GUIDE TO HYDROPONICS

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INTRODUCTION

Hydroponics is a method of growing crops without soil. Plants are grown in rows or on trellises, just like in a traditional garden, but they have their roots in water rather than in dirt. Most of us confuse soil with nutrients. In fact, soil provides structure, not the actual food itself, for plant roots. The food comes from other materials mixed in the soil, such as compost, broken-down plant waste or fertilizers. Plants grown hydroponically can actually grow faster and healthier than plants in soil because they don't have to fight soilborne diseases; in addition, all the food and water they need are given directly to their roots around the clock.

Growing plants hydroponically doesn't have to be done on a large scale, and it's easier than you might think. Now there are kits, do-it-yourself systems and even fully automated growing tables, all designed for home gardeners.

Hydroponics is very simple -- in many ways, it's simpler than growing plants in soil. Plants need food, water and air. When you break it down to those three things, it becomes simple to give plants only what they need. Hydroponics is the science of growing plants without soil. The plants thrive on the nutrient solution alone; the medium merely acts as a support for the plants and their root systems.

What is hydroponics?

Hydroponics is a form of gardening that uses no soil, but instead grows plants in a solution of water and nutrients. A hydroponic system can grow plants and vegetables faster and year-round. Plants grown this way usually yield more, require less space, and conserve soil and water. This system is an ideal solution if you are an apartment dweller who does not have an outdoor gardening plot. Throughout the growing process, you will need to control several factors, such as lighting, water quality, air circulation, and more.

Plants grow through a process called photosynthesis, in which they use sunlight and a chemical inside their leaves called chlorophyll to convert carbon dioxide (a gas in the air) and water into glucose (a type of sugar) and oxygen. Write that out chemically and you get this equation:$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ There's no mention of "soil" anywhere in there—and that's all the proof you need that plants can grow without it. What they do need is water and nutrients, both easily obtained from soil. But if they can get these things somewhere else—say, by standing with their roots in a nutrient-rich solution—they can do without soil altogether. That's the basic principle behind hydroponics. In theory, the word "hydroponics" means growing plants in water (from two Greek words meaning "water" and "toil"), but because you can grow plants without actually standing them in water, most people define the word to mean growing plants without using soil.

The History of Hydroponics

You may have seen some types of soilless plants grown anywhere on movies or books and treated it like a science-fiction story.

However, this practice (which is so-called Hydroponics) has actually been used for thousands of years.The famous Hanging Gardens of Babylon in around 600 B.C. are the earliest record of Hydroponics.

Hanging Garden of Babylon

These gardens were built along the Euphrates River in Babylonia. Since the region's climate was dry and rarely saw the rain, people believe that the ancient Babylonians used a chain pull system for watering the garden plants.

In this method, water was pulled from the river and flowed up along the chain system and dropped to the steps or landing of the garden.

Other records of Hydroponics in the ancient times were found with the floating farms around the island city of Tenochtitlan by the Aztecs in Mexico in the 10th and 11th century. And in the late 13th century, the explorer, Marco Polo noted in his writing that he saw similar floating gardens during his traveling to China.

Timeline of Modern Hydroponic Development

It was not until 1600 that there were recorded scientific experiments done on plants growth & constituents. Belgian Jan Van Helmont with his experiment indicated that plants obtained substances from water. However, he failed to know that plants also need carbon dioxide and oxygen from the air.

John Woodward followed to study the growth of plants using water culture in 1699. He found that plants grew best in water that contained the most soil. So he came to the conclusion that it was certain substances in the water derived from the soil that led to the plant growth, rather than from the water itself.

There was a number of following studies done until 1804 when De Saussure proposed that plants were composed of chemical elements absorbed from water, soil, and air.

Boussignault, a French chemist, went on to verify this proposition in 1851. He did an experiment to grow plants in an insoluble artificial media including sand, quartz, and charcoal without soil. He used only water, media, and chemical nutrients. And he found that plants need water and get hydrogen from it; the dry matter of plants contains hydrogen plus carbon and oxygen which comes from the air; plants consist of nitrogen and other mineral nutrients.

1860 & 1861 marked the end of a long search for the nutrient source essential for plants' growing when two German botanists, Julius von Sachs, and Wilhelm Knop delivered the first standard formula for the nutrient solutions dissolved in water, in which plants could be grown. This is the origin of "nutriculture". Today, it is called Water Culture. By this method, plants'roots were totally immersed in a water solution that contained minerals of nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg),

sulfur (S) and calcium (Ca). They are now seen as the macroelements or macronutrients (elements required in relatively large amounts).

However, surprisingly enough, the method of plants growing in water and nutrient solution was only seen as experiments and merely used in the laboratory for plant research.

Only when the greenhouse industry appeared that interest in the application of the nutriculture practice was eyed on in 1925. Researchers were caring about the issues of soil cultural methods with soil structure, fertility, and pests. They worked extensively to implement the benefit of nutriculture to large-scale crop production.

In the early 1930s, W.F. Gericke of the University of California at Berkeley experimented with nutriculture for the production of agricultural crops. Initially, he called this process aquaculture but dropped it after learning that this term has been used to describe aquatic organism culturing.

W.A. Setchell recommended the term "hydroponics" to Gericke in 1937. So the name goes.

The word was derived from two Greek words. Hydro (“water”) and Ponos (“labor”)— literally “water working.”

Gericke began publicizing the practice of growing plants in a water solution while he was at the U.C. Berkley.

However, he met up with the skepticism from the public and the university. His colleagues even denied the use of the on-ground greenhouses for his study.

Gericke declared them wrong by successfully growing 25-foot tall tomato plants in nutrient-filled solutions.

The university still doubted his account of successful cultivation and requested two other students investigate his claim. The two performed the research and reported their findings in an agriculture bulletin 1938, titled "The Water Culture Method for Growing Plants Without Soil"

They confirmed the application of Hydroponics but concluded their research that crops grown with Hydroponics are no better than those grown on quality soils. However, they missed many advantages of agricultural Hydroponics in comparison with the cultural practice. The benefits that nowadays any hydroponic growers know by heart.

The earliest well-known application of Hydroponic plant cultivation was in the early 1940s when Hydroponic was used on Wake Island, a soilless island in the Pacific Ocean. This island was used as a refueling stop for Pan American Airlines. The lack of soil meant that it's impossible to grow with the cultural method and it was incredibly expensive to airlift fresh vegetables. Hydroponics solved the issues excitingly well and provided fresh vegetable for the whole troops on this distant island.

After World War II, Hydroponic cultivation was still used widely by the military. The U.S. army planted a 22 ha at Chofu, Japan.

In the 1950s, the soilless method of Hydroponics expanded to a variety of countries including England, France, Italy, Spain, Sweden, the USSR, and Israel.

The Present - Hydroponic Application

With the distinct advantages of Hydroponics such as higher growth rate, space saver, water efficiency and better control of pests & disease, it's no wonder that Hydroponics has been applied widely around the world.

It has become an indispensable part for any greenhouse growers.

Virtually any greenhouse farms use some sorts of Hydroponics for their trees & food productions.

According to the International Greenhouse Vegetable Production - Statistics (2017 Edition), the total commercial production area of greenhouse vegetables was estimated at 489,214 hectares (1,208,874 acres)

It estimates that most countries in the world have built vegetable greenhouses, of which the largest one being the developing countries, namely the USA, Canada, Netherland, and Australia

http://cuestaroble.com/listghproducers.htm

Recently, in New Jersey in the USA, the largest hydroponic farm (at the time) is being built. They are to bring 2 million pounds of fresh, leafy lettuce per year.

The Future - Why Using Hydroponics for Farming?

There are going to be big challenges for agriculture sectors in the future when food production is predicted to increase by 70% according to the FAO in 2050. Human beings have to achieve this despite the lack of lands, the increasing demand for fresh water (agriculture consumes up 70% of fresh water on earth) and the expecting climate change which can lead to the alteration in temperature, lights as well as the plants and animals' life cycle.

Hydroponics is undoubtedly considered as an approach to the future of agriculture.

Using no soil, it is a valuable culture method to grow fresh vegetables in countries or any place with little arable land and those whose area size is small yet contains a huge population.

Distant places and tourist sites like hotels, resorts can grow their own fresh food hydroponically instead of importing from far away regions.

Some successful examples are the West Indies and Hawaii. People have served large tourists with their own vegetable production. We'll expect to have more site like these in the coming time.

For the scarcity of water, while desalination technology is in place, people will be able to extract fresh water from the sea to supply for the hydroponic garden as well as agriculture in general.

Currently, a big downside of the soilless planting method is its expense. For large scale hydroponic farm, lights used to grow plants constitute a big part of the cost. Thereby the prices of Hydroponic gardens grown indoor and those in the northern latitudes with limited sunlight throughout the year from late fall to early spring are much higher. We expect that with the advent of new technology in artificial lights, growing plants will become much more economically applicable.

In the space science industry, NASA has considered the hydroponic growing method for feeding and nourishment to astronauts on the space station and on Mars.

In a world where scientists are working day by day to solve the matters of food and natural resources in a sustainable and ecological way, Hydroponics still plays a major part in human being's cope to the future survival.

Why grow things hydroponically?

Although the benefits of hydroponics have sometimes been questioned, there seem to be many advantages in growing without soil. Some hydroponic growers have found they get yields many times greater when they switch from conventional methods. Because hydroponically grown plants dip their roots directly into nutrient-rich solutions, they get what they need much more easily than plants growing in soil, so they need much smaller root systems and can divert more energy into leaf and stem growth. With smaller roots, you can grow more plants in the same area and get more yield from the same amount of ground (which is particularly good news if you're growing in a limited area like a greenhouse or on a balcony or window-ledge inside). Hydroponic plants also grow faster. Many pests are carried in soil, so doing without it generally gives you a more hygienic growing system with fewer problems of disease. Since hydroponics is ideal for indoor growing, you can use it to grow plants all year round. Automated systems controlled by timers and computers make the whole thing a breeze.

It's not all good news; inevitably there are a few drawbacks. One is the cost of all the equipment you need—containers, pumps, lights, nutrients, and so on. Another drawback is the ponic part of hydroponics: there's a certain amount of toil involved. With conventional growing, you can sometimes be quite cavalier about how you treat plants and, if weather and other conditions are on your side, your plants will still thrive. But hydroponics is more scientific and the plants are much more under your control. You need to check them constantly to make sure they're growing in exactly the conditions they need (though automated systems, such as lighting timers, make things quite a bit easier). Another difference (arguably less of a drawback) is that, because hydroponic plants have much smaller root systems, they can't always support themselves very well. Heavy fruiting plants may need quite elaborate forms of support.

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How does hydroponics work?

There are various different ways of growing things hydroponically. In one popular method, you stand your plants in a plastic trough and let a nutrient solution trickle past their roots (with the help of gravity and a pump). That's called the nutrient-film technique: the nutrient is like a kind of liquid conveyor belt—it's constantly sliding past the roots delivering to them the goodness they need. Alternatively, you can grow plants with their roots supported by a nutrient-enriched medium such as rockwool, sand, or vermiculite, which acts as a sterile substitute for soil. Another method is called aeroponics and it's typified by a popular product called the AeroGarden (see box below). Although the name suggests you're growing plants in air, the roots are actually suspended inside a container full of extremely humid air. Effectively, the roots grow in a nutrient-rich aerosol a bit like a cloud packed full of minerals.

In theory, you can grow any plant hydroponically but—as is always the case with gardening—some things inevitably do better than others. Fruit crops such as tomatoes and strawberries, and lettuces and herbs, are among plants that do particularly well.

There are multiple approaches to designing hydroponic systems, but the core elements are essentially the same.

What you need:

Fresh water. Were talking primo, filtered stuff with a balanced pH. Most plants like water with a pH level around 6–6.5. You can adjust the acidity of your water with over-the-counter solutions found at your local hardware, garden, or hydroponic store.

Oxygen. Don’t drown your plants! In traditional farming, roots can get the oxygen needed for respiration from pockets of air in the soil. Depending on your hydroponic setup, you will either need to leave space between the base of your plant and the water reservoir, or you’ll need oxygenate your

container (think of bubbles in a fish tank), which you can accomplish by buying an air stone or installing an air pump.

Root Support. Even though you don't need soil, your plant's roots still need a little something to hold on to. Typical materials include vermiculite, perlite, peat moss, coconut fiber, and rockwool. Stay away from materials that might compact (like sand) or that don't retain any moisture (like gravel).

Nutrients. Your plant is going to need plenty of magnesium, phosphorus, calcium, and other nutrients to stay healthy and productive — just like plants growing in the ground need healthy soil and fertilizer. When you're growing plants without soil, this "plant food" must be included in the water that's feeding your plants. While you can technically make your own nutrient solution, it's easy to buy mixtures online and in stores.

Light. If you're growing your plants indoors, you might have to invest in some special lighting. Each kind of plant will have a different requirement for the amount of light it needs and for the placement of lights (typically referred to as Daily Light Integral or DLI).

While there are other elements to consider as you increase the sophistication of your hydroponic farm (for instance, things like CO2 supplementation), the five listed above are the most foundational elements of any hydroponic system.

By monitoring and adjusting these key variables, you can begin to discover precisely what your plants need to thrive, and replicate those conditions for every grow in the future.

Ways to Start Hydroponic Gardening

Three systems are suitable for beginners: the wick system, the water culture system, and the ebb and flow system. More advanced systems include the nutrient film technique and the aeroponic system. The easiest plants to start with are greens like lettuce, spinach, Swiss chard, and kale; herbs like basil, parsley, oregano, cilantro, and mint; and fruiting plants like tomatoes, strawberries, and hot peppers.

The Wick System

The wick system is the simplest system mechanically; there are no moving parts or electrical components. This system is not ideal for water-hungry plants like lettuce or tomatoes but works best for microgreens, herbs, and peppers.

Project Metrics

Working Time: 30 minutes

Total Time: Change or add water every few days

Material Cost: $50 ($100 if you need a grow light)

What You'll Need

Equipment/Tools

Drill or screwdriver (optional)

Grow light (optional)

Materials

Bucket or basin for water reservoir

Water

Hydroponic fertilizer (dry or liquid)

Cotton or nylon cord

Growing medium

Seedling

Growing tray

Instructions

Set up a Water Reservoir

Create a reservoir filled with water and nutrients. This reservoir will be beneath the tray holding your plant and growing medium.

Connect Wicks to the Growing Tray

You will need to connect one or two wicks through holes in the bottom of the growing tray. If you need to make holes in the growing tray, use a drill or screwdriver. The wicks will soak up water from the reservoir and draw it up the wick to the growing medium in the tray.

Set up a Growing Tray

The growing medium, containing a seedling, is set above the water reservoir. Use a medium that will not drain too fast and will utilize the capillary action of the wick most effectively, such as vermiculite, perlite, and soilless mixes.

Set up a Light Fixture if Necessary

If using natural light, skip this step. Otherwise, set up a light fixture above the growing tray. If using incandescent light bulbs, set it 24 inches from the plants. LED and fluorescent lights are not as hot; place them 6 and 12 inches, respectively, from the plants.

Water Culture (Raft) System

A water culture system is another simple system to set up. In this system, the plants are placed in a styrofoam platform that floats on top of the reservoir with the nutrient-enriched water. Unlike the wick system, you will need to aerate the water in this system.

Project Metrics

Working Time: 45 minutes

Total Time: Add water-fertilizer solution as needed

Material Cost: $50 ($100 if using grow light)

What You'll Need

Equipment/Tools

Drill, rotary tool, or Exacto knife (optional)

Grow light (optional)

Air stone and pump

Materials

Bucket or basin for water reservoir

Water

Hydroponic fertilizer (dry or liquid)

Styrofoam sheet

Seedlings in net pots

Instructions

Set up the Water Reservoir

Create a reservoir filled with water and nutrients. This reservoir will be beneath your plant and floating plant raft. This system is suited for water-hungry plants like lettuce, but it is not recommended for more long-lived plants, like tomatoes.

Aerate the Water

The most common and inexpensive aeration system is an air stone and pump. The air stone, the same as a bubbler found in home aquariums, is placed in the water and connected to an air pump outside the reservoir. The pump pushes air through the stone, which blows out tiny bubbles to distribute oxygen through the water.

Set up Your Growing Raft

Cut a floating styrofoam platform to fit the top of the reservoir and cut holes to insert net pots. Net pots are plastic containers with perforated bottoms that contain a growing medium (coconut coir, perlite, clay balls) and seedlings. The roots will need to be in contact with the reservoir water.

Set up a Light Fixture if Necessary

If using natural light, skip this step. Otherwise, set up a light fixture above the growing tray. If using incandescent light bulbs, set it 24 inches from the plants. LED and fluorescent lights are not as hot; place them 6 and 12 inches, respectively, from the plants.

Ebb and Flow System

An ebb and flow system, also called the flood and drain system, is slightly more complex in design but is extremely versatile. This system works by flooding the growing medium with a water-nutrient solution, then it drains back into the reservoir.

Project Metrics

Working Time: 1 hour

Total Time: Refresh the water-fertilizer solution every week

Material Cost: $75 ($125 if using grow light)

What You'll Need

Equipment/Tools

Grow light (optional)

Two tubes (fill tube and drain tube)

One submersible pump

Electronic timer

Materials

Bucket or basin for water reservoir

Water

Hydroponic fertilizer (dry or liquid)

Growing tray

Seedlings in net pots

Instructions

Set up the Water Reservoir

The reservoir is placed directly below the flood tray's stand with the water and nutrients. You can use the same water for about a week at a time, making sure to renew the nutrients every time you change the water.

Connect a Fill Tube and Drain Tube

Connect the reservoir to the tray via a fill tube and a drain tube. The fill tube attaches to a submersible pump with a timer, which controls the flow of water up into the flood tray. The drain tube allows gravity to pull the water back into the reservoir after flooding so that the water can be reused.

Connect a Submersible Pump and Timer

A submersible pump with a timer allows for a lot of control in this type of system. You can customize the length and frequency of watering based on your plant's needs.

Set up the Flood Tray

The plant tray or flood tray is a large, shallow container on a tall stand. Plant your seedlings in perforated pots filled with a growing medium like perlite. The pots that your seedlings are in should be about twice as deep as the flood tray.

Set up a Light Fixture if Necessary

If using natural light, skip this step. Otherwise, set up a light fixture above the growing tray. If using incandescent light bulbs, set it 24 inches from the plants. LED and fluorescent lights are not as hot; place them 6 and 12 inches, respectively, from the plants.

Nutrient Film Technique

The nutrient film technique uses a water-nutrient solution that constantly flows in a loop from a reservoir through a growing tray, where plant roots are suspended in air and absorb nutrients as the solution flows by. This system makes the ebb and flow system a continuously flowing system, never taking periodic breaks.

Project Metrics

Working Time: 1 hour

Total Time: Refresh the water-fertilizer solution every week

Material Cost: $85 ($135 if using a grow light)

What You'll Need

Equipment/Tools

Drill or rotary tool (optional)

Grow light (optional)

Air stone and pump

Two tubes (fill tube and drain tube)

One submersible pump

Materials

Bucket or basin for water reservoir

Water

Hydroponic fertilizer (dry or liquid)

Tube or PVC pipe to fit the seedlings

Seedlings in net pots

Instructions

Set Up the Water Reservoir and Aeration

The reservoir is placed directly below the flood tray's stand with the water and nutrients. You will add an aeration bubbler in the reservoir to oxygenate the water.

Connect the Fill Tube, Drain Tube, and Pump

Connect the reservoir to the tray via a fill tube and a drain tube. The fill tube attaches to a submersible pump, which controls the flow of water up into the flood tray. The drain tube allows gravity to pull the water back into the reservoir after flooding so that the water can be reused. Unlike the ebb and flow methods, you do not need a timer, since it is continuously pumping the water.

Set up the Growing Tray

Instead of a flat tray, this method uses tubes or channels for the grow tray. This tubing makes it easier to set it at an angle and to make sure that the nutrient solution flows directly to the roots. You can use a round tube or PVC pipe with holes drilled to fit the net pots or seedlings.

Set up a Light Fixture if Necessary

If using natural light, skip this step. Otherwise, set up a light fixture above the growing tray. If using incandescent light bulbs, set it 24 inches from the plants. LED and fluorescent lights are not as hot; place them 6 and 12 inches, respectively, from the plants.

Aeroponic System

An aeroponic system is a more complex hydroponic method. Plant roots are suspended in air and misted every few minutes with a water and nutrient solution. It is a highly effective method but one that requires sophisticated pumps and misters. If the equipment malfunctions, the plant roots can dry out and die quickly.

Project Metrics

Working Time: 1 hour

Total Time: Refresh the water-fertilizer solution every week

Material Cost: $100 ($150 if using a grow light)

What You'll Need

Equipment/Tools

Drill or rotary tool (optional)

Grow light (optional)

Air stone and pump

One tube (spray tube)

One submersible pump

Sprayer/misting head

Materials

Bucket or basin for water reservoir

Water

Hydroponic fertilizer (dry or liquid)

Tube or PVC pipe to fit the seedlings

Seedlings in net pots

Instructions

Set up a Water Reservoir With Aeration

A container filled with nutrient-filled water is positioned under the growing chamber. Add an aeration bubbler in the reservoir to oxygenate the water. This reservoir also acts as a catch basin for misted droplets of solution.

Connect a Submersible Pump and Tube to a Mister or Sprayer

The reservoir solution pumps to the mister or sprayer vIa tubing from a submersible pump tube in the reservoir. The sprayer will be aimed at the plant's root in a growing chamber.

Set up the Growing Chamber

Similar to the nutrition film technique, you will set up tubes or channels for evenly suspending each seedling's roots.

Set up a Light Fixture if Necessary

If using natural light, skip this step. Otherwise, set up a light fixture above the growing tray. If using incandescent light bulbs, set it 24 inches

from the plants. LED and fluorescent lights are not as hot; place them 6 and 12 inches, respectively, from the plants.

Hydroponic Growing Tips

Most edible plants require at least 6 hours of sunlight each day; 12 to 16 hours is better. Make sure to put your lighting system on a timer, so the lights turn on and off at the same time each day.

The best lighting for a hydroponics system is high-intensity discharge light fixtures, which can include either high-pressure sodium or metal halide bulbs. Halide bulbs emit a more orange-red light, which is great for plants in the vegetative growth stage. T5 is another type of lighting used in hydroponic grow rooms. It produces a high-output fluorescent light with low heat and low energy consumption. It is ideal for growing plant cuttings and plants with short growth cycles.

Ideal temperatures are between 68 and 70 degrees Fahrenheit. High temperatures may cause plants to become stunted, and if the water temperature gets too high, it may lead to root rot.

The ideal humidity for a hydroponic grow room is from 40 to 60 percent relative humidity. Higher humidity levels—especially in rooms with poor air circulation—can lead to powdery mildew and other fungal problems. Consider a humidifier or dehumidifier to adjust the relative humidity.

Your grow room should also have an ample supply of carbon dioxide; your plants will grow faster. The best way to get carbon dioxide to your plants is to make sure the room has a constant flow of air. If necessary, invest in a fan or air circulation equipment to improve the airflow.

Hard water that contains a high mineral content will not dissolve nutrients as effectively as water with lower mineral content, so you may need to filter your water if it is high in mineral content.

The ideal pH level for water used in a hydroponic system is between 5.8 and 6.2 (slightly acidic). If your water doesn't meet this level, chemicals can be used to adjust the pH into the ideal range.

The nutrients (or fertilizers) used in hydroponic systems are available in both liquid and dry forms, as well as both organic and synthetic. Use fertilizers that are designed for hydroponic gardening; do not use standard fertilizers. The fertilizer should have the main macronutrients—nitrogen, potassium, phosphorus, calcium, and magnesium—as well as micronutrients iron, manganese, boron, zinc, copper, molybdenum, and chlorine.

Advantages of hydroponics

1. No soils needed

In a sense, you can grow crops in places where the land is limited, doesn't exist, or is heavily contaminated. In the 1940s, Hydroponics was successfully used to supply fresh vegetables for troops in Wake Island, a refueling stop for Pan American airlines. This is a distant arable area in the Pacific Ocean. Also, Hydroponics has been considered as the farming of the future to grow foods for astronauts in the space (where there is no soil) by NASA.

2. Make better use of space and location

Because all that plants need are provided and maintained in a system, you can grow in your small apartment, or the spare bedrooms as long as you have some spaces.

Plants' roots usually expand and spread out in search of foods, and oxygen in the soil. This is not the case in Hydroponics, where the roots are sunk in a tank full of oxygenated nutrient solution and directly contact with vital minerals. This means you can grow your plants much closer, and consequently huge space savings.

3. Climate control

Like in greenhouses, hydroponic growers can have total control over the climate - temperature, humidity, light intensification, the composition of the air. In this sense, you can grow foods all year round regardless of the season. Farmers can produce foods at the appropriate time to maximize their business profits.

4. Hydroponics is water-saving

Plants grown hydroponically can use only 10% of water compared to field-grown ones. In this method, water is recirculated. Plants will take up the necessary water, while run-off ones will be captured and return to the system. Water loss only occurs in two forms - evaporation and leaks from the system (but an efficient hydroponic setup will minimize or don't have any leaks).

It is estimated that agriculture uses up to 80% water of the ground and surface water in the US.

While water will become a critical issue in the future when food production is predicted to increase by 70% according to the FAQ, Hydroponics is considered a viable solution to large-scale food production.

5. Effective use of nutrients

In Hydroponics, you have a 100% control of the nutrients (foods) that plants need. Before planting, growers can check what plants require and the specific amounts of nutrients needed at particular stages and mix them with water accordingly. Nutrients are conserved in the tank, so there are no losses or changes of nutrients like they are in the soil.

6. pH control of the solution

All of the minerals are contained in the water. That means you can measure and adjust the pH levels of your water mixture much more easily compared to the soils. That ensures the optimal nutrients uptake for plants.

7. Better growth rate

Is hydroponically plants grown faster than in soil? Yes, it is.

You are your own boss that commands the whole environment for your plants' growth - temperature, lights, moisture, and especially nutrients. Plants are placed in ideal conditions, while nutrients are provided at the

sufficient amounts, and come into direct contacts with the root systems. Thereby, plants no longer waste valuable energy searching for diluted nutrients in the soil. Instead, they shift all of their focus on growing and producing fruits.

8. No weeds

If you have grown in the soil, you will understand how irritating weeds cause to your garden. It's one of the most time-consuming tasks for gardeners - till, plow, hoe, and so on. Weeds are mostly associated with the soil. So eliminate soils, and all bothers of weeds are gone.

9. Fewer pests & diseases

And like weeds, getting rids of soils helps make your plants less vulnerable to soil-borne pests like birds, gophers, groundhogs; and diseases like Fusarium, Pythium, and Rhizoctonia species.Also when growing indoors in a closed system, the gardeners can easily take controls of most surrounding variables.

10. Less use of insecticide, and herbicides

Since you are using no soils and while the weeds, pests, and plant diseases are heavily reduced, there are fewer chemicals used. This helps you grow cleaner and healthier foods. The cut of insecticide and herbicides is a strong point of Hydroponics when the criteria for modern life and food safety are more and more placed on top.

11. Labor and time savers

Besides spending fewer works on tilling, watering, cultivating, and fumigating weeds and pests, you enjoy much time saved because plants' growth is proven to be higher in Hydroponics. When agriculture is planned to be more technology-based, Hydroponics has a room in it.

12. Hydroponics is a stress-relieving hobby

This interest will put you back in touch with nature. With this an other hobbies you can even make some money by selling grown stuff to your neighbors. Tired after a long working day and commute, you return to your small apartment corner, it's time to lay back everything and play with your hydroponic garden. Reasons like lack of spaces are no longer right. You can start fresh, tasty vegetables, or vital herbs in your small closets, and enjoy the relaxing time with your little green spaces.

Disadvantages and Challenges of hydroponics

1. A Hydroponic garden requires your time and commitment

Just like any things worthwhile in life, hard-working and responsible attitude gives satisfactory yields. However, In soil-borne counterparts, plants can be left on its own for days and weeks, and they still survive in a short time. Mother nature and soils will help regulate if something is not balancing. That's not the case in Hydroponics. Plants will die out more quickly without proper care and adequate knowledge. Remember that your plants are depending on you for their survival. You must take good care of your plants, and the system upon initial installation. Then you can automate the whole thing later, but you still need to gauge and prevent the unexpected issues of the operations, and do frequent maintenance.

2. Experiences and technical knowledge

You are running a system of many types of equipment, which requires necessary specific expertise for the devices used, what plants you can grow and how they can survive and thrive in a soilless environment. Mistakes in setting up the systems and plants' growth ability in this soilless environment and you end up ruining your whole progress.

3. Organic debates

There have been some heated arguments about whether Hydroponics should be certified as organic or not. People are questioning whether plants grown hydroponically will get microbiomes as they are in the soil. But people around the world have grown hydroponic plants - lettuces, tomatoes, strawberries, etc. for tens of years, especially in Australia, Tokyo, Netherland, and the United States. They have provided food for millions of people. You cannot expect perfection from anything in life. Even for soil

growing, there are still more risks of pesticides, pests, etc. compared to Hydroponics. There are some organic growing methods suggested for Hydroponic growers. For example, some growers provide microbiomes for plants by using organic growing media such as coco coir and add worm casting into it. Natural-made nutrients are commonly used such as fishes, bones, alfalfas, cottonseeds, neems, etc.

4. Water and electricity risks

In a Hydroponic system, mostly you use water and electricity. Beware of electricity in a combination of water in close proximity. Always put safety first when working with the water systems and electric equipment, especially in commercial greenhouses.

5. System failure threats

You are using electricity to manage the whole system. So suppose you do not take preliminary actions for a power outage, the system will stop working immediately, and plants may dry out quickly and will die in several hours. Hence, a backup power source and plan should always be planned, especially for great scale systems.

6. Initial expenses

You are sure to spend under one hundred to a few hundreds of dollars (depending on your garden scale) to purchase equipment for your first installation. Whatever systems you build, you will need containers, lights, a pump, a timer, growing media, nutrients). Once the system has been in place, the cost will be reduced to only nutrients and electricity (to keep the water system running, and lighting).

7. Long return per investment

If you follow news on agriculture start-up, you may have known that there have been some new indoor hydroponic business started recently.

That's a good thing for the agriculture sector and the development of Hydroponics as well. However, commercial growers still face some big challenges when starting with Hydroponics on a large scale. This is largely because of the high initial expenses and the long, uncertain ROI (return on investment). It's not easy to detail a clear profitable plan to urge for investment while there are also many other attractive high-tech fields out there that seem fairly promising for funding.

8. Diseases and pests may spread quickly

You are growing plants in a closed system using water. In the case of plant infections or pests, they can escalate fast to plants on the same nutrient reservoir. In most cases, diseases and pests are not so much of problem in a small system of home growers.

So don't care much about these issues if you are beginners.

It's only complicated for big hydroponic greenhouses. So better to have a good disease management plan beforehand. For example, use just clean disease-free water sources and growing materials; checking the systems periodically, etc.

Should the diseases happen, you need to sterilize the infected water, nutrient, and the whole system fast.

What are the Environmental Benefits of Hydroponic Gardening?

The impact of global warming is making sustainable plant and food growth a big priority in commercial and government-based settings. Hydroponic systems come with a number of benefits and are becoming a popular choice for environmentally-conscious organisations.

Though the costs of producing food in commercial hydroponic settings are still quite high, the benefits make it well worth the cost.

Five of the biggest environmental benefits of hydroponic plant growth are:

No Pesticides

Hydroponic equipment is used in the growth of hydroponic plants, which means no soil is required. Not only does this mean plants can be grown in almost any setting, it also means no herbicides or pesticides are required to keep the plants safe. Farmers now use integrated pest management systems, which utilise predatory insects to reduce pest infestations. The reduction in pesticide usage has a positive impact on human health and the environment.

Faster Growth

When growing with hydroponics in Australia, you can grow an average of four times the amount of crops in the same space you could with traditional soil-based farming. Most crops will also grow at a faster rate, as you're able to control certain factors like the amount of sunlight and the temperature. This allows the growth of crops all year round.

Increased Water Conservation

When compared to traditional forms of agriculture, growing plants hydroponically can reduce water consumption by up to 90%, this accounts for approximately 70% of the world's water usage, so cutting back on excess water usage in the agricultural sector will make a big difference to water supplies across Australia, and the world.

Makes Greater Use of Natural Resources

Growing plants hydroponically is a great way to produce food in areas that have limited natural resources, such as deserts or highly urban areas.

Limits Fossil Fuel Consumption

Hydroponic systems place less reliance on fossil fuels. This is because most plants are grown in urban areas, eliminating the impact of transportation as well as the use of agricultural machinery.

How to Assemble a Homemade Hydroponic System

Locate the hydroponic system in an enclosed structure, such as a greenhouse or the basement of your house, or on an outdoor patio or deck. The floor should be level to ensure even coverage of water and nutrients to the plants in the system. If placing the system outdoors, protect the system from the elements, such as providing a wind barrier, and check the water levels more often due to water loss from evaporation. During cold temperatures, bring the hydroponic system indoors. If placing the system in an interior room of your house, add grow lights to provide supplemental lighting to the plants.

STEP 1

Assemble the Hydroponic System

The system consists of six growing tubes made of 6" PVC pipe, a stand and trellis made of PVC, a 50-gallon nutrient tank, a pump and a manifold. The tank sits under the table of 6" PVC growing tubes, and the pump sits inside the tank to push nutrients up to the plants via a manifold of smaller PVC pipes and plastic tubes. Each growing tube has a drainpipe that leads back to the tank. The manifold sits on top of the pipes and sends pressurized water to the tubes. To get the nutrients to the plants in this system, water is pushed through a square of PVC, the manifold, and then gets shot out to small plastic tubes that run inside each of the larger growing tubes. The nutrient tubes have very small holes in them, one hole between each plant site. The nutrients shoot out the hole and spray the plant roots. At the same time, the jet of water makes air bubbles so the plants get enough oxygen.

STEP 2

Mix the Nutrients and Water in the Tank

Fill the 50-gallon tank with water. Then add two cups of nutrients to the tank (or as recommended by the fertilizer label), turn on the pump and let the system run for about 30 minutes to get all of the nutrients thoroughly mixed.

STEP 3

Add Plants to the Growing Tubes

One of the easiest ways to plant a hydroponic garden is to use purchased seedlings, especially if you don't have time to grow the seeds yourself. The key is to choose the healthiest plants you can find and then remove all of the soil off their roots. To wash the dirt off the roots, submerge the root ball in a bucket of lukewarm to cool water (Image 1). Water that's too warm or too cold can send the plant into shock. Gently separate the roots to get the soil out. Any soil left on the roots could clog up the tiny spray holes in the nutrient tubes.

After the roots are clean, pull as many roots as you can through the bottom of the planting cup and then add expanded clay pebbles to hold the plant in place and upright (Image 2). The expanded clay pebbles are hard, but they're also very light so that they don't damage the plant roots.

STEP 4

Tie the Plants to the Trellis

Use the plant clips and string to tie the plants to the trellis. The string will give them support to climb straight up, which helps to maximize the space in this confined area. Tie the string loosely to the top of the trellis (Image 1), attach the clips and string to the base of each plant (Image 2) and gently wind the tips of the plants around the string.

STEP 5

Turn on the Pump and Monitor the System Daily

Check the water levels daily; in some regions, it may be necessary to check it twice a day, depending on water loss due to excessive heat and evaporation. Check the pH and nutrient levels every few days. Because the pump runs full time, you don't need a timer, but make sure the tank doesn't dry out or the pump will burn up.

STEP 6

Monitor Plant Growth

A few weeks after planting, the plants will completely cover the trellis because they'll have all the water and nutrients they need to grow quickly. It's important to keep a close eye on plant growth and tie or clip the plant stalks every few days.

STEP 7

Inspect for Pests and Diseases

Look for signs of pests and diseases, such as the presence of insect pests, chewed leaves and foliar diseases. One diseased plant can swiftly infect all the other ones since they are so close to each other. Remove any sick plants immediately. Because plants grown hydroponically don't have to spend their energy trying to find food, they can spend more time growing. This helps them to be healthier and stronger because they can use some of that energy to fight off diseases. Since the leaves of the plants never get wet unless it rains, they're much less likely to get leaf fungus, mildew and mold.

Even though hydroponic plants are good at fighting off diseases, they still have to fight pests. Even if it's hydroponic, insects and caterpillars can nevertheless find a way into the garden. Pick off and dispose of any bugs you see.

Conclusion

For our project on Hydroponics, we tested four plants each contained by different liquids. Our hypothesis was rejected due to lack of plants. The plants were placed outside for shade and natural lighting, but the temperature was too extreme. Throughout the project, our plants began showing feedback to the changing temperature and died. This error led us to unanswered questions about hydroponics. We wanted to know if planting in water, with nutrients, is better than planting in soil. Knowing that Epson salt gives nutrients to plants, when using Hydroponics, allows the plant to survive, but nutrients was not one of the main keys to maintaining a plant. The test subjects had to be kept in a controlled environment. For future studies, we recommend having access to a greenhouse and changing the liquids every day for best results. Use the same plants that are easier to preserve and keep track of data.