Aquaponics

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Aquaponics, though it's a weird word, is actually amazing and could be the future of food production. Aquaponics is a farming method where fish and water replace traditional soil and fertilizer. According to the website “Aquaculture, raising fish in a controlled environment and phonics the Latin word for growing plants in a soilless media”(Green And Vibrant). Aquaponics is an alternative farming system in which fish are used in a base tank that flows down into plant tanks where there are usually rocks used to suspend the plants above water. Water containing fish waste provides plants with nutrients needed for their vigorous growth. In return, the plants take up excess nitrogen, providing purified water that goes back into the tank.

Aquaponics was built off of two ideas: hydroponics and aquaculture. Aquaculture is just raising fish in a mostly controlled environment, and hydroponics is farming where plants are grown in treated water. Typical farming comes with many problems, like some soils have fertile “soil-Web ecosystems,” which is basically the interaction of the ecosystem in fertile soil (the aquaponics source). However, many soil structures that are “heavy in clay or sand have challenges related to water, nutrient availability, and texture for planting”(Aquaponics.com). Many locations lack soil because “they have concrete, asphalt, or rock to contend with”(the aquaponic source). But that's only a few of the problems posed by soil farming. There are also erosion, wind, pests, and the constant need for fertilizer. “Fertilizers with only N – P – K (Nitrogen, Phosphorus and Potassium), means that the plants grown will absorb these nutrients but could be depleted of other micronutrients such as calcium, boron, copper, iron, zinc, and many others”(The Aquaponics Source). These are some of the problems solved by aquaponic

and hydroponic farming. . According to aquaponics.com, hydroponics was created out of the idea that somehow the roots could get the nutrients and water directly sourced to them instead of having to fight for it in soil. However, there were some issues, like too much of a certain chemical or not enough of a nutrient, and soon hydroponic farmers were pondering if there was a way to solve their problem. Using aquaculture, they were able to solve all of their problems simply by adding fish to the equation and soon made a system possibly better than regular farming. They did it by “putting the fish to work”(aquaponics.com). According to Green and Vibrant, Starting an aquaponic system big enough to pay for itself and make a living off of is quite an investment, but once started and done right, you have less maintenance and a higher yield than regular farming. An aquaponic system also provides, in small amounts, fish. This amazing system not only requires less attention but also gives better tasting food as well. Not only that, but anyone can do this in their own backyard. Though it's quite costly and sometimes limited due to the unlevel ground or solar arcs and shade, most homes can make their own aquaponic system. A very simple system can cost from 400-1000 Dollars and that's just the system itself. As a hobby, it's very engaging and may seem confusing but is actually quite simple. Basically, for hobby aquaponics you only need two things: plant beds and a fish tank, which empties into the plant beds (Green And Vibrant). “Plants then absorb the nitrogen in the water and return with purified water to the reservoir. And this cycle goes on”, so hobby aquaponics is actually quite cheap (green and vibrant).

Aquaponics gets the farming aspect from hydroponics, where water is used in place of soil. Hydroponics is just “farming in a soilless media.” Traditional hydroponic systems rely on the careful application of expensive, man-made nutrients made from mixing together a concoction of chemicals, salts, and trace elements”(the aquaponic source). Hydroponics as a hobby is quite expensive and very challenging. Tending to the water and making sure the plants are getting

the right nutrients is really the problem with hydroponics. Without aquaponics, hydroponics is really just a big pain. When it comes to construction, hydroponic systems vary from simple grow beds with one main container, and pipes with holes for plants. There are many options but not all are available to everyone, maybe because of a backyard, animal, or the solar arc of the place you're living (green and vibrant). According to Green and Vibrant, Hydroponics is a very interesting hobby with a lot to offer, especially food. After about the first month you only have to monitor the Ph weekly. Not only that, but hydroponic systems need to be completely emptied and refilled to prevent the build-up of salt and other chemicals in the water. On top of that, a form of root rot called “Pythium” is very common in most hydroponic systems. Commercial hydroponics is practically unheard of and extremely unprofitable. You will eventually end up spending more on water treatment then you will earn on the plants. Although it has a very high yield with plants grow faster than in typical farming. Managing a commercial hydroponic system, or a system big enough to profit from would be virtually impossible. Hydroponics comes with many downsides, but almost every single one can be solved by simply adding fish to the picture. So after aquaponics was invented, hydroponics became less popular(Aquaponics.com) but it is still very alive as an interesting way to farm.

“Aquaculture is the breeding, rearing, and harvesting of fish, shellfish, algae, and other organisms in all types of water environments”(ocean service). Aquaculture can sometimes be seen as a way to make large amounts of food to be shipped away and enjoyed, but aquaculture is not only used commercially for food production. It is also used for the conservation of endangered marine life (ocean service). Aquaculture can be used commercially to satisfy the increasing demand for seafood. We are killing marine life in so many different ways, and many species have become endangered, so aquaculture allows us to have this amazing food without damaging ecosystems by raising fish instead of catching them. There are two kinds of

aquaculture. Freshwater, trout, catfish, and salmon are usually raised in man-made systems or ponds (Green And Vibrant). Then there's saltwater aquaculture, usually in nets or floating cages, which is more commercial or focused on rebuilding ecosystems (Ocean Service). Aquaculture is less improved by aquaponics than the environment is. Aquaponics limits aquaculture to a very small contained area where the fish are a small part of the harvest. The fish don't even really benefit from the plants, except that they purifying water. The fish are really there to poop and continue the cycle. Plants get nutrients from the fish and in turn the plants purify the water. Hobby aquaculture is very difficult and very unusual. (The Aquaponic Source)

One of the most important components in aquaponics and the most important in aquaculture is Fish!. The fish in aquaponics are essential to the plant's growth and are a big part of the system overall. Fish in aquaponics are almost half the system and are the primary nutrient source for the plants. But not all fish have what it takes to be aquaponic fish. Fish need to be able to thrive in a clustered environment, and "be resistant to fluctuating dissolved oxygen levels, as well as nitrate saturation and pH fluctuations (green and vibrant)." They also need to be resistant to parasites and disease, and finally, be edible or ornamental(Green And Vibrant). Now that we know the requirements, here are some fish used in aquaponic systems. Tilapia is one of the best fish and also the most commonly used. For its hardiness, it's also quite good looking and has very good tasting meat. Trout, less commonly used but still an option, thrives in cold waters of less than 15 C. Catfish are also used because of tolerance to fluctuating chemicals in the water and resistance to parasites and disease. Besides that, they will need sinking food and can be grown with other fish. Carp is a widely cultured fish and also works very well in an aquaponic system. Different kinds of carp can be grown in the same system as the grass and silver carp. Carp can live in an amazing temperature range from 39-93 degrees Fahrenheit. Largemouth bass, though they are less resistant than tilapia, have a great

temperature range and can be used as a great year-round fish. And finally, if you're less interested in eating the fish you can go with ornamental fish like koi and goldfish, which are better looking and can also be sold (green and vibrant) (The Aquaponic Source). The fish have a simple job in an aquaponic system to stay alive and parasite free and to give nutrients to the plants. As the owner of the aquaponic system, it's your job to feed the fish, the fish's job to feed the plants, and the plant's job to filter the water. Tilapia convert feed to body weight at an efficient 1.2-1.5lb of fillets for every 1lb of feed (The Aquaponic Source). This means to feed ten tilapia for a year you would need $22.5, which is incredibly cheap. Tilapia can grow from fingerling-sized to plate-sized within a year, meaning at the end of your $22.5 you'll have not only all the crops from your grow beds but 10 whole delicious tilapia.

In aquaponics, there are two main bodies needed to make a functioning system: an aquaculture system containing fish, and a hydroponic system containing plants. And finally, you'll also need micro bacteria. A colony of nitrifying bacteria in the biofilter filters out ammonia and harmful nitrates, turning them into helpful plant-feeding nitrogen (green and vibrant). So in a system, the fish waste containing minerals and nutrients for the plants is filtered through the biofilter and sent off to the plants. After another round of purifying, the water is sent back to the fish. The biofilter gets rid of build-ups of ammonia and nitrates in the water, making it into nitrogen for the plants. After the plants get a hefty meal of nitrogen and nutrients, they purify and oxygenate the water for the fish and the cycle begins again. (green and vibrant). When building a system, it's vital to understand how important these micro bacteria are and what they do. In a system, there is a plant basin, a fish tank, usually a settling tank for solid waste, and a biofilter for the micro bacteria. And of course, there is a pump, the very thing that pushes the cycle onward. Kinds of pumps and filters vary, and they usually all work the same way. (aquaponics.com). The first kind of pump is the submersible, the most commonly used pump

because it’s the easiest to set up and use. It's called that because it’s always under the water. This pump is typically used in smaller systems and tends to heat the water. The next pump is an inline pump which is out of water. This pump is typically used in bigger systems and won’t heat the water. The problem with this pump is it's more expensive, a lot louder than the submersible pump, and is harder to set up. But when properly used, this pump is more durable and stronger than the submersible. Another pump is an airlift pump, used to bring the air nutrient solution right to the roots. Water is pumped from the bottom of a pipe to the top to water the plants constantly. This, however, is not as strong as the rest of the pumps and cant be used commercially (green and vibrant). Different sized systems call for different sized pumps. The strength of these pumps can be measured in GPH (gallons per hour). A big reason hydroponics is flawed is because of the constant need for artificial nutrients and cleaners for the water. “So the goal of aquaponics is to create a closed cycle system (green and vibrant)”. It’s very important to understand these chemicals. The first is nitrogen, the building block of life, and good for plants. This is one big part of it but the others are the chemicals present in the fish waste, the big ones being ammonia and residual foods (green and vibrant). Ammonia is toxic and not good for the plants, but thanks to the nitrifying bacteria on the biofilter, ammonia is taken over by the nitrifying-oxidizing bacteria and turned into nitrate compounds which the plants absorb with ease (green and vibrant).

Aquaponics commercially is very profitable, if done right. Commercial aquaponics is a whole new conversation and is on a whole other level from hobby aquaponics. The size of the System overall is massive. While commercial aquaponics can be profitable, a system big enough to pay for itself could cost anywhere between 2000 - 10000 American dollars, and beyond (aquaponics.com). An online study was done of 257 different commercial systems. A total of 538 full-time workers, 242 halftime workers, and 1720 unpaid workers or volunteers. The

fish raised were 69% tilapia, 43% ornamental fish, 25% catfish, 18% were other aquatic animals, 16% were perch, 15% were bluegill, 10% trout, and 7% bass (ScienceDirect). Laffin says on a commercial scale, aquaponics is profitable when done to a certain scale, not necessarily large but to the right size where the upkeep is manageable. A big problem is the big investment aquaponics requires and the uncertainty around the profit (leaffin.com) A big problem with attempting to map aquaponics is the varying areas and their demands for different kinds of food. i=In an area with high demand for locally grown food, and maybe a fish market, an aquaponic system could be profitable. However, a study showed that 30% of growers were profitable, and for 70%, aquaponics wasn't their main source of income. 55% were forecasted to be profitable in the next 12-36 months (leaffin.com). Not a single grower could find the fish profitable. The main cost of aquaponics is a greenhouse, at least an acre of land, labor, and fish feed. Electricity is an expense, but not to the same degree as the others. Still, unlike aquaculture and hydroponics, 100% of commercial aquaponics systems have gross profit, meaning the profit after deductions (leaffin.com). Aquaponics isn't Automatically profitable, but when done right can be very profitable.

Sustainability: This single word is what inspired me to learn about aquaponics. The idea of something being sustainable, especially self-sustainable, is extraordinary. Most of the time you can refer to aquaponics as semi-self-sustainable. Self-sustainability is where the magic of aquaponics is. Self-sustainability is the reason that aquaponics is better than aquaculture and hydroponics. Hydroponics has a constant need for intervention when treating water and plants. Aquaculture also has a problem: the build-up of salts and other harmful chemicals make it necessary to empty the water, usually into waterways which can be very toxic and horrible for the natural fish. But by putting them both together, you can create a perfect cycle, or almost perfect. When starting a system it needs a little management to get going, like monitoring Ph

levels constantly, shooting for a neutral 7.0. Usually, the monitoring will be weekly when starting and move on to be monthly when started. In terms of the self-sustainability of the cycle, once it's started it can take care of itself mostly, besides occasional cleaning and possibly algae in the PVC, if you choose to use PVC, checking the Ph of the water monthly, adjusting the ph if it's too far from 7.0, and of course, feeding the fish. When changing the Ph of the water there is sometimes a good side effect. If you use calcium hydroxide or potassium hydroxide, you can actually correct your Ph while providing nutrients that aren't usually in the system but are still needed for the plant's growth (green and vibrant). Another example of less self-sustainability is potassium. Potassium is a vital nutrient for plants and can harm the plants if there's a deficiency. Why not use supplements to provide the plants with potassium? To solve that, we have to look at a regular solution that usually supplements calcium, magnesium, and potassium. The roots or "pumps that the plants use to take up potassium" are often the same that take up calcium and magnesium, and the plants usually can't distinguish between the two, so if there's too much calcium and not enough potassium the plant has a very hard time distinguishing them (Bright Agrotech). Not only that, but signs of potassium deficiency in plants are almost identical to magnesium or calcium deficiencies. Solving this problem takes time and a trained eye. Overall self-sustainability in aquaponics is amazing compared to most media of farming.

Understanding aquaponics isn't an easy task. My personal experience with the construction of a system is very limited but thanks to a shrunken down model I do have a little bit of experience. I still find myself struggling, mostly because to really be a master of aquaponics you have to understand the many diverse and changing factors of the system. So I don't really know enough to call myself advanced at aquaponics. Understanding the plants, being able to tell if you have a potassium or magnesium deficiency just by looking at the plants, Being able to understand the inner workings of this plant down to a microscopic scale, But

knowing enough to build a system with some assistance from a real master. My second meeting with my mentor was to a farm where I got to see a full system, and he explained what everything was. There I learned that using a sump tank (extra tank), you can use shrimp for extra nutrients and if one happens to get sucked into the pump and put into the cycle -- free snack for the fish. Personally I built a small version of an aquaponic system. It was so small there was no need for a pump, and I used microfibers instead. I definitely witnessed how quick, without proper filtration, fish water can become toxic for these fish.

Aquaponics is a confusing thing and isn't often done right. It's genuinely difficult to understand aquaponics, but I don't regret picking it as my 8th-grade project. I still think even after all this research, note-taking, and essay writing, I still want to learn more about aquaponics and sustainability. Although now it's not being used to its full potential, I think maybe one day someone could invent a medium of farming that could improve on aquaponics. Still today, aquaponics is rarely used despite more food and better-tasting food! Aquaponics could be the future of food security.

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