Low-Cost Aquaponics

www.upper-yarra-aquaponics.com

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Introduction: I put together this document upon request, when some interest was expressed regarding documenting a simplified aquaponics system for extremely low cost deployment. This was suggested as a demonstration of the potential viability of aquaponics in remote locations with little infrastructure – particularly aimed at developing or unstable countries. This is in no way a detailed explanation of aquaponics, and is intended as a practical guide to encourage people to get started.

Objective: I aim to present a simple model for a viable, low-cost, semi-mobile aquaponics system that draws 0.12kWh - suitable for remote powering. This will be presented in a manner that aims to make it achievable for people in developing nations. This system is built by repurposing existing products, acquired either locally or internationally. When the water and medium is removed, this system fits into any car, with the stackable plastic grow beds on the roof (approx. 1.1metres high).

Assumptions: Although aquaponics can be adapted to a variety of conditions, care must be taken in regards to a wide range of environmental factors. For example:

- Different climates lend themselves to different species selection for aquaponics systems. Often species cannot be grown successfully in climates outside their native regions without the use of expensive heating or cooling. This is equally true for fish and edible plants.
- Different culinary traditions prefer different species.
- Aquaponics systems increase in efficiency over time, and continue to do so for more than a year before they reach full potential. Starting a new system from an old system can help reduce this time, by providing an existing bacterial population. Aquaponics is based on helpful bacteria.
- Although this system is considered “non-toxic”, some components have not been rated “Food Safe” – e.g. pool liner.

Products and countries variously use metric or imperial measurements. I use them interchangeably. Freight costs are not included in costings. Group buying or buying many items from the one merchant is encouraged to reduce costs. Water proofing of power sources is paramount, but assumed.

The art of aquaponics covers a wide range of sciences such as physics, engineering, chemistry, and biology. The better that one is educated in these areas, the more efficient the aquaponics system will be.

Materials: These materials can be acquired in a number of ways – sometimes locally is cheapest, sometimes international delivery is cheapest. To get an eBay and PayPal account, you need a bank account, an email address, and a postal address. These details are then verified. When you then purchase something on eBay, the money comes out of the bank account, goes to PayPal, who then pays the manufacturer. The item is then posted to your postal address.

As of the date of this document, many of the following products were available on eBay, for worldwide delivery, at the prices stated:

- **Intex 10' x 30" Metal Frame Pool:** 4500ltrs, 68cm water depth. These frames are extremely sturdy, and the lining will stand up to years of *normal aquaculture* use. I can personally vouch for them. **$US150 each**

7kg

- **9x 300ltr (80gal) plastic cattle trough:** These can be expensive, or cheap – depending on how you get them. Make them all the same (stackable). **$US??**

- **3x 4500lph (1200gph) Multifunction Pond Pumps:** Chinese pumps that are available all over the world. Often named JT JHQ-4500. Cheap and reliable. **$US50 each**

3kg each

- **2x P3 International P7880 LED Bug Trap:** Feed your fish night-time flying insects.**$US20 each**

0.3kg

- **3x 25mm (1”) Antelco Barbed Valves:** Water tight. **$US5 each**

0.1kg

- **15metres of 13mm (1/2”) and 30metres of 25mm (1”) LDPE irrigation pipe:** Cheap and durable. **$US40 lot**

- **8 outlet power board with timer:** Cheap and reliable. **$US30**

0.35kg

Method:

1. **Early Seedlings:** Prepare and plant your seeds and seedlings well in advance. This will give them a head-start for when you eventually get the system working.
2. **Location:** Prepare a flat, 4mX4m area. Remove as many twigs and stones as you can.
3. **Base:** Cover the ground with a soft, organic under-layer, 10mm deep – cardboard, canvas or dried grass will do.
4. **Base:** Cover the 10mm under- layer with a 4mx4m waterproof tarp. Secure the tarp so that it is flat and won’t move.
5. **Fish Tank:** Very carefully assemble the pool, as per included instructions, centred perfectly on the 4mX4m tarp, and fill with the cleanest water available. Setup the included pump as per instructions – but remove the filter and throw it away. This pump is providing water movement and will cause the water in the pool to spin in a slow whirlpool. This pump should be powered 24/7 if possible. Remove any pegs or tarp weights and store them away from the pool.
6. **Insulation/Reinforcement/Protection:** Once the fish tank is full and the pump is working, place the cover over the pool. Move the pump as far away from the pool as possible, while still connected and running. Slowly and carefully pack *fine soil or damp sand* all the way

around the fish tank, right up to the maximum water level (70cm). *Don't puncture the lining*. This should be at least 2 cubic metres of earth. Retaining walls are not required. Upon completion, stepping stones should be dug into the base of the dirt to access the fish tank more easily. Replace the pump to as near to the tank as possible

7. **Earth mounds/Grow bed support:** Construct a large mound of heaped earth to support the grow beds. This mound should be 10cm higher than the maximum water level (80cm high), at least 10 metres long, and curved around the fish tank. It should be densely packed with a flattened top. This could be over 15 cubic metres of earth if done without retaining walls.
8. **Grow beds:** Place the 9 cattle troughs on the curved earth mound. Ensure they are flat, and as close to the fish tank as can be achieved. Remove the pool cover.
9. **Grow beds:** We need 3 groups of 3 grow beds for our 3 pumps. We will connect grow bed #2 to grow bed #1 and #3, grow bed #5 to grow bed #4 and #6, and grow bed #8 to grow bed #7 and #9.
10. **Grow beds:** Burn/melt a perfect 24mm hole (use heated metal), in the wall of the trough, a few mm from the bottom, into *both* sides of the *centre* bed in each group (two opposite holes, in 3 separate troughs). Burn/melt a *single*, perfect 24mm hole on each *adjacent* trough (1 hole, in 6 separate troughs). Force the 25mm pipe into the 24mm hole, and connect the troughs into 3 groups of 3.
11. **Grow beds:** Burn/melt a perfect 12mm hole in an *end trough* in each group, in the wall, a few mm from the bottom, as close to the fish tank as possible. Force the end of the 13mm pipe into the 12mm hole. Run the shortest possible length of pipe from the each of the three troughs to the fish tank. Cut the return above the water line, so that the water splashes back into the fish tank. These are the 3 main drain lines.
12. **Grow beds:** Burn/melt a perfect 24mm hole, 400mm directly above the last 12mm hole, in each of the same 3 troughs. Force the 25mm pipe into the 24mm hole. Run the shortest possible length of pipe from each trough to the fish tank. Cut the return above the water line, so that the water splashes back into the fish tank. These are the 3 main overflow lines.
13. **Grow beds:** Fill all 9 grow beds with 12mm-25mm diameter stones/gravel ("grow medium") – the lighter the better (volcanic pumice/scoria works best) - but as long as they don't pack down too tightly, and are not contaminated, any stones/gravel will do. Fill the beds to 10mm above the 25mm overflow pipe (approximately 415mm deep total).
14. **Pumps/Inlets:** Connect 25mm pipe to the 3 pumps, submerse the pumps in the fish tank, and space them out. Run the shortest possible length of 25mm pipe from the pump to the top of the *opposite bed from the return/drain bed,* in each of the 3 groups. So, inlet bed #1 drains into middle bed #2 which drains into the outlet/return bed #3, which overflows into the fish tank. Attach a 25mm Antelco barbed valve to the end of each inlet of the 3 tubs, with the water flow coming from about 25mm above the medium, and splashing down. Leave the valve 100% open.
15. **Pumps/cycling:** Connect the pumps to the power board with timer. Set each pump to run for 15 mins, one after the other. After the third pump has cycled for 15 mins, leave 15 mins with no grow bed pumps on. This makes for a one hour cycle.
16. **Water cycle balancing:** Watch the grow beds begin to fill. If the pump completely overflows the grow beds (onto the ground) within its 15min cycle, you must close the Antelco valve a little, until it stops. The system is balanced if the maximum water level is held constant by the combined overflow of the 13mm and 25mm return lines. When the timer switches off,

the beds will drain to empty. If the pump cannot reach the 25mm overflow in the 15mins, simply add another 15mins to each pump so each bed fills for 30mins in turn, with no pause. Leave running forever. Adjust as necessary. The water will turn dirty from the grow medium.

17. **1st Planting:** Plant the grow beds sparsely with only 5-10 established seedlings each.
18. **Insect Feeding:** Remove the catcher from the rear exhaust of the LED Bug Trap. Securely suspend the device over the fish tank, with the exhaust pointing at the water surface from around 120mm away and plug it into the power board with timer. Set the timer to come on at sunset for two hours, and again 30mins before sunrise for 2 hours. The effectiveness of this will vary throughout the seasons, but over a year an enormous amount of fish food and fertilizer can be gathered this way, for free. Hungry fish learn quickly. You can feed supplementally as needed.
19. **Cycling:** One healthy human should urinate in the fish tank, once daily, for a week. From this point the water is not safe for humans to touch for another 3 weeks (4 weeks from 1st planting). Leave the system cycling like this for another week (2 weeks from first planting). This is all about kick-starting the ammonia-loving bacteria.
20. **Testing:** Take two small healthy fingerlings, and place them in the tank. If they show no signs of illness after 24hrs, you can begin adding more fish, up to 500 fingerlings. If the fish do show illness, do not add more fish until they appear to recover. If they die, you need to wait another week, and then repeat Step 19.
21. **2nd Planting:** Once you have your fingerlings in the system, plant out the grow beds to maximum density with seedlings. These plants will likely struggle initially. Plant seeds all over the surface of the grow beds around the seedlings. This 3rd planting will likely thrive.
22. **Operating:** Monitor the feeding of your fish and ensure they are getting enough food. Strong flow and splashing water are the keys to a good system. Always keep the grow beds heavily stocked with plants at all stages of growth, and eat it as it produces. Always plant, always harvest. Treat it like a living food store. You can keep adding cattle trough grow beds and pumps until you have 6300ltrs of cattle troughs (21)!! Just make sure you share the water around evenly, and add some extra water as well! Stagger your power timers!!
23. **Harvesting fish:** Your fish will grow at all different rates. Once the largest reaches edible size, eat it! Then the next biggest and next biggest, until 75% are gone. Then restock with 500 fingerlings behind a fine net, and eat the other 25%. Remove the net and start again!

Any system will take at least 6 months to reach productivity. With the right operator, dedication, location and feeding rates, this system could reliably produce up to 300kg of fish and 2 tons of edible plants in the first 18months, and then every 12 months. If the system was expanded to 21X 300ltr grow beds, it could reliably produce up to 450kg fish and 4 tons of edible plants a year. This does not include the potential for using floating rafts on the water surface also, however I have omitted this addition for oxygenation reasons. If properly treated, I would expect this system to last anywhere from 3-6 years.

Good luck, and remember – you cannot just build an aquaponics system. You have to grow one.

Adam

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