Hydroponics Information Guide

The term *hydroponics* refers to the practice of growing crops without soil, with the plants receiving their nourishment directly from water instead. In contrast to soil-based agriculture, where the plants feed by extracting nutrients from the soil, the roots of hydroponically grown plants are bathed in a complete liquid plant food that contains all the nutrients the plants need.

In place of soil, some hydro systems employ a soilless medium such as rockwool, coconut fibers (coir), or clay pellets to anchor the plants. Other systems contain no solid growing medium, with the roots bathing directly in the liquid. The common thread tying all hydro systems together is that the plants are receiving fertility from the nutrient solution, rather than soil.

Most hydroponic systems are housed under cover, primarily in greenhouses, to allow maximum control over the growing environment. Without the absorptive and buffering effects of soil, any precipitation that falls on an uncovered system would alter the nutrient solution conductivity, throwing the system off balance. Of the hydro systems that are set up outdoors, most are located in arid parts of the world.

Hydroponic systems can be located almost anywhere, including otherwise underused spaces such as vacant lots and rooftops, and areas lacking arable soil or an ample water supply. Installations can be scaled to footprints ranging anywhere from hundreds of acres down to inches, or configured vertically, depending on grower needs. Hydroponic culture helps growers avert weeds, soilborne disease, and fertility problems by bypassing soil altogether.

Johnny's Selected Seeds

Hydroponic Systems

Between commercially manufactured and homemade hydroponic systems, hydroponics systems can be configured in many different ways, but most hydro systems used to grow food crops fall into two main camps: those that do include a solid growing medium (also known as substrate) in place of soil, and those that do not (also known as liquid hydro systems).Regardless of the type of hydroponic system, seeds are usually sown in soilless plugs that are designed to hold the growing plant for the entire cropping cycle. The seeds of long-season fruiting crops are usually sown into small plugs that fit into a larger block, usually a 4" (10cm) cube, to allow the seedling to grow larger before being transplanted into the production greenhouse. Shorter-cycle crops, such as lettuce and greens, are usually transplanted into the growing system in their original plug without being potted-on to the larger block. The most common materials used for propagation plugs and blocks are coir, rockwool, or inert foam, such as Oasis cubes.

For more information, visit **Johnnyseeds.com/hydroponic-growing**

SUBSTRATE-FREE/LIQUID HYDRO SYSTEMS

Hydroponic systems where the roots bathe directly in nutrient solution, free of any type of solid soil substitute securing the plants, are known as liquid hydro systems. While there are many different ways to design a liquid hydro system, these are the 3 basic types:

Nutrient Film Technique (NFT). The most common hydroponic system used today, NFT systems use long gutters or troughs to hold the plants as they grow. Typically, there is a cover on the gutter, with holes where the plants are placed. The roots grow in the gutters without any medium other than a small plug securing the plant in place. Nutrient solution is piped in at the top of the gutter, flows down, and drains at the bottom of the channel. The nutrient film refers to the thin layer of nutrient solution present in the channel where the roots grow. An air pump and air stone are often used to aerate the nutrient solution and increase the supply of oxygen to the roots.

Deep Water Culture (DWC). Deep water culture involves growing crops in standing nutrient solution, with their roots dangling in the solution. Instead of channels, crops grow in tubs or basins, with the plants commonly anchored in floating rafts, with no medium other than the plugs securing the plants in place. Because the roots are submerged, it's critical to provide oxygen to them by aerating the nutrient solution, often accomplished with an air pump and air stone within the reservoir.

Aeroponics. Aeroponic hardware designs and configurations vary widely, but in all aeroponic systems the crops are held suspended in air and irrigated with a nutrient vapor mist, sprayed at regular intervals. Primary benefits are the greater levels of oxygen available to the roots and significantly less weight in the system. Although less common in the past than the other two main types of liquid hydro systems, aeroponics systems are rapidly becoming a focus of research and development in lean-input crop production.

SOLID MEDIUM/SUBSTRATE SYSTEMS

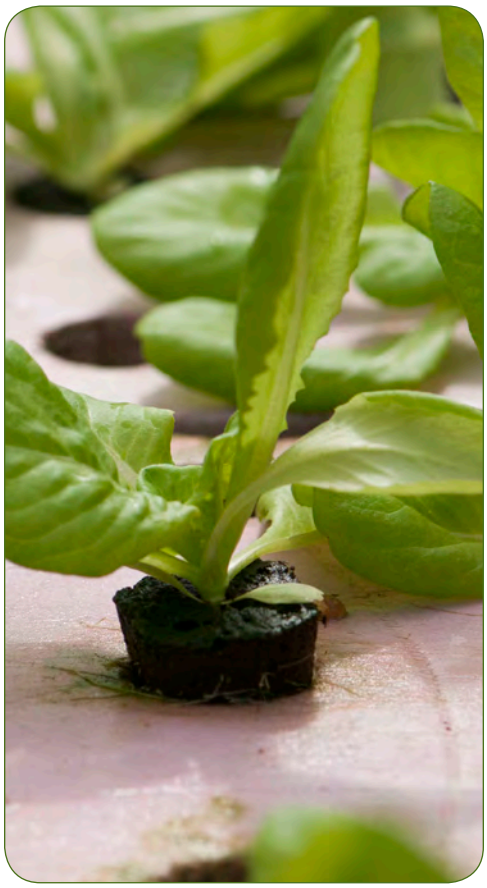
Hydro systems that include growing media can be divided broadly into container culture and slab culture. The medium holding the plant in hydro systems can be composed of a wide range of inert materials, including rockwool, coir, sand, perlite, sawdust, wood chips, or others.

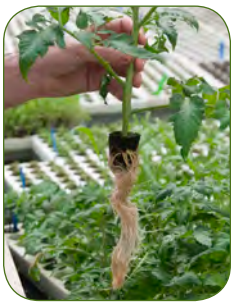
Container Culture. Container culture refers to the use of containers to hold the soilless aggregate medium in which the plants grow. The containers can be anything from buckets, pots, or grow-bags specifically manufactured to hold plants, to repurposed bags, buckets, or other alternatives.

Slab Culture. In slab culture, plants are grown in long, flat slabs of media made specifically for this application. Commonly available materials for slabs include rockwool and coco coir. Slab dimensions vary by crop and conditions but typically measure a couple inches in depth, a foot or so in width, by a few feet in length. Each slab is designed to house multiple plants growing from its top, with the number of plants depending on the type of crop. Slabs are usually wrapped in plastic or biodegradable film, to contain the nutrient solution. Individual slabs are laid end-to-end to form a row.

One big difference between liquid and substrate hydroponic systems is that substrate systems usually require one emitter per plant, to deliver the nutrient solution to the roots. This is in contrast to liquid hydroponics, where the nutrient solution is contained in the root zone by the channel or the basin, depending on the system.

Aquaponics. This methodology involves growing crops with the recycled nutrient waste from aquaculture. The nutrient solution is derived directly from water used to raise fish or other aquatic animals. The nutrients in the waste from the animals are used to feed the crops, creating an efficient food production system. Aquaponic systems can be integrated with any of the above hydro systems. The aquaculture waste is the source of fertility, and the hydro system of choice, whether NFT, DWC, or otherwise, is the method of delivery.





PLANTING PROGRAMS — SCHEDULING WHAT TO PLANT AND WHEN

While hydroponic production can follow much the same seasonal cycles as soil-based culture, conditions within the hydroponic setting are more amenable to tight control, allowing for intensive management protocols to maximize ROI. In areas with cold winters and moderate summers, fruiting crops can be started in the winter or early spring and terminated the following fall or winter. In areas with summers that are prohibitively hot for growing, the opposite crop schedule is often used. Seedlings are started in the summer, transplanted into the greenhouse after the hottest weather has passed, and grown through the winter to be terminated the following year before the hottest weather.

Lettuce, greens, herbs, microgreens, and shoots can be scheduled for as many short production cycles as the growing environment permits. Varieties may need to be modified with the changing seasons to allow year-round production of any given crop.

SPECIALTY HYDROPONIC TECHNIQUES: MULTISEEDING AND LIVING HARVESTS OF LETTUCE, GREENS, AND HERBS

The "living harvest" concept is one to which hydroponics is especially well-suited. Since plants can be quickly and efficiently removed from the system with their roots intact, growers are harvesting lettuce, greens, and herbs by pulling them from the system for sale as whole plants. The main advantage of this method is the prolonged shelf life, as the damp roots continue to feed the plant. Produce sold in this fashion is usually packaged in clamshells or individually bagged, to protect other produce from contact with the roots and nutrient solution.

One variation on this technique involves planting multiple seeds into a single plug to deliver multiheaded living produce to the customer. For example, two or more seeds of lettuce, basil, and/or greens of contrasting colors can be planted into the same plug, so the customer receives a multicolored living "bunch."

The Growing Differences
Hydro vs. Soil

Concerted Management. As with any other engineered system, hydroponic growing only works as well as the system is designed and managed. Unlike some field crops that can grow with little attention for extended periods of time, hydroponic systems require management on a daily basis. Instead of building up the soil and inputting fertility at the beginning of the crop cycle, soilless crops are typically fertilized at every watering. With their smaller root volumes and lower buffering capacity than soil-grown crops, hydroponically grown crops are prone to more rapid and drastic consequences when a pump or timer fails or a nutrient solution goes out of balance.

Fertility Programs. Hydro system fertility requirements also vary widely on the basis of crop, growing environment, regional and seasonal factors. Success of the crop is dependent on having a nutrient solution that matches all of those factors. Beginning hydro growers are encouraged to use a complete fertility program that has been designed by the manufacturer with their circumstances in mind. Once they have an idea of how the crops should perform, more experienced growers can blend their own custom fertilizers from single elements.

Popular Crops

The most popular food crops for hydroponic production are tomatoes, lettuce, cucumbers, greens, peppers, eggplant, herbs, microgreens, and shoots. These crops fall into one of two main production models: one long harvest or multiple quick harvests. For example, fruiting crops such as tomatoes, cucumbers, peppers, and eggplant are typically raised for a long season of up to a year, and the same plants are harvested many times for an overall high yield. Crops such as lettuce, greens, herbs, and microgreens are significantly quicker-cycle crops, which provide a high overall yield by being planted and harvested many times over the course of a season.








System Choice

While technically, nearly any crop can be grown in any hydro sytem, here are 3 popular system-crop combinations:

- **SLAB OR BUCKET CULTURE** for fruiting crops, e.g., tomatoes, cucumbers, peppers, eggplants.
- **LIQUID HYDRO SYSTEMS** for leafy crops, e.g., lettuce, greens, herbs.
- **NFT systems** for microgreens and shoots.

EQUIPMENT & SUPPLIES

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HOW TO CHOOSE VARIETIES SUITED FOR HYDROPONICS

Together with excellent flavor and appearance, crops best suited for hydroponics share certain characteristics. In fruiting crops, a high level of vigor is important to keep the plants strong over a long season. Resistance to blossom end rot is important in the solanaceous crops, since fast-growing fruits can be susceptible to this disorder. Resistance to diseases common in various growing regions will help keep the plants healthy. Having an open plant habit that promotes air flow can be equally important, as fruiting crops are frequently planted densely in greenhouses. Last but not least, careful, ongoing breeding and selection help verify that varieties thrive in hydroponic conditions.

The features that make lettuce, greens, and herbs suitable for hydroponics include resistance to diseases common in the greenhouse for leafy crops, such as downy mildew. Tipburn resistance is important as well, as this disorder can be a problem in rapidly growing greens, especially lettuce. Resistance to bolting is also important.

When it comes to form, varieties that are dense and compact will allow you to fit more plants into a given space. Lettuce and greens crops that have a head-type growth habit will yield more than open, leafy types in hydro systems. That is a big advantage of Salanova®-type lettuces, enabling salad mix production in hydro systems. Prior to the development of Salanova®, it was difficult to achieve good yields of high-quality salad mix hydroponically because it is not possible to densely seed in a line, as is typical for field production of salad mix. For greens, yield varies widely by species; varieties must be chosen carefully to ensure the yield is sufficiently high in a plug system to justify the expense.

Microgreens and shoots, with their short crop cycles, are well suited to hydroponic culture because they rarely need fertility inputs. They are commonly grown in a modified NFT system, with a piece of burlap or other fabric material lining the gutter to secure the roots. The microgreens can then be harvested by cutting the stems to provide loose microgreens, or by cutting the medium to provide a square of rooted, living product.