Instituto Superior de Engenharia do Porto

Aquaponics System

Final report

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Abstract

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Chapter 1: Introduction

1. Presentation

We are a group of 5 international students. At the end of February 2014 we started a program called the European Project Semester at the Instituto Superior de Engenharia do Porto. During the semester we will work on a project lasting whole semester and we will participate in the complimentary classes.

2. Motivation

As a group we came to an early decision that we would like to choose a proposal that incorporated sustainable techniques and been eco-friendly, as this is the future of all Design/Engineering. As a group we were all interested in creating our own Aquaponics system as this is a system/technique that is becoming ever more popular throughout the world, more so in poorer regions and where water is a limited resource.

3. Problem

We were tasked with designing and building an Aquaponics system that supports both fish and plant culture without the use of soil and supported by water recirculation. The system must be as sustainable as possible. From this, our idea's focussed on the sustainability of the system. We decided to target the household market as a small system would be easier to control and keep sustainable compared to a large (small farm) sized system. This system would also allow us to create an aesthetic product that would sit within the home. Even though there are many Aquaponics systems in use at a large scale there are not many for use within the home and this is why our market was targeted towards this area.

4. Objectives

The main objective of the project is to create a working system as to support both fish and plant culture. The system must be able to be monitored so that optimum conditions are in place. This would mean using sensors to check temperature and other parameters. In order to fulfill the secondary objective of being as sustainable as possible we must look to use as little power as possible and be efficient when using the water recirculating so more water does not need to be inputted into the system. To use materials that have been recycled or reused as to be sustainable in creating the prototype.

5. Requirements

There are a number of requirements needed to be fulfilled for the Aquaponics project to work correctly. First of all it needs to be as much sustainable as it is possible. To achieve this we need to pay attention to the structure of the system: the water must recirculate and the amount of energy input to the system should be kept to a minimum. Secondly, our prototype must be easy to control. Therefore users of our Aquaponics system must be able to monitor parameters such as temperature, flow, conductivity, pH or dissolved oxygen. Moreover, due to the target we have chosen, which is the domestic use of our prototype, it requires having an attractive design. Furthermore, the project obligation is to reuse provided components or low cost hardware solution which we must take into account when constructing our system. Also it is necessary to use open source and free software and technologies.

6. Functional tests

7. Project planning

The work plan and the Gantt Chart were created. We divided the whole project into smaller parts and created the list of the tasks we need to complete. Afterwards, we allocated each task to the team members according to their skills and knowledge. Next, in the Gantt chart we specified details of each task and dates to perform it.

Table 1: task allocation

Chapter 2: State of the art

1. Aquaponics system

1.1. Introduction

The aquaponic is based on productive systems that can be found in nature. It can be described as the combination of the aquaculture and hydroponic and this is where the name comes from: aqua-ponic.

Hydroponic systems rely on the use of nutrients make by humans for optimum growth of plants. Nutrients are manufactured from a blend of blend of chemicals, mineral salts and trace elements to form the 'perfect' balance. Water in hydroponic systems must be discharged periodically, so that salts and chemicals do not accumulate in the water that could become toxic to plants.

Aquaculture systems focus on maximizing the growth of fish in ponds. Fish are usually crammed into ponds, it is not uncommon to have a density of 10 kg of fish per 100 l of water. High densities of breeding often mean that water from the reservoir becomes polluted by effluent from fish that produces high concentrations of ammonia. The water must be drained off at a rate of 10-20% of the total volume of the basin, once per day, every day. This water is often rejected directly wilderness where it pollutes and destroys natural resources.

The aquaponic combines the two systems in a symbiotic environment. It can cancel the negative aspects of each. Instead of adding toxic chemicals solutions to cultivate plants, the aquaponie uses highly nutrient effluent from fish that contain virtually all the nutrients needed for optimum growth of plants. Instead of discharging water, theaquaponie uses plants to cleanse and purify the water, after which the water is back in the aquarium. This water can be re-used indefinitely and must be replaced when it evaporates.

1.2. Functioning

1.2.1. The nitrogen cycle

Invisible essential to an aquaponics system is the benefit of bacteria. Bacteria thrive in the dark gravels of culture beds and Breeze elements in the water in a form that plants can absorb and use. An aquaponics system is organic by nature. Synthetic fertilizers may not be given in food plants without risk of harm to fish and beneficial bacteria, the system must be maintained naturally. There are two different bacteria that break down fish waste, the first is the Nitrosomonas, that convert ammonia to nitrite. These nitrites are then converted to nitrate by Nitrobacter bacteria, plants can then consume nitrates and grow.

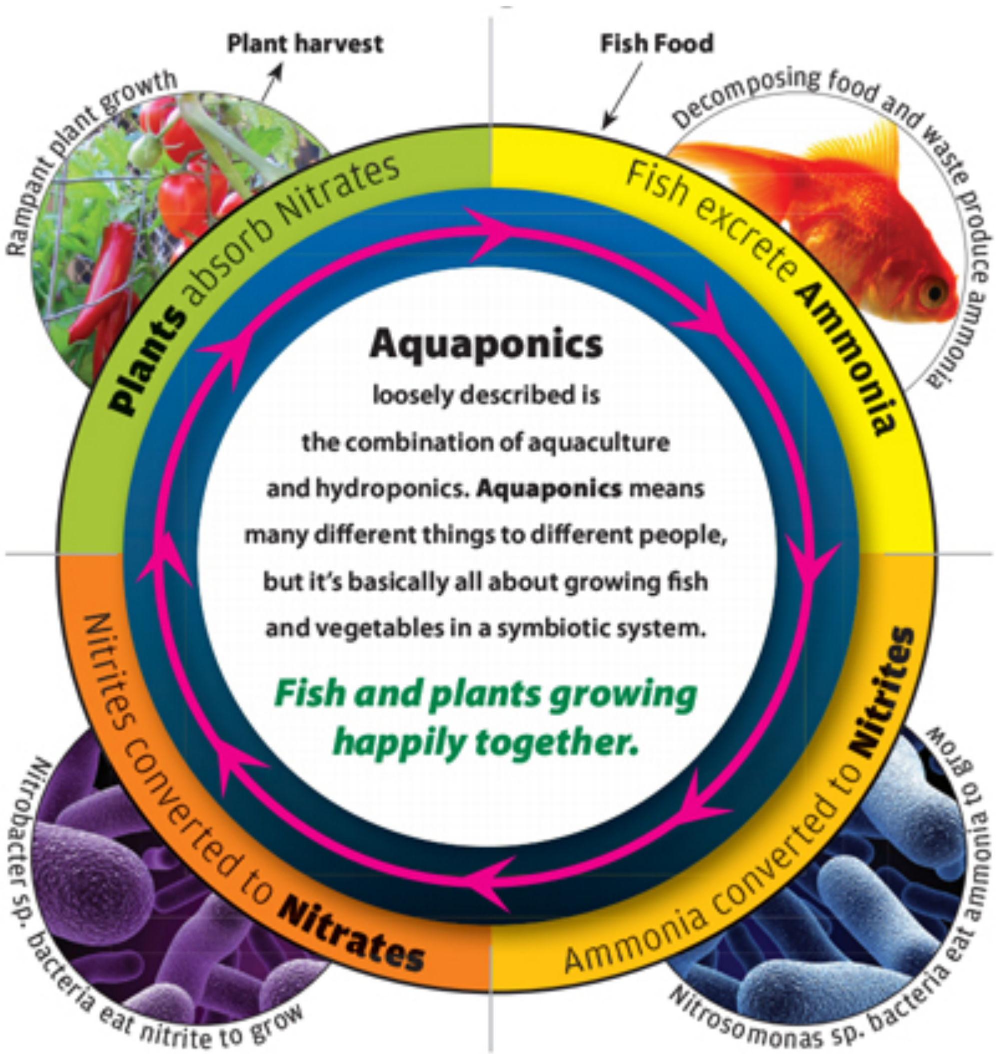

Figure 1: the nitrogen cycle in an aquaponics system

1.2.2. Simple example

It is in fact a near self sustaining ecosystem which requires minimal input and includes live bodies within an ecological cycle:

- Fish are fed and produce excrement rich in nitrogen (ammonia NH3 and urea), phosphor and potassium. This excrement is the source of nutrients for the plants. Food given to the fish is put back into the water in the form of fertilizer (excrement) but the ammonia is toxic for the fish. We must filter the water to reduce/rid of the ammonia so the fish will survive.

- The water of the tank is pumped and sent to the tubs of culture where plants/vegetables are grown in a neutral substratum expanded clay balls. Complex natural reactions are set up alone: Bacteria transforms ammonia into nitrites then nitrates.

- Plants can use the nitrates and absorb them by their roots.
- This produces a natural filter which clears the water of its toxic components.
- The clean water is sent back to the tank.
- The water on return will at one point be open to the air to oxygenate it (this oxygen will be useful for the fish, plants and bacteria).

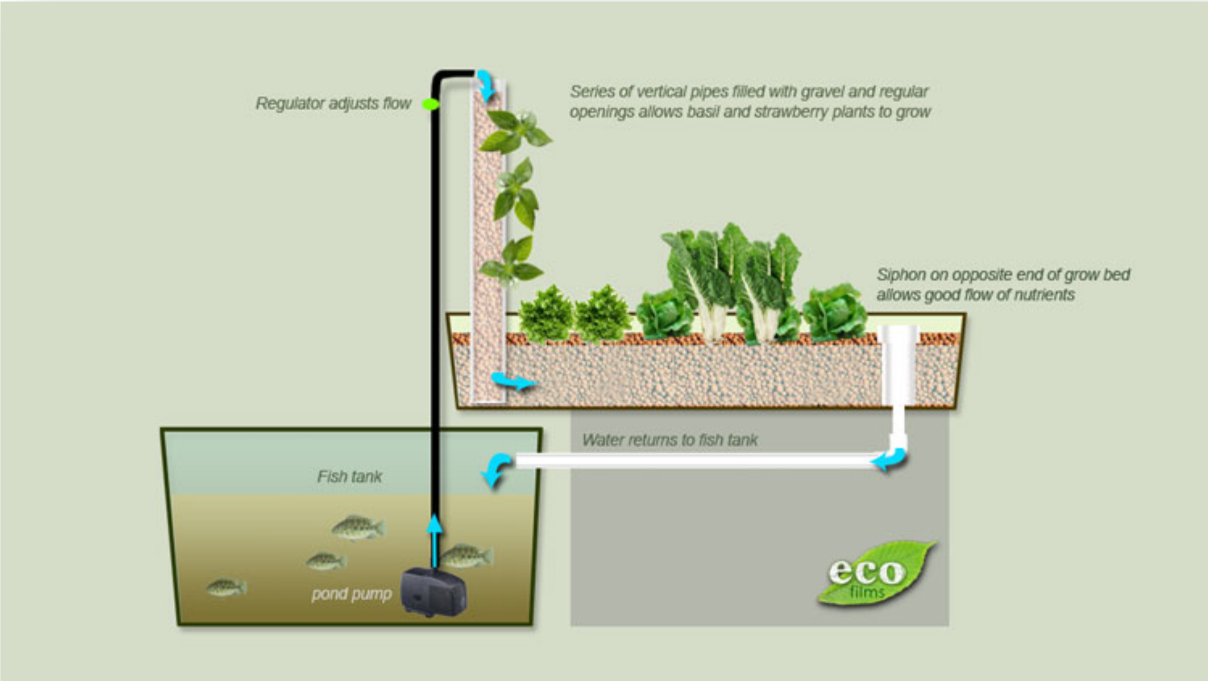

Figure 2: aquaponics system example of functioning

1.3. Components

There are basic components that every aquaponics system will need, regardless of the type of aquaponics system we set up. There can be some variation in what we actually use for each component, usually dependant on how much money we want to spend. We will need the following for an aquaponics set-up.

1.3.1. Fish Tank

We can use an aquarium, a pond/pool, a used food-grade container, a barrel/drum; basically anything that will hold water and can hold fish without being poisonous to the fish. The size we need will be dependent on the amount of fish we are going to keep and whether we want them as an integral part of the system or to grow out as food.

1.3.2. Grow Beds

What we use will be determined by the type of system we set up, so we will decide once we know what system set up we are using. There are three types of aquaponics systems: media-based, N.F.T.[1] and deep water/raft. Depending on the system, we could need rain guttering, half barrels, styrofoam sheets, pipes/channels, buckets/plastic containers. The depth of these can range between 5-30 cm to hold enough growth media to allow the plants to grow.

1.3.3. Growing medium

Again, this will be determined by the type of system we have. Aquaponics systems do not use soil so we need to have something else to support the plants as they grow as well as hold some water, if we are using a media-based system.

1.3.4. Pump

A water pump is needed to circulate the water from the fish tank through the grow bed and back to the tank.

1.3.5. Tubing

Tubing is needed to carry the air and water through the system. Water pumps generally use half inch tubing while air pumps are set up for quarter inch tubing. Plastic tubing is available in both clear and black; black tubing deters algae from growing and clogging the tube. Drip irrigation systems use quarter inch tubing and this is very good for aquaponics; it is very durable and cheaper than what is available in aquarium supply stores.

1.3.6. Timer

Some systems require a timer to manage the turning on and off the water pump, as with an ebb and flow system. In a home Aquaponics system, the timing is generally in half hour increments. This could be completed by the use of an Arduino system where we can control multiple electronic elements at once by using Inputs from sensors placed within the aquarium.

1.3.7. Biological filter

Whether we need a bio filter or not may depend on the type of system we have. An aquaponics system is just like an aquarium; good bacteria need to build up to convert dangerous toxins from the fish waste into less-harmful nitrites and nitrates. Gravel in the bottom of the fish tank is effective or we might need a separate biological filter. If we have gravel as part of our aquaponics system this can act as a bio filter but we could have the problem of needing to allow the bacteria to build up again after every time we change our growing medium.

1.3.8. Plants

We can choose from a wide range of plants to grow in our aquaponics system and will have fun experimenting with different types. Start off with herbs and then move onto leafy greens like spinach, silverbeet and lettuce.

[1] N.F.T. : Nutrient film technique

Again, the type of system we use can influence the type of plants we can grow. Most experts advise against trying to grow root vegetables like carrots, radishes and potatoes.

1.3.9. Fish

Fish are the other part of the process that makes Aquaponic gardening work. We can choose to have decorative fish like goldfish or cichlids or to grow edible fish species like trout, carp or tilapia, the most common farmed fish worldwide. We must research the available fish species in our local area because it is important to source fish that are suited to our climate.

These are the basic components we will need when we set up our aquaponics system but what we end up using depends on the type of system we decide on. It is advised to start small so we can learn the art and science of Aquaponics before investing too much time and money. As we gain experience, we can add more tanks and grow the size of our Aquaponics garden and move up to miniature farms.

1.4. Different type of culture system

There are three basic styles of Aquaponic systems. Each system have some advantages and disadvantages and may be preferred depending on the type of culture we choose.

1.4.1. Nutrient film technique

The N.F.T. is a method commonly used in hydroponics, but is not as common in aquaponic systems. In systems N.F.T., nutrient-rich water is pumped into small enclosed gutters, the water flows in a very thin film down the gutter. Plants are placed in small plastic cups enabling their access to water and roots to absorb nutrients. The N.F.T. is not really suitable for all types of plants, usually this will be booked to the leafy green vegetables, large plants have root systems that are too large and invasive or they become too heavy for the gutters.

Figure 3: Example of a N.F.T. culture system

1.4.2. Deep water culture

The D.W.C.[2] is based on the idea that plants float on top of water allowing the roots to hang in the water. This can be done in a number of ways. This is one of the most common commercial methods. The D.W.C. can be implemented by floating a raft of foam on top of the aquarium, but the most common method is to have the fish in an aquarium and pump water through a filtration system, and then into long channels where there are floating rafts filled with plants on the surface of the water and the roots extract the nutrients.

Figure 4: Example of a D.W.C. culture system

1.4.3. Media filled beds

Culture beds represent the simplest form of aquaponics. This method uses containers filled with media in place of the soil which ranges from foam to clay pebbles. Water from a fish tank is pumped into the beds of plants and the plants grown between the media and use it as a solid base.

<u>This style of system can operate in two different ways:</u>

- A continuous stream of water running through the media filled grow bed,
- Or by flooding and draining the grow bed.

[2] D.W.C. : Deep water culture

Figure 5: Example of a media filled beds culture system

1.4.3.1. Water circulation in MFB

Many configurations are possible in aquaponics, this may be as simple as a pond with floating plants above, or complex using a connection of multiple pipes and tanks.

There are a few basic models that have been adopted and tested by many people around the world with each of these styles comes its own advantages and its own disadvantages associated with them.

- Continuous flow

First of all the method of continuous flow, where the water is pumped from the fish tank to the grow bed and as is then sent back to the fish tank after moving through the grow bed. This is one of the simplest methods in Aquaponics but has some disadvantages. Main disadvantages could include a fluctuating water level within the fish tank, a pump is required to be placed within the fish tank and not all nutrients are absorbed by plants and return to fish tank. To counter this, it may be possible to set up a system where the media is constantly moist at all levels not just the bottom so that the roots of the plants can take advantage of the water and nutrients. If there is no grid of irrigation, most of the gravel will remain dry and will no longer function as a bio-filter or an area of plant growth.

Another disadvantage is that standing of water as the system requires water to travel through a small area where there will be a large blockage from plants/growth media. A large grow bed plus a simple system of keeping all media wet is the main way to counter the disadvantages often seen within Continuous flow systems.

- Flood and drain

Almost the same as a continuous flow system. The grow bed lies above the aquarium; water is pumped from the aquarium to the grow bed; water flows back to return to the aquarium below. The only difference from the continuous system is that the flood and drain system uses either a syphon or a stand pipe to flood the grow bed then allow it to drain. If there is a problem with the pump or power, the water will drain whatever happens back into the aquarium.

By mimicking the natural cycle similar to the waves or tides, we can enjoy the benefits of having the Grow bed flooded and drained completely, allowing oxygen to circulate in the root zones of plants, while limiting the accumulation of solids in the bed, due to the constant action of the surging water in flooding and draining the bed of culture. With the regular flooding of the Grow beds, there has more potential growth for plants on the bed all while reducing the absolute need for an extensive irrigation network that covers the entire surface of the bed, a definite advantage in aquaponics.

In many trials of systems by many enthusiasts around the world, it was found that flood and drain aquaponics systems benefits outweigh the benefits of a flow-through system. This does not mean that continuous flow systems do not work. Many systems with continuous stream still work perfectly as can be seen with the aquafarm (market leader in indoor aquaponics).

- Chift Pist

Consisting of two fish tanks and the grow bed. Set up with one fish tank below the grow bed (sump tank) and a second fish tank reaching to the height of the grow bed. Water is pumped from the sump tank into the main fish tank. This forces the water to rise in the tank and is sent through tubing to the Grow bed. This tubing runs to the bottom of the Main Fish tank to pick up larger solids (known as solids lift overflow). The Water that has been pumped into the grow bed causes it to flood and be continuously drained back into the sump tank below. A much harder system to design and not suitable for indoor Aquaponics.

1.4.3.2. Media for Grow Beds

There are several types of different Media that we can use in our aquaponics system.

First of all, there is gravel, for the size of the particles it's preferable to use gravel which are 16 mm or 20 mm, there are a few disadvantages to use different sizes. If the media is much smaller then there will be not enough space for a good aeration and oxygenation of the Grow bed. If the Media is much larger, our surface of planting of vegetables will be significantly reduced, so it will be much more complicated to design our Aquaponics system.

Secondly, we have the choice often used in hydroponics of expanded clay pebbles.

We must be very careful with regard to the use of Grave/Rock as they often have high mineral (e.g Limestone) and pH levels that can prevent the uptake of nutrients by the plants and be harmful to the fish.

Media easily available for our aquaponics system.

Types of rock available locally for us: River stones, shale, slag and many others. One disadvantage is rock or gravel media is very heavy and we must think about this when designing our Aquaponics system and plan to have sufficient support for our Grow Beds. The benefits of rock media however are that it is readily available and generally very inexpensive.

The balls of expanded clay are extremely light, neutral pH and are sold in large bags. This makes them practical to transport, store and use. Also Expanded Clay Pebbles are often seen as Expensive compared to Rock but for Indoor Aquaponics the Expanded Clay is still cheap with the cost only being slightly more for such a small amount needed.

1.5. What plants can be used?

It seems that most of the herbs and vegetables adapt well to aquaponics. Of course, some plants will not work as well as with other methods. Grow Beds with gravel or clay balls seem to be the most effective for the cultivation of a wide range of plants.

1.5.1. Vegetable roots and Aquaponics?

Although you probably would prefer your better potatoes to be grown in the ground, they can grow successfully by the use of Aquaponics. The carrots are another vegetable whose culture is possible in a Grow bed with the use of Aquaponics. These vegetables require alterations to the simple methods shown but it is possible to grow them with the correct system and consistent temperature/sunlight.

1.5.2. Deficiencies within Plants?

As with all gardens, deficiencies in plants are going to occur, but in general these can be treated very simply. Algae extract is an excellent way to compensate for the shortcomings of all minerals that may be lacking in an Aquaponics system. Extract of algae exists in many different forms and it is important to take care not to use harmful additives, because everything that is added into the system will be forwarded to the fish, bacteria, plants and ultimately to the consumer. It is also possible to use powdered minerals. There are a number of them on the market, but again it is wise to pay attention to their ingredients if they were not used before as this could upset the system. The best way to combat deficiencies is to use a good quality fish feed. What makes good food for fish is the quality of the bi-product composition, this means that there is a lot of minerals and trace elements in good fish food.

1.5.3. Can I plant seeds?

In the grow beds, there is typically a combination of plants and seeds. With the first plantation in a grow bed in a new installation, it is recommended to sow on the fly a mixture of seeds, as well as planting seedlings. The planting of seedlings is simple but it is recommended to use normal plants before planting seedlings.

With the planting of seedlings in the grow beds, the hustle and bustle of the gravel with the water flow lets seeds that were sprinkled on the bed fall between the gravel where it can absorb water and germinate safely. This method has many advantages: As the plants grow and shelter germinating seeds, they tend to dominate the bed and most germinating seeds can grow very slowly, however, once the plants ripened and harvested, this opens a window giving a chance to the small plants to grow. These plants now have a mature root system and have the right footing to grow very quickly. This mimics the natural forest ecosystems, where young trees and bushes grow very slowly, until large trees die and thus opens the canopy allowing light to seep for lower lying plants, which then stimulates their growth as a race to be the dominant plant.

1.5.4. What is the rate of growth in aquaponics?

The growth rate of plants in aquaponics systems can be quite phenomenal, in fact Dr. Nick Savidovs' tests in Canada, showed that rates of growth within aquaponics can exceed the growth of hydroponic plants up to four times for some vegetables and herbs. The advantage of the Aquaponics vegetables over vegetables grown in soil is that during the warm season plants get water as much as they need due to regular flooding of the Grow beds whereas in regular farming the land could go dry for an extended period of time.

Plants grown in the ground can use water around their roots very quickly in hot weather, which leads to wilting if there is a lack of water on a hot day. In an Aquaponics system, plants are watered continuously, so that they always have water, regardless of the ambient temperature.

1.6. Fish within aquaponic systems

1.6.1. The importance of fish in aquaponics

Fish are the motor of your Aquaponics system, they provide nutrients for vegetables/plants and if your fish are edible, they also provide a source of protein. Raising fish can be a little intimidating for some, especially those without any previous experience, but you should not be discouraged. Raising fish in an Aquaponics system is simpler than raising them in an aquarium, as long as you follow simple instructions, then the growth of your fish will be healthy and possible to eat if desired.

1.6.2. Choosing the correct species of fish

There are many different species of fish that can be used in an Aquaponics System. The fish should be chosen depending on the temperature of the water in which they will live and obviously the ease of supply. It is common in some countries of seasonal production of fish. In Australia for example, Aquaponic Systems are widely used and it is not uncommon to see the farming of trout in winter and Barramundi or Tilapia in summer. There is also the possibility to use only one species that can live both in summer and in winter, but these fish take in general more time to grow. In France the Trout keeps steady growth throughout the year and are common in our country. Worldwide, the most used fish are Tilapia, the Barramundi and Nile perch. These three fish require a heated water.

To decide what may be the best species of fish to raise for you, you need to take a few factors into account, the most important is to know what you want to make your system. If you do not want to eat your fish, then you'll probably not want to raise edible fish, or you might want to raise edible fish that can live year-round in your area, so you won't have to change according to the seasons. The second most important factor is 'what is available ?' You must be able to buy fish to keep using your system, even with species such as tilapia, which grow rapidly, you need to keep a good supply.

Here is a list of useful species in aquaponics with some details about each of them.

1.6.2.1. Barramundi

Barramundi is often used in Aquaponics Systems during the hottest months of the year. Most producers buy fish of big size to be able to have big fish, at the end of the season. Barramundi in Aquaponic systems have a thin and crispy taste. The rearing of Barramundi will excite your guests. They will give a good harvest at the end of the season and are one of the most majestic species of edible fish.
{{ :barramundi-poisson-aquaponie.jpg?200 |}}

1.6.2.2. Catfish

There are many different species of catfish worldwide that are well adapted to Aquaponics. The bearded of the rivers is the highest population of the aquaculture species to the United States, and they are available in many countries of the world. Catfish have no scales, so they must be skinned, they are fast-growing and have a very good taste.
{{ :poisson-chat-aquaponie.jpg?200 |}}

1.6.2.3. Carp

There are many species of carp that could be very well adapted to Aquaponics. Unfortunately, because of their reproductive capacities, their rude

nature and ability to adapt in many circles, carp have become harmful pests for the environment. In most Western cultures, carp also have a rather poor reputation in gustatory terms. However Carp is still the highest populated fish in the world and in particular in Asia.
{{ :carpe-poisson-aquaponie.jpg?200 |}}

1.6.2.4. Red fish

Although some people may group them with carp, I decided they be treated separately as most people refer to them as the goldfish, and they will be sold as such, in pet stores or local suppliers of fish. Goldfish are usually easy fish to keep and make a great addition to an Aquaponics system. In many regions, they will breed in an aquarium, but they usually need cover in the aquarium to breed.
{{ :poisson-rouge-aquaponie.jpg?200 |}}

1.6.2.5. Jade perch

This native fish from Australia deserves special mention because it has the highest rates of acids, fats, and omega-3 than all other species of fish in the world. In fact, it is so rich in omega-3 that the producers are trying to raise less oil-rich fish, they are trying to create a less oily strain, because they have found that consumers do not like the high oil content.

They live in hot water and are omnivores. Very well suited to Aquaponics as they grow quickly and can are eaten widely across the world in warmer regions.
{{ :perche-jade-poisson-aquaponie.jpg?200 |}}

1.6.2.6. Koi carp

Once more, another species of carp, but better known as 'Koï' rather than Carp. Koi are very common in many Asian communities and they are often found in large aquariums as ornaments. For those who love Koi an aquaponics system is an ideal way to raise these fish.
{{ :carpe-koi-poisson-aquaponie.jpg?200 |}}

1.6.2.7. Murray cod

The Murray cod is a beautiful Australian native fish which is known to grow to gigantic sizes in their natural habitats. The Murray cod is high in recirculating aquaculture systems and can also be found in many Aquaponics systems. I hope that this fish will be used more and more over time because it is quick to grow and is a very good fish to eat. One of the disadvantages is that they must be kept at high densities and be well fed otherwise they will eat each other.
{{ :morue-murray-poisson-aquaponie.jpg?200 |}}

1.6.2.8. White perch, bar-perch or small bar

The white perch is another Australian native fish that grows well in certain conditions. The Poles are omnivorous and will gladly eat the Green remains as well as the duckweed. They develop at all temperatures and they do not have a rapid growth as many other fish and take 12 to 18 months to reach the correct size to be eaten.
{{ :barret-perche-blanche-poisson-aquaponie.jpg?200 |}}

1.6.2.9. Tilapia

Extremely popular in aquaponics systems. It is an ideal species for Aquaponics for many reasons. Easy reproduction, fast-growing, resistant to very poor water, omnivorous diet and are good to eat. The only negative point for some people will be Tilapia need hot water. If you live in a cold place, it would be preferable to choose a species of fish which is acclimated to your latitudes, rather than trying to heat the water. Tilapia is also regarded as harmful in many areas.
{{ :tilapia-poisson-aquaponie.jpg?200 |}}

1.6.2.10. Trout

The trout is a largely used fish for Aquaponic Systems where temperatures are a little cooler. Trout prefer water between 10 ° C and 20 ° C temperatures. They have extremely fast growth rates and are very good to eat.
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1.6.2.11. Other species

There are other species of fish that are quite suitable for Aquaponics, which may be available in your area. In Europe many different species of carp are high and within the United States species such as Bluegill are often available.
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Other aquatic animals which can be incorporated into an Aquaponics System are Freshwater mussels, Freshwater prawns and Freshwater crayfish. The mussels filter water and do a great job to help clean up the water, they will be happy to grow in flooded culture beds or can be incorporated into ponds with fish. Crustaceans are a nice addition to an Aquaponics system and there are a few different types available depending on your latitude and water temperature.

For those who live in tropical regions, there are crayfish which have rapid growth and for those in cold climates there is the Yabbies or the Brown.

The Yabbies breed easily in a good environment and proper temperatures, with long hours of clarity. They rise fairly quickly, but they can be prone to fights and cannibalism when they become too numerous.

1.6.3. Number of fish

This is a subject of debate among people who practice Aquaponics. Levels of fish stocks in a system can be as high as in intensive aquaculture, but if the density is high there is more probability that things can go wrong. In high density you need to keep a constant eye on all parameters of the water to be sure that the conditions are maintained at the optimum level.

If you lower the levels of fish stocks you reduce your risk. The rates of growth of plants in the slightly dense systems may still be very impressive.

1.7. Starting the aquaponics system

There will be many ways in which we can create a successful system. We must always remember that in an Aquaponics system we need a 'cycle' system, which means we must establish our population of bacteria in the system so that they can convert the ammonia into nitrates to allow vegetables/plants to grow.

It would be beneficial to use an existing tank where natural bacteria has already grown and developed but as we are creating a new system then we must allow time for the bacteria to grow so that it can alter the ammonia into nitrites and nitrates so the plants can use these and grow. Without this bacteria fish cannot be introduced as the filter will not work and this will be harmful to the fish population. It is possible to encourage this bacteria through certain Grow Bed media.

We have to keep in mind that the most important thing is to get a 'cycle' system, it is a good idea to allow our system to run about a day or two before the introduction of fish or before making long-term plans mainly because we must ensure that the system works well and that there are no leaks or other potential problems that can be harmful to the fish.

1.8. Cycling the System

1.8.1. Urea-based fertilizer

A method to add a source of ammonia to assist in the establishment of our beneficial bacteria colonies is to use urea fertilisers, generally available in gardening, hardware stores or nurseries. It is a fairly simple method for a cycle system but we must be careful about the dosage and regular water analyses are recommended.

1.8.2. Ammonia

Household ammonia may come from several different sources. As with urea, special precautions are necessary to ensure that we do not exceed the critical dose for our system. We also must ensure to use only ammonia that does not affect food quality, there are many industrial ammonia for cleaning that tend to be scented or contain other additives.

1.8.3. Dead Fish/Crustacean

It involves placing a little fish or rotten crustacean in our system to allow ammonia emission which will feed our bacteria. Simple as it is a natural source of Ammonia.

1.8.4. Fish food

We can start our Aquaponics system cycle by introducing fish food that we will use to feed our fish in our system, food will begin to break down on the bottom of the basin, this release of ammonia will cycle into our Grow beds and allow bacteria to grow.

1.8.5. Urine

Yes it's strange, but some people start their aquaponics system and the cycle by adding urine. Urine contains urea and urea breaks down into ammonia. This method is not suitable if any medical substances are currently being used.

2. Sensors

3. Conclusion

There are really no limits to the ways in which we can design an aquaponics system. However it is recommended to start with a simple system, so that we can get an idea of how it works before trying more complex methods. Methods of flood and drain are much more favorable than the continuous flow methods and we will look into how we can use this method within an indoor system.

The main decisions to be made are the Fish and Plants that are to be used within the system and whether both or one will be consumed. As we are looking at a small indoor system it would be wise to use the fish as a view only part of the system as they are often kept as pets.

Chapter 3: Project management

Chapter 4: Marketing plan

Chapter 5: Eco-eficiency measures for sustainability

Chapter 6: Ethical and deontological concerns

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