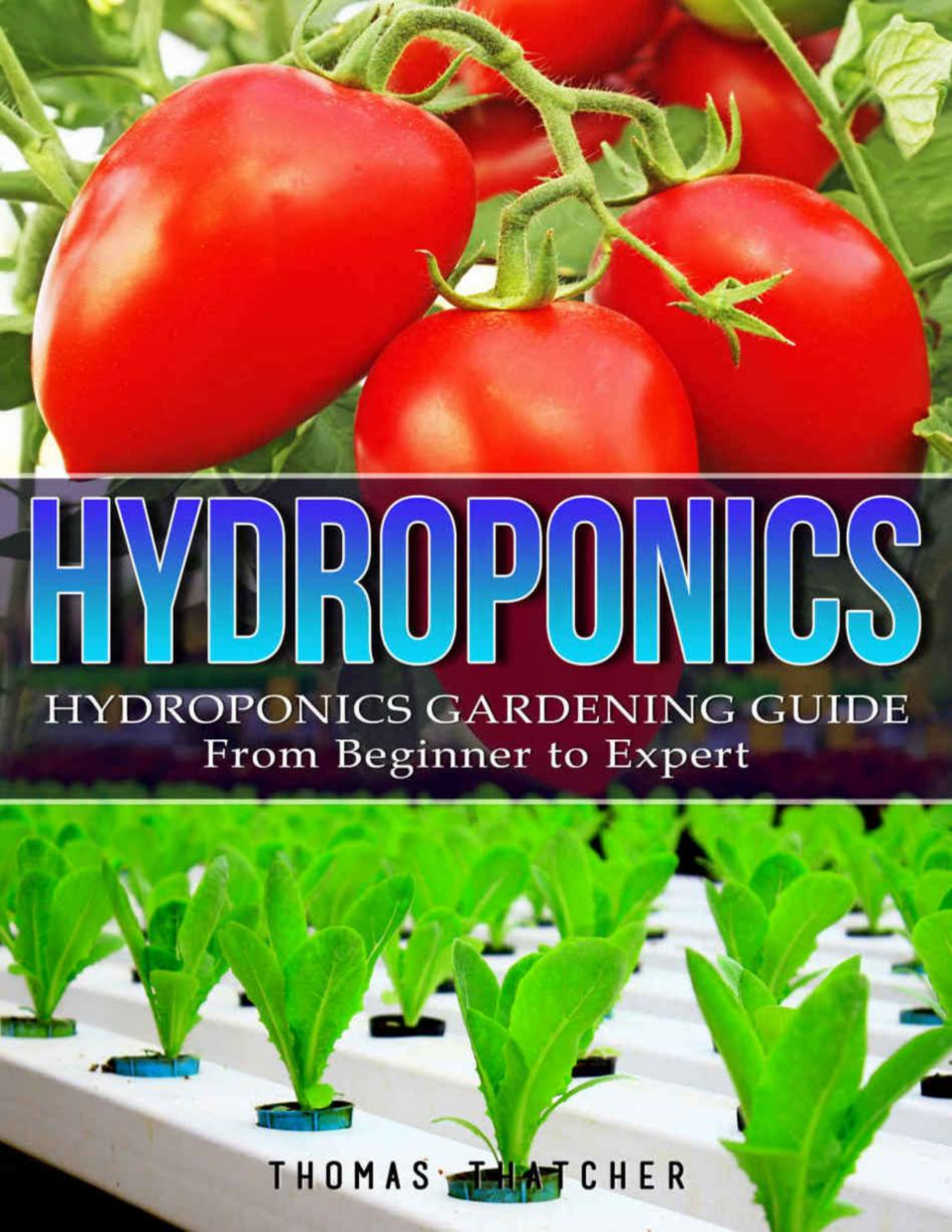

HYDROPONICS

HYDROPONICS GARDENING GUIDE
From Beginner to Expert

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HYDROPONIC GARDENING GUIDE FROM BEGINNER TO EXPERT

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Introduction:

Hydroponics is the method of growing plants without soil by supplying them with a constant nutrient solution. Despite the fact that this method remains fairly unknown outside of a small sector of the horticultural world it has in fact been around for a long time. It is a system that was used extensively in the hanging gardens of Babylon and has been studied extensively by scientists and horticulturists for the last several hundred years.

There are many powerful reasons for commercial food growers to use this method but it is also now being used more frequently by the domestic gardener keen to produce a high yield in a small amount of space. Though it is seen primarily as a way of producing crops for the table it is also a method that can be used for the production of ornamental plants.

All plants require air, light, and dissolved nutrients to grow. Hydroponics allows for a very precisely controlled amount of nutrients, dissolved in water, to be administered directly to the root system as the plant requires it. Because the root system is no longer obliged to spread so far in order to attain the nutrients it requires this in turn enables the grower to plant his crops at much higher densities which is just one reason why hydroponic crop yields are so much greater than the more traditional soil planted yields.

There are a variety of variations on the hydroponic theme and this book will take a look at the main options the gardener has available to them. Though some of the methods might sound overly complicated for the home gardener I advise you to persist because what at first might appear a difficult system to reproduce is in fact surprisingly easy in many cases and the increase in yields will be staggering. I hope you enjoy the book.

Chapter 1: A Little History and Some Basic Principals

Primitive forms of hydroponics have been carried on by various societies for thousands of years. The word hydroponic itself stems from an amalgamation of two Ancient Greek words, hydro for water and ponic for work. In other words, the water was supposed to do the work that had created such toil for mankind ever since he began to practice agriculture.

Various forms of it have been carried on in Kashmir for centuries and one group, the Aztecs of America, developed a form of floating garden. Pushed to the marshy regions of Lake Tenochtitlan, in what is now Mexico, by other more aggressive tribes these nomadic people were forced to come up with a viable agricultural system in order to survive. They developed a system of floating rafts woven together out of reeds that eventually turned in to an archipelago of floating islands. These islands teemed with vegetables, flowers and even trees. The historian William Prescott recorded the destruction of the Aztec empire by the colonizing Spaniards and he described the floating gardens as 'Wondering islands of Verdure, teeming with flowers and vegetables and moving like rafts on the water.'

Many historians believe that hydroponics was an important ingredient in the creation of the famous hanging gardens of Babylon which was one of the seven wonders of the Ancient World. If that is the case this is probably the first example of hydroponics being used as a farming method.

In more modern times the first scientific studies took place in the 1600s when the Belgian Jan van Helmont demonstrated that you could grow a willow in a tube containing 200 pounds of dried soil and fed only with rain water. After five years the willow shoot had obtained a weight of 160 pounds whilst the soil had only decreased in weight by two ounces. He concluded that plants obtain what they require for growth from water. Whilst partially correct in his assumptions, that early demonstration failed to take into account the need for carbon dioxide and oxygen which are also crucial to plant development.

In 1699 John Woodwards took the experiment a stage further when he grew plants in water which contained differing amounts of diluted soil. The plants that had the highest concentrates of soil grew best. In this early version of the man made hydroponic solution Woodwards realized that soil probably contained some nutrient crucial to plant growth but with chemistry not yet discovered he was unable to identify what those nutrients were.

Science began to gather momentum in the decades that followed and scientist were able to prove that plants absorbed water via their roots and that this then passed through their systems to be released through pores in the leaves. They also discovered that the roots also draw up nutrients and oxygen and that leaves draw carbon dioxide from the air.

In 1851 French scientist Jean Baptist Boussingault began experimenting with inert growing media and water with various combinations of elements available in soil. In 1860 the first nutrient solution in which plants could be grown was published by Professor Julius von Sachs. Various solutions continued to be developed but at this stage all studies had been based around laboratory research. It was not until the 1920's that Doctor William Gericke began to extend lab work to include outdoor crop production. In the process he termed the use of the word hydroponics and laid the groundwork for all forms of modern day hydroponics as we know it. Developments continued of course, and still today this is an evolving science but we now have a far better handle on the methodology of growing plants without the use of soil.

There are several major benefits to using this method to cultivate plants. We immediately eliminate soil borne pests and diseases. Greater control over the plants provides more consistent size and production. Water waste is massively reduced since the water is reused. Crops mature more rapidly often allowing for two crops per year where only one is possible in traditional soil growing systems and finally greater yields are produced. In a world with decreasing natural resources and a rapidly increasing population growth it is almost inevitable that this will be an area of agricultural production that sees massive growth.

Gericke had proved that it was not soil that plants needed, it was the nutrients and moisture that the soil contained along with adequate plant

support. This could be provided just as, and possibly even more effectively, by adding the exact nutrient requirements to the water and then growing the plant in an inert medium purely for stability and support. In the soil nutrients tend to be leached away from the plant roots thus forcing the plant to continuously extend its root system in an effort to reach them. Nutrients can be replaced but it is difficult to estimate the exact requirements a plant has in a system where the leaching cannot be controlled or measured accurately. This creates a further disadvantage in that the plant must waste valuable energy in root production which could be diverted to crop production. When growing in soil, the root system draws up nutrients and acts as an as an anchor and support for the plant. Provided the plant is given plenty of nutrients then the root system can be considerably smaller and the anchorage function can take place in any non leaching material. Some hydroponic systems do away with the planting medium altogether and suspend the plant, feeding the trailing roots by a mist system. This method is perfectly successful.

Gericke's initial systems soon proved too technical for most would be hydroponic growers. One of the main problems lay in keeping a consistent supply of oxygen in the nutrient solution. Interest in the methods he developed had been triggered, however, and since then ongoing developments have made hydroponics more and more simple. Now there are huge green house producers throughout the world producing very high yields. There are now over 1000 000 soil-less household units in the USA. The need to develop this system is demonstrated by these figures: in 1950 there were 3.7 million acres of land being cultivated and a population of just under 151 000 000 people. Today that population has soared to 204 000 000 and the amount of land under cultivation dropped to 3.2 million acres. With figures like this it becomes apparent that the need for viable crop production to increase and it is likely that there will be less land available for it to increase in.

Roof tops are one area that are being looked at and utilized more and more. Vast flat surfaces within city confines offer a perfect place to produce crops. What is more when we start to produce crops within urban environments we dramatically reduce the amount of mileage that the crops must travel in

order to get to the end user with knock on benefits, both in terms of pollution created and freshness of the end product.

Modern hydroponics can go even smaller scale than that though. Nowadays it is easy for a home owner to set up his own hydroponic garden in the back yard and there are even smaller units being designed for kitchens and apartments. The main requirements of water and electricity are already in place in these situations. At its most basic level here is what you will need to make your own unit.

A growing chamber or tray. This will contain the growing medium and plant roots and can be anything that holds water and is big enough for the plants you want to grow.

A reservoir. This will contain the water and nutrient system that will then be pumped to the growing chamber in a cyclical action. Once again, it can be made of just about anything as long as it holds sufficient liquid. It should, however, be light proof so as to inhibit the growth of algae and microorganisms.

A submersible pump. This does not need to be expensive and pumps the water from the reservoir to the growing chamber and back again. Fish pond pumps are often used.

Some method of delivery. This is just a system to convey the solution from the reservoir to the chamber. PVC tubing works perfectly well.

Already you have the basis for a basic but functional system. A timer is one addition that would make your life easier and costs very little. This will switch the pump on and off and ensure that the roots of the plant are always kept moist. An air pump, even one as simple as you see in small fish tanks, will help keep the solution oxygenated which is essential to plant growth and will also ensure the nutrients circulating evenly. The air pump is normally situated in the reservoir. Remember that roots need to be kept in the dark to perform at their best so depending on what growing medium you use it may be necessary to cover them in some way.

Grow lights are another addition that will give you greater control and increase the optimum growing period but these are not necessary in the

most basic units. If you do opt for grow lights you may want to consider an additional timer for those.

This very basic system can be made at home or purchased as a premade kit. There are even examples of people making a system by stringing plastic soda bottles across an apartment window then linking them with PVC tubing and pumping the nutrient solution around with very good results.

The point I am trying to make is that this method of plant production is no longer restricted solely to large scale professional outfits. There is little point in growing your own vegetables if your start up cost is such that each tomato you produce owes you twenty dollars.

Chapter 2: The Different Hydroponic Systems

Although there is a great deal of variety in the different types of hydroponic systems in essence it comes down to six different types. The drip system, the ebb and flow system, N.F.T., the water culture system, aeroponics and the wick system. These systems can all be modified to suit the environment and budget of the individual user and the space they have available to them. In choosing an appropriate system for your own needs you need to consider these things as well as the size and types of plant you will be growing. Remember also that systems will need to cleaned very thoroughly from time to time so look for a unit that you can disassemble and clean easily.

The drip system:

This is one of the most popular systems both for the home gardener and the commercial producer. One of the main reasons that it is so popular is that it facilitates the production of large plants. Basically each plant is potted into growing medium in an individual pot. A drip line is then extended from the reservoir to each pot and when the pump is turned on nutrient solution drips into the pots until such time as the medium is soaked through. The excess solution then drains through the pot to where it is captured in a tray which returns it to the reservoir by means of gravity. The timer is set to turn the pump on again just before the medium gets dry so that the roots are kept constantly moist.

In domestic units these systems tend to be circulating but some commercial units are non- circulating. What happens in these larger operations is that when the water drains through the growing medium it is not captured. This may sound wasteful but it relies on the fact that the timer is so accurate that when set correctly it gives enough solution to the growing medium to wet it exactly with very little waste. Just before the medium dries it then adds more solution. The advantage to the commercial grower is twofold. Firstly, he is not required to have a huge area of catchment trays running the solution back to the reservoir and secondly each time he tops up the reservoir he can replace the exact amount of nutrient appropriate to the

plants needs. The nutrients within a system decrease as they are absorbed by the plant and so a circulating system must be checked frequently to measure the nutrient levels. In a non circulating system the reservoir must be topped up frequently but on large scale operations there are normally staff in place to see to this.

Ebb and flow system:

This is a method that suits the smaller scale of the domestic user either in the house or in the garden because it is easy to build and can be designed to fit into any available space. Plants are potted into a growing medium and placed into a fairly deep tray. An overflow line is connected to the tray at a level of one or two inches below the surface of the growing medium and water is then pumped from the reservoir into the tray. When the water level reaches the overflow it simply runs back to the reservoir. When this starts a float valve turns off the pump. The same valve turns the water back on again when the reservoir refills. In this way the roots of the plant are constantly being submerged in solution and drained again. It is a system that can be made on a really tiny scale and many pre-made systems utilize this method. When building your own system be sure that the overflow pipe is sufficiently large to carry away water faster than it can arrive via the pump.

Nutrient film technique:

In this system plants are grown in a matt of material such as rock wool and placed into a tray with a fine film at its base. A pump carries the nutrients through the film and this soaks the film keeping the roots constantly damp. Excess water simply runs back to the reservoir via gravity. Plants are normally planted through some sort of material to keep light from reaching the roots as there is no growing medium to cover them.

The system can be very small but when used on large scale operations long channels are filled with film and the same system is just notched up to a greater size. Because of the shallow depth of this system it is most suited to small fast growing crops such as lettuce and certain types of herb. The system is very effective but with small fast growing plants of this nature there is a risk of them dying quickly in the event of the roots drying out so

there is little time to respond if there is some sort of breakdown in the system such as electrical failure.

Water culture system:

In this system the root is constantly kept wet by the very fine splashing of tiny droplets of nutrient mix. The plants in are suspended with their roots hanging down into the reservoir. Instead of a water pump an air pump is placed into the reservoir and the water aerated at a pressure that will make the water look like it is boiling lightly. Because the top of the roots are just above the nutrient mix level the bubbling effect created by the pump will cause droplets to hit the roots. This system can be as simple as a large plastic bucket with a hole or holes cut into the lid through which the roots are suspended. The air pump is then placed in the bottom of the bucket and the lid put back on. (You may need to cut a groove for the lead to the pump). The most difficult part of the operation is setting the water depth so that it adequately splashes the roots. Don't worry if the lower roots touch the solution as long as there is still plenty of root material exposed to the air. Make sure that the lid is made of a material that will keep the roots in the dark. This method ensures a really well oxygenated mix reaching the roots but it also requires monitoring of the depth of the solution. More sophisticated systems of the water culture system are used commercially but at the same time it is just an upgrade of the system used by the Aztecs that I mentioned at the beginning of this book.

Aeroponics:

Another variation of the hydroponic system is called aeroponics but as you will see the main principals differ very little from the other techniques you have seen so far. Once again the plants are supported above the solution supply only this time the solution is mist sprayed onto the roots. Like with NFT no growing medium is needed. Think of those small fine sprays you have on an ordinary garden irrigation system. Nutrient solution is pumped from the reservoir and instead of going directly to the routes it passes through the sprayers which wet the roots with a fine mist of water. Excess water can then be captured in trays and run back to the reservoir although the spray spreads the water further and so recapturing the nutrient solution is harder. Most commercial units don't attempt to recapture the moisture but

instead try to regulate the delivery system so precisely that there is minimal waste.

The wick system:

Of all the systems that have been discussed so far this is by far the simplest one. The plants being grown are potted in their growing medium and then suspended above a bucket of nutrient mix. At its most basic you could have a plastic container with a plant inside balanced on a bucket of nutrients. A wicking material is then placed between the growing medium and the nutrient mix. This can be any material that will carry moisture such as a hemp rope, strips of carpet under-felt or some twisted strips of hessian sacking. There are no moving parts, material costs are minimal, if any, and there is very little skill needed to put it all together.

There are however multiple problems with this method. Firstly only small plans should be grown as the wick, even if you use several, will not be able to carry sufficient water to satisfy the needs of a larger plant. Secondly the wick will not transport the nutrients evenly and those left behind in the reservoir will build up to form a residue that could become toxic to the plant. Thirdly there is no oxygenation taking place in the reservoir. This means could be used by a beginner to grow a few small plants as an introduction to other systems of hydroponics. It is also often used by teachers as a means to demonstrate capillary action as that is what is taking place here. Some people use an L shaped tube to carry water to the bottom of a plants roots. When the water is poured down the pipe it will be carried upwards by capillary action in the growing medium but this is not really hydroponics in its true sense as devised by Dr. William Gerricke.

There is another system called aquaponics which is often confused with hydroponics and does in fact have many similarities but it is not regarded as true hydroponics. Aquaponics principals involve using the waste matter created by fish to feed plants with a system very similar to those of hydroponics. Adding nutrients in controlled quantities is so essential to the philosophy behind hydroponics that the two subjects are best considered separately.

Chapter 3: Different Growing Mediums

There are many different growing mediums which gardeners and horticulturists all get into the habit of blending to their own requirements so here we shall look at some of the most popular and discuss their advantages and disadvantages. In all cases you are looking for a medium that is light soilless and does not contain nutrients or chemicals that will affect the plant in any way or interfere with the nutrient mix that you are providing. It also needs to be porous enough to facilitate the easy transfer of oxygen and nutrients to the roots. We use these inert planting mediums for two main reasons. They minimize the amount of light reaching the root ball and they provide a support for the plant to grow in.

Probably the three favorite materials that you are likely to come across are coconut coir, perlite and LECA.

Coconut coir:

Coconut coir is a byproduct of the coconut industry. It is made of the hairy outer coating that surrounds the coconut shell and prior to being discovered as a useful product for the horticultural trade it was used for little more than stuffing for cheap mattresses. The recognition that the harvesting of peat was causing major environmental problems meant that environmentally concerned growers needed to look for new products to replace peat as a growing medium and coconut coir fitted the bill in many instances. It is sold in blocks and may also be called palm peat or simply coir.

The blocks swell to between six and eight times their compressed size when mixed with water so if you are ordering some don't be too disappointed when they arrive and appear a little smaller than you had hoped. They are particularly good at holding moisture and can absorb up to eight times their own weight. One of the disadvantages of this medium is that because it is so light it has a tendency to be washed about and for this reason is not suitable for ebb and flow systems unless combined with one of the other materials available. Growing mediums can be washed and reused after each crop. The medium is rinsed in diluted bleach then rinsed again and allowed to dry.

With coir this system can only be used three or four times before it begins to break down.

Perlite:

This is another product that has been around in the horticultural industry for many years. It is made by heating silica flakes which expands into very small and light pieces. These have good moisture retention and are chemically neutral so are favored by makers of potting mixes as it increases moisture holding capacity without adding weight. If cleaned by washing with bleach it can be used many times as a hydroponic planting medium. Its light weight makes it impossible to use in the ebb and flow system unless combined with something like LECA. It has a good wicking action which makes it one of the favorite choices in wicking systems.

LECA:

LECA stands for light expanded clay aggregate and is made by lightly heating clay particles until they expand from anything between six to eighteen millimeters in diameter. It is a lightweight free draining product that is very popular in the indoor plant industry and which you have probably seen used as a mulch on potted plants in shopping centers or offices. It is fairly good at holding moisture but is not on a par with something like coir in this respect and when high water retention is required the two products are often mixed at a fifty fifty ration. The coir then holds the moisture while the LECA acts as a stabilizer to stop the coir being washed away. In this way you can get the best use from both products. You may decide to experiment on the ratios that work best for you.

These are three of the products you are most likely to come across but there are many others that will work well and you may decide to adapt to one of the products below either because of price or availability.

Vermiculite:

A product with many similarities to perlite it looks like mica. It is mined in South Africa, China, Brazil and Zimbabwe. Once mined the product is expanded by heating in a kiln and becomes very light and water retentive. Like perlite it is often used as a moisture retainer when mixed with potting composts because of it neutral Ph and its light weight. In the hydroponic

arena it should be used in its pure form and not mixed with compost or soil. It does not break down and can be reused if correctly cleaned.

Peat Based Soilless Compost:

Peat is mad from compressed moss and plant products that have been compressed in the ground for hundreds and even thousands of years. It has been the mainstay of the nursery industry for a very long time but its widespread use has led to a breakdown of much of the local flora and fauna in the associated environments where it is dug and there are now growing calls for its extraction to be banned in favor of more sustainable products such as coir. That said it is an extremely versatile growing medium though if you choose to use it please make sure you get it from a sustainably managed producer.

It has excellent moisture retentive characteristics and is very lightweight. Suppliers often mix it with biofungicides, which are naturally occurring anti fungal agents, or mycorrhizae which are natural root stimulants.

Rock Wool:

Suitable for both ebb and flow and for continuous drip systems rock wool is a versatile growing medium. It retains water well and its porous texture means that it facilitates the free flow of air. It is made from a type of rock that is melted and then spun to produce a material similar to foam. Two factors do need to be borne in mind when choosing this material for your growing medium. Initially it must be soaked overnight to ensure the Ph is neutral and secondly it does not break down so disposal can be a problem.

Oasis cubes:

This lightweight foam has been used by the florist industry for decades and is ideal for the small scale hydroponic producer. It can hold up to forty times its own weight in water and still remain breathable. It is ideal for starting both seeds and cuttings and is very wickable making it a good product for the simple wick system. These properties can be used in any of the six main growing systems and the Ph is neutral.

Other options:

So long as the growing medium contains no nutrients and is free draining there are plenty of products that are not related to the horticultural industry that serve well in the hydroponic world and you are free to think out of the box and experiment with whatever ingredients you find that may fit the bill. Those light weight packaging peanuts you had sitting around in the garage with no real use for, are one example. Builder's sand was used widely in the early days of hydroponics. It needs to be rinsed to leach out any chemicals and it has a low water retention capacity but it does work. Be careful though because it tends to pack down when it has been wet a few times and then drainage will deteriorate.

Gravel is another cheap and easy to find material. It offers no water retention but sometimes both of these qualities might prove desirable. In Australia sawdust is often used for large scale tomato growing because it retains moisture and is often free. If you decide to experiment with this material make sure it has not been polluted with any products whilst still at the sawmill. They could damage your plants. It does tend to break down but as it is usually free it is easily replaced.

Rice hulls are a bi product of rice farming. They are as effective as perlite though they do decompose so will have a limited life span. As it is usually cheap or free this may not be an issue and regular replacement is recommended as there tends to be a buildup of salts that are detrimental to plant growth.

What I hope I have demonstrated is that there is no specific product you have to use provided it is Ph neutral and drains well. I have heard of instances of people using torn up cardboard, broken brick and tiles and even the stuffing out of an old mattress. Feel free to experiment with whatever comes to hand.

Chapter 4: Nutrient Solutions

Getting the correct nutrients to the roots of your plants roots is what hydroponics is all about. The science behind plant nutrition is quite complicated and at first can seem very daunting but it is not necessary to become a plant scientist to get to grips with what you will need to know in order to be a successful grower. It will, however, help to know some of the basics so you have an idea of what is going on and what all those chemicals are.

There are many different nutrients that a plant requires in order to grow and without which they will soon die. The three main nutrients are called macro nutrients whilst an array of other nutrients are needed but in much smaller quantities.

The three macro nutrients are:

Nitrogen (N): used in the production of chlorophyll and amino acids.

Phosphate(P): used in the production of sugars, energy, flowers and fruit.

Potassium (K): used in the production of sugars starch, roots and general hardiness.

These three components are always listed most prominently on bottles or packets of nutrients and given in numbers proportional to their quantity so if you were to see 15:9:12 you would know their proportions were fifteen percent Nitrogen, nine percent Phosphate and twelve percent Potassium. That would make up thirty six percent of the mix with the remainder being given over to water and micro nutrients. It should be noted that the three figures are always given in the same order NPK although the percentage of each will vary according to its intended usage.

In hydroponics the nutrients most commonly supplied come in a powdered or a concentrated liquid form which you would then dilute according to instructions of the manufacturer. In my opinion, and that of many other growers, the liquid form is by far the most practical and easy to use.

As I have already mentioned the reservoir should be a tank that does not let in light so as to reduce the possibility of mold and algae build up. This reservoir should be at least the same size as the pots or tray that it is feeding and possibly bigger. Don't mix the nutrients in the reservoir but add them after premixing with water.

The pH level of your water is very important as it can have a detrimental effect on the nutrient take up if it is either too high or too low. Ideally you want it to be at between 5.5 and 7.0. Too much chlorine can also have adverse effects so that too will need to be dealt with. If you stand water in a bucket for twenty four hours the chlorine will breakdown. Alternatively, you can buy distilled water which seems a bit of a waste of money to me or you can catch rain water which will be chlorine free and seems to me the most logical solution to the chlorine problem. Don't be too distracted by chlorine levels as they don't kill plants and water that has stood for twenty four hours tends to be fine.

The pH is most commonly affected by the amount of calcium it contains. Too much calcium leads to hard water and a high pH. This will need to be tested with a pH tester and if it falls outside of the given range then you can add some drops of a chemical for raising it or another for lowering it depending on the reading you are getting. All hydroponic suppliers sell a two part kit for raising and lowering pH. Simply dilute a few drops of one or the other in order to either raise or lower the pH to the required level. Do this mixing in a little at a time and then let the water settle before testing again. It is good to have a general idea of the pH of you water when you first start but after that most of the pH testing should be done after you have added the various nutrients as these will further alter the pH levels. The digital testing devise, a bit like a thermometer, is quite cheap and simple to use.

One way to make your life easier is to have a second reservoir. One will be in use and the other will be full with just water. This will ensure that the water is at the same temperature so the plants don't have to deal with a sudden temperature change and will also mean you are free of any chlorine if using mains tap water. Try to always use tepid water at around 18°C but

don't make this a major issue as you are going to have enough to get to grips with at the moment.

Once you have your water more or less pH neutral it is time to start mixing your nutrients and for the moment I am only going to deal with purpose bought hydroponic nutrients. They normally come in three parts which are mixed according to the manufacturer's instructions for the plants that you are growing. They tend to come with a chart for a range of plants and with a week by week dosage according to the age of the plants. In the beginning you will want to follow this chart quite closely but as your experience levels increase you will no doubt start experimenting with recipes of your own. Almost all hydroponic gardeners develop their individual recipes and start to add a series of additional products that they all swear are the best for the plants they hope to produce. I will get into some of those additives late but for now we will just stick to mixing of the basic three part nutrients.

Once you have the three bottles and have found the appropriate part of the chart that applies to your plants and the stage of growth they are at you will need to mix them. Don't just throw them all into a jar and shake them all up. In strong concentration they can react with one another and create an effect called blocking that inhibits their individual effectiveness. Instead place a few liters of water in a bucket that is the same size as your reservoir. This water will need to be chlorine free and to the correct pH. Of course if you have the second reservoir already prepared then that will be perfect. Pour the correct amount of the first nutrient into a measuring beaker and then pour it into the water. Now wash out the beaker and wait two minutes before repeating the procedure with the second nutrient. Finally repeat the process with the third nutrient. Remember it is important that you wash out the measuring beaker between nutrients to avoid blocking. It is also possible to purchase some cheap measuring syringes and use a separate one for each nutrient so as to avoid any possibility of mixing them up.

Once I have all my nutrients in the reservoir and I have waited a minute or two after adding the three then I give the reservoir a bit of a stir. At this stage I can retest my pH to ensure the levels are still within the accepted range of 5.5 to 7.0. It is likely that over time the pH will creep up slightly as the nutrients are drawn up by the plant. Because this is the case it would be

good if you could keep the pH just slightly below neutral so if you can keep it to around 6.0 that would be ideal. I then also test my mix using another meter called a PPM meter or an EC meter and occasionally a TDC meter. Effectively they all do the same thing. They measure the salts in the nutrient mix. PPM stands for parts per million, EC stands for Electrical conductivity and TDS stands for total desired salts. This easy to use little gadget will be used often during the growing stage as you will need to be constantly monitoring your nutrient mix to ensure the plant is getting all that it needs. Getting to grips with nutrient mixes is one of the trickiest parts of hydroponic gardening and I don't want to make it appear too complicated because you can generally learn all you need to by just following the chart that comes with the mixture. Remember that each producer will have a different recipe and so each system will vary slightly.

What you are trying to do with the plant varies at different times of its growth cycle and that is why the mixture of ingredients keeps altering. To start off you want plenty of nitrogen to bring the plants to a flowering stage as soon as possible. Later you will reduce the nitrogen but increase the phosphates to increase the flowering rooting and fruiting and all the way through the process you plant will be in need of small amounts of micronutrients. In the early days there will normally be a strong desire to add more nutrients in the hope that this will generate more and faster growth. In fact, too much nutrient can be worse for the plant than too little nutrient so if you must tamper with the manufacturers recommendations try to always err on the side of less rather than more.

Now you have got your reservoir to the pH you want and the nutrients to the level recommended by the manufacturer you are set to start pumping. Most systems require circulation at least twice a day and if you can get that up to once every two hours without water logging the plants that would be even better. You should be using your meter to check the nutrients every couple of days. If they start to get low then you can add a top up mix which is essentially a mild version of the mixes you are using without the micro nutrients. The reason for this is that the plants use a lot of the macro nutrients and only very little of the micro nutrients. If you add more micro nutrient it builds up in the system and becomes toxic to the plants. Outdoor units must not be exposed to rain that will dilute the water in the system.

Every two weeks you should replace the nutrient mix altogether. It is safe to pour the old mix onto any soil garden plants you have. Before making up the next mix clean out the reservoir with hot water or diluted bleach. You are then ready to start a new batch provided the water is chlorine free. This is also a good time to check the rest of the system to check that everything is working and there is no sign of algae. Pay particular attention to mist heads if you are using them as they are easily blocked up by micronutrient build up.

Although I have suggested checking your unit you should be checking your plants every day to ensure that they are strong and healthy and not showing any signs of stress. They will also let you know very quickly if there is any problem with the system. When you have harvested your crop then it is a good idea to strip the entire unit down and give everything a thorough cleansing.

To Recap:

By now you may be starting to feel like you have been bombarded with a little too much information especially if hydroponics is something you have never dealt with before. The whole idea is to ensure that you get a nutrient rich liquid to the roots of your plants with a nearly neutral pH. If you focus on those priorities you won't go too far wrong. To do this you will need an EC meter for the salts or nutrients and a pH meter. You can buy fairly inexpensive units that do both measurements for you so checking the levels is not difficult. You should be checking your mixture once a day. Small scale units tend to fluctuate more than larger ones so the home grower has to be just as alert to changes as the large scale producer.

In the event of pH getting too high or too low then add a few drops of the appropriate product after diluting. There are two products you can buy for this and they clearly state that they are either for raising or lowering the pH. You should not try to change the pH more than 0.5 in either direction in one day as you may shock the plants. As you started with the right pH balance larger changes are unlikely.

The EC meter will give you a reading of the conductivity of the water based on the amount of salts that it contains. Aim for a level of between 1.2 and 2.0. If it goes above this you can dilute the mix by adding water and if it

goes below then you can top it up with top up according to the manufacturer's instructions. I hope that simplifies this chapter for you.

Chapter 5: What to Grow

One of the great advantages of hydroponics is the wide variety of crops that you can grow. In many ways the choice is endless but you do need to take into consideration the constraints imposed on you by the size of your unit and the space that it is in. If you are a large producer in a green house set up you will probably want to concentrate on a small range of crops that sell easily and if you are a home grower working in an apartment then perhaps it is best to focus on just the crops that you buy most of. For the small producer a good place to start is always with lettuce as it is a salad crop that is eaten by ninety percent of westerners on a daily basis. It is also a crop that takes up little space and really tastes better freshly picked. In addition you can also harvest enough leaves for a salad whilst leaving the plant to continue growing.

The second most popular crop is tomatoes. If there is one crop that tastes better than all others when picked and eaten immediately then it has to be the tomato. There are hundreds of varieties so choose one that you think you will enjoy and that takes up not too much space. If possible grow two plants of different varieties that will produce at different times so that you can harvest for a longer period. If you are combining your hydroponics with grow lights and growing indoors then it is possible to have tomatoes virtually all year round.

Cucumbers are another plant that can be very rewarding. In an indoor environment go for a dwarf variety and have a frame up which they can climb.

Peppers are not only easy to grow they also make surprisingly attractive plants especially if they are the brightly colored varieties. Another crop we use on a regular basis in our homes so an instant saving there.

Spinach is one of the most popular leaf vegetables and is very high in vitamins and iron. These days there are many varieties ranging from those with small rounded leaves through to the more traditional longer leaved

ones. All of them can have some leaves harvested whilst leaving the parent plant to continue growing and reproducing new leaves.

For fruit strawberries are one of the best fruit for the hydroponic producer in both the private and commercial environments. With the vastly extended growing season you will have, the potential for good economic returns are high.

Blue berries are going through a major popularity boom at the moment because of their high levels of antioxidants which have proven health benefits. They like an acid soil when growing in the ground and as it is so easy to control acidity in a hydroponic production unit this makes them solid candidates for both home and commercial production.

Herbs can be surprisingly expensive when you actually work out what quantities you get when you buy them in a supermarket. Growing your own makes sense and even if you are only intending to grow enough for you and your family it is possible that you may find that you are producing more than you can eat. If you ask around it is highly likely that you will find ready buyers amongst your family and neighbors. Basil is used in a number of recipes as an addition to salads. It is also high in antioxidants. A very easy to grow herb, it costs a small fortune in supermarkets when you look at the price per kilogram.

The other really easy to grow herb is coriander. With its many health benefits and multiple culinary uses this is a versatile crop that you can be harvesting within four weeks and which can easily provide two and sometimes three crops per year.

Chapter 6: Pests and Diseases

There is one sure thing about any form of gardening and that is that you will always run into problems with pests and disease at some stage or other. In the case of hydroponics the problem of pests is reduced considerably because your crop is not growing in the soil where many bugs tend to lay their eggs and hibernate. Unfortunately, that still does not mean that you will be totally immune to receiving attention from nasty creatures as those healthy looking leaves and fruit will be just too much for them to resist and they will find other ways of getting at an easy meal.

One of the most important lessons any gardener learns is that of observation. Bugs and insects have developed various defense mechanisms and the main one is the ability to blend into their environment so that they can go unnoticed for as long as possible. Another survival strategy is to breed very rapidly. The gardener needs to almost cultivate a sixth sense when it comes to spotting pests. A casual glance will see only a healthy looking lettuce but the trained eye will soon spot one or two tiny aphids lurking hidden beneath the leaves. If they are dealt with swiftly then the problem has been averted but left to their own devices those few aphids can breed to almost plague proportions within a matter of days and suddenly you whole harvest is at risk and getting rid of them now demands all out war. Take the time to look closely at your plants, turning over leaves and using a magnifying glass if you need to. Also learn to recognize when a plant is not looking one hundred percent healthy and is displaying even the slightest signs of stress.

Here are some of the most common pests you are likely to encounter.

Mealy Bug

An oval shaped scale insect that sucks sap from the veins of leaves. They produce a sticky substance known as honey dew which often gives away their presence. They can be dealt with by wiping with rubbing alcohol on a cotton ball or spraying with an insecticidal soap.

Spider Mites

These tiny insects are almost invisible to the naked eye and they thrive in green house conditions. You often only become aware of them when you see a fine web covering the underside of leaves and the base of leaves starts to become a mottled brown as they suck out the chlorophyll. In small infestations caught early they may be destroyed simply by misting the leaves with a mild soapy solution. Use vegetable based insecticidal soap if they get out of control.

Thrips

Small winged insects a little larger than the head of a pin and they too like to suck sap. Leaves become distorted and loose color. They are best dealt with by spraying with soapy water.

Aphids

There are various types of aphid but they all have one thing in common and that is that they can breed really fast. It is estimated that if all the offspring from a single aphid were to survive for a year then their combined body weight would be sufficient to throw the earth out of orbit. Fortunately for us they are quite fragile creatures and if you spot them early they can be dealt with before we go spinning off toward another universe. They are sap suckers and tend to favor the tips of green leaves. They are easily destroyed by a quick blast of soapy spray.

This is a very short list of some of the most common pests but there are many more and many varieties of the ones that I have listed. What I was trying to emphasize is that they are easy to deal with if you catch them early. Given that most of the plants you are growing are likely to be edible then you need to decide if you are going to treat your pests with chemicals or organic treatments. Organic pest control tends to be cheaper and as I don’t want to expose myself to any more toxic chemicals than I need to I tend to opt for them. There is, however, a vast array of chemical sprays and treatments on the market that are highly effective at killing any pest you

care to mention and you only have to go into a garden center and describe your problem and you will be offered a selection of arms with which to respond.

On the organic front the arsenal is more limited but here are some of the treatments that Have worked perfectly well for me.

Insecticidal soaps can be sprayed from an ordinary spray bottle and are my weapon of choice. You can purchase them or make up your own using any number of recipes off the net using common house hold ingredients.

Neem oil is produced from an evergreen tree that originates in India and is now grown widely around the world. Its oil is prized by both the organic gardening and cosmetic industry. It will be available at most nurseries or online.

Nettle tea. This is a product that any gardener who has access to nettles can make himself. Simply steep a large handful of nettles in lightly simmering water for five minutes then filter the greenish brown liquid into a spray bottle. It gets more powerful as it ages and is a great insect deterrent but beware as it does smell.

On the disease front the main threat comes from high humidity and the close density of planting that is common in the hydroponic system. This makes growers, particularly green house producers, susceptible to molds and mildews of which there are many. The secret is to increase ventilation as much as possible and to reduce humidity down to the lowest levels your plants will accept.

Both pests and disease are reduced if you practice good garden hygiene. Remove and throw away dead plants and leaves immediately. Thoroughly clean and disinfect all equipment between crops as well as green houses. Use tools specifically for the hydroponic system so as to avoid unintentionally carry in disease spores from other plants in the garden. If you are using grow lights then don’t be tempted to share the light with other house plants that you may have as you risk transfer problems.

Conclusion:

I hope that some of the technicalities here have not put you off what can be a very rewarding field of horticulture. In the beginning it may seem a little overwhelming but as you start to work with the different systems and methods you will find that you begin to get a feel for the subject. In gardening terms this is still a fairly new method and we are all still learning as the system evolves. There are some really cheap and easy methods for you to experiment with and once you have seen how straightforward hydroponics really is and how much bigger a yield can be achieved then I am sure you will want to move up to greater things. This system is already being used to produce many of the crops we buy at the supermarket and eat on a day to day basis and there is no reason why you should not be doing some of that production for your own home and perhaps from there even looking to expand toward bigger things.