Hydroponics

Mo Naushad[1]* and Nivedita Prasad[2]

[1]M.Sc. Scholar, Department of Agronomy, United University, Jhalwa, Prayagraj (U.P.)
[2]Assistant Professor, Department of Agriculture & Allied Sciences, United University,Jhalwa, Prayagraj (U.P.)

Corresponding Author
Mo Naushad
Email: naushad6143@gmail.com

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ABSTRACT

Due to urbanization, industrialization, environmental deterioration, and other factors, soil-based agriculture is currently experiencing significant problems. The loss in available land per person is the most significant issue among others. With 6 billion people on the planet, there will only be 0.25 hectares of land available per person in 2050. This harmful impact is amplified by climate change, urbanization, and industrialization. Due to its effective resource management, hydroponics has emerged as a feasible solution to address these challenges, and it is now gaining popularity globally. Due to regulated settings and stringent certification regulations, hydroponic farms provide a workable method for producing food that is more environmentally friendly while avoiding harmful chemicals. Hydroponic farming is currently included into sustainable agriculture, far from being a pipe dream.

INTRODUCTION

Aquaculture, nutriculture, soilless culture, or tank farming are other names for hydroponics, which is the practice of growing plants in nutrient-rich water with or without the mechanical support of an inert medium like sand, gravel, or perlite.

Types of Hydroponic Systems

1) Wick System

This configuration is the simplest and was given its name because of how functionally similar it is to a candle wick. A string is used to pump nutrients up to the growth medium where the plants are located from a water reservoir. Home gardeners who wish to attempt hydroponics often choose for this strategy. Larger plants, however, cannot get enough water from a string, therefore it is not ideal for them. Additionally, the plants may perish if the setup or material is improper.

2) Deep Water Culture System

This technique, which is also known as the Kratky Method after its developer, University of Hawaii horticulturist B. A. Kratky (who, and I'm not making this up, graduated from Purdue University with a degree in "Weed Science"), functions by setting plants in pots on top of a floating holder so that the roots are in the growing medium. It is cheap and requires relatively little maintenance since it cycles water, saving waste. However, because they must be small enough to be adequately supported by the floating raft, this approach is not suitable for huge plants or those with lengthy growth cycles.

3) Nutrient Film Technique (NFT) System

Many vertical farms, which are effectively plant skyscrapers, employ this approach. Some can have hydroponic growing systems that are hundreds of square feet in size. The most typical kind used in domestic, academic, and professional settings is NFT. It functions by utilizing a tube that is slightly angled downward to provide a continual flow of nutrients to the plant and back to the reservoir. This design has two benefits: first, since the pump works continuously, there is no need for a timer, which makes setup simpler (though it can pose problems in a power loss).

4) Ebb and Flow System

This technique controls the flow of nutrients from the reservoir to the growth tray using a pump on a timer. After completely encircling the plant roots, the nutrients return to the reservoir. This technique is adaptable to the demands of the grower, efficiently utilizes water and energy, but necessitates a sizable volume of growth material.

5) Drip System

The nutritional solution is distributed through a network of drip lines using a timer to determine when the plants will get small drops of water. It offers more scheduling flexibility and is reasonably priced. But it can waste a lot of water and is probably unnecessary for a small garden at home.

6) Aeroponics

One of the most complicated hydroponics alternatives seems to be aeroponics. No growth medium is needed because the plants are hung in the air. Additionally, a timer regulates a spray mechanism to regularly spray nutrients into the roots. Because of this arrangement, the roots are exposed to more oxygen.

7) Aquaponics

In aquaponics, fish and vegetables are merged into one symbiotic system, along with other aquatic creatures including snails, prawns, and crayfish. The plants filter the waste products out of the system by using them for their own nourishment, which can be toxic to fish in excessive quantities.

Benefits of Hydroponics

High Yield

A greater output of calories per growing area is provided by hydroponics. In order to increase crop production and feed more people, the UN's Food and Agriculture Organization (FAO) is assisting in the implementation of hydroponic farming in places where there is a food crisis. Additionally, plants cultivated hydroponically can expand at least 20% quicker than those grown on soil.

Less Water

Because most hydroponic systems employ recirculation techniques to reduce waste, they use less water overall – up to 90% less than conventional field crop watering approaches. In traditional farming, water is wasted for a variety of reasons, including evaporation, ineffective irrigation, and soil erosion. Hydroponics can reduce losses in these places since it is not a part of the normal water cycle.

Regional Diversity

Farmers can practically anyplace to produce food thanks to hydroponics. For instance, hydroponic systems may be installed in greenhouses, interior spaces, or even residences. Even desert environments, like those in Egypt and the Middle East, may sustain hydroponic farming on a scale large enough to meet local food demands. Scientists are even attempting to use equipment on the International orbit Station's "Veggie" facility to produce food for astronauts so they may spend more time in orbit. In reality, following extensive research, astronauts were allowed to consume leafy greens produced in space in 2015.

Continuous Production

Additionally, hydroponic technology provides constant output. In contrast to conventional agriculture, which mostly makes use of sizable outside agricultural fields, hydroponics producers are not affected by the passing of the seasons. Year-round crop production increases supplies and decreases the demand for food preservation.

Growing Systems

There are two types of hydroponic systems: liquid and aggregate. Plant roots cannot be supported by a solid media in liquid systems, but they may be in aggregate systems. In addition, there are two types of hydroponic systems: closed (extra solution is collected, refilled, and recycled) and open (after the nutritional solution is provided to the plant roots, it is not reused).

What's the problem?

By 2050, when there will be 9.8 billion people on the planet—68% of whom are expected to live in cities—we will need to raise food production by nearly 70% in order to fulfill the caloric demands of this population. Fortunately, our existing agricultural system is equal to the challenge. We would not be close to attaining this level of development by 2050 if we projected a linear gain in yield from our agricultural output during the previous five decades.

Traditional agriculture uses an enormous amount of resources. Intensification and the expansion of the land used for food production have been seen as the only viable options to meet these rising food demands because most crop production has already reached its genetic and chemical limits (a significant increase in fertilizer or pesticide use will not sufficiently increase yields). 70% of water used worldwide is used for agricultural production, primarily as a result of irresponsible irrigation techniques. At present, 38% of earth's non-frozen land is used for growing food. This percentage will continue to rise: by 2050, 593 million hectares of land will need to be transformed into agricultural land to meet the projected calorie needs of the global population if we continue with business as usual.

Why Hydroponics?

Climate change, dangerous infectious illnesses, rising urbanization, and the depletion of natural resource reserves are just a few of the pressing concerns facing humanity today. These issues are dramatically altering our worldwide lifestyles. There is a great deal of promise for hydroponic farming to lessen the risks these problems represent to our agricultural system. One of the main advantages of hydroponic farming is the ability to grow crops in almost ideal circumstances utilizing controlled environment agriculture (CEA) technologies. Climate change, dangerous infectious illnesses, rising urbanization, and the depletion of natural resource reserves are just a few of the pressing concerns facing humanity today. These issues are dramatically altering our worldwide lifestyles. There is a great deal of promise for hydroponic farming to lessen the risks these problems represent to our agricultural system. One of the main advantages of hydroponic farming is the ability to grow crops in almost ideal circumstances utilizing controlled environment agriculture (CEA) technologies.

Costs and Challenges

Although hydroponic farming has numerous advantages, there are also some difficulties. Entering the hydroponic farming industry can be expensive for small, beginning farmers due to the high costs of space rental, mortgage payments, remodeling a building or space to accommodate the hydroponic structures, initial material costs (such as LED lights, watering and feed systems, plant racks, seeds, controlled environment technology, etc.), labour costs, and electricity costs to keep the farm operational. While these entry costs are high, hydroponic farms have the potential to turn underutilized buildings into farmland to serve the community and create jobs.

Here is an example of a reduced calculation done for the startup costs for a typical indoor farm by Zip Grow, for more details click here:

Footprint of a 500 ft2 indoor hydroponic farm, automated nutrient dosing and high efficiency LED lighting

Initial cost: $110k (does not include upgrades to the facility)

Energy costs for hydroponic lettuce (using 48 LED lighting units running 18hrs/day total up to 306.72 kWh daily energy usage): $31.80 daily commercial cost and $38.52 daily residential cost

Average profit margin on a hydroponic farm (½ basil, ½ lettuce) over a 3.6 week crop cycle: Revenue produced up to $10,482

Once these initial costs are overcome, more challenges must be faced in order to ensure a productive and secure hydroponic farm. Stacked rack systems (as opposed to vertical growth towers) can face challenges with air flow, heat and humidity. With horizontal modeling, there needs to be much more space between each plane to reduce the risks associated with poor airflow, such as high humidity, increased vulnerability to pests and disease, and a reduced growing capacity from lower CO2 levels. Additionally, the energy costs associated with hydroponic farming and maintaining optimal growing conditions for the plants are quite high.

How Does a Hydroponics System Work?

Even though there are other metabolic pathways involved in plant development, water, sunshine, and vital nutrients are the three major factors that drive plant growth. In a conventional garden, the soil holds the plant in place and serves as a storage area for nutrients and water. By giving the plant's roots a nutrient-rich aqueous solution that keeps them hydrated and fed while additional lighting options simulate sunshine, a hydroponics system removes the need for soil.

More on soil-free growing

In a hydroponics growing system, plants are either suspended directly in the aqueous solution or grown in a soil-free medium such as coconut coir, rock wool, LECA, vermiculite, or perlite. The plant's roots receive the nutrient solution in either an active system or a passive system.

Active systems use pumps to circulate and aerate nutrient solutions, delivering the nutrients to the plant's root zone for uptake.

Passive systems have no pumps or moving parts. The nutrient solutions are fed to the root zone through flooding, gravity, or capillary action.

More on supplemental lighting

Because natural light is limited indoors, plants grown in a hydroponics system typically receive supplemental lighting. Hanging lights above the plants and controlling their brightness mimics the natural cycles of daylight and darkness that plants need to grow.

CONCLUSION:

The hydroponic plants have grown significantly higher and developed more leaves sooner than the plants growing in regular soil due to the usage of a continual feeding of nutrients and water. As a result, the null hypothesis is disproved since the evidence does not support it.

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