



Build your own Aquaponics System at home

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Aquaponics is the integration of recirculating aquaculture and hydroponics in one production system. The three main common design concepts used for the plant growing areas are; Media Based Grow Beds, grow pipes called Nutrient Film Technique (NFT) and grow canals called Deep Water Culture (DWC). The preferred concept, normally utilized in commercial size systems, is Deep Water Culture. The reasons for this are that the water temperature and pH tend to be more constant in this design and it is not as labour intensive and easy to manage. These large-scale commercial operations usually cover 2 hectares or more.

All aquaponics systems share several common and essential components. These include a fish tank, a mechanical (radial for instance) filter, a biofilter, and hydroponic containers. All systems use energy to circulate water through pipes and plumbing while aerating the water. This article provides a brief explanation of the main components of this production method and a systematic guide to construct a small-scale Deep Water Culture (DWC) system at home. This kind of system is ideal to grow leafy greens. If you preferred

to grow plants that require more support, for instance tomatoes and cucumbers, then convert the DWC grow beds to Media Based Grow Beds in your system.

Main components:

This “Do It Yourself” Deep Water Culture aquaponics system consist of the following main components:

- **One fish Tank** – 1000L Intermediate Bulk Container (IBC).
- **Three DWC troughs** – Constructed from IBC PVC liners and cages cut in half ($\pm 300L$).
- **Radial filter** – Constructed from 210L PVC drum, a bucket & funnel
- **Biofilter / Sump Tank** - Constructed from 210L PVC drum
- **Submersible Pump** – To suppress noise as well as to save on energy consumption in comparison to conventional centrifugal pumps.
- **Aerator** – To provide sufficient oxygen to the fish tank, biofilter as well as the DWC grow beds. A Venturi is added to the

design to provide additional oxygen to the fish tank.

- **Shutter board** – To help distribute the weight (3.3 tons) as well as to protect the suspended wooden floor in this case.
- **Cement Blocks** – To elevate DWC troughs and fish tank enabling gravity flow.
- **Plumbing** – Various PVC connectors and pipes connecting the various aquaponics components.

Information about the design:

Water flow:

In a deep water culture (DWC) method, also known as the raft method or floating system, the nutrient rich water is circulated through long canals at a depth of about 25cm – 30cm while rafts (usually polystyrene) float on top. Plants are supported within holes in the rafts by net pots. The plant roots hang down in the nutrient-rich, oxygenated water, where they absorb large amounts of oxygen and nutrients which contribute to rapid growth conditions.

In the deep water culture unit described in this technology, water flows by gravity from the fish tank, through the mechanical (radial) filter into the combination biofilter/sump. From the biofilter, the water is pumped in two directions through a “Y” connector (T-Junction) and valves. 80% of the water is pumped to the fish tank while the remaining water (20%) is pumped into a circulating loop system which distributes the water evenly through the canals. By gravity, the water exiting the canals and returned to the biofilter/sump, where again it is pumped either into the fish tank or canals. The water that enters the fish tank causes the fish tank to overflow through the exit pipe and back into mechanical filters, thus completing the cycle.

The flow rate of the water entering each canal is relatively low. Generally, every canal has 1–4 hours of retention time. Retention time is a similar concept to turnover rate, and refers to the amount of time it takes to replace all the water in a container. For example, if the water volume of one trough is 300 litres and the flow rate of water entering the container is 150 litres/h, the retention time would be 2 hours (300 litres ÷ 150 litres/h).

However, when a low stocking density of fish (i.e. 1 – 5 kg of fish per m³ of fish tank) is used, the DWC can be designed without using external filtration containers, mechanical or biological. In this system, water is pumped to the fish tank as well as the DWC canals. Water in the fish tanks, biofilter and canals is aerated using an air pump. The fish waste is broken down by nitrifying and mineralizing bacteria living in the biofilter, plant root surface and the canal walls. To avoid waste accumulation of solids at the bottom of the canals and biofilter, a radial filter is positioned where the water exits the fish tank.

Filtration:

Two types of filters need to be constructed for the system: first, a physical trap to catch the solid wastes (radial filter), and then a biological filter for nitrification. The designs described in this document use a mechanical swirl or radial filter to trap particulate wastes, with periodic draining of the captured solids. On exiting the radial filter, the water passes through a mesh screen (Japanese matting) to trap any remaining solids and then reaches the biofilter. The biofilter is well oxygenated with air stones and contains a biofiltration media, usually Bioballs®, nylon netting or bottle caps, where the nitrifying bacteria transform the dissolved wastes. With insufficient filtration, the DWC units would clog, become anoxic and exhibit poor growing conditions for plants and fish alike.





DWC Grow Canals:

Canals can be of variable lengths, from one to tens of meters, enabling an adequate nutrient supply due to the large volume of water used in this system. As far as the width is concerned, it is generally recommended to be the standard width of a sheet of polystyrene, but it can be multiples of this. However, narrower and longer canals enable a higher water speed that can beneficially hit the roots with larger flows of nutrients. The choice of width should also consider accessibility by the operator. The recommended depth is 30 cm to allow for adequate plant root space and to allow for sufficient water flow.

Like fish tanks, canals can be made from any strong inert material that can hold water. For small-scale units, popular materials include fabricated IBC plastic containers or fiberglass.

Much larger canals can be constructed using wood lengths or concrete blocks lined with food-grade waterproof sheeting. If using concrete, make sure it is sealed with non-toxic, waterproof sealer to avoid potential toxic minerals leaching from the concrete into the system water.

The retention time for each canal in a unit is 1–4 hours, regardless of the actual canal size. This allows for adequate replenishment of nutrients in each canal. Plant growth will benefit from faster flow rates and turbulent water because roots can then be exposed by many more ions, whereas slower flows and almost stagnant water would have a negative impact on plant growth.

Aeration for DWC units is vital. In a densely planted canal, the oxygen demand by the plants can cause dissolved oxygen (DO)

levels to plummet below the minimum. Any decomposing solid waste present in the canal would exacerbate this problem, further diminishing DO. Thus, aeration is required. The simplest method is to place several small air stones in the canals. The air stones should release about 4 litres of air per minute, and be arranged every 2–4 m² of canal area. In addition, Venturi siphons can be added to the water inflow pipes to aerate the water as it enters the fish tank and on the back-pressure line in the biofilter.

Do not add any fish into the canals that could eat the plant roots, e.g. herbivorous fish such as tilapia and carp. However, some small carnivorous fish species, such as guppies, mollies, or mosquito fish, can be used successfully to manage mosquito larvae, which can become a huge nuisance to workers and neighbours in some areas.

Planting in a DWC Unit:

As mentioned previously, this method involves suspending plants in polystyrene sheets, with their roots hanging down into the water. The polystyrene sheets should have a certain number of holes drilled to fit the net cups (or sponge cubes) used for supporting each plant. The amount and location of the holes is dictated by the vegetable type and the distance desired between the plants, where smaller plants can be spaced more closely. The standard number is normally approximately 25 holes for every 1 m².

Seedlings can be started in a dedicated plant nursery in soil blocks or a soil-less medium. Once these seedlings are large enough to handle, they can be transferred into net cups and planted into the DWC unit. The remaining space in the net cup should be filled with hydroponic media, such as volcanic gravel, Rockwool or LECA, to support the seedling. It is also possible to simply plant a seed straight into the net cups on top of the media. This method is sometimes recommended if vegetable seeds are accessible because it avoids the transplant shock during replanting.

When harvesting, be sure to remove the whole plant, including roots and dead leaves, from the canal. After harvest, the rafts should be cleaned but not left to dry to avoid killing the nitrifying bacteria on the submerged surface

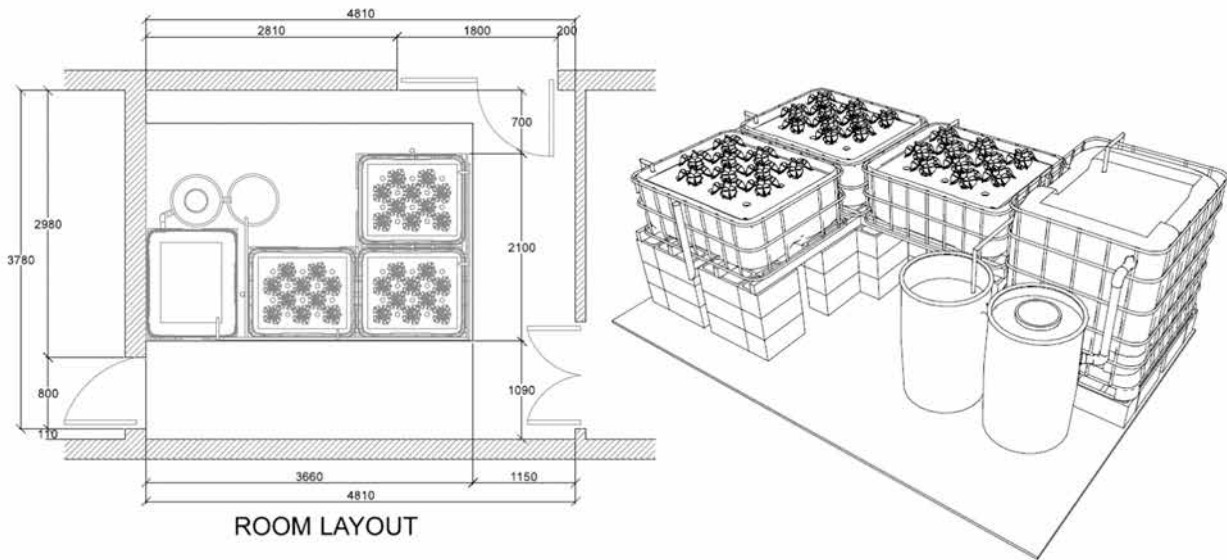
of the raft. In Large-scale units, one should clean the rafts with water to remove dirt and plant residues and immediately repositioned them with seedlings in the canals to avoid any stress to the nitrifying bacteria.

Guide to construct the DWC Aquaponics system:

Layout of tunnel, greenhouse, room or outside area for the system:

It is important to plan your Aquaponics system according to space available, enough light as well as access to electricity and water. Wind and insects will damage the plants and ideally, one should try to close the system off. For this article, the plan is to construct the system indoors. In this case, sun would not be a problem for this demonstration unit will make use of red and blue LED lighting to assist with the photosynthesis of the plants. So, in the planning phase, it is important to consider room for openings (doors and hallways) as well as sufficient access to the various parts of the system i.e. draining of waste, feeding and general maintenance and inspection.



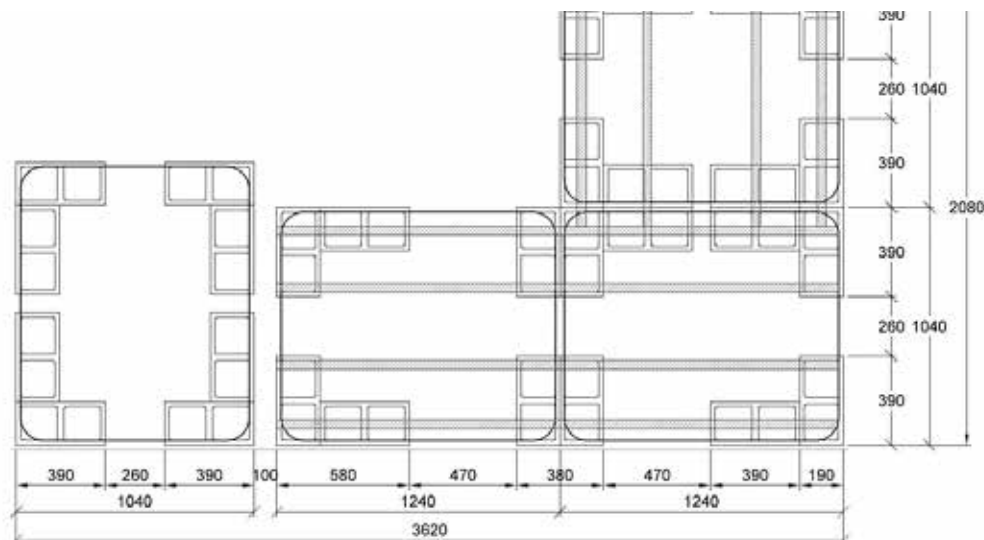


Design drawing to illustrate the layout of the complete system:

Layout of concrete blocks and purlins:

- The three sheets of shutter board must be laid down, 1100mm from northern wall.
- The total number of blocks required is 75. The fish tank will be supported on one layer and blocks and the DWC on three layers of blocks. The radial and biofilter will stand at ground level on the shutter board.
- The best position to start is with blocks for the fish tank. The blocks are layed from the edge of the shutter board on the northern wall side.
- All blocks must be layed out precisely from this point forward according to the measurements and pattern specified below.
- Where it is possible, stagger (overlap) the blocks for additional support
- Once completed, it is time to cut the 38 x 76mm purlins to size. An order can be placed for 6 x 2400mm lengths. You will notice that 4 x 2400mm is 80mm too short according to the dimensions given. This is not a problem for the tanks will slightly overhang 40mm each side over the edges.
- Cut the remaining two purlins in half (2 x 1200mm each) and cut 160mm off each end to get to a length of 1040mm.
- Once complete, space the purlins on its side (38mm side upright) as per plan.

Design drawing to illustrate the layout of the cement blocks and purlins:



CEMENT BLOCK & PURLINS LAYOUT

Construction of fish tank:

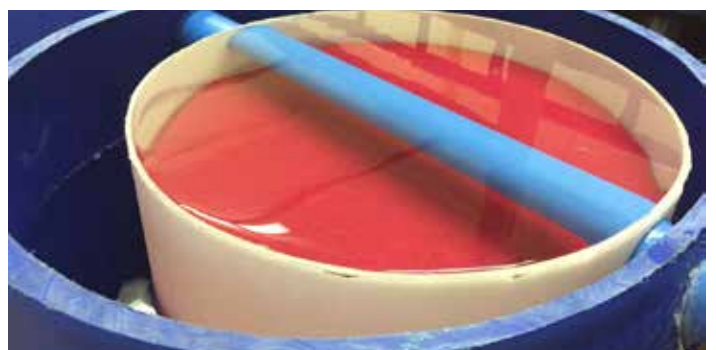
Components required:

To prepare your fish tank, the following list of components would be required

Outlet		
63mm x 2" Adapter Socket (Female Thread)	2	each
63mm Tee-Junction Solvent Socket	1	each
63mm 90° Elbow Solvent Socket	2	each
2" Running Nipple	1	each
50mm Rubber Gasket	2	each
50mm PVC Lock Nuts	2	each
Venturi Inlet		
25mm 90° Elbow Solvent Socket	3	each
40mm T-Junction Solvent Socket	1	each
32mm x 20mm Reducing Bush	1	each
32-25 x 20 Conical reducer	1	each
Waste / Drain		
50 x 1½" Adapter Socket (Female Thread)	2	each
50mm Ball Valve Single Union Solvent Socket	1	each
50mm 90° Elbow Solvent Socket	6	each
50mm T-Junction Solvent Socket	1	each
1.5" Running Nipple	0.5	each
40mm PVC Lock Nuts	2	each
40mm Rubber Gasket	2	each

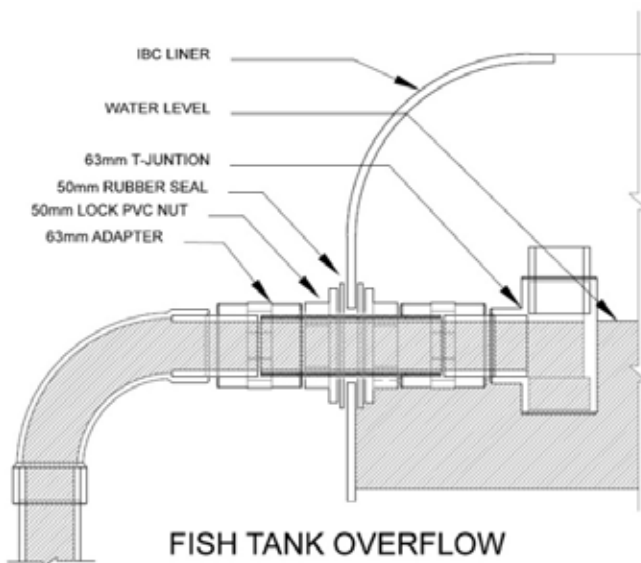
Fish Tank Opening on Top:

- Remove the two horizontal steel lengths attached to the top surface of the IBC tank holding the inner plastic container in place. The steel lengths are fixed with 4 star headed screws. Remove these four screws using a star headed screwdriver.
- Mark a square with a permanent marker on top of the IBC, 150mm from each side of the tank.
- Take a grinder and cut the PVC lining or the tank along these lines.
- Once removed, wash the inside of the container thoroughly with soap (sunlight liquid and warm water) and leave to dry for 24 hours.



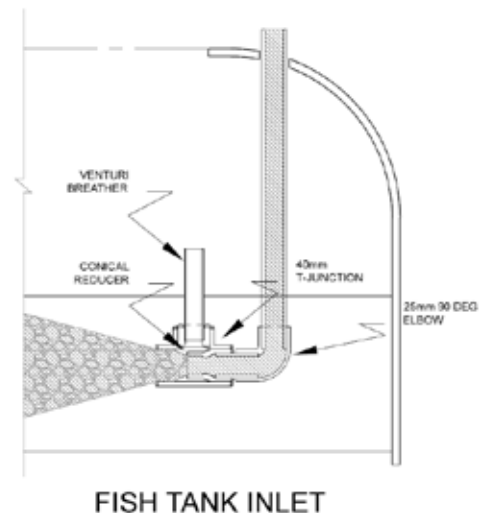
Fish Tank Outlet Construction:

- Take the fish tank and turn it so that the narrow side without the tap faces towards you.
- Take a measuring tape and measure 150mm from the top and 150mm from the right-hand side. Take a permanent marker and make a dot on the plastic liner.
- Drill a 50mm hole with a hole saw through the side of the tank with the dot as your centre.
- Place the 2" threaded nipple through the hole and fasten it to the fish tank with a 50mm rubber gasket and 50mm PVC locknut on each side.
- Put thread tape around the ends of each thread of the nipple and fasten a 63mm x 2" Adapter Socket (Female Thread) on each side of the nipple.
- Take a 63mm PVC pipe and cut three 80mm long tubes with a circular saw.
- Fit the two tubes on each side of the two adapters.
- Once done, on the outlet side, fit a 63mm 90° Slow Elbow facing downwards.
- On the inlet side, fit a 63mm Tee-Junction facing 90° upwards to prevent floating fish food or fish waste going through the outlet.
- Insert the last tube into the T-Junction (see diagram)



Fish Tank Inlet Construction (Venturi):

- Take a 40mm T-Junction.
- Insert a 32-25 x 20 conical reducer into the one end of the 40mm T-Junction as indicated in the diagram.
- It is important that the nose of the conical reducer pass more than halfway into the 40mm T-Junction. If the conical reducer cannot go deeper due to an obstruction in T-Junction, file the edges inside the T-Junction down or alternatively cut a 20mm short piece of pipe into the nose of the conical reducer. It is very important, whatever option you decide that the nose of the conical reducer or small piece of pipe goes past the halfway mark.
- Insert the 32mm x 20mm Reducing Bush into the top of the T-Junction and insert a 30mm breather pipe into the reducing bush. This pipe must be long enough to stick out above the surface of the water.
- For the inlet into the venturi, cut a short piece of 25mm pipe and attach a 25mm 90° elbow. Once done connect the elbow to your 25mm main water inlet and you are good to go.



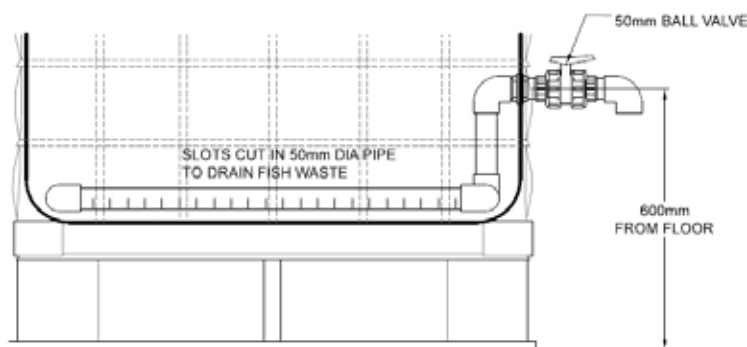
Fish Tank Waste Drain Construction:

It is important to have a drain in your fish tank for two reasons. Firstly, to flush the fish waste that settled on the bottom of the fish tank floor and secondly, to drain the fish tank if needed to do maintenance. It is important to install the ball valve high enough for a bucket to fit. The nozzle of the outlet must be large enough to fit a swimming pool hose to drain the whole tank. The draining tubes inside the tank is in a square, approximately 200mm from each side and slots are cut at the bottom of the tubes for fish waste to drain. Many designs make use of a solid lift overflow (SLO) where fish waste drains through the tank outlet into the radial filter. Personally, I found this method not to be very effective for the water drains too slow and not collecting all the waste. Having a tap to discharge the water at a much greater rate making the draining of waste more effective. Follow these steps in your construction;

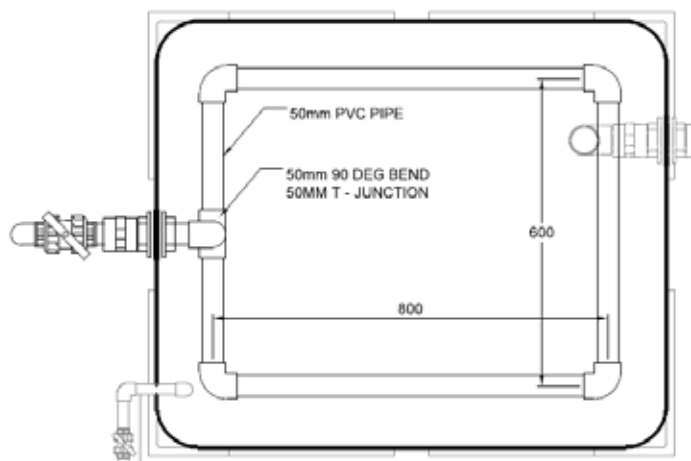
- Cut 5 pieces of tube, 2 x 200mm, 2 x 750mm and one piece of 500mm long.
- Cut the draining slots with a grinder, approximately 50mm apart to the centre of the tubes. We are going to use this a bit later in this exercise.
- The waste outlet gets installed on the opposite side of the fish tank outlet.
- Measure a vertical distance, 600mm from floor level and make a dot centre horizontally on the tank.
- Drill a 40mm hole with a hole saw with the centre as your reference point.
- Take a 40mm (1 ½") running nipple and cut it in half. The other half will be used at a later stage.
- Insert a running nipple and fasten it to a

tank with a rubber gasket and 40mm PVC lock nut on each side.

- Wrap each end of the nipple with threading tape and fasten a 50 x 1½" adapter Socket (Female Thread) on each side.
- Cut three pieces of 50mm PVC tubing, 50mm long and one piece 180mm long.
- Insert the 180mm piece on the tank's inlet sides adapter's socket and a 60mm piece in the socket outlet side of tank.
- On the inlet side, fit a 50mm, 90° elbow facing downwards.
- Take a 50mm T-Junction with stem facing upwards and place it at the bottom of the tank.
- Measure the distance from the inside rim of the elbow to the inside rim of the stem of the T-Junction and cut a piece of 50mm tube to length. Insert tube into the elbow and T-Junction.
- Take the two 220mm tubes and insert on each side of the T-Junction with the draining slots facing downwards and fit a 90° elbow on each side.
- Insert the two lengths of 750mm tubes into the elbows and attach another two elbows at the end. Insert the 550mm tube between the last two elbows to complete the square.
- Please note that in all cases, the slots of the tubing must face downwards.
- On the outside of the tank, insert a 50mm tube into the socket and attach a 50mm ball valve.
- Insert the last remaining piece of 50mm tube on the outlet side of the ball valve and attach an 50mm elbow facing downwards to form the nozzle.



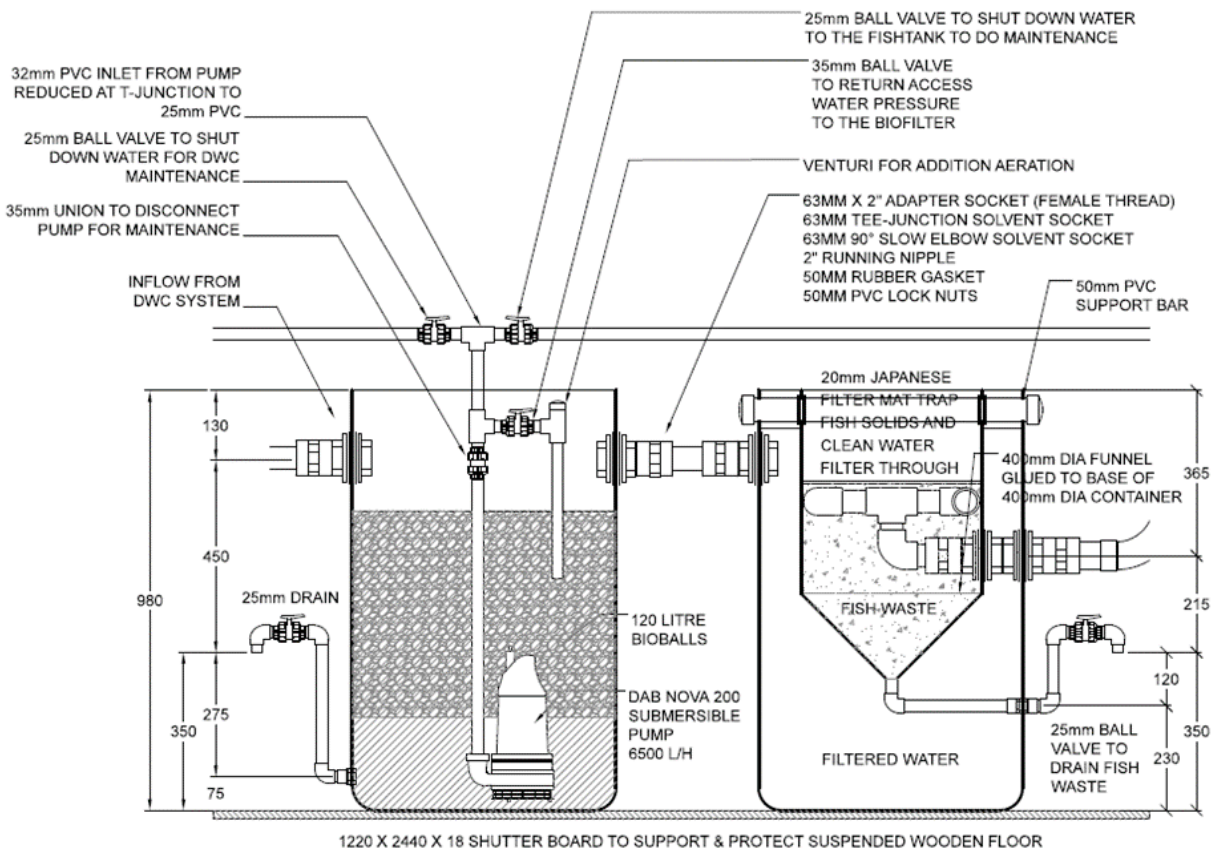
FISH TANK DRAIN DETAIL



Construct the radial filter

A clarifier or radial filter is a dedicated vessel that uses the properties of water to separate particles. Generally, water that is moving slower is unable to carry as many particles as water that is flowing faster. Therefore, the clarifier is constructed in such a way that speed up and slow down the water so that the particles concentrate on the bottom can be removed. In a radial filter, the water from the fish tank enters near the lower middle of the clarifier through a pipe. This pipe is positioned tangentially to the container thereby forcing the water to swirl in a circular motion inside

the container. The centripetal force created by the circular motion of the water forces the solid waste in the water to the centre and bottom of the container, because the water in the centre of the vortex is slower than that on the outside. Once this waste is collected on the bottom, a pipe attached to the bottom of the container can be periodically opened, allowing the solid waste to flush out of the container. The clarified water exits the filter at the top, filtering through a secondary mesh filter, and flows from the outer container into the biofilter. The solid wastes trapped and removed contain nutrients and are very useful for the system or for garden plants in general.



BIOFILTER AND RADIAL FILTER



Components Required

The following components are required to construct the radial filter.

MAIN COMPONENTS		
210 Litre PVC Drum	1	unit
350mm diameter funnel	1	unit
A bucket or drum's bottom that can fit in the funnel	1	unit
Japanese Filter Mat	1	unit
INLET		
63mm x 2" Adapter Socket (Female Thread)	2	each
63mm Tee-Junction Solvent Socket	1	each
63mm 90° Elbow Solvent Socket	3	each
50mm Solvent Cap	2	each
2" Running Nipple	1	each
50mm Rubber Gasket	4	each
50mm Lock Nuts	4	each
WASTE / DRAIN		
32mm x 1" Adapter Socket (Female Thread)	2	each
25mm Ball Valve Single Union Solvent Socket	1	each
25mm 90° Elbow Solvent Socket	4	each
1" (25mm) Running Nipple	1	each
25mm Rubber Gasket	2	each
25mm PVC Lock Nuts	2	each
OVERFLOW		
63mm x 2" Adapter Socket (Female Thread)	1	each
2" Running Nipple	1	each
50mm Rubber Gasket	2	each
50mm PVC Lock Nuts	2	each



Construction of the Radial Filter:

- Cut the tapered nozzle of the funnel shorter & shorter until a 25mm PVC pipe fit snug in the shortened nozzle.
- Take the bucket and turn it around so that the bottom facing upwards.
- Take the funnel and place it upside down within the rim of the bottom of the bucket and draw a circle.
- Cut circle with a grinder and once done and glue it to the bucket with PVC Weld.
- Make inlet hole in side of bucket a third down from the bottom.
- Build swirl system with 63mm pipes and one 90° Bend (showing down), T-junction + 2 Bends
- Cut 2nd lid round and cut also holes to let water through (tight fit).
- Drill the bottom of bucket full of holes. Glue it in such a way that you can take it apart.
- Place scouring sponge on top or netting.
- Clean water overflow bucket into drum.
- Outlet of 210L drum must be 150mm lower than edge of bucket.



Construct the Biofilter:

Biofiltration is the conversion of ammonia and nitrite into nitrate by living bacteria. Most fish waste is not filterable using a mechanical filter because the waste is dissolved directly in the water, and the size of these particles is too small to be mechanically removed. Therefore, to process this microscopic waste an aquaponics system uses microscopic bacteria. Biofiltration is essential in aquaponics because ammonia and nitrite are toxic even at low concentrations, while plants need the nitrates

to grow. In an aquaponics unit, the biofilter is a deliberately installed component to house most of the living bacteria. Furthermore, the dynamic movement of water within a biofilter will break down very fine solids not captured by the clarifier, which further prevents waste build up on plant roots in NFT and DWC.

Construct the DWC Canals:

Components Required:

To prepare the outlet of the DWC canals, the following list of components would be required:

Water Outlet		
32mm x 1" Adapter Socket (Female Thread)	6	each
50mm x 25mm Reducing T-Junction Solvent Socket	3	each
50mm 90° Elbow Solvent Socket	5	each
50mm T-Junction Solvent Socket	1	each
50 x 1½" Adapter Socket (Female Thread)	1	each
1.5" Running Nipple	0.5	each
40mm PVC Lock Nuts	2	each
40mm Rubber Gasket	2	each
1" (25mm) Running Nipple	1.5	each
25mm Rubber Gasket	6	each
25mm PVC Lock Nuts	6	each
Water Inlet		
25mm Ball Valve Single Union Solvent Socket	3	Each
25mm T-Junction Solvent Socket	3	each
25mm 90° Elbow Solvent Socket	12	each

Cutting the IBC Tanks:

- Remove the two horizontal steel lengths attached to the top surface of the IBC tank holding the inner plastic container in place.
- The steel lengths are fixed with 4 star headed screws. Remove these four screws using a star headed screwdriver. Once the steel lengths are removed, pull out the inner plastic tank.
- After pulling out the tank, it is recommended to paint the outer surface of the IBC liner black to prevent algae from forming.
- Remove also the metal base by removing the screws. If there is no star key, cut the screws with an angle grinder.
- Cut the vertical metal bars above the 2nd horizontal framing with a grinder (see picture). The beds won't be exactly

even, one side will be slightly higher than the other side, but it makes very little difference in the actual system.

- Once you have all the bars cut, you'll have to cut the plastic. Use the frame as your guide and draw with a permanent marker around the IBC. Then, using the angle grinder, cut along the line and remove the cut piece from the top.

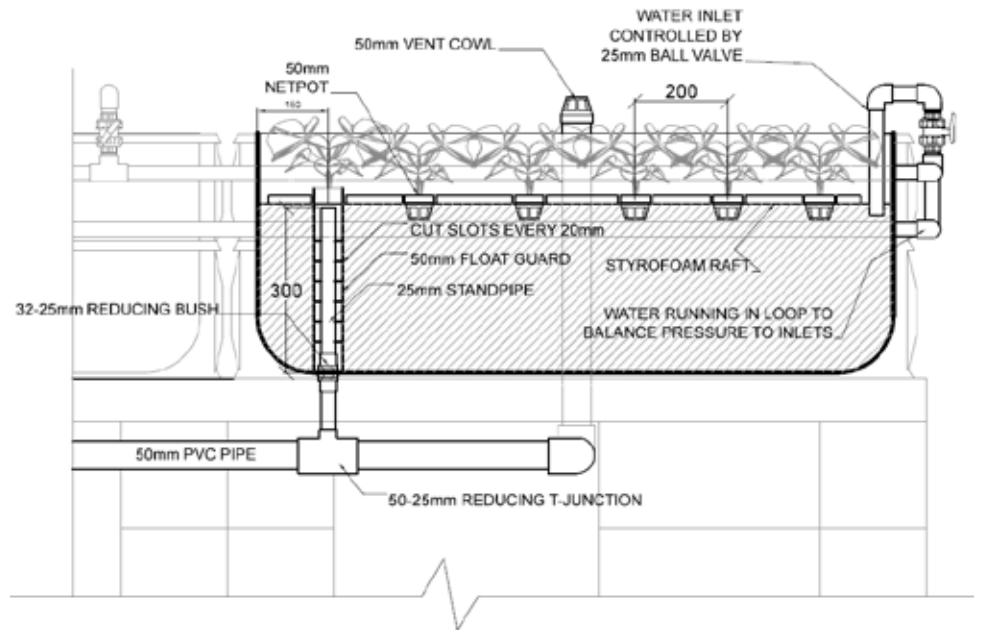


- Once removed, wash the inside of the container thoroughly with soap and warm water and leave to dry for 24 hours.

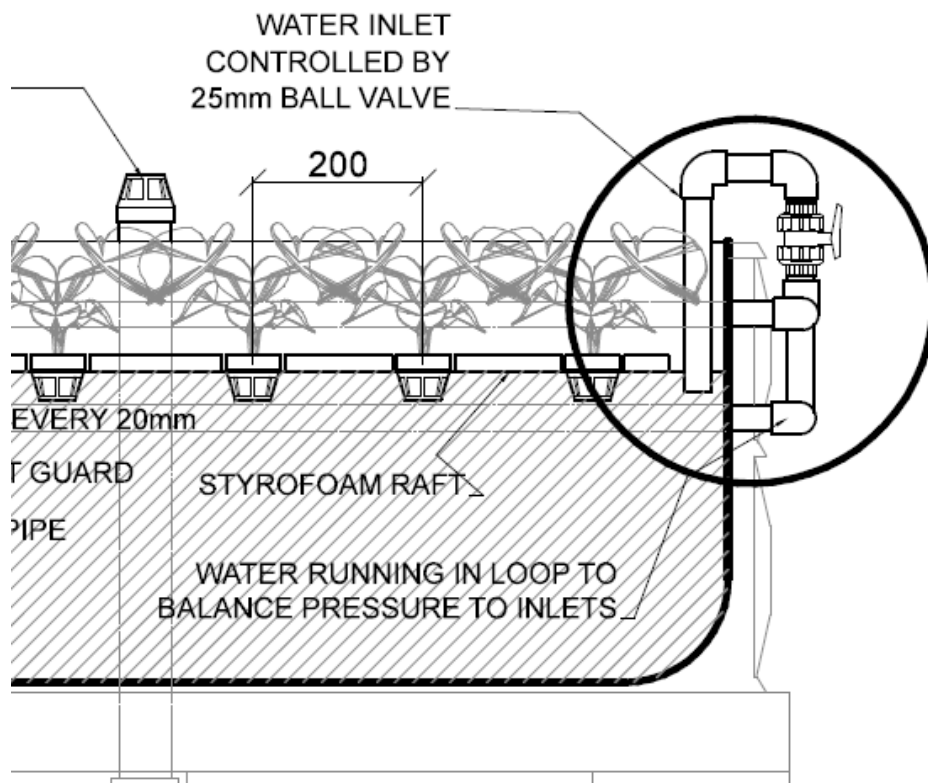
Since you need three DWC channels as per our design, follow the same steps with the other IBC. Once completed place the DWC channels on the purlins to ensure that everything lines up. Ensure that you have enough clearance for your plumbing (see diagram "Plumbing Layout") and if need to, move the necessary blocks or purlins to ensure sufficient clearance

Construction of the Water Outlets:

The water of a DWC canal overflows into a 25mm x 300mm standpipe. A 320mm x 50mm piece of pipe with draining slots goes over the standpipe and is long enough to go through the raft to the surface to prevent the raft blocking the standpipe. The standpipe drains into a 50mm pipe which in turn returns all the water from the interconnected canals back to the biofilter. At the end of the first and last canal is a vent pipe which prevents airlocks forming in the drainage pipe.



Design drawing to illustrate the construction of the DWC grow beds:



INSIDE THE CANAL:

- Measure 150mm from the side of the canal centre across the width of the canal as indicated in the diagram above. Mark a dot at the bottom with your permanent marker.
- Drill a 25mm hole in with a hole saw and lightly sand down the edges to remove the fluff.
- Cut a 25mm running nipple in half (keep other half to use on another canal) and place it in the hole.
- Place a rubber gasket on either side and fasten the running nipple with 25mm PVC locknuts.
- Attach a 32mm x 1" Adapter Socket (Female Thread) on either side.
- Inside the tank, insert a 25mm PVC pipe in the adapter and measure the vertical distance of 300mm from the bottom of the tank. Mark this length and cut three standpipes to size (additional two for the other two canals).
- Once inserted, cut a 320mm piece of 50mm PVC pipe. Cut slots 15mm deep into the pipe at 20mm. Once completed, place the float guard over the 25mm Standpipe.

BELOW THE CANAL:

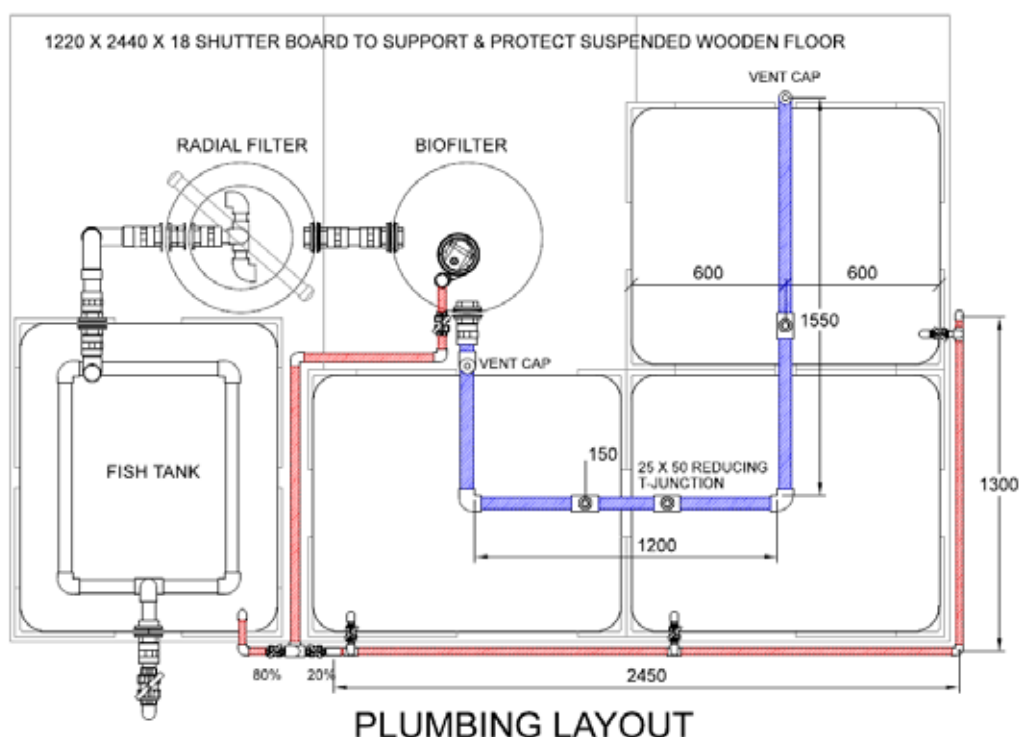
When designing a system using gravity flow, it is very important that drainage pipes must

run at a slight angle, usually a minimum of 1mm for every 100mm (1: 100) of length to the lowest point. In our case, our water levels balance out on atmospheric pressure on the surface of the water. The water levels in the canals are higher than the 50mm outlet in the biofilter thus trying to balance out the water levels by forcing the water out.

- Cut three lengths of 25mm pipe 100mm long and insert one length into the bottom adapter. The other two is for the other tanks.
- Attach a 50mm x 25mm Reducing T-junction Solvent Socket to the 100mm pipe. Do the same for all three tanks with the 50mm sockets of the T's following the run of the drainage pipe (see previous diagram).
- Once done measure the distance between the shoulders of the reducing sockets and add 25mm either side to compensate for the insertion of pipe into sockets on either side.
- In canal 1, insert a T-junction in line with the biofilter and cut a piece of 50mm pipe after measuring the distance between the head of the T-junction and the socket of the biofilter.

Construction of Water Inlets:

The water is pump via a 32mm PVC pipe from the biofilter and the flow split into a T-Junction, 20% to the DWC canals and 80%



to the fish tank. This difference in flow in the two directions gets controlled by two 25mm ball valves sitting either side of this T-Junction. On the DWC side, the pipe splits into a loop with two pipes running the length of the canals and meet again at the end to close the loop. Building a loop is important for it balances the water pressure equally over the three outlets of the canals. Each outlet of the three outlets also has its own ball valve to shut down the flow for an individual canal to do maintenance. You probably noticed that the canals don't have bottom drains? It's very simple, just pull the standpipes and the water will drain.

CONSTRUCTING THE LOOP:

Looking at the diagram, "Plumbing Layout" previously you will see "20%". This is the position where your loop will start. The next steps will guide you construct your loop.

- Looking at the diagram, the approximate length of the loop is 2450mm & 1300mm. It is very; very important to verify these distances on site before cutting these lengths of pipe for it might cost you to buy a whole six-meter length. It is strongly advisable to cut these lengths of FIRST before any other cuttings because the "off cuts" can be used to make up standpipes, short joints between components etc.
- Cut lengths of pipe:
- Two lengths of approximately 2450mm (to be verified on site)
- Two lengths of approximately 1300mm (to be verified on site)
- Best position to start is in the bottom right hand corner of the diagram (IBC 2) where the loop makes a 90-degree turn.
- Install two, 25mm x 90° elbows into the two pair of lengths.
- Now we move to the top right-hand corner of the loop. Cut a 100mm piece of 25mm pipe and insert two 25mm x 90° elbows on each side of the 100m pipe. The openings of the two elbows must face the same direction.
- Insert the two lengths of 1300mm pipe into the sockets of the 25mm x 90° elbows
- Connect two, 25mm x 90° elbows on the other end of the two 1300mm lengths and now connect the two 2450mm lengths.
- The piping might become flimsy to handle

so it is advisable to tie the plumbing to the cages with cable ties.

- On the top 2450mm length, insert a T-junction with the stem facing downwards.
- Insert a 100mm piece into the stem of the T-junction and now complete the loop by joining the 100mm pipe and the bottom 2450mm pipe with an elbow.

FITTING THE BALL VALVES:

- Cut in a T-junction into the top pipe lengths, 150mm from the IBC's side in the positions as indicated on the plan. The stems of the T-junctions must face upwards.
- Insert a 30mm long piece of pipe into the stem and fit a 25mm ball valve with the tap handle facing outwards.
- Insert another 30mm piece of pipe on the other end of the ball valve and fit a 90° elbow facing towards the canal.
- Cut a 100mm piece of pipe and insert it into the elbow. Fit another elbow on the other side of the 100mm tube facing downwards.
- Cut a 250mm pipe and insert into the down facing elbow to complete the tap.

Plumbing the Water Pump:

The pump is situated in the biofilter which also serve as a sump. This is the lowest point to which water of the system drains and from here, the water gets pumped into the two directions (fish tank and DWC). Although the system only requires a circulation rate of 2900 litre per hour, the pump has the capacity to circulate 6000 litres of water per hour. The reason for an oversized pump is to cater for future expansion.

It is not a good idea to put strain on a pump by closing the relevant valves to get the desired flowrate throughout your system. Therefore, it is important to provide some form of relieve by installing a "back pressure" pipe to return the access water to the sump. Since the biofilter bacteria require dissolved oxygen (DO) for the nitrification process, it is advisable to fit a Venturi to this back-pressure pipe. A valve is also installed to control the flow of water. If you consider expanding your system at a later stage, the valve can be adjusted to provide additional flow of water when required.

Components Required:

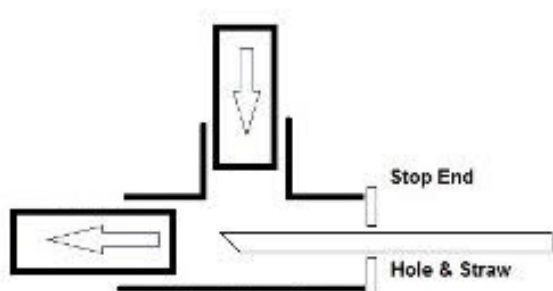
The following components are required to plumb the pump and connecting it to the canals and fish tank.

PLUMBING & COMPONENTS REQUIRED		
32mm x 2" Male Adapter (To fit Pump)	1	each
25mm Ball Valve Single Union Solvent Socket (80%, 20%)	2	each
32mm Ball Valve Single Union Solvent Socket (Back Pressure)	1	each
32mm Double Union (Pump Maintenance)	1	each
32mm x 25mm Reducing Bush	2	each
32mm T-Junction Solvent Socket	2	each
32mm 90° Elbow Solvent Socket	3	each
32mm PVC Pipe	6	m

Commissioning of Plumbing on Water Pump:

- Attach the 32mm x 2" Male Adapter to the pump outlet.
- Cut a length of 32mm pipe, 600mm long and glue it to the adapter (Yes, glue).
- Glue the union to the other end. The reason we install a union is to disconnect the pump from the plumbing when needed for maintenance purposes.
- Cut a piece of 32mm pipe, 30mm long and glue the one end into the union and the other end into a 32mm T-junction with the stem facing to the right.
- Cut two pieces of 32mm pipe, 30mm long and insert it into the stem fitting a 32mm ball valve on the other side and the other 30mm pipe on the other side of the ball valve.
- Take another 32mm T-junction which will form part of your Venturi and insert the stem into the 30mm pipe.

- Fit a 32mm cap to the upright end of the T-junction and drill a 5mm hole in the cap. Insert a straw in the whole and push it down until the end of the straw is 2/3s passed the diameter of the stem.
- Cut a 300mm piece of pipe and insert it into to the other end of the Venturi to complete the back-pressure line.
- With regards to the 1st T-Junction, plumb it all the way using 32mm elbows and different lengths of 32mm pipe until the place where the DWC and Fish Tank 25mm lines meet.
- Connect the stem of the 32mm T-junction to the pump line.
- Insert 2 x 32mm x 25mm Reducing Bushes on either side of the 32mm T-junction.
- Cut two 40mm long, 25mm pieces pipe and insert it into the reducing bushes.
- Connect the two "80%/20%" 25mm ball valves on either side of this 32mm T-junction and connect the fish tank and DWC lines.



Conclusion:

If all the components of the system are connected, the system is completed. It is important to test run the system for a week before you add the fish. During this time, possible leaks can be identified and fixed. Adjust the water flows in your system to get a good water level balance in the system. The fish can now be stock at a stocking density of

20 to 25 kg per m³. They will still grow bigger which will increase the biomass in the fish tank over time. The bacteria in the biofilter normally takes approximately 1 to 3 months to mature. This process can be kick started by inoculating the bacteria culture with commercial available products. After the stocking of the fish, the seedlings can be planted in the net pots. The lettuce seedlings normally take 4 weeks to reach a marketable size. It is very rewarding to harvest your own fresh leafy greens and you will get much satisfaction out of your own aquaponics system.

Sources:

- Mansomthombo - DWC Aquaponics Demonstration System: Installation Manual
- Design drawings – Japie Muller
- Aquaponics System Pictures – FAO Technical Paper 589, Small-scale aquaponic food production

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