AQUAPONICS

THE ESSENTIAL GUIDE

A STEP-BY-STEP AQUAPONICS GARDENING GUIDE TO GROWING VEGETABLES, FRUIT, HERBS, AND RAISING FISH

ANDY JACOBSON

FRUGAL FREEDOM

The Essential Aquaponics Guide

A Step-By-Step Aquaponics Gardening Guide To Growing Vegetables, Fruit, Herbs, and Raising Fish at the Same Time

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Foreword

“To plant a garden is to believe in tomorrow.”
- Audrey Hepburn (1929 – 1993)

Aquaponics captured my interest and fascination the first time I heard about this farming tradition and the theory that underpins it. In my eyes, the most beautiful aspect of aquaponics is that it mirrors nature in its harmonious self-sufficient eco-cycles. This innovative production process is something I wish to share with you. Water is what keeps ecosystems thriving and is essential to our very existence. Water is the foundation of life. Sadly, and worryingly, water scarcity is a profound and imminent problem in today’s world. Because of all this, the use of recycled water in aquaponics has never been more attractive.

Motivated by the potential to make food security a priority and frugal living a possibility, I am thrilled to take you on an aquaponic voyage – from guiding you through how to build your own fully-sustainable aquaponic garden to breaking down the science into concise, proven steps on how to yield the best results. This easy-to-follow guide is carefully tailored toward hobby gardeners as well as more advanced explorers of urban homesteading.

For your best understanding and results, I recommend reading this book in the order it has been structured with. This essential aquaponics guide will cover the following: An introduction to aquaponics, how it works and its benefits, the best plants and fish to use, aquaponic system designs, how to assemble, cycle and maintain your aquaponic garden, and much more! All information will be presented with clear explanations, reference pictures and diagrams. This DIY guide will give you all the tools you need to create your own aquaponic Eden which will provide you with fresh and organic greens all year round.

By the end of the book, you will be able to create your own customized aquaponic garden by choosing and combining some of the systems and growing options we supply, depending on your food growing goals.

The ultimate goal? To allow you to grow your own food from the comfort of your own home whilst paving your path to a frugal, self-sustaining lifestyle.

Best Wishes,

Andy Jacobson

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Section 1: An Introduction to Aquaponics

“The home gardener is part scientist, part artist, part philosopher, part ploughman. He modifies the climate around his home.”

- John R. Whiting

What is Aquaponic Gardening?

Aquaponics is a revolutionary, highly effective gardening system which combines conventional aquaculture (raising aquatic animals in tanks) with hydroponics (cultivating plants in soil-free media). In a symbiotic environment, it raises both fish and plants in mutual ecological harmony. Like Hydroponics, the aquaponic growing methods don’t require any soil and instead make use of highly oxygenated, nutrient-rich water.

Aquaponic gardening is highly productive in growing organic vegetables, herbs, fruits and raising fish. More so, aquaponic systems are four to six times more productive than ordinary gardens and require 90% less water. On a small scale, they provide a cost-efficient alternative to families and anyone seeking self-sufficiency. On a larger scale, they are a potential solution to urban food insecurity.

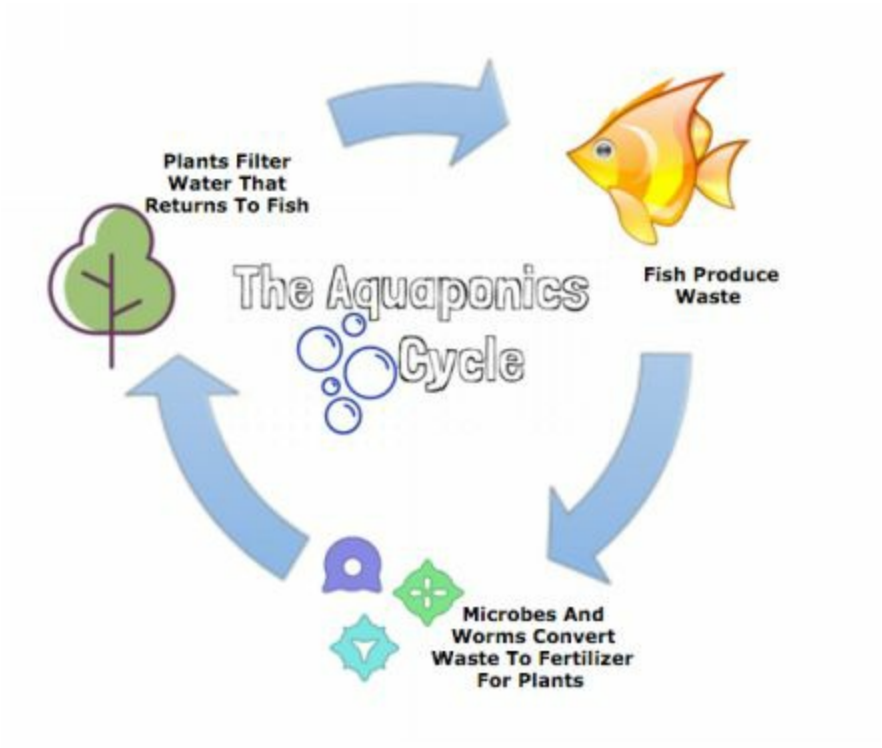
Not only is aquaponics among the most effective gardening techniques, but it is the easiest way to grow herbs and vegetables. Aquaponic systems are self-regulating: you don’t have to water your plants and you don’t have to clean the fish tank. Aside from some simple maintenance tasks (which we will outline in ***Section 10***), the only thing left to do is to feed your fish and harvest your vegetables!

The Aquaponic Cycle: How It Works

Put simply, as water is pumped from the fish tank to the grow beds, the fish waste is converted to organic food for your plants. Your plants in turn clean, filter and recycle the water for your fish. Because aquaponics is a closed and recirculating system, it gives rise to naturally occurring bacteria (microbes

and worms). These bacteria and worms break down the fish waste (ammonium and nitrites) into fertilizer for your plants (in the form of nitrites).

When absorbing these nutrients, plants naturally filter the water. The clean water then streams back into the aquarium, providing your fish with a clean and oxygenated environment in which they can thrive.



This growing method is environmentally-friendly, natural and economical. Using natural bacterial cycles, it eliminates all need for expensive chemical fertilizers and water filters, all whilst avoiding waster wastage.

We will expand on the many benefits of aquaponics in the next section, before moving on to how you can get started on your journey to self-sufficiency and food independence!

Section 2: The Benefits of Aquaponic Gardening

"The destruction of aquatic ecosystem health, and the increasing water scarcity, are in my opinion the most pressing environmental problems facing human kind."
- *Maude Barlow*

Sustainable Aquaculture:

In aquaponic cycles, the same water is used to raise both fish and plants. Fish waste is used as fertilizer to grow agricultural products. Plants in turn filter and recycle the water, thereby cleaning the fish tank and allowing your fish to thrive. This makes aquaponics one of the most waste-efficient, water-saving and most natural farming systems.

Low Maintenance and Greater Yields:

Because aquaponics mimics the natural ecosystem, maintenance requirements are extremely low when compared to other agricultural systems. There is no ploughing, tilling, mulching or weeding to do. Apart from feeding your fish and some simple maintenance checks, there is not much else to do other than to harvest your produce. You will find more on maintenance in ***section 10*** of this guide, where we will outline the daily, weekly and monthly checks and tasks recommended to keep your system healthy.

Despite lower maintenance requirements, aquaponics is among the most efficient growing methods. Aquaponics is said to be 4-6 times more productive than traditional farming.

For Health Reasons:

When compared to traditional agricultural farming, aquaponics is both safer and much cleaner. On top of this, aquaponic gardening is completely organic! The dangers of pollution, pesticides and other risks associated to the use of chemicals is greatly reduced as well. Furthermore, because the plants are not grown in soil, this eradicates all risks of soil-borne diseases and weeds.

For Environmental Reasons:

Modern aquaponics uses a small amount of freshwater and little energy. Although aquaponic gardening does require some energy (to power the pumps), this is significantly less when compared to soil-based farming. Modern agriculture is a massive contributor to climate change. Other overuse of petroleum use in traditional farming is vast and the consequences devastating. Because aquaponic systems are soil-free, this removes the need for tractors and other farming equipment. In addition to this, there is also no need for petroleum-based fertilizer nor chemical pesticides in aquaponic gardening.

More importantly, because aquaponics is a closed and recirculating system, there is virtually no water wastage.

Self-sufficiency:

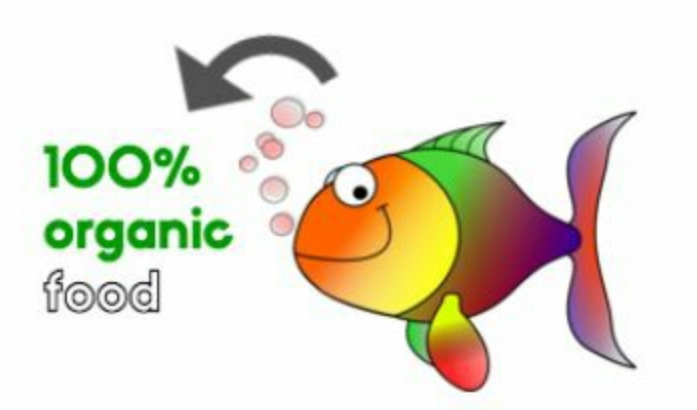
Once your system is fully cycled (a process explained in ***Section 9*** of this guide), it is extremely sustainable and self-sufficient. You are not dependent on arable land nor restricted by climate. Productive and fertile soil is a nonrenewable and endangered ecosystem. In aquaponics, there is no soil to show tiredness and which might be at risk of erosion and degradation.

Not only is aquaponics therefore the ideal solution for the urban gardener, but also for communities that live on non-fertile land. In a global context,

aquaponic gardening therefore provides a potential solution to food shortages around the world.

Organic Fish:

Furthermore, buying sustainably grown and harvested fish today, is a difficult undertaking. Being able to grow your own fish is thus a more convenient, more ecological; a fresher and safer alternative.



Aquaponics vs Hydroponics

Aquaponics, essentially, is a hydroponic growing technique in that it requires no soil. Both are highly efficient methods for growing plants which achieve results that are greater than those found in soil-based gardening. In many ways however, aquaponics is an improvement to hydroponics. Fish waste replaces expensive chemical nutrients and there is no need to throw away your nutrient solution. Additionally, once your aquaponic bio-filter is fully established (usually after six months), aquaponics is said to produce greater and faster-growing plants when compared to hydroponics.

Now that we have a sound understanding of the many benefits of aquaponic gardening and it potential impact locally and globally, this is now a great time to start considering the different types of hydroponic systems that are possible.

Section 3: The Design of Your Aquaponic Unit

"One of the most delightful things about a garden is the anticipation it provides."

- W.E. John (1893 – 1968)

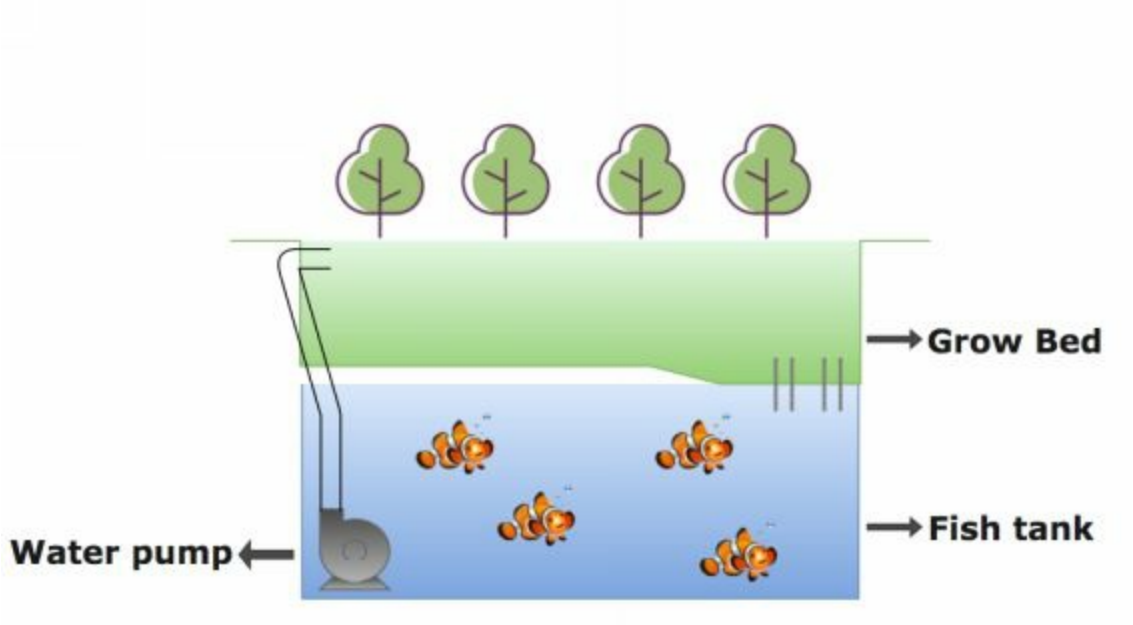
In this section, I will explain the essential elements of your aquaponic garden. This is to give you a general idea of the outline and possible designs of aquaponic systems. Later on in the guide, I will discuss the importance of sizing and ratios, as well as how to assemble and construct your own aquaponic unit.

Let's begin with the outline of the basic flood and drain system before explaining how you can advance your system with time.

For Hobby Growers:

Flood and Drain

The flood and drain system is among the easiest systems to assemble. When starting to build your aquaponic garden, I would always recommend to start with a 1:1 ratio between the grow bed and the fish tank. In other words**,** try and select a grow bed that mirrors your fish tank in volume size.



How it works:

- The grow bed is raised above the fish tank.
- Water is pumped from the fish tank into the grow bed.
- The plants filter and recycle the water.
- The clean water flows back into the fish tank through the draining pipes as a result of gravity.

Water movement is central to the health of your system. As a general rule, try and cycle the water of your system twice every hour. For example, if your system contains a volume of water which is 1000 liters, the rate at which your water flows should be 2000 liters/hour.

After 4 to 6 months…

While your fish are still small and are producing relatively little waste, I would recommend sticking to one grow bed. But once your system has matured (after 4-6 months) and your fish have grown, you may wish to add another grow bed.

Achieving the 'flood and drain' effect

There are two ways in which you can create the flood and drain effect. In

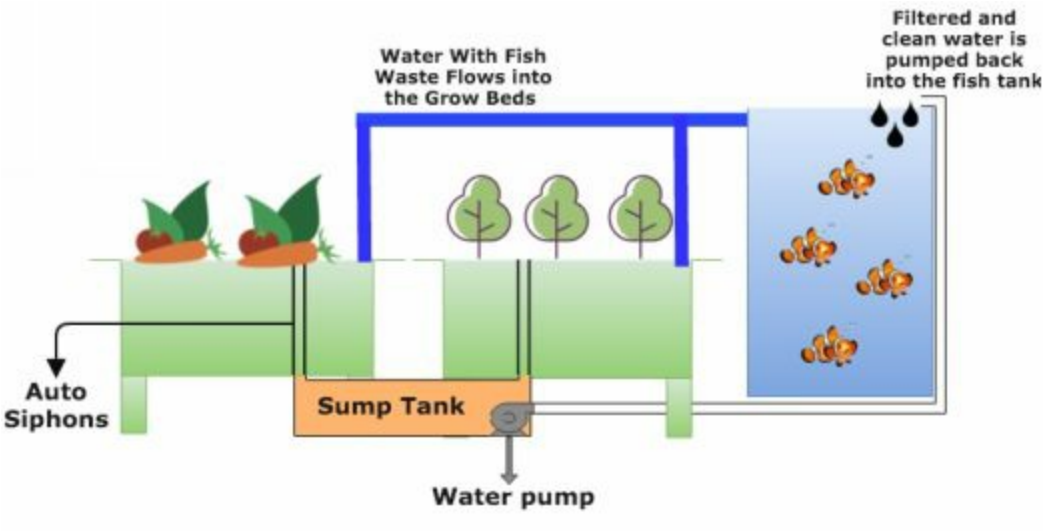
both plumbing systems, the pump is located in the fish tank. The first option is to have a standpipe in the grow bed alongside a timer on the pump. Alternatively, you can use an auto siphon in the grow bed along with a continuous pump.

We will explore more deeply how these plumbing systems work and how you can set them up in *Section 8* of this book, where we will will provide you with a shopping list as well as a step by step guide to building your very own aquaponic system.

For the Ultimate Garden Guru

The CHIFT PIST System

You might also be interested in the following more complex aquaponic set-up.



This system design is called CHIFT PIST, which stands for 'constant height in fish tank, pump in sump tank.'

How it works:

- Water from the grow beds flows into the sump tank by the force of gravity.
- This recycled water is pumped into the fish tank either

continuously or periodically by the pump located in the sump tank. For periodic pumping, you can install a float switch which will activate your pump once the water in the sump tank has reached a certain level.

- Water from the fish tank flows into the grow beds as a result of gravity through an overflow pipe. Because of this, the fish tank will remain at a constant water level.
- Water level in the grow beds are controlled by auto-siphons, which drain excess water into the sump tank.

Which of the above system you choose will depend on a number of factors: If you wish to keep it relatively small-scale, I would highly recommend the basic flood and drain system. If you wish to grow more vegetables and are concerned about saving energy, the CHIFT PIST system should definitely be the one to go for.

In the next section, we will explore the different available mediums that you can use in your aquaponics system as a substitute to soil. We will then delve into the different fish species and plants species that are well suited to aquaponics.

Section 4: Media-based Aquaponics

There are other aquaponic systems that exist, for example the raft system (deep-water culture), as well as the Nutrient Film Technique (NFT). Please note that this guide will only cover media-based aquaponics for multiple reasons.

A key reason why I only cover the media-based approach is that this is the only system which allows you to grow the greatest variety of plants. In the raft system for example, only small leafy vegetables can be grown. Alongside greater flexibility and greater choice, the media-based system is the most frugal, energy-efficient set-up, and the one which also requires the least maintenance. Because of this, media-based aquaponics is the single most suited system for backyard aquaponics and, in my opinion, even for commercial growers.

The Media-filled Bed Method

A media-filled bed is a vegetable bed filled with 'growing media.' The media, in many ways, replaces soil and its purpose. Functionally, the media acts as a filter as well as coat, protecting roots from rapid changes in temperature, otherwise detrimental. Structurally, the media acts as a platform for CO2/H2O exchange, and as a home for worms. Worms?

Yes, the secret to these vegetable beds are red worms; also called red wigglers. These red wigglers are composting worms which do a tremendously great job in breaking down the solids in the vegetable bed, keeping your garden clean and tidy. On top of this, red wigglers also create fertilizer – providing additional food to your plants.

Selecting the ideal media:

There is a variety of requirements when it comes to selecting the right media. Among the most important are that they don't decompose, are resistant to changes in pH and also the correct size. Media that is too small becomes

clogged whilst media that is too big creates air pockets which are not favorable to your plants.

Below is a list of media I have used and recommend, and which also fulfil all of the above requirements:

Expanded Shale: This is acquired from quarries. Expanded Shale is pH neutral with round edges and therefore easy to handle and also good for your plant roots.

Expanded Clay (Hydroton): Like Expanded Shale, Expanded Clay is also mined from a quarry, pH neutral and easy to handle.

River stone: River stone is heavy but easy to handle. Please note however that river stone is the riskier option. If your batch contains limestone, this could raise the pH levels in your growing bed, which would make the grow media unsuitable to your aquaponic system. To test whether it contains limestone, rinse your stone and place it in a cup of vinegar. If you can observe fizzing bubbles coming to the surface, don't use it.

The same test can be used on gravel. Although gravel is also one of the cheapest options, it's not one that I would personally recommend. If you do however opt for gravel, please make sure it doesn't contain any limestone or marble.

Synthetic media: Synthetic media is made from petroleum and is pH neutral and very light. Synthetic media has the ideal qualities for an aquaponic media grow bed, however, it tends to be more expensive compared other grow medias.

Whichever media you choose, make sure to thoroughly wash it before using it in your system! Now that you have a general knowledge of the mediums that can be used to support the growth of your plants, in the next section it's time to learn everything you need to know about fish!

Section 5: Fish: Selecting, Purchasing and Breeding

“Growing your own food is like printing your own money.”

- Ron Finley

Selecting the Right Fish for You

When selecting your fish beware that you must use freshwater fish only. This is because extended exposure to sodium in salt water is not an ideal environment for your plants.

Below are a list my favorite fish as they are very well suited to be raised in an aquaponic garden. Please note however that it is advised to stick to one fish type per tank because different fish are best suited to specific water qualities:

- Tilapia
- Goldfish
- Perch
- Catfish
- Peruvian Pacu
- Oscars
- Trout
- Koi
- Freshwater prawns

Of course, there are many other options open to you, including barramundi and even freshwater lobster!

For beginners and anyone taking their first dive into aquaponics, I would highly recommend Tilapia and Goldfish, depending whether you wish to raise fish for food or not. Both fish produce very high levels of ammonia, providing your plants with a lot of organic food. Both fish are also extremely resilient to changes in temperature, pH levels and pollutants.

Tilapia are the most frequently used fish in aquaponics and there is a reason

for this! I highly recommend this fish due to the qualities they possess. Not only are Tilapia easy to breed, they are also among the fastest growing fish and can tolerate and survive in very poor water conditions.

For vegetarians and gardeners not interested in breeding but rather in raising beautiful fish, I would recommend both koi and goldfish. These are both ornamental fish that are at the same time well-suited to aquaponics. If you're not too fussed about which fish to choose, I would suggest you start with goldfish. Goldfish are easy to grow and easily acquired. On top of this, they tolerate a wide range of temperatures and conditions, produce good waste for your plants and also live comfortably in small aquariums.

When deciding which fish you choose, the following are key factors to take into account:

Stock density: The size of your aquarium will affect the size of fish that is best suited to your aquaponic garden. As a general guide, you can grow approximately 500g of fish for every 5 to 7 gallons of fish tank water.

Edible vs ornamental: As previously discussed, your choice of fish will depend on whether or not you seek to raise fish for food.

Water temperature: Different fish have different temperature requirements. We will outline the temperature requirements of the most popular fish later on in this section.

Oxygen requirements: Certain fish will survive in low quality water, that is, water with low oxygen levels. However, highly oxygenated water will allow your fish to thrive. More on oxygen requirements of your fish later on in this section.

Carnivore vs Omnivore:

Whichever fish you choose; they will have specialized feeding needs. Beware to keep the diet of your fish in mind when selecting which fish species to opt for.

However, don’t worry too much about which fish to raise – you can always change your mind at a later stage!

Purchasing your fish:

When purchasing your fish, these are a few tips and tricks to keep in mind. First of all, the most cost-efficient way to acquire fish is by purchasing fingerlings. Fingerlings are small young fish, which are both inexpensive and easily transportable. Don’t worry if you don’t live near a fish farm as there are also many hatcheries that sell online.

The ideal environment for your fish:

Remember that different fish have different requirements which is dependent on their natural habitat.

To make your fish selection process easier, I have included the fish requirements of some of my favorite fish below. It is important to bear in mind that fish will reach their highest metabolic rates in their most comfortable temperature and thus provide most fertilizer to your plants when kept in their ‘optimal’ environment. Keeping fish in the right temperature is also best for their immune system which directly affects their life cycles as well as the health of your plants.

<u>Edible fish</u>

Tilapia:

Tilapia originate from the waters of Africa and therefore thrive most in warm waters. Their optimal temperature is 74 – 80 ºF, although they can tolerate temperatures ranging from 60 – 95 ºF. Furthermore, Tilapia naturally live in ponds and lakes. Because of this, they are used to relatively low quality of water and limited amounts of oxygen and can therefore survive in environments which would generally be considered less than favorable.

Catfish:

Their optimal temperature is 75 – 85 ºF, although they can tolerate temperatures ranging from 35 – 95 ºF. Like Tilapia, Catfish originate from ponds and lakes and can also survive in low oxygenated, low quality water. However, as a general rule of thumb, all fish do best in water with great amounts of oxygen.

Trout:

Trout originate from North America and therefore prefer colder water. Their optimal temperature is 55 – 65 ºF, although they can tolerate temperatures ranging from 35 – 68 ºF. Because trout hail from streams and mountain rills, they are best adapted to water high in oxygen.

Another important factor to keep in mind is that trout are carnivores and thus require a high-protein diet. To sustain this, I would advise to purchase commercial fish food of high quality and nutrition. When dealing with carnivorous fish, it is likewise recommended to only keep fish of

approximately the same size together in a tank. This will save your smaller fish from being eaten by their big brothers.

Ornamental fish

Goldfish:

Their optimal temperature is 65 – 75 ºF, although they can tolerate temperatures ranging from 35 – 95 ºF. As goldfish are routinely kept in ponds, they too, can survive in low quality water with limited amounts of oxygen.

Koi:

Their optimal temperature is 65 – 75 ºF, although they can tolerate temperatures ranging from 35 – 95 ºF. Like goldfish, Koi can also live in waters with lower levels of oxygen. Unlike goldfish however, Koi can prove slightly harder to source. It is advised to consult a specialty aquarium shop as well as to explore the many koi variations available.

Feeding your fish:

Be careful not to overfeed your fish. A good indication as to how much food to feed your fish is to feed your fish as much as they can eat within 5 minutes.

If your fish aren't eating, this can be a sign of stress either due to a lack of oxygen or because the water temperature is outside their optimal range.

Before we move on to the best plants to grow in your aquaponic garden, it is important to note the dangers of temperature swings. Although fish can tolerate varying temperatures, fast changes in temperature should be approached with caution. If you experience temperature changes of more than 3 – 4 ºF within 24 hours, it is advised to ***immediately*** stop feeding your fish. This is because temperature swings can cause gut bacterial problems that may be fatal to your beloved fish.

Now that we have covered the different fish species well suited to aquaponic systems and their optimal environments, it is time to explore the plant species which will guarantee you the greatest success on your aquaponic journey!

Section 6: Picking the Best Plants

“Gratitude for the seemingly insignificant – a seed – this plants the great miracle.”

- Ann Voskamp

To give you an idea of the range of produce you can grow, the following is a list of plants which are commonly grown and which are known to flourish and respond exceptionally well to aquaponic gardening:

- Salads (everything from lettuce to spinach)
- Herbs (including basil, parsley, watercress, coriander, sage, lemongrass)
- Chives
- Broccoli
- Cauliflower
- Tomatoes
- Peppers
- Egg plant
- Choy
- Cucumbers

- Beans and peas
- Squash
- Melons
- Strawberries

Beyond these possibilities, the variety of plants you can grow is even greater! So what can't you grow in your aquaponic system? The only plants you cannot grow are those that require a pH level beyond your optimal range. Aquaponic systems only support a pH of 6.8 – 7 (more on pH and how to control and change pH levels in ***Section 9***). Blueberries for example, which require very acidic soil, are not well suited to aquaponics. The list of acid-loving vegetables and fruits however, is very small and hardly restricts the variety you can grow.

Timing

In any case, I would recommend starting with lettuce and other leafy greens as they have relatively low nutrient requirements. This means that they are best supported and will still successfully grow in developing aquaponic systems. This is because fingerlings will produce relatively little waste when compared to adult fish.

Once your fish have grown and are producing more waste (plant food) they will also be able to support the growth of plants with higher nutritional needs, such as tomatoes and squash.

Section 7: Selecting Your Grow Bed and Fish tank

The grow bed and fish tank are the backbone of your aquaponic system and it is therefore crucial that you select these carefully.

Like the ecosystem you are trying to replicate, there needs to be a balance between the amount of waste produced and the number of plants to take up the waste. If there is too much waste in your system, your fish suffer. If there is too little waste, your plants suffer. It is therefore incredibly important to get the ratios right when designing your aquaponic system.

When selecting your grow bed and fish tank, although it may sound obvious, it is absolutely critical that they possess the following qualities: water tightness, strength and non-toxicity. Furthermore, it is important that the material out of which your grow bed and fish tank are made from, are inert, i.e. not able to affect the chemical composition of your aquaponic system.

Grow bed:

When selecting and purchasing your grow bed, it is to be noted that it should be at least 12 inches deep. This will allow you to grow a wide variety of plants (with different root lengths), as well as provide complete and efficient filtration.

Fish tank:

Although space-permitting, I would always suggest that beginners start with a fish tank of greater volume because these are easier to control and the consequences are usually less devastating when an error is made. A 1000+ liters' tank (250 gallons) will generally allow for the most controllable and most sustainable aquaponic garden.

Ultimately however, you can be relatively creative when selecting (and purchasing) the elements that will make up your aquaponic backbone. Among my favorite materials and products to use are stock tanks. I would always opt for stock tanks made of plastic as there are no risks of leached

metals or rusting.

If you do opt for the more visual steel stock tanks, make sure you coat or line it to avoid potential leakages of metals. However, you are also free to be a lot more creative. You can recycle old bathtubs, or even explore vertical aquaponic gardening.

For indoor aquaponics, I would highly recommend using an aquarium for the fish tank. Not only are these robust and widely available, but aquariums also make a great home feature, especially when you plan on raising ornamental fish only.

Fish tank to grow bed ratio

In the beginning stages, I would always recommend that you start with a 1:1 ratio, that is, a grow bed volume which is equal to the volume of your fish tank. Once your system has matured (after approximately 4-6 months), you may wish to add another vegetable grow bed. This 2:1 ratio is often preferred especially when you do plan to keep your fish tank fully stocked at all times.

Now that we have almost covered everything you need to know put together a successful aquaponic system, you are very close to your goal of having your own aquaponic garden unit!

Section 8: Building Your Aquaponic Garden

“True happiness comes from the joy of deeds well done, the zest of creating things new.”

- Antoine de Saint-Exupéry (1900 – 1944)

Before we delve into how to build your aquaponic system, I thought this be a good time recap on all the different elements you need to purchase to start assembling your aquaponic garden.

In previous sections, we have discussed the species of plants and species of fish which are well suited to aquaponics. We have also discussed key criteria to keep in mind as well as the different options available when selecting and purchasing a fish tank, grow bed or growing medium.

In this section, before providing you with a step-to-step guide as to how to assemble your system, we will discuss how to choose and select key elements of your plumbing system and how to ensure efficient water circulation.

<u>Aquaponic Shopping List</u>

Substantial parts:

- Fish tank
- Grow bed
- Growing medium
- Dechlorinated water
- Water pump
- Plastic tubing
- Standpipe and timer *OR* bell siphon
- Freshwater test kit

Living components:

- Red worms

- Fish
- Plants

Optional materials:

- Air pump
- Liquid ammonia
- Lights

Choosing the right-sized pump for your aquaponic system

The success of your aquaponic system will depend on the water quality of your system which is ultimately also dependent on high oxygen levels. When it comes to picking the air pump for your fish, a regular aquarium pump will suffice. Because your system is dependent on oxygen, I would highly advise to invest in a reliable air pump.

Arguably, if you replicate the systems as outlined in ***section 3***, you will not necessarily need an air pump. This is because the draining action does inject oxygen into your system. I personally however prefer having an air pump just because you can't ever have too much oxygen!

More importantly, effective water circulation is central to the health of your aquaponic system. Your water pump is the heart of your aquaponic garden which circulates the water through the system. Because of this, it is crucial not to cut corners nor skimp when selecting your pump. Mag-drive pumps are best suited to aquaponics. Because the motor is sealed, this eradicates the risk of oil leakage into your water. Whatever choice you make; I would always advise sticking to a trusted source of pump providers.

Plumbing

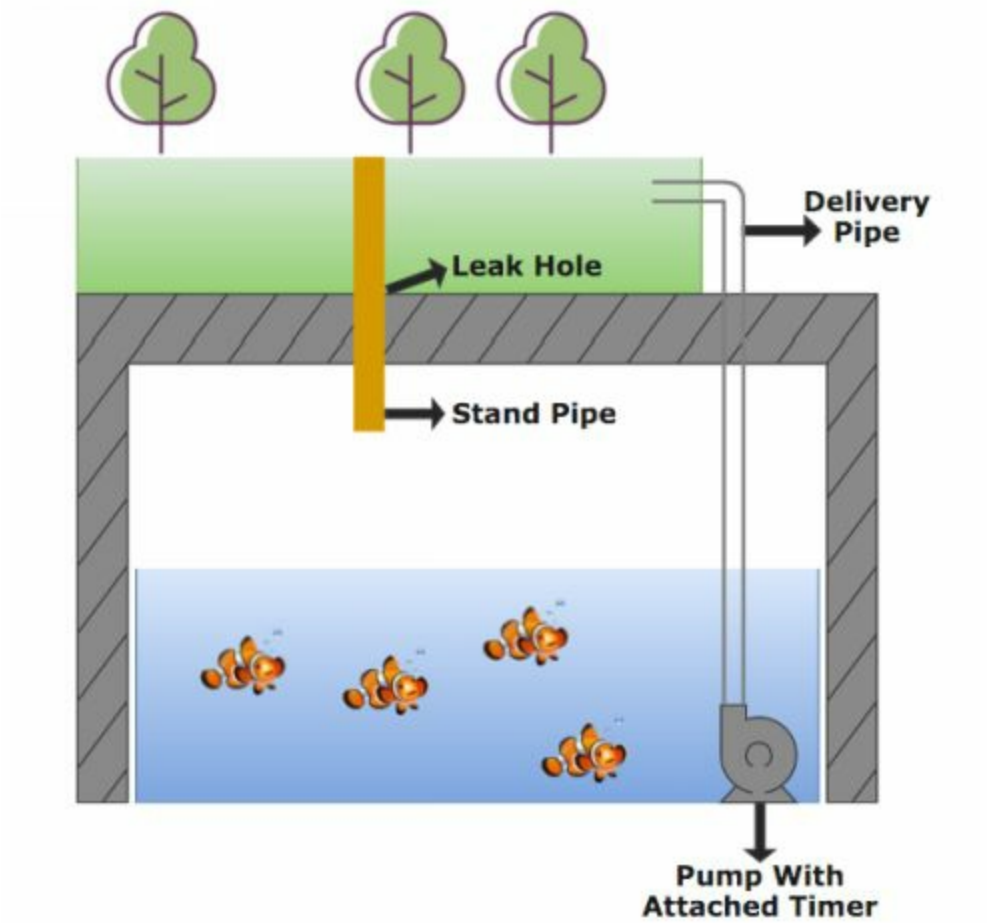
An ideal and widely-available material for your aquaponic piping is PVC or CPVC. Both materials are inexpensive, food-safe, durable and don't develop rust and are therefore ideally suited to aquaponics.

The grow beds and fish tank need to be connected through plumbing. As

explained in ***section 3***, there are two ways in which you can achieve the flood and drain effect.

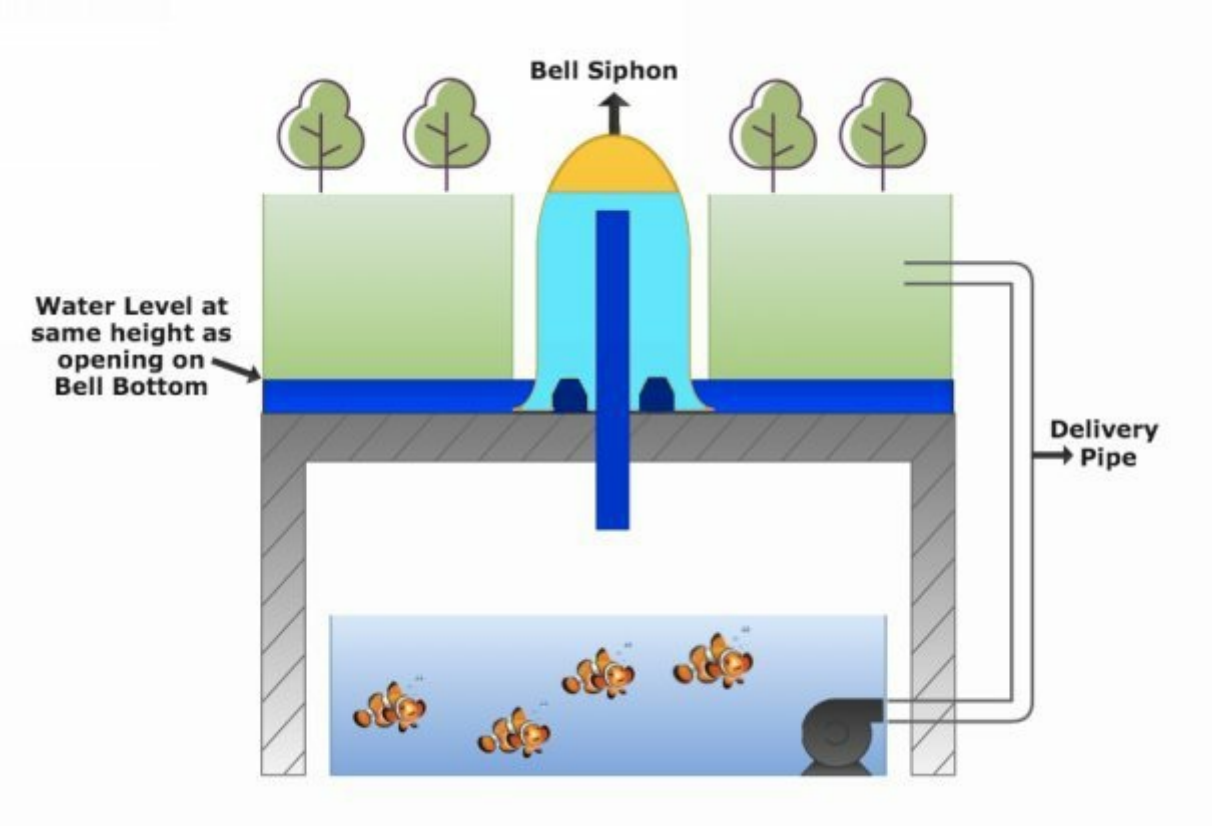
The Timed Flood and Drain System:

1. In this plumbing system, you have a standpipe connecting your grow bed and your fish tank and the water pump is controlled by a timer.
2. The timer, which is attached to the water pump, powers the pump for 15 minutes every 30-45 minutes.
3. During this time, water enters your grow bed ‘flooding’ your grow bed.
4. After the 15 minutes have expired, the pump switches off.
5. The recycled water in the grow bed then drains through the standpipe back into the fish tank.



The Auto Siphon System

1. In this system, the pump is continuously pumping water from the fish tank into the grow bed.
2. This pumping causes air to be sucked out of the siphon which triggers a rapid draining of water from the grow bed back down into the fish tank.
3. Once the grow beds are almost entirely drained, air enters the siphon which stops the draining action.
4. At this stage the cycle repeats itself and the grow beds start filling up again.
5. In order to achieve the ‘flood and drain’, water has to be pumped into the grow beds at a slower rate than the draining action.



Step-by-Step Guide to putting together your aquaponic system

1. Wash your growing media and place it into the grow beds.
2. Place the grow bed above the fish tank and connect it to the fish

tank via a standpipe or siphon, depending on which of the above plumbing systems you've gone for.

3. Assemble the pump by following the instructions of your specific pump. If your pump contains a filter, feel free to take this out as it is not needed in your aquaponic system, which is self-filtering.
4. Place the pump into your fish tank.
5. Attach piping (called the delivery pipe) to your pump which carries water with fish waste to the grow beds
6. Add dechlorinated water to your fish tank and run the pump.
7. Make sure the water drains back into your fish tank. Speed up or slow down you pump if necessary and regulate the water circulation accordingly.

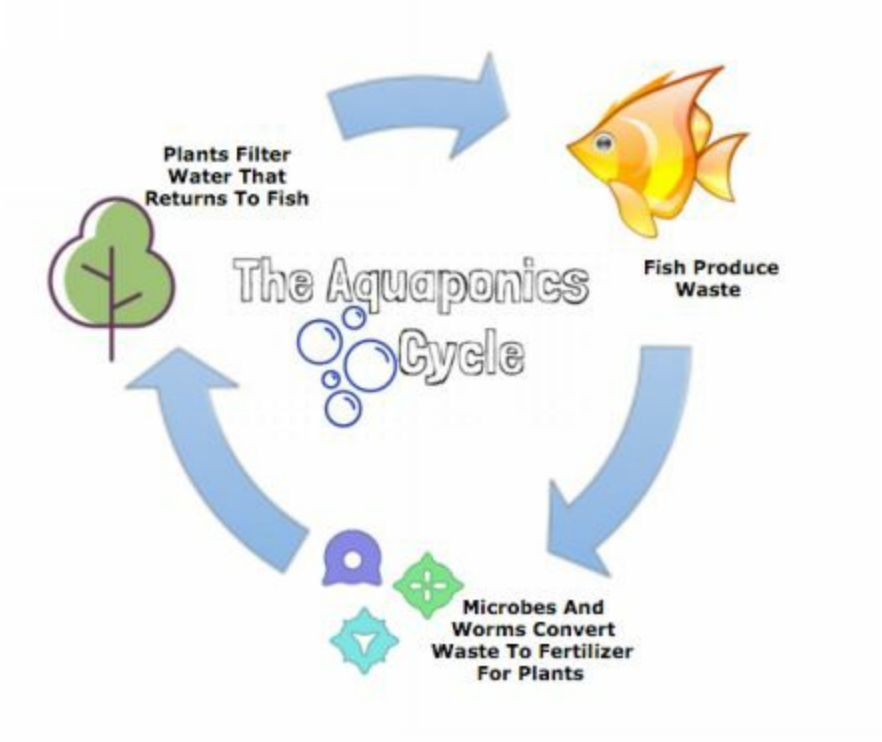
Once you have assembled your system, you will have to go through a process called 'cycling' before your aquaponic ecosystem is fully established. Cycling is the process of establishing a bacteria colony for your aquaponic system. It is the very thing that will ultimately determine the success of your aquaponic venture.

Section 9: Cycling a New Aquaponics System

"The ecosystem adjusts itself and for every action there is a reaction."
- Steve Mills

Despite our focus on fish and plants, the secret ingredient to the success of your aquaponic system lies with the bacteria and worms that inhabit your grow beds. These are the key actors that transform fish waste into plant fertilizer.

So once your system is set up, the first step is to initiate the nitrogen cycle, a process which is called 'cycling.' I can't stress enough the importance of cycling, which is effectively the creation of an ecosystem. Cycling is also the most daunting and stressful part of setting up an aquaponic system, but the reward is not to be taken lightly. Once your ecosystem is successfully cycled you will be rewarded with a thriving and self-sustaining aquaponic garden.



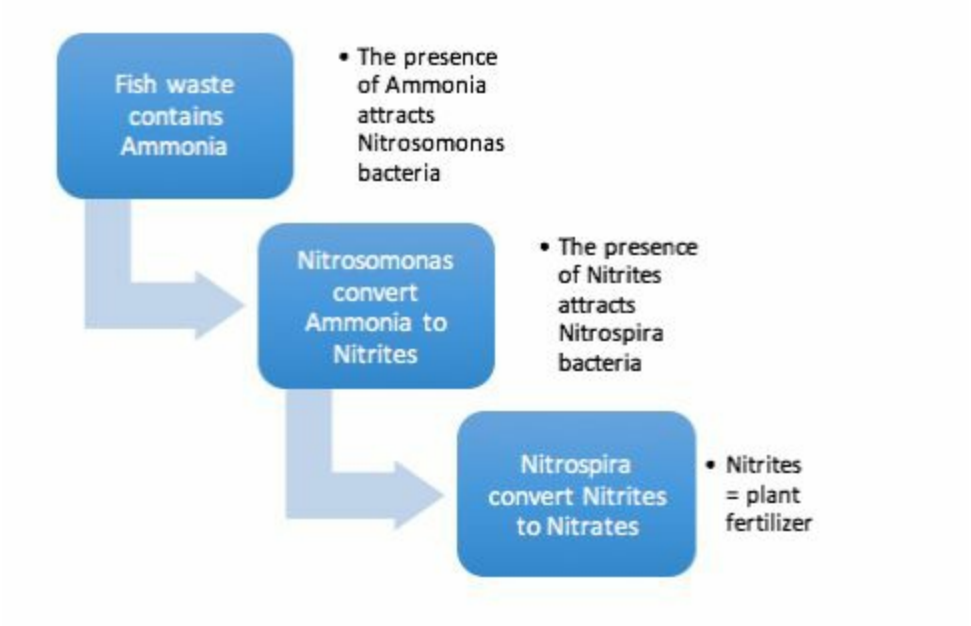
You probably remember this diagram from the beginning of the book and its role here is for you to visualize the nitrogen cycle and its central place in

aquaponics. The nitrogen cycle is the process in which the bacteria break down otherwise toxic ammonia and nitrates into nitrites, or, non-toxic food for plants.

The Cycling Process Explained

Cycling begins the moment you or your fish add ammonia to your aquaponic system. It is important to note that ammonia (a compound which contains nitrogen and hydrogen) and nitrites are toxic to fish unless they are broken down or diluted to non-toxic levels.

The presence of ammonia, however, attracts bacteria called Nitrosomonas, which convert ammonia into nitrites. The presence of nitrites in turn attract bacteria called Nitrospira. Nitrospira convert nitrites into nitrates. And nitrates are what we're ultimately after because nitrates = food for plants!



Initiating the cycling process

As explained before, adding ammonia to your fish tank initiates the cycling process. There are two ways to add ammonia: with or without fish.

Roughly 80-90% of the nitrogenous wastes of fish are excreted as ammonia. Ammonia however, as mentioned earlier, is toxic and can kill your fish if not diluted, removed or converted.

When initiating the cycling process with fish, it is recommended to start with only half as many fish as you would have in a fully stocked tank. Test ammonia and nitrite levels on a daily basis and only feed your fish once a day in order to keep ammonia levels low. Increase fish stock levels only gradually.

Monitoring the cycling process

Cycling with fish is a four- to six-week process during which it is important to monitor your water ensuring that all elements are in range.

For monitoring and testing your water, it is advised to purchase a thermometer as well as a Freshwater Test Kit. The most popular kit, one which I would also highly recommend, is the API Freshwater Master Test Kit, purchasable for a mere $20. This kit is easy to use and specifically designed for aquaponics!

Monitoring and Adjusting pH Level

During cycling, you will need to monitor your tank daily for rising ammonia levels. It is advised to keep the pH levels of your tank at 5.8-7. Higher pH readings suggest higher ammonia levels. pH readings of above 7.0 are therefore problematic as they are indicative of toxic ammonia concentrations.

Adjusting the pH in your aquaponic system

You should at all times maintain a pH level of 6.8-7.0. Again, this is why its best to have a bigger volume of fish tank especially when you’re a beginner, because, the more water, the more stable your pH levels.

The best way to stabilize pH levels is to perform a one-third water exchange. In the section below we have included the best methods to raise pH (if it drops below 6.6) and the best methods to lower pH (if it goes above 7.6).

It is also important to note that whenever you introduce water or other elements into your aquaponic system, try and avoid adding anything that contains sodium. Sodium harms your plants and the sodium levels of your water should never rise above 50mg/l.

Raising pH levels

The best way to raise the pH levels of your aquaponic system is to use calcium hydroxide or calcium carbonate. I would highly recommend alternating between the two. On the plus side, these also add calcium and potassium into your aquaponic system which will strengthen your plants.

Lowering pH levels

In order to lower the pH levels, you can use nitric or phosphoric acid. An added benefit of adding these is that your plants also benefit from the nitrate or phosphate that will be released after these acids enter your system.

Nitrite

The other thing you need to monitor during cycling are nitrite levels. Nitrite levels which are too elevated can cause oxygen deprivation, which is equally as devastating for your fish as toxic ammonia concentrations.

Therefore, if your nitrite levels rise to above 10ppm during the cycling process, it is strongly advised to do a water exchange. Exchanging water means diluting the water in your tank by taking roughly a third out and replacing it with clean, dechlorinated water. When performing a water exchange however, make sure that the new water is the same temperature and pH as your tank water.

Besides the water exchange, it is also highly recommended to add some salt to the water. Make sure you only used non-iodized salt and add at least 1 gram of salt per 1 liter of water. Dissolve the salt in a bucket before adding it to the water. Stop feeding your fish until the nitrite levels drop and try to

aerate the water as much as possible.

Cycling your system without fish

An alternative option is to cycle without fish. This method is significantly less stressful as well as quicker. Your system can be fully cycled within 10 – 30 days and at the end of it you can fully stock your tank, which is also an added bonus.

There are many ways in which you can add ammonium to your system. Below are some of them most common methods listed.

- **Urine:** Probably the most natural source, although many people might be opposed to this for various reasons. One thing to keep in mind when using urine is that urine takes a while to convert to ammonia and levels will rise rapidly from one day to another.

- **Liquid ammonia:** When adding liquid ammonia to your system, make sure it is 100% pure ammonia and water. While purchasing ammonia is inexpensive, acquiring pure ammonia can be a difficult task depending on where you live.

- **Ammonium chloride:** This is crystallized ammonia that is readily available in aquarium stores and photography supply stores, among other places.

Once you have selected your source of ammonia, the following is a list of easy-to-follow steps to kick-start your cycling process:

1. Add a little bit of ammonia to your fish tank on a daily basis until you obtain a reading of approximately 2-4 ppm.
2. Make sure you test your ammonia levels daily. If your ammonia levels are nearing 6 ppm, it is advised to stop adding ammonia until its concentration has decreased back to 2-4 ppm.
3. Once nitrites form, reduce the amount of ammonia that you add to your system on a daily basis by 50% until ammonia levels decrease to 2 ppm.

4. Once nitrates appear (5-10 ppm) stop adding ammonia to your fish tank.
5. Add your fish only once ammonia and nitrite levels are both below 0.5 ppm.

Your system is fully cycled once you detect nitrites in your water and once the levels of both nitrates and ammonia have dropped to 0.5 ppm or lower.

Other things to consider

Adding plants: It is also recommended to add plants to your aquaponic system as soon as you begin cycling. This will allow them to grow their roots early as well as start removing nitrogen-based waste as soon as possible.

Water temperature: Another thing to keep in mind is that water temperature also has a big effect on the cycling process and particularly the time it takes for your system to become fully cycled. The optimal temperature for cycling is 77 – 86 Fº.

Composting worms: Once your aquaponic system is fully cycled and the fish have been added, also add a handful of red wigglers to your grow beds for the best results!

Section 10: Maintaining Your Aquaponic Garden

"Extremes are easy. Strive for balance."
- Colin Wright

Because aquaponics is entirely natural, maintenance is relatively low especially when compared to traditional soil gardening. However, as with any other man-made system, some maintenance is recommended. The checks and tasks recommended below are designed to keep your plants green and fresh and to make sure your fish don't end up like this!

<u>On a Daily Basis:</u>

Feed your fish

Feed your fish at least one to two times a day. If your fish aren't eating, this is a sign that they are stressed and an indication that something is wrong. Make sure that the temperature of your water as well as pH level are in the optimal range for your fish (see ***Section 5***).

Check water temperature

Even if you fish are eating and look happy, it is in the best interest of your fish to also check water temperature on a daily basis. Additionally, check that your pumps are working and that the water is circulating smoothly.

<u>On a Weekly Basis:</u>

Check pH and ammonia levels

Once your system is fully cycled, check the pH and ammonia levels of your aquaponic system at least once a week. Obviously, if you receive signs of distressed fish, it is crucial to check pH and ammonia levels immediately and rectify the problem to counter any future disasters.

Check water levels and top up if necessary

Furthermore, I also recommend to top up your fish tank once a week, or more often depending on the climate that you find yourself in. When topping up, make sure you use only dechlorinated water with pH levels and a temperature that matches the one of your fish tank.

On a Monthly Basis:

Check nitrate levels.

It is likewise advised to check the nitrate levels of your system on a monthly basis. If you can observe a rise in nitrate levels, this is a good indicating that it is time to either plant more plants, add a grow bed or to harvest some of your fish. Try and avoid reaching nitrate levels of more than 150 ppm

Clean pump and pipes

Finally, to ensure that the circulatory system of your aquaponic garden is running smoothly, it is advised to clean you pump and pipes once month. This is to avoid any potential clogging inside your pipes.

Section 11: Some Final Considerations: Light, Temperature and Space

"One must maintain a little bit of summer, even in the middle of winter."
- Henry David Thoreau (1817 – 1862)

The plant-fish relationship in aquaponics is one which is found everywhere in nature – in lakes and streams around the earth. Aquaponic cultivation is an ancient hydroculture used around the world. It was used in central Mexico by the Aztec and today is most ordinary in Fast Eastern countries where this technique is used by paddy field farmers.

However, depending where you are situated on earth, you might not share the same hot climate of Mexico or South East Asia. Because of this, it is important to consider a final few things in order to provide the optimal environment for your aquaponic garden.

Climate considerations: growing indoors vs growing outdoors

If you live in a climate where freezing temperatures are the norm in the winter, it is important to consider some alternative options. Unless you have the means and space to erect a greenhouse, the following are the three options open to you:

Harvesting all your crop and fish at the end of summer and shutting down your system over the winter

Not ideal as you would have to go through the cycling process again at the beginning of each summer. The good news is that after a few times, you know the process and what to look out for.

Growing outdoors in the summer and moving your aquaponic system indoors in the winter

Although space-permitting, this option also incurs some practical issues. Portability of your system obviously depends on the size of it. But this option also has many benefits. In the summer, you save energy by using natural heat and light to keep your aquaponic garden in its optimal environment. In the winter, the indoor aquaponic garden will create ambient air by adding humidity and oxygen to your home.

Growing indoors all year round

When growing indoors, beware that aquaponic systems introduce humidity to their environment. Depending where you live, this might be a desired side-effect. When growing indoors, another factor to keep in mind is light. Limited natural light over the winter months may need to be supplemented with additional light sources depending on which plants you grow. While herbs will grow with shorter stints of light, additional light will give you the flexibility to also grow fruiting plants over the winter months.

Below are some indoor lights I would recommend and which are well-suited for indoor aquaponics.

For the hobby grower:

T5 bulbs: These bulbs are inexpensive, energy-efficient and have a broad lighting spectrum. This will allow you to grow both greens as well as fruiting plants indoors. A downside is that these bulbs need replacing every 6 months.

LED lighting: These lights are energy efficient and emit no heat, which is a definite advantage. They are slightly more expensive compared to T5 bulbs. Another added bonus is that these bulbs never need replacing.

For the advanced grower:

HID lighting: HID stands for High Intensity Discharge. These bulbs are more expensive than the above options but the bulbs last for years and provide a much more intense light.
HID lighting is usually made of four components which you can purchase as separate parts or in a bundle. There are also available optional features.

- **Reflector Hood**, which covers the top of the bulb directing all light down to your plants
- **Remote ballast**, which provides the power to the light
- **Bulb**, which is either a MH (metal halide) or HPS (high-pressure sodium) bulb. MH bulbs are best for vegetative growth, and HPS are best for the flowering stages.
- **Cord set,** which is the power cord which plugs into the ballast and the bulb.
- **Optional**, there are various other optional elements you can add to your lighting system, such as a timer or a fan to blow the heat away from your plants if desired.

Section 12: Last but Not Least

"There are no gardening mistakes, only experiments."
- Janet Kilburn Phillips

I'd like to take this opportunity to thank you for downloading this book. I hope you now have a solid foundation on the process, and that you're equipped with the knowledge to put you on the path to becoming an aquaponic success!

My final piece of advice - no matter how diligent you are in your research, your best learning will come from doing, so don't hesitate in getting started. Start simple, perhaps with one of the basic systems outlined and with a easier crop such as lettuce and herbs. Once you put your knowledge into practice you'll soon have the skills to advance onto more challenging systems and growing vine and fruit plants. I recommend revisiting the sections along with careful further research to constantly refresh your knowledge as you progress.

I sincerely wish you the best of luck in your aquaponic adventure. If you feel you've gained some valuable knowledge from this book, I'd really love to hear any feedback that you may have. Reviews can be left on the Amazon book page. I look forward to hearing from you!

Click Here to Leave a Review on Amazon.com

Best wishes,

Andy Jacobson