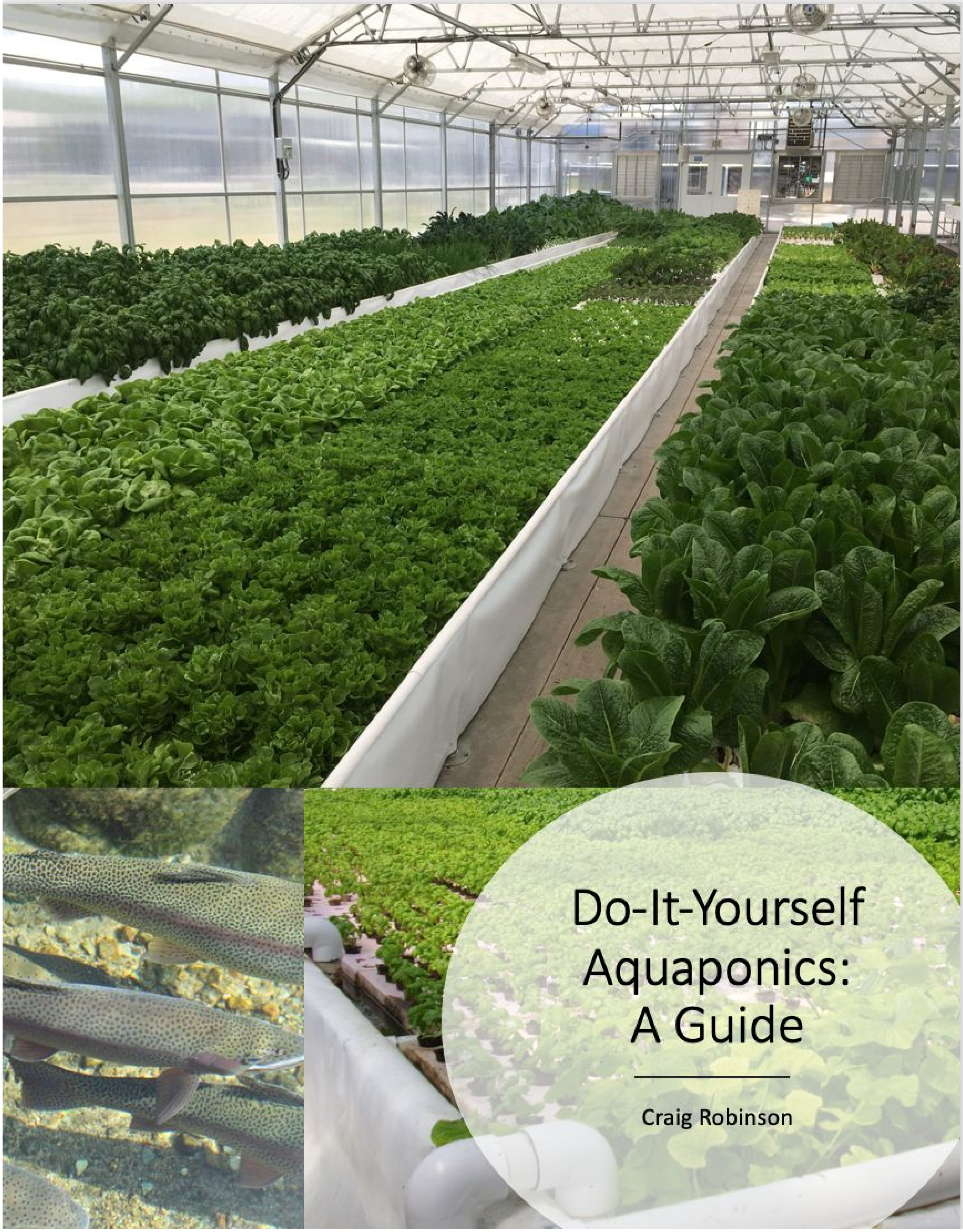

Do-It-Yourself
Aquaponics:
A Guide
Craig Robinson

BENEFITS OF AQUAPONICS:

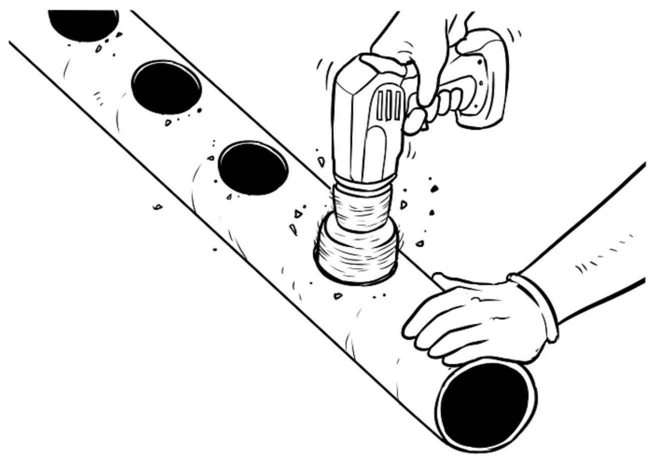
- Aquaponics uses 90% less water than a traditional farm: a way of growing food that promotes water sustainability [1].
- No fertilizers, pesticides, or other chemical additives are used, leading to organic crops; the use of these chemical products would create toxic conditions for the fish [1].
- No nitrogenous chemicals are used in aquaponics, therefore, stormwater runoff won't be able to collect any of these harmful substances.
- Fish use no growth hormones, antibiotics, or PCBs [2].
- Plants grow twice as fast compared to a traditional farm; the water from the fish is naturally fortified, allowing for the growth of the plants to be expedited [2].
- Aquaponics can be grown anywhere - whether it is in suburban, rural, or urban areas.
- Aquaponics uses less land than a traditional farm, conserving space [3].
- Aquaponics is typically grown and distributed locally, decreasing one's carbon footprint [2].
- The possibility of farmed fish escape is completely eliminated [3]. To learn more about farmed fish escape, see Sustainable South Jersey's Aquaponics article!
- According to Jane Lubchenco, an environmental scientist at Oregon State, believes that "switching from meat to sustainably farmed fish would make a significant impact [on the effects of climate change]" since the beef industry accounts for 6% of global CO_2 emissions [4].

HOW TO SET UP YOUR AQUAPONICS SYSTEM [5]**:**

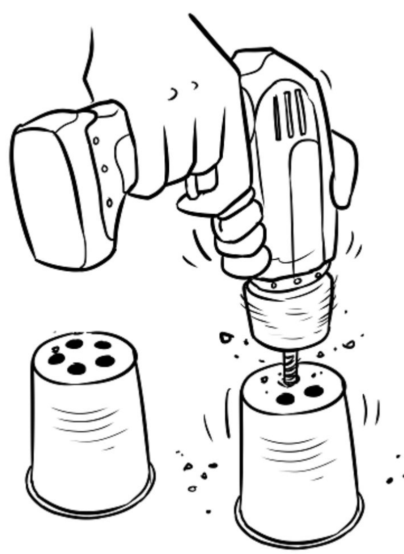
MATERIALS

PVC pipes, PVC pipe caps and elbows, plastic cups, a fish tank of ideal length, two tanks, tubes of ideal lengths, biofiltration media, water pump, aeration device, mesh filter, solid barrier, hydroponics growing media, plants, fish, fish feed.

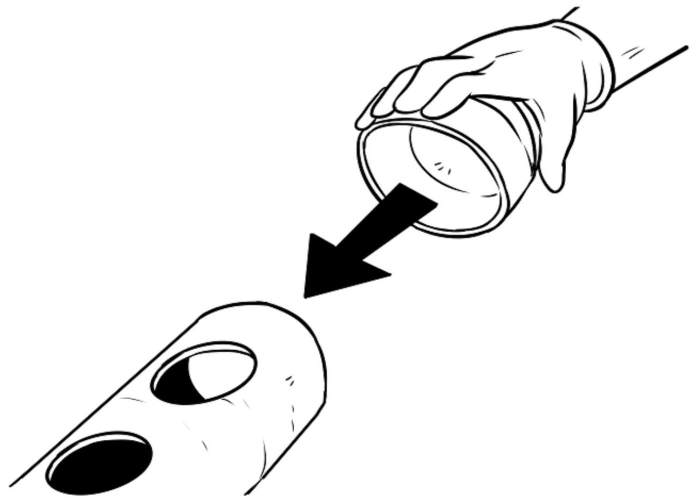
1. Find a PVC pipe of ideal length. This PVC pipe will hold the plant life.
2. Use a hand saw with a hole saw bit to drill holes into the PVC pipes. Holes should be separated by an inch or so.



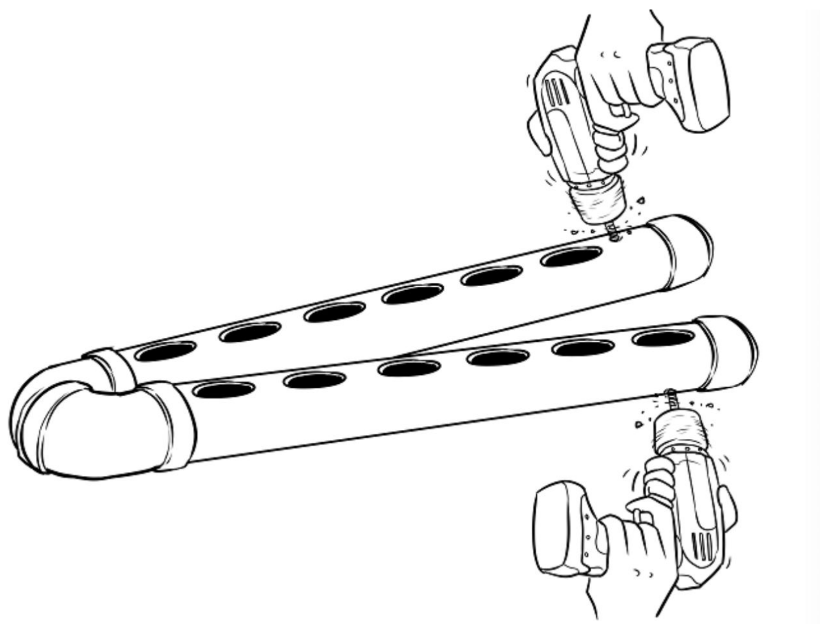
3. Use cups that will perfectly fit into those holes in the PVC pipes. Drill 4-6 holes at the base of that cup. The cups are going to hold the growing media and the plant. The holes allow for water waste to be absorbed by the plant.



4. Connect the PVC pipes using elbows and cap the open ends.

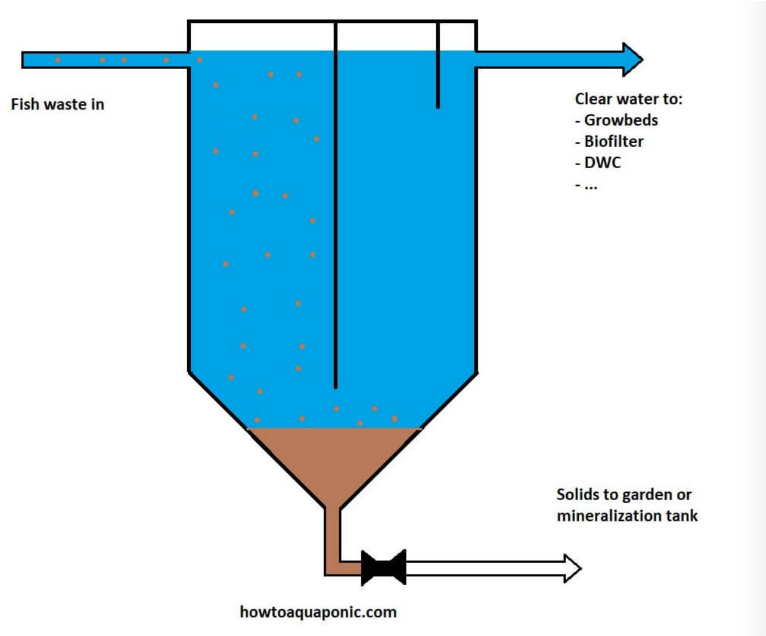


5. Drill a small hole on the top of the most elevated pipe. Drill a small hole on the bottom of the least elevated pipe.



6. Set aside two tanks. These will be used for the biological filtration tank and the clarifier.
7. These two tanks should be placed above the fish tank. This way the force of gravity will allow the water to flow downward into the grow beds.
8. Place a water pump in a tank and connect it to the first elevated tank (the clarifier) using a slender tube.
9. The clarifier tank should consist of a separator that allows for particles to sink and clean water to rise (see below) [6]. Additionally, a tube should be placed at the

elevated part of the clarifier in order to guarantee that clean water remains in the system.



10. Use a PVC pipe or a tube to connect the clarifier to the biological filtration tank.
11. Use a T-shaped pipe in order to increase the water's exposure to oxygen and removal of CO2 from water [7].

12. The biological filtration tank should consist of multiple layers. The top layer should be a screen filter or a mesh filter used to further filter out particles. Next, a layer of plastic biofiltration media should be included. “Bio-balls” are highly recommended.
13. Use a PVC pipe or a tube to lead the water flow to the plants. Connect this tube to the small hole on the top of the most elevated pipe.
14. Connect an aeration device to the fish tank to deliver oxygen to the fish.
15. Add growing media in the PVC pipe holes; plants your crops in the media.

16. Fill the tanks with water and create a comfortable environment for the freshwater fish (see FAQs for the specifics of a comfortable environment).
17. Frequently monitor the pH and temperature of the water and the behavior of the fish.

FREQUENTLY ASKED QUESTIONS:

Should my aquaponics systems be indoors or outdoors?

The location of your aquaponics system is dependent on a variety of factors: climate conditions in your area, exposure to sunlight, ability to provide ultraviolet light and adequate temperatures indoors.

If you live in an area that has sufficient exposure to sunlight - as well as temperature ranges that can support fish life - you should consider locating your aquaponics system outdoors.

If you live in an area that does not have much exposure to sunlight, you should consider locating your aquaponics system indoors. If your aquaponics unit is indoors, you must provide ultraviolet light and adequate temperatures year round. In order to maximize sustainability, it is highly recommended that your electricity is powered by renewable sources.

How large should my fish tank be? How many fish should I include in my aquaponics system?

A common rule to follow is for every 1 pound of *mature* fish, you should have a fish tank with a volume of 5-7 gallons. You can determine the number of fish included in the system by measuring the growing area of your plants. For every square foot of growing area, you should have a pound of mature fish [8].

What kind of fish should I include in my aquaponics system?

This is a very important aspect when designing your aquaponics system. The type of fish you chose is contingent on the climate your aquaponics system is in. If you plan on doing an outdoor aquaponics system and you live in a warm climate, it is highly recommended that you have warm water fish - such as tilapia - in your system. If you live in a cold climate, using cold water fish, like trout, would be ideal.

However, if the climate of your area is cold in the winter months and warm in the summer months, using fish such as a catfish is recommended. The ideal temperature range for a catfish is 35-38 degrees Fahrenheit; however, they are able to handle temperatures up to 90 degrees Fahrenheit [9].

Prior to obtaining your fish, it is highly recommended that you research the fish, especially the conditions they would be able to live in. If these conditions match the conditions your environment would be able to provide, that specific fish would fit your aquaponics system. Below are different types of fish that can be used in an aquaponics system:

- Tilapia
- Brim
- Crappie
- Carp
- Goldfish
- Pacu
- Guppies
- Swordfish
- Blue Gill
- Sunfish
- Catfish
- Koi
- Pacu
- Angelfish
- Tetra
- Mollies

How often should I feed the fish?

An adult fish should eat 1% of its body weight per day; a baby fish should eat around 7% of its body weight per day [8]. Feeding is an essential part of the aquaponics system, since fish cannot produce waste without feed. However, it is important to feed the fish responsibly.

Why are my fish not eating?

First, make sure that you are feeding your fish the proper amount of fish feed (see above).

Next, fish not eating could be a sign of an uncomfortable climate. In this scenario, check the pH levels, the temperature, and the oxygen levels in the fish tank [8].

What kind of plants should I include in my aquaponics system?

The following plants have successfully been used in aquaponics systems [10]:

- Lettuce
- Kale
- Microgreens
- Pak Choi
- Swiss Chard
- Carrots

- Radishes
- Beets
- Watercress
- Cauliflower
- Herbs
- Broccoli
- Cabbage
- Hemp/Cannabis (note: growing is illegal in some states)

What is growing media and how do I use it?

Growing media are various inert substrates that take the place of soil in aquaponics or hydroponics [11].

Essentially, growing media is more sustainable than soil since they are able to be reused and they have the ability to hold more water; they also allow for physical stability of the plants [12]. Growing media can have varying water holding capacity (WHC): a measurement of how absorbent or restrictive the growing media material is [12]. Mother Earth Coco Coir and Grodan Gro-Wool are examples of media with high absorption rates (hold on to a lot of solution) - leading to little irrigation. Other examples on the other end are Mother Earth Hydroton Expanded Clay Pebbles which hold little water and require a lot of irrigation [12].

What is pH, how do I measure it, and what is the ideal pH for my aquaponics system?

pH is the measurement of the acidity or basicity of an aqueous solution or a liquid. It is measured on a scale from 0-14. A solution is more acidic as it's pH comes closer to 0; a solution is more basic as it's pH comes closer to 14; a pH of 7 indicates a neutral solution - such as water.

pH can be measured using the following methods: litmus paper, indicators, and colorimeters. For aquaponics, the litmus paper method is recommended since it does not require the removal of water from the system. It is crucial that the pH is routinely monitored!

The ideal pH of an aquaponics system is ideally between 6.8 and 7.2: a neutral measurement; however, a range of 6.6 to 7.6 is also accepted [1, 8]. Ultimately, in this environment, the fish will live comfortably with a minimal concentration of ammonia. Additionally, if the pH is out of this range, plants will be unable to absorb nutrients, leading to toxic conditions for the fish tank [1].

My pH is too high or too low! How do I get it back in range?

If your pH falls below 6.6, the best methods for raising a pH would be using a calcium hydroxide product or a potassium carbonate product. Both of these products are quite basic and would increase your pH without harming fish life. Calcium Hydroxide products are often found in the form of hydrated lime or builder's lime [8].

If your pH goes above 7.6, the best methods for lowering a pH are using acids such as nitric or phosphoric. The following strong acids are also acceptable: hydrochloric and sulfuric. Weak acids, such as vinegar, often do the trick as well [8].

What should I include in my clarifier tank?

The purpose of the clarifier is to filter out any particles in the water. A barrier is created in order for the particles to fall and the clean water to rise.

The barrier should measure to be the diameter of the tank and ¾ the height of the tank. The tube - that directs water into the biological filtration tank - should be placed on the elevated part of the tank. Furthermore, a hole should be made in order to dispose of the excess particles [6].

What should I include in my biological filtration tank?

The purpose of the biological filtration tank is to convert remaining ammonia molecules (NH_3) into nitrate (NO_3^{-2}); nitrate is used to fertilize the plants.

Essentially, a layer of biofiltration media is included. This media contains a high surface area, allowing for a high concentration of bacteria to congregate: this bacteria is used to convert the ammonia into nitrate [7].

The layer of biofiltration media usually consists of "bio-balls". These are rubber spheres that have a high surface area, making it advantageous for bacteria collection.

There are so many design options for my aquaponics system set-up. Which one should I choose?

The aquaponics system you select should be based on the following factors: the amount of space you are able to allocate, the amount of fish or plants you are able to maintain, the design that utilizes the materials made available to you.

Below are aquaponics system designs created by the United Nations Food and Agriculture Organization [11].

FIGURE 1.3
Simple hydroponic unit

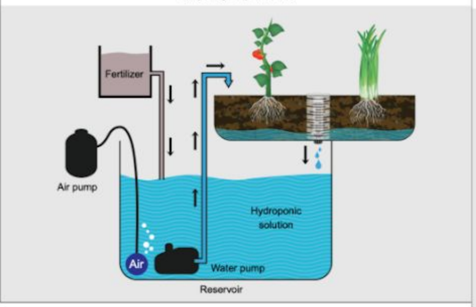


FIGURE 1.4
Recirculating aquaculture system

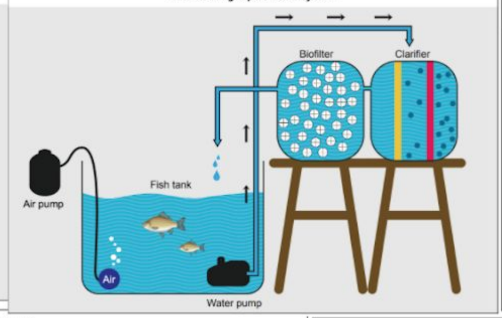


FIGURE 4.1
Illustration of a small media bed unit

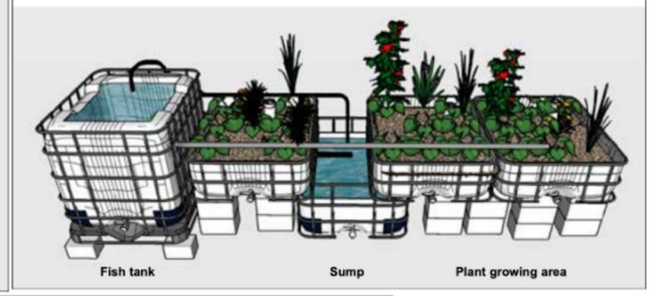


FIGURE 4.6
Illustration of a small nutrient film technique unit

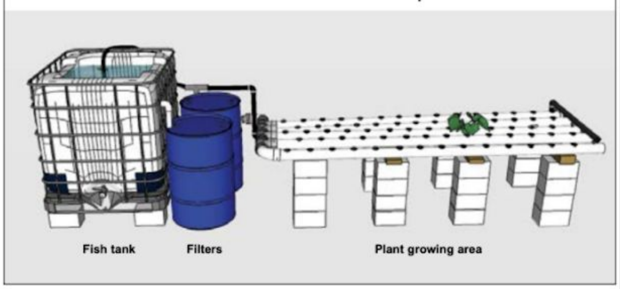
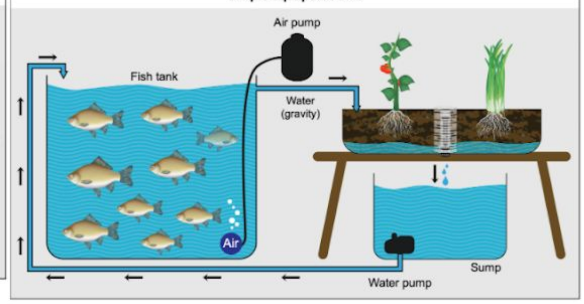


FIGURE 1.5
Simple aquaponic unit



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