

Hydroponics: The Way of the Future

The term hydroponics is considered by many, in this day and age, as a way of growing marijuana. Hydroponics, however, is not just used for growing marijuana, but can be used to grow and produce salad greens, lettuces and culinary herbs. In fact, hydroponics is a relatively new term for growing plants without the use of soil. In the book *Hydroponics: The Complete Guide to Gardening Without Soil* by Dudley Harris, he says the term hydroponics is derived from two Greek words “hydro” meaning water and “ponos” meaning “labour.” Howard M. Resh the writer of *Hydroponic Food Production* points out, “The hanging gardens of Babylon, the floating gardens of the Aztecs of Mexico, and those of the Chinese were a form of “hydroponic culture” (1). This shows that even though the term is new, the practice of hydroponics has been in use for hundreds of years. Resh’s book also tells us that the term itself was coined by W.F. Gericke of the University of California after he started using non-soil farming on a commercial scale for his experiments (2). Resh helps us clearly define what hydroponics is:

Hydroponics can be defined as the science of growing plants without the use of soil, but by the use of an inert medium, such as gravel, sand, peat, Vermiculite, pumice, perlite, coco coir, sawdust, rice hulls, or other such substrates, to which is added a nutrient solution containing all the essential elements needed by a plant for its normal growth and development (2).

Glenn Collins, a journalist for the New York Times, interviewed Dr. Giacomelli, a hydroponic designer who is a professor of agricultural engineering at the University of Arizona said that hydroponics done on a commercial scale with large greenhouses, special lighting, and takes quite

a bit of technical sophistication. Many modern hydroponic farms use rooftop weather stations to monitor wind, rain, temperature, humidity, carbon dioxide and light intensity. There are also irrigation pumps, greenhouse vents, exhaust fans, gable shutters and shade curtains (Collins).

With the use of hydroponics, societies can produce more food with less impact on natural resources, thus helping preserve the land. However, the quality, and start up costs of hydroponic food have become a subject of controversy. Despite some objections, misunderstandings and stigmas, hydroponics is clearly the way of the future and a smarter, more productive way to farm.

In the United States, traditional farming is mainly used for the growing of produce, due to the large amount of land the United States has. According to “How Is Land in the United States Used?” around 450 million acres of land out of the 2.3 billion acres are being used for crop farming, which is about two percent of all the land in the United States (Nickerson). With populations growing the world is in need of more food. Giving up two percent of our land for the necessity of food production seems like a small price to pay, but for places like the United Kingdom and Japan, there is dramatically less space for traditional farming. Infact, according to Nations Encyclopedias Website, Japan is only 93.3 million acres in total. As a solution, a company in Japan, Shigeharu Shimamura’s Indoor Farm, has an entire hydroponic factory dedicated to growing lettuce. According to the Smithsonian website, this company grows 10,000 heads of lettuce a day all year round (Palus). That is 3,650,000 heads of lettuce a year. This was done on a 25,000 square foot factory, which is little less than one acre (Palus). The 2014 USDA crop yield count states the average yield for lettuce on an acre of land is 63,000 heads of lettuce a year. This means that the hydroponic company has a 59% higher yield in the year of 2014. In this

way Shigeharu Shimamura's Indoor Farm, and all hydroponic farms, are making more food for the world's population, while also using less room.

If the world's farmers switched solely to hydroponics they would only need about five million acres of land instead of the 450 million to produce the same amount of yield. This is an astounding difference. With such results lots of scepticism also come into play. Why are the numbers so different? To find out why look back to W.F. Gericke of the University of California. Gericke started using hydroponics, to begin with, for experiments (Resh). As a scientist Gericke knew his experiment needed a "control". The "control" for Gericke was the environment. Using hydroponics, growers are able to start growing indoors. which means there needs to be an artificial sun for the plants to receive light. Shigeharu Shimamura's Indoor Farm uses vertically stacked LED lights (Palus). This, with the invention of air conditioning creates a steady, consistent, and pest free environment for the plants to grow all year round. Traditional Farming can produce one or two harvests a year, but for hydroponic companies like Shigeharu Shimamura's Indoor Farm, they can harvest every day. Thus, farmers can produce food all year round.

Dr. Giacomelli said "We are all subject to limited resources on this planet and we need to make greater efforts to feed more people with fewer and fewer resources"(Collins). What better way to do this then with hydroponics. Hydroponics has ten times higher yields according to Collins. Infact, there are many traditional farmers that are now using the hydroponic methods, including drip irrigation and constant-feed formulas to extend their growing season and use less water. Traditional farmers have learned with water levels dropping, they need to preserve more water. Collins goes as far as to say that the reason why traditional farmers are using hydroponic

methods is because it uses one tenth of the water dirt farming does. Babstita, writer of the article “Water Use Efficiency in Hydroponics and Aquaponics”, says that with some systems you can even use up to twenty times less water than dirt gardening and fifty times less water than irrigation methods. The reason why hydroponics uses so much less water is because farmers are able to recycle all the water that the plants do not use.

In an academic article where the land, water, and energy requirements of hydroponics were compared to those of conventional agriculture by example of lettuce production in Yuma, Arizona it is stated that 70% of the world's withdrawn freshwater is devoted to agriculture (Barbosa et al). The article states that lettuce is the main crop grown in the U.S. and a substantial portion of that production (approximately 29% in 2012) occurs in Arizona, primarily in Yuma. Since Arizona devotes approximately 69% of its current freshwater withdrawals to agriculture, the authors felt an investigation into hydroponic alternatives could be beneficial in reducing the strain on water resources in such regions. It found that there was 2.7 times less water demand in hydroponic production compared to conventional production (Barbosa et al). It is clear that with how much less land and water hydroponics uses, farmers could make some big leaps on the problems that are being caused by global warming and droughts throughout the United States and the world. Infact, DSU professor of Biology, Cristian Edwards, who has a Masters in Ornithology, and also works at the Utah Division of Wildlife Resources as the Wildlife Biologist, when posed the question of what he would do with an extra 445 million acres of land for hydroponics, said,

I would suggest multiple methods of habitat restoration or enhancement over the majority of the land. A habitat left alone will usually produce maximum resources (i.e.

food, shelter, water, space) for that ecosystem. To keep our planet happy, we need to preserve wilderness and try to maintain healthy ecosystems. I think us humans would benefit greatly if crop land returned to its natural, wild habitat. With the remaining freed up land I would suggest two things. First, create and maintain plots of land for research purposes only. Areas that could duplicate natural communities and be used for scientific experiments and learning. Second, use the open land to construct tree farms, hatcheries, and nature preserves to act as refuge populations for threatened or endangered species.

With discussions happening in Paris, and global warming on the rise, many would consider that Mr. Edwards is correct in that the human race would benefit while keeping our planet happy by switching to hydroponics.

Many worry about the nutritional value, and taste of hydroponically produced plants. With such high yield, and so much water being saved the question of quantity over quality comes into discussion. Sarah, the writer of “Organic Hydroponics? Not for Me” goes as far as to say, “organic hydroponics is not nutrient dense food and is basically a waste of money.” Resh points out that “plants are comprised of 80-95% water, depending on the plant.” Does this mean that because hydroponics uses so much less water that these plants will not be able to grow to their full potential? The short answer is no. When using hydroponics the roots come into direct contact with the water. which means the roots system can be much smaller, but still be able to take all the water it needs. All the water that the plant does not use is then drawn back into a reservoir tank until the next watering cycle (Babstita). The gardener can rest assured that their plants are getting all the water they need. The only reason why hydroponics uses less water is because it is recycled. Resh goes on to say, “the 20-5% that isn’t water is about 90% Carbon, Oxygen,

Hydrogen. That leaves 1.5% of a plant that is affected by the soil or soilless medium.” Resh continues to point out that of the 92 known elements, only 16 of them are needed for plant growth. Normally soil or fertilizer will contain these elements to help the growth process, but without research into the fertilizer products or having someone come and test the soil for the elements there is no real way to know for sure.

Though consumers are right to worry about the nutrient density of the food produced from hydroponics, the worry is unfounded. Scientists now know the components and natural processes that occur inside plants, in regards to traditional soil farming and hydroponic farming. Just as traditional soil farmers look to fertilizers to get the correct nutrients, hydroponic farmers look to products such as GreenHaze, Ionic, Metrop MR 1 Grow, and many others that can be found and ordered at sites like npk-technology.com. All these products are organically based and are added to the water as the “base” nutrient. These products are very straight forward as to what farmers are going to be giving the plants, and yes, they provide those 16 elements that are essential for plant growth.

Richard Ball, the owner of Schoharie Valley Farms in Schoharie, N.Y, said in an interview that he would argue that consumers can tell a difference in the taste of soil-based produce and hydroponics-based produce. “In theory, it makes sense that you can tweak the nutrients in hydroponic growing, but soils are too complex. Soil is a living thing. You can’t reproduce my soil in a hydroponic farm” (Collins). To get more information on what the public thinks about the taste of the hydroponic food there are have been surveys conducted. One such survey was taken in a forum group in the Reddit website called Hydro. The Hydro subreddit or [r/hydro](https://www.reddit.com/r/hydro) is comprised of 6,876 people who either have tried to do hydroponics or have some

interest in the subject. When asked about some of the problems one r/hydro user, left814 said, "having grown both food and Cannabis in both mediums. I can tell you that the taste of food and Cannabis from soil far surpasses the taste that comes from Hydroponics. They just do not compare." When thinking about switching to hydroponics the taste is not something many people want to give up, no matter what other benefits it may provide. A different user, by the name of sdd3476, brought some wonderful insight to this by responding, "That absolutely depends on what nutrients you're giving your plants. Hydroponically grown plants can be more nutrient dense. That's the thing about hydro growing, the amount of nutrients the plants get is completely up to the grower." Dr. Giacomelli said, "we may not know of every nutrient you get from the soil," adding, "but in a taste test, often you can't tell the difference" between hydroponic and field-grown crops (Collins). Obviously, there is still some debate about the taste of soil or hydroponic food, but when the world's limited natural resources and global warming factors are considered, does a slightly less tasty tomato make it right for farmers to completely disregard the world's future?

One element of farming that all soil-based farmers have to deal with are the outside elements, this includes insects and animals, also known as pests. These pests can destroy whole crops if they are not dealt with. Thus, pesticides have been a necessary evil in traditional soil farming. Clevo Wilson, writer of the article "Why Farmers Continue to Use Pesticides Despite Environmental, Health and Sustainability Costs," says,

Continuous use of chemical inputs such as pesticides has resulted in damage to the environment, caused human ill-health, negatively impacted on agricultural production and reduced agricultural sustainability. Fauna and flora have been adversely affected.

Numerous short- and long-term human health effects have been recorded. Human deaths are not uncommon. (Wilson)

Despite all these negatives, Wilson says that because farmers started to use pesticides it is making the use of pesticide even more necessary. This is due to the fact that the pesticides are not only killing the insects, but are also killing the natural predators of the insects they are trying to get rid of. Therefore, if they were to stop, the insects would override the farmers crops. This is another reason why hydroponics, with its indoor environment, can grow our plants in a no pest zone. Because hydroponics is done primarily outside the bonds and restrictions of the natural environment, the crops can thrive without pesticides, fungicides or herbicides, and natural pest controls like parasitic wasps, lacewings and ladybugs are all that are needed (Collins). It is easy to see that hydroponics is offering a healthier and safer alternative to the pesticide-ridden produce you primarily get in the store.

Unfortunately, switching from traditional soil farming to hydroponics is something that cannot be done easily, inexpensively, or overnight. Farmers must think logically about the economics of such a transition. One aspect of Hydroponics that is a deterrent to many people is the start up cost, as well as demanding labor and management. Cheryl Kaiser and Matt Ernst writers of the article hydroponic lettuce for the Center for Crop Diversification Crop Profile. which went over some of the basic start out costs.

Initial investments include greenhouse construction, production system costs and equipment. The cost of a production ready greenhouse, excluding land costs, can run approximately \$10 per square foot... Initial investments include greenhouse construction and equipment purchases as well as purchase of seed and other inputs. Higher marketing

and packaging costs may be expected for producing hydroponic herbs and greens for premium markets. (Kaiser)

A well-run hydroponics operation can have gross returns of \$10 to \$25 per square foot of production space for the season, depending on crop quality and market. Breakeven costs for a 3,000-square-foot greenhouse with eight harvests per year and 5,900 marketable heads per harvest were estimated at \$0.71 per head for variable costs and \$0.18 per head for fixed costs. This equals a breakeven price above all costs, including operator labor time, of about \$0.90 per head (Kaiser). Companies, such as Walmart, sell heads of romaine lettuce for about \$3.00. This turns a net profit of about \$99,000 a year for a 3,000-square-foot greenhouse. Hydroponic farming can be lucrative and profitable, as long as they have the capital to start the company and cover all the start up costs.

Another aspect of hydroponics that is attractive to many businesses is the fact that they are able to get much of their produce fresh, thus eliminating food waste. For restaurants like the Gramercy Tavern in Manhattan, most of their produce is shipped over from California and is three-days-old by the time it arrives in the restaurant, increasing food waste. However, Gramercy Tavern has recently started buying some of their produce from a hydroponic farm four miles away. They are now able to get fresh produce within 15 minutes (Collins). This not only enables consumers to have fresher food, but will allows businesses to spend less on shipping, and hydroponics allows communities to keep the money local.

With any new technology or method of doing something that has been done a certain way for so long there is bound to be resistance and skepticism. Traditional soil farming is a well known and experienced method of producing food, but in today's circumstances it is not the best

option. There are several reasons Hydroponics is the superior farming method. Hydroponics uses less land, and water, freeing up much of the world's natural resources. The food grown in Hydroponic farms is nutritional and is argued to have just as much taste as traditional soil grown food. Hydroponics is offering a healthier and safer alternative to the pesticide ridden produce primarily purchased from the store. Although Hydroponics can be costly to start up, the revenues more than make up for cost of the initial investment. Because Hydroponic farms use such little land and don't have to depend on the surrounding environment, they can be built almost anywhere. This allows communities that may not have been able to have local soil grown food to be self-sufficient and sustain their economy. With all sides considered, Hydroponics is undoubtedly the way of the future.

~J. Daniel Woodstock

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