Aquaponic Gardening Rules of Thumb

I had the distinct honor of collaborating with Dr. Wilson Lennard from Australia on these guidelines for beginning aquaponic gardeners. Dr. Lennard has earned one of the few PhDs in aquaponics in the world, and he currently runs a consulting practice called Aquaponic Solutions. These guidelines have also been reviewed and endorsed by Murray Hallam of Practical Aquaponics, and the “Aquaponics Made Easy” and “Aquaponics Secrets” videos, and been vetted by the Aquaponic Gardening Community.

Nothing we say below is set in stone and there are exceptions to almost every one of the listed rules-of-thumb given certain conditions. However, they do offer a set of generally accepted principles that, if adhered to, will put you on the path towards successful aquaponic gardening.

- **System Design**
  - Media bed is recommended for new, hobby growers. Why not NFT or Deep Water Culture (AKA raft or DWC)?
    - A media bed performs three (3) filtering functions;
      - mechanical (solids removal)
      - mineralization (solids breakdown and return to the water)
      - bio-filtration
    Because the media bed also acts as the place for plant growth, it basically does everything all in one component – making it all simple.
  - Media also provides better plant support and is more closely related to traditional soil gardening because there is a media to plant into.
  - The cost of building the system is lower because there are fewer components.
  - It is easier to understand and learn.
  - Basic Flood and Drain is the simplest system to design and is appropriate for a 1:1 grow bed to fish tank volume.
  - CHOP or 2-Pump systems have sump tanks and enable a 2:1 and even up to a 3:1 grow bed to fish tank ratio. More grow beds filtering the water is generally better for the health of the fish.

- **Steps for Planning your System**
  1. Determine the total grow bed area in sq ft (or sq m)
  2. From grow bed area, determine the fish weight required (pounds or kg) using the ratio rule 1 lb (.5 kg) of fish for every 1 sq ft (.1 sq m) of grow bed surface area, assuming the beds are at least 12” (30 cm) deep.
  3. Determine fish tank volume from the stocking density rule above (1 pound fish per 5 – 7 gallons of fish tank volume or 1 kg per 40-80 liters). When your fish are young and small, reduce the number of plants in proportion to the size of the fish and their corresponding feed rate / waste production.
**Grow Bed and Fish tank**
- Start with a 1:1 ratio of grow bed volume to fish tank volume. You can increase that up to 2:1 once your system starts to mature (4 – 6 months) if you want to.
- Must be strong enough to withstand the lateral and downward forces of the media, water, and plant roots
- Must be made of food safe materials and should not alter the pH of your system
- **Grow Bed**
  - Should be at least 12” (30 cm) deep to allow for growing the widest variety of plants and to provide complete filtration.
  - Be sure to create or purchase a media guard to facilitate easy cleaning of your plumbing fittings.
- **Fish tank**
  - If you have flexibility here, 250 gallon (1000 liters) or larger seems to create the most stable aquaponics system. Larger volumes are better for beginners because they allow more room for error; things happen more slowly at larger volumes.
  - You need at least a 50 gallon volume to raise a fish to 12” (“plate size”)

**Plumbing**
- You should flood, then drain your grow beds. The draining action pulls oxygen through the grow beds. The least complicated way to achieve a reliable flood drain system is using a timer. While more complex, siphons are also excellent options for aquaponics.
- If you are operating your system with a timer you should run it for 15 minutes on, and 45 minutes off.
- You want to flow the entire volume of your fish tank through your grow beds every hour if possible. Therefore, if you are running your pump for 15 minutes every hour (see above), and you have a 100 gallon tank, you need at least a 400 gallon per hour (gph) pump. Now consider the “lift” or how far against gravity you need to move that water and use the sliding scale that is on the pump packaging to see how much more power you need beyond the 400 gph.

**Media**
- Any media you select
  - Must be inert – i.e won’t alter the pH of the system
  - Must not decompose
  - Must be the proper size (1/2” – ¾” aggregate is optimal)
- The most widely used media types are LECA (Lightweight Expanded Clay Aggregate, AKA Hydroton), Lava Rock, Expanded Shale, and Gravel.
- If you choose gravel, understand it’s source and avoid limestone and marble as they could affect your pH.

**Water**
- **Purity**
  - Be sure to “off gas” chlorine from your water before adding it to your system
- **Temperature**
- If possible, select fish that will thrive at the water temperature your system will naturally gravitate towards
- It is easier to heat water than it is to cool it
- Attract heat by using a black tank or making it black
- Retain heat through insulating techniques

  - **Oxygen**
    - Dissolved oxygen levels for fish must be above 3 ppm, and preferably above 6 ppm
    - You cannot have too much oxygen in an aquaponics system

  - **pH**
    - Target a pH of 6.8 - 7.0, in your aquaponic system. This is a compromise between the optimal ranges of the fish, the plants, and the bacteria.
    - Test pH at least weekly, and as frequently as 3 – 4 times per week, using your API Freshwater Master Test Kit.
    - During cycling pH will tend to rise.
    - After cycling your systems, pH will probably drop on a regular basis and require being buffered up. If you need to lower pH it is generally because of the water source (such as hard ground water) or because you have a base buffer in your system (egg shells, oyster shell, shell grit, incorrect media).
    - Best method for raising (buffering) pH if it drops below 6.6
      - Calcium hydroxide – “hydrated lime” or “builder’s lime”.
      - Potassium carbonate (or bicarbonate) or potassium hydroxide (“pearlash” or “potash”).
      - If possible, alternate between these two each time your system needs the pH raised. These also add calcium and potassium, which your plants will appreciate.
      - While they work, be cautious about using natural Calcium Carbonate products (egg shells, snail shells, sea shells). They don’t do any harm, but they take a long time to dissolve and affect the pH. So, you add it, check pH two hours later and nothing has changed, so you add more. Then suddenly, the pH spikes because you have added so much.
    - Best methods for lowering pH, in order of preference, if it goes above 7.6
      - pH Down for Hydroponics- (be careful of using the aquarium version as this has sodium that is unhealthy for plants).
      - Other hydroponic acids like nitric or phosphoric as the plants can use the nitrate or phosphate produced.
      - Other acids, such as vinegar (weak), hydrochloric (strong), and sulphuric (strong) – last resort as directly adding these acids to your system could be stressful for your fish.
    - Avoid adding anything to your system containing sodium as it will build-up over time and is harmful to plants.
    - Do not use citric acid as this is anti-bacterial and will kill the bacteria in your bio-filter.

  - **Fish**
o Stocking Density
  - 1 pound of fish per 5 – 7 gallons of tank water (.5 kg per 20-26 liters)

o Fish selection should take into account the following
  - Edible vs. ornamental
  - Water temperature
  - Carnivore vs. omnivore vs. herbivore
  - Oxygen needs

o When introducing new fish into your system
  - Be sure your system is fully cycled
  - Match pH
  - Match temperature

o Feeding Rate
  - Feed your fish as much as they will eat in 5 minutes, 1 – 3 times per day. An adult fish will eat approximately 1% of its bodyweight per day. Fish fry (babies) will eat as much as 7%. Be careful not to over feed your fish.
  - If your fish aren’t eating they are probably stressed, outside of their optimal temperature range, or they don’t have enough oxygen.

- Plants
  o Avoid plants that prefer an acidic or basic soil environment. Otherwise just about any plant can be grown in an aquaponics system
  o Plants can be started for aquaponics the same way they would for a soil garden – by seed, cuttings or transplant
  o If your plants are looking unhealthy after the first few months it is probably for one of two reasons
    - Nutrient imbalance caused by out of range pH - Maintain pH between 6.8 and 7.0 for optimal nutrient uptake by your plants
    - Insect pressure

- Worms
  o Add a handful of composting red worms to each grow bed once your system is fully cycled and fish have been added.

- Starting your System or “Cycling”
  o Cycling with Fish
    - Add only ½ as many fish as you would to be fully stocked
    - Test daily for elevated ammonia and nitrite levels. If either gets too high do a partial water exchange.
    - Feed once per day or less to control ammonia levels.
  o Fishless Cycling
    - Sources of ammonia
      - Synthetic - pure ammonia and ammonium chloride
      - Organic – urine and animal flesh
    - The process
      - Add the ammonia to the tank a little at a time until you obtain a reading from your ammonia kit of ~5 ppm.
      - Record the amount of ammonia that this took, and then add that amount daily until the nitrite appears (at least 0.5 ppm). If ammonia
levels exceed 8 ppm stop adding ammonia until the levels decline back down to 5 ppm

- Once nitrites appear, cut back the daily dose of ammonia to half the original volume. If nitrite levels exceed 5 ppm stop adding ammonia until they decline to 2.0.
- Once nitrates appear (5 – 10 ppm), and both the ammonia and the nitrites have dropped to zero, you can add your fish.

  - The Murray Hallam Cycling Technique
    - Add liquid seaweed to the system
    - Add plants
    - Wait for two weeks
    - Then add fish.
  - pH should be between 6.8 and 7.0
  - Plant your system as soon as you begin cycling. Adding liquid seaweed will help your plants quickly acclimate to their new environment
  - Adding bacteria will dramatically speed up the cycling process. Keeping the temperature of your water above 70 will help as well

- **System Maintenance**
  - Ammonia, Nitrites, Nitrates – after cycling,
    - Ammonia and Nitrite levels should be less than .75 ppm
      - If you see Ammonia levels rise suddenly, you may have a dead fish in your tank.
      - If you see Nitrite levels rise you may have damaged the bacteria environment in your system.
      - If either of the above circumstances occur, stop feeding your fish until the levels stabilize, and, in extreme cases, do a 1/3 water exchange to dilute the existing solution.
    - Nitrates can rise as high as 150 ppm without causing a problem, but much above that, you should consider harvesting some fish and/or adding additional plants or another grow bed to your system.