Typically, after a system has stabilized ammonia levels range from 0.25 to 2.0 ppm; nitrite levels range from 0.25 to 1 ppm, and nitrate levels range from 2 to 150 ppm. During system startup, spikes may occur in the levels of ammonia (up to 6.0 ppm) and nitrite (up to 15 ppm), with nitrate levels peaking later in the startup phase. Since the nitrification process acidifies the water, non-sodium bases such as potassium hydroxide or calcium hydroxide can be added for neutralizing the water's pH if insufficient quantities are naturally present in the water to provide a buffer against acidification. In addition, selected minerals or nutrients such as iron can be added in addition to the fish waste that serves as the main source of nutrients to plants.

A good way to deal with solids buildup in aquaponics is the use of worms, which liquefy the solid organic matter so that it can be utilized by the plants and/or animals.

These particular worms are the same as used by fishermen, so, you can buy them from your local fishing equipment store. You could also try and dig them out of the ground. Places such as moist forest floors, or moist patches of grass near roots and fences in your own backyard will do. They will liquefy solids and also, fish will love them.

Aquaponic systems do not discharge or exchange water under normal operation, but instead re-circulate and reuse water very effectively. The system relies on the symbiosis between the animals and the plants to maintain a stable aquatic environment that experience a minimum of fluctuation in ambient nutrient and oxygen levels. Water is only added to replace water loss from absorption and transpiration by plants, evaporation into the air from surface water, overflow from the system from rainfall, and removal of biomass such as settled solid wastes from the system. As a result, aquaponic systems uses approximately 2% of the water that a conventionally irrigated farm requires for the same vegetable production. This allows for aquaponic production of both crops and fish in areas where water or fertile land is scarce. Aquaponic systems can also be used to replicate controlled wetland conditions that are useful for water treatment by reclaiming potable water from typical household sewage. The nutrient-filled overflow water can be accumulated in catchment tanks, and reused to accelerate growth of crops planted in soil, or it may be pumped back into the aquaponic system to top up the water level..

The three main inputs to the system are:

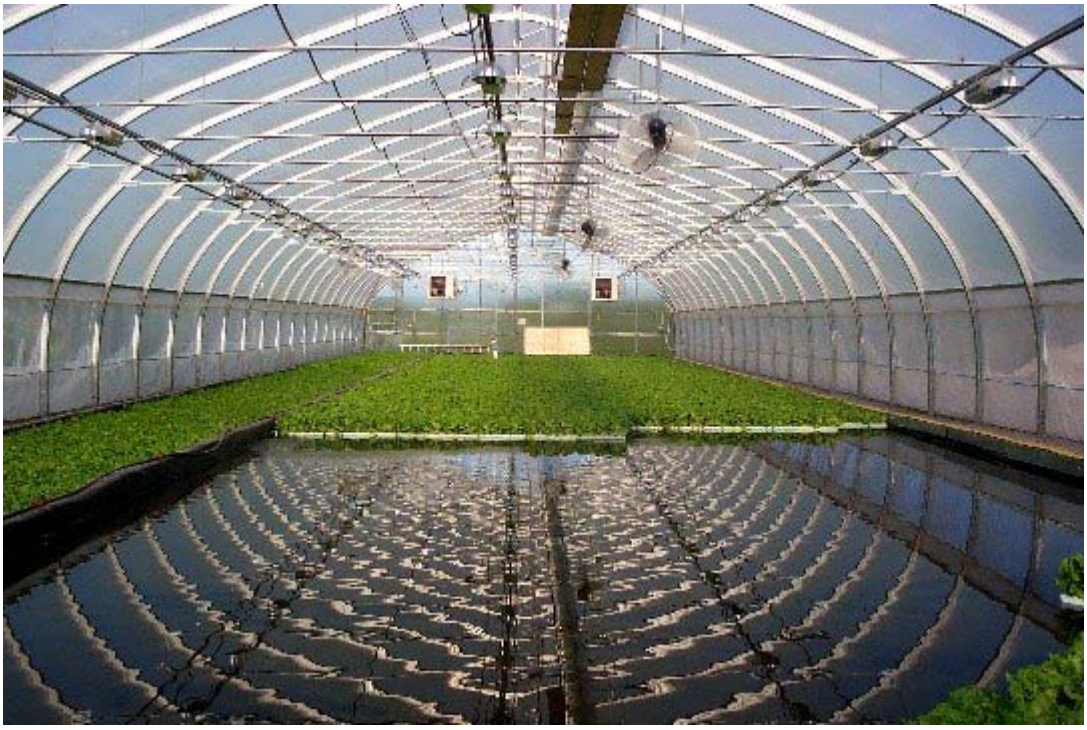
- **water**

- **feed** given to the aquatic animals

- **electricity** to pump water between the aquaculture subsystem and the hydroponics subsystem.

Spawn or fry may be added to replace grown fish that are taken out from the system to retain a stable system. In terms of outputs, an aquaponics system may continually yield plants such as vegetables grown in hydroponics, and edible aquatic species raised in an aquaculture.

In conclusion Aquaponics is a viable, sustainable and practical option for everybody to create and enjoy within their environment. Aquaponics allows for alternative organic-food production methods and has a wide scope of use within many plant types and gardens. The learning opportunities from an Aquaponics system of any size are immense, and when compared to other traditional methods of growing animals/plants in an home-based setting is far more varied. In a place such as the Northern Territory, fresh food is a valuable commodity and Aquaponics provides the opportunity to grow crops that would struggle in traditional settings. Through good management the program can become completely self sustainable economically and over time even turn a profit. With such importance now being placed on renewable resources, environmental responsibility and climate change, Aquaponics will lead the way in providing sustainable alternative for producing food and developing an understanding and respect of the environment by all who participate.



BUILDING GUIDE

Now, it's your time to build your own aquaponic system. We will do it step by step. It's best if you watch the video provided along with the book, to ensure that the system comes out perfectly.

You will need the following items in order to achieve the build you set upon:

- one 200 gph water pump

- cordless drill

- flat drill bit for wood or plastic

- small drill bit for wood or plastic

- wrench

- box cutter knife

- pliers

- measuring tape

- duct tape or teflon insulator

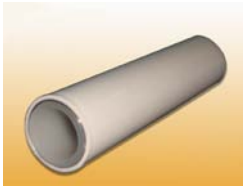
- 3/4 inch pvc connector
  with exterior thread

- 3/4 inch interior threaded jack

- 2 X 3/4 to 1/2 inch pvc reduction nut

- 10 cm 1/2 inch pvc pipe

- 1.5 meter long PEX-AL pipe

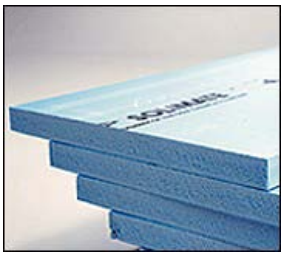


- 1 meter long 3/4 inch pvc pipe

- 1 or 2 flower pots

- different sized plastic cups
  (you can also use net pots,
  whatever comes in hand)

- 1 extruded polystyrene board
  1/2 inch thick



- and of course, the fish tank (1), and the grow bed (2) (you can use any kind of tanks or barrels as long as they hold water)

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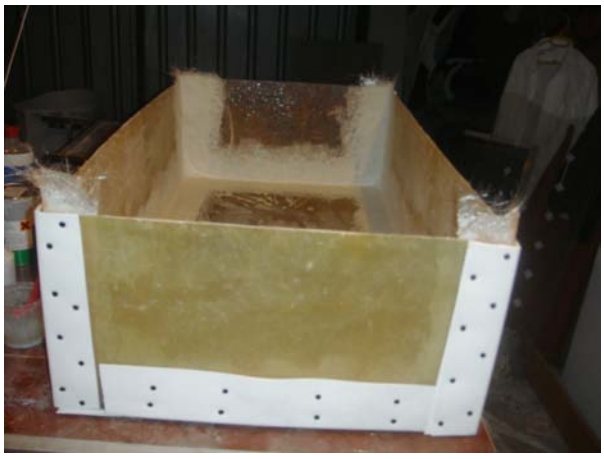
In some areas, finding suitable tanks for both fish and plants might be difficult. This is the problem I came to solve by building my own tanks. I built them using fiberglass molding. This way, I got the tanks I wanted and at the specific size I wanted them to be.



Fiberglass is a great material to use when in need of water holding objects. You can make drain pipes, tubs, tanks, pots etc. Just about anything that comes to mind, fiberglass is the right material for the job. It shouldn't be used, though, without supervision from a professional. At least for the first time.

I was also in need of a frame to support my tanks one on top of the other. The problem is that once you've built your own tanks using your own measurements, it will be difficult to find a suitable frame in commerce. So, I took the necessary action and built my own metal frame.

I used rectangular iron bars, and welded them together in a good and sturdy frame. If you want to build your own, I suggest you pay maximum attention at the following: joints, long surfaces such as tank walls and bottom surfaces of the tanks. These are the weak spots in the fiberglass tanks that need to be strengthen by the metal frame surrounding it. The fiberglass will not be able to sustain itself once you fill the tanks with water. It would be torn apart by the pressure. My containers are of approx. 50 and 80 gallons. I used green paint on both inside and outside of the tanks for it's an eye-relaxing color, and white paint for the frame just to be in a good contrast.

The first step is to drill a hole in the bottom of the grow bed. Use the cordless drill with the flat drill bit to complete step 1 of this build. Make sure to drill the hole near a corner, not in the middle of the grow bed.

Next, you'll have to make a gasket for the hole so the water won't leak. You can do it like i did, using a two component adhesive such as Poxiline, or you can use teflon insulator or a rubber gasket.

Place the gasket on the hole, and take the pvc connector and the threaded jack. Put the pvc connector through the hole, and screw the jack on the other side. Tighten the two pieces until the gasket is tight.

Now, depending on how high is the grow bed, cut a 3/4 inch pvc pipe. In my case, the grow bed is 30 cm high so I cut the pipe 22 cm long. The length of this piece of pipe will determine the water level inside the grow bed. Place the piece of pipe inside the connector and tighten it.

Next, take the 10 cm 1/2 inch pipe, and screw the reduction nuts on it like you see in the video. use the pliers for better tightening.

Drill a hole in the pvc pipe, preferably in the middle and make sure that you clean it afterwards so it won't get stuffed.

Now, take the duct tape and cover the threads, keep in mind that both sides of this pipe need to enter by force inside a 3/4 inch pvc pipe.

Take the 1 meter long 3/4 inch pipe and measure 25 cm from one end. Cut the pvc pipe using the box cutter knife. Afterwards, force the 1/2 inch pipe into the 3/4 one.

Take the connected pipes, and screw the 3/4 inch one into the threaded jack that's beneath the grow bed. Use the remaining piece of 3/4 inch pipe and screw it in the 1/2 inch one. After the entire pipe is set, you can use duct tape to insulate the joints further.

You will now have to bend the PEX-AL pipe to it's needed shape. I already did mine but you can see how easy it is to bend it. Do it according to your tank's dimensions and height. Also, make sure you give it a hook shape at one end for it to hang on the grow bed.

Now connect the water pump to the PEX-AL pipe and place it inside the fish tank.

Fill the fish tank and the grow bed with water, and check again for any leaks.

Plug in the water pump, and let's see how the system works. Once the water reaches the level of the pipe inside the grow bed, it will remain that way.

The water flows down the pipe, and it's forced in a vortex inside the1/2 segment. Because we made a hole inside the 1/2 piece, water drips out. The water that drips out is replaced with air sucked from above. The air channels down the pipe and into the fish tank, aerating the water so the fish have enough oxygen. This is an alternative solution to using an aquarium air pump. It doesn't use electrical current and it cost less to build.

You can see here how the water pump sits on the bottom of the fish tank, pulling water from beneath.

Because I placed the water pump in one corner of the system and the return pipe at the opposite corner, I created a water current through both tanks. this water current will insure that the plants and fish will always have the same amount of nutrients and oxygen inside the tanks.

Now, we'll have to make the float wich supports the plants.

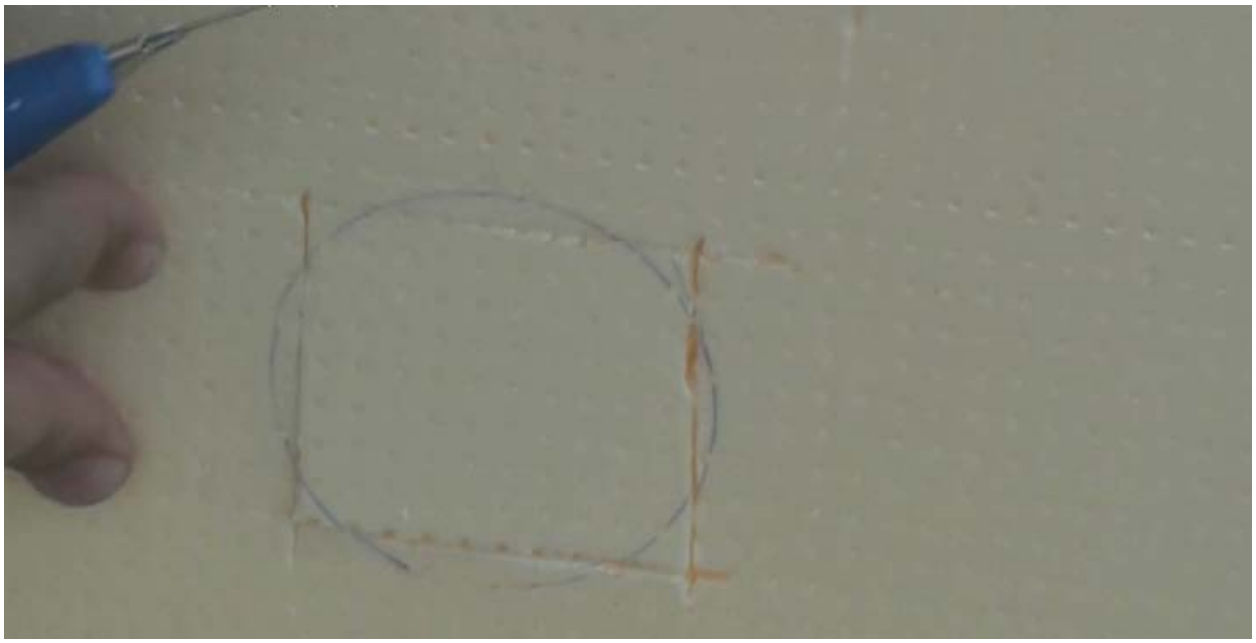
I think is best if you cut the polystyrene board just like i did. You won't need any fancy measurements. just common sense and a pencil.

Place the board inside the grow bed with one corner still. Use a pencil to draw the outline of the opposite grow bed wall. Cut the board near the pencil mark. If it fits the first time it's perfect. If not, trim it a little bit. Cut out a piece for where the PEX-AL pipe sits. Now cut the board at the required length to fit inside the grow bed.

Pay attention at this little trick for cutting a hole above the return pipe. Place the board on the water, and press it on the return pipe. It will leave a mark, so it will be easier now to cut out the specific piece. Make sure to cut it a little bit larger so there is enough room for the water to flow.

For the final part of the build, you will have to make the holes for the plastic cups, flower pots or net pots. I used a heated nail to make the holes in the plastic cups and a drill to make the holes in the flower pot. It's best to have as many holes drilled in them as you can. This way, water circulates through the roots.

Place the cups upside down and trace them on the board. Take the board out of the water, and using the box cutter knife cut the holes square, just like you see in the video. Make sure you cut them inside the pencil tracings.



Put the board back in the grow bed and place the cups and pots inside the holes you just made.

And congratulations!!! From now on you can enjoy tasty organic food grown in your own **aquaponic system.**

USEFUL TIPS

What can you grow in an aquaponics system? Leafy vegetables like lettuce and spinach do very well. Herbs such as chives, mints, and basil are also happy growing this way. Some people are also able to grow flowering plants, including zinnias and marigolds. And while commercial growers work with fish such as tilapia or bass, home hobbyists can start their systems using koi, goldfish, or even tropical fish.

1. **The Perfect Location**. Where you put your Aquaponics system will affect how well your plants grow. Shelter them from extreme weather conditions (hot and cold temperatures and wind) and make sure they get enough light to grow.
2. **Oxygenating The Water**. Keeping your fish very happy will also keep your Aquaponics system running well. Make sure you Oxygenate the water in your system daily.
3. **Choose Your Fish**. The great thing about this is that you can have just about any kind of fish in your system and it will still work. You can use many types of freshwater fish. Catfish are popular because of their efficient digestive system. You will however need to check with your states regulations for what fish you can keep. I recommend you buy fingerling's and not fry. Fingerling's will ensure your system will be running soon rather than fry which take time to mature.
4. **Easy Maintenance And Harvest**. In order to ensure that you have a easy time harvesting and conducting maintenance you should keep your Aquaponics systems height level with your waist. This way you will not have to bend over to do the work required to maintain your *Aquaponics system*.
5. **Test And Maintain**. You need to test the water in your system daily to ensure that your fish are still producing the right nutrients for your plants. If they are not producing well then you need to add the missing nutrients. Most common is Iron, Calcium carbonate or Potassium carbonate. Adding this nutrients yourself is easy and may be required to ensure your plants are getting what they need.