Hydroponics: Future of Indian Farming

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ABSTRACT

In order to keep up with the demands of the ever-increasing population, farmers and owners of commercial plantations are forced to resort to using harmful chemicals to produce more, but this affects the consumers in the long run. Hydroponics is the method of growing plants directly in a water medium, eliminating the use of soil, thereby taking away the high maintenance costs and side effects mentioned earlier. This paper covers several different metrics for managing plant growth using Internet of Things (IoT)andourobjectiveistoderiveamachinelearningalgorithmtooptimizethevaluesofallthemetrics.Ourfutureproje ctfocuses on devising a hydroponics system that is robust and has increase deficiency.

Keywords—component; formatting; style; styling; insert (key words)

INTRODUCTION

Global warming is becoming such a major concern for the entire planet, in addition to other emerging climate impacts. Our present farming industry has to tackle a massive challenge by 2050, we will have to increase food production by approximately 70% to fulfill the calorie consumption of a worldwide population of 9.8 billion of people, 68 percent of total of whom are predicted to reside in cities. If we continue on our current route, 593 million hectares of land must be converted into farmland by 2050 to satisfy the anticipated caloric intake requirements of the world's population. With land becoming scarce and an increasing population lacking housing conditions, a technique of agriculture that enables production without the need for land could be immensely important. This is the reasons why we need to look for alternatives to our current agricultural system so thatwe can satisfy increasing food demand. Hydroponic farming offers an answer to many of our world's current agricultural problems. Urban farmers are increasingly turning to hydroponics, a water-saving method of growing pesticide-free produce on rooftops and terraces.India will expected to expand at a compound annual growth rate (CAGR) of 13.53 percent between 2020 and 2027.

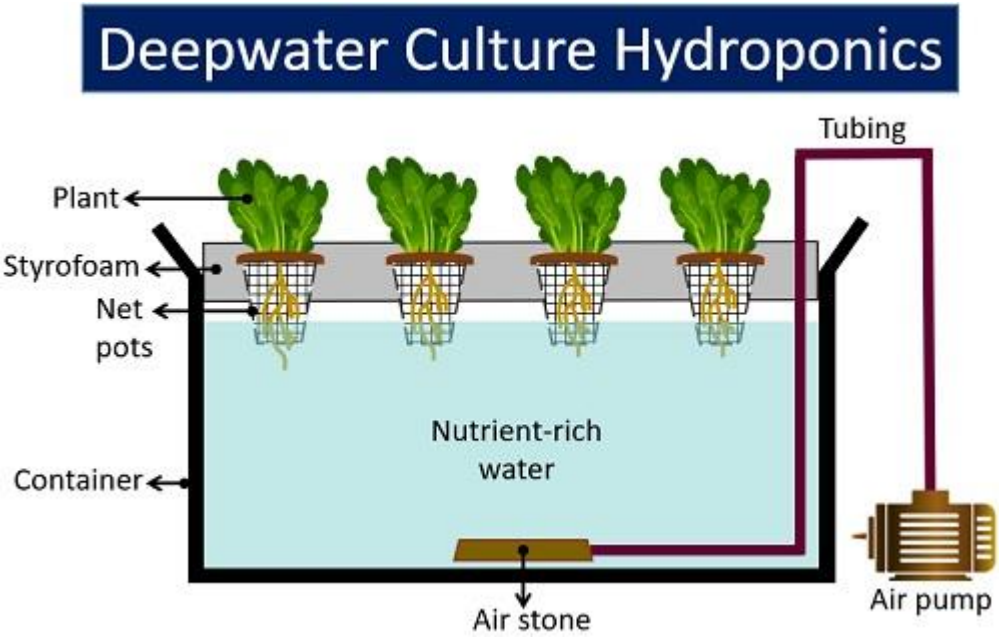
Hydroponic farming

The term hydroponics is derived from the Greek words ‘hudor’ for water and ‘ponos’ for ‘work’Hydroponics is a modern way to cultivateplants indoors, typically farm produce, with no need for soil. Plants grow on the water in this method,which is rich in essential micro and macronutrients. As according to research findings, plants grown hydroponically grow more quickly and efficiently than soil-grown plants since nutrients are directly transferred to their roots via water in the form of an aqueous solvent as opposed to the soil. When we recall the photosynthesis process, we can recall the core elements of plant growth as energy, nutrients, water, and CO_2. Hydroponics eliminates all unneeded inputs that are crucial to our existing agricultural system, such as soil and pesticides. Plants receive energy from LED lighting that is tailored specifically to the energy needs of the plants, rather than from the sun. Instead of soil, seeds are planted in soil-free growth. These seedlings are sometimes placed in growth trays that are stacked vertically, rather than horizontally, in a vertical racking system. Vertical plant integration enables farmers to optimize the total space usage of their growth area, allowing them to reduce land use by up to 90-99% while increasing productivity.

Types of Hydroponics

1) ***Deepwater Culture Hydroponics (DWC):***

It is also called a reservoir system. The reservoir in DWC contains water and nutrient solution. Here, the plant roots are in direct contact with the nutrient source. It means there is **no support material** between the plants and nutrient sources. A **diffuser** or air stone allows uniform distribution of oxygen in the reservoir. Thus, plant roots submerged in the reservoir directly absorb nutrients, water and oxygen. The deepwater culture system uses **net pots** to keep plants in their proper position.



Advantages

- It is a **simple** method for the operation.
- DWC is an **inexpensive** method for most growers, requiring a reservoir, suspension system and air pumps.
- Plants in DWC grow faster as they have **direct access** to nutrients, water and oxygen. Large size plants with big root systems can proliferate through this method.
- You can top up the nutrient solution.
- DWC method produces less waste, as it is a **recirculating process**.

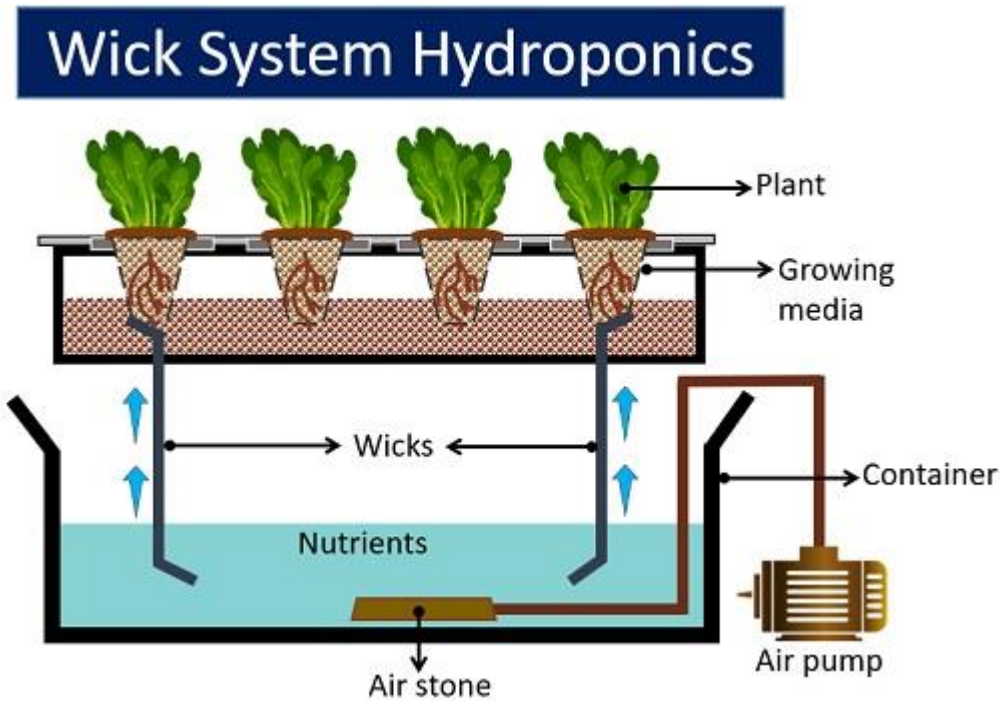
Disadvantages

- The **maintenance** of DWC is not easy, as you can only clean the system when it's not in function.
- Several **root diseases** may occur in case of dirty growing conditions and stagnant nutrient solutions.
- Here, the basic air pumps do not provide good aeration, or there is **no uniform oxygen distribution** to all the plants.

2) Wick Hydroponic System

It is the **simplest** type of hydroponics. The Wick system works without the use of aerators or pumps. The plant is fixed within the porous absorbent media (like perlite or coconut coir).
Wick hydroponic systems use a **nylon thread** to supply water and nutrients to the plants. Here, one end of nylon thread is around the absorbent media and the other end is immersed in the reservoir. The Wick system is best for plants that consume very less water and nutrients to grow. The wick or nylon thread supplies water and

nutrients whenever the roots are ready to absorb.It is a **passive system** because there is no involvement of electricity, air or water pumps.



Advantages

- The Wick system is best for growing smaller plants like **herbs**.
- It is **simple** to operate as the wick system does not need equipment like a pump and aerators.
- Wick hydroponics is an **inexpensive** method.

Disadvantages

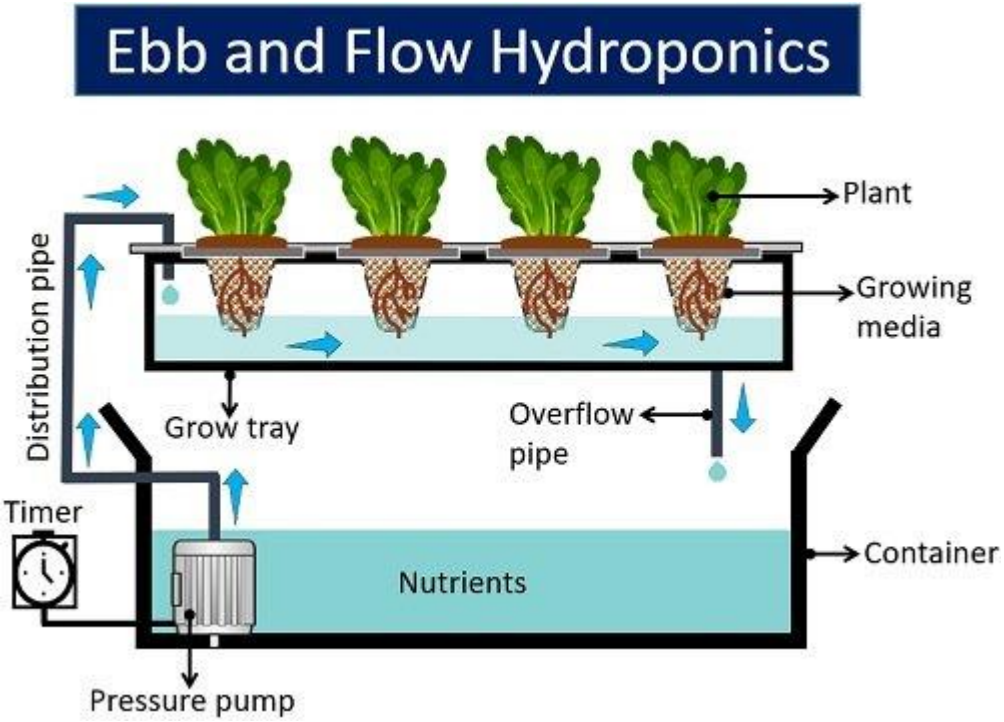
- The Wick system is only useful in cultivating plants that do not need an adequate water supply.
- It is not suitable for growing **heavy-feeding plants**, as they need more nutrients to grow.
- There is an **uneven distribution** of water and nutrient in this system.
- For the maintenance, you need to flush extra nutrients with fresh water every 1-2 weeks.

3) Ebb and Flow Hydroponic System

It is common for **home gardening** and is also termed the **flood** and **drain system**. Here, a growing material like Rockwool or perlite houses the plants. Then, a growing material holding the plant is positioned within the cavities of a grow bed or grow tank. In this system, the water pump distributes a nutrient-rich solution into a grow bed until the water level reaches a certain height from the bottom of the reservoir to the top layer of the growing medium.

The **water pump** is outfitted with a timer that regulates the flow of nutrient-rich water. The water pump floods the nutrient solution in the grow tank on a **cyclic schedule**. After a predetermined time, the timer shuts off the water pump.

As a result, the **water drains out** from the grow bed and returns to the reservoir. The air pump in the Ebb and Flow system oxygenates the water in the reservoir.



Advantages

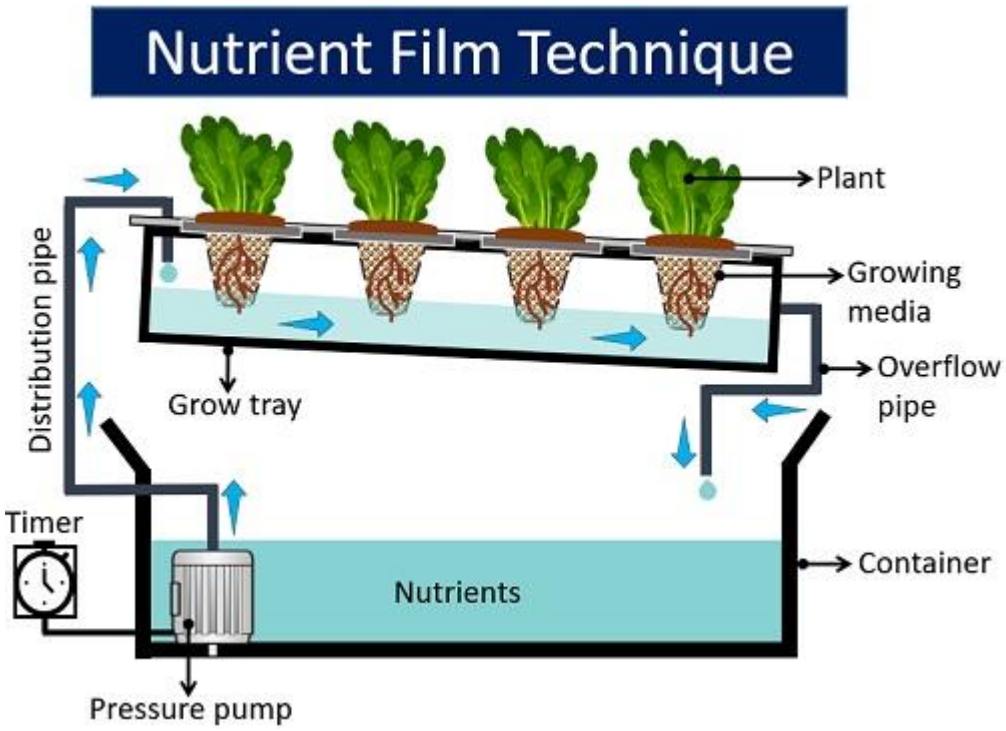
- The Ebb and flow method is suitable for growing **root vegetables** like carrots and radishes.
- It is a **recirculating system** that effectively uses water and energy.
- Knowing the plant growth intake of nutrients, the Ebb and flow method work best. We can improve the **plant's growth** and **yield** by providing limited nutrients.

Disadvantages

- The method is not successful for **growing large plants**.
- Its operation requires **continuous monitoring** of the factors like water and pH.
- The flood and drain methods do not fulfill the nutrient requirements of the plant roots.
- The pump controller can **malfunction**.

4) ***Nutrient Film Technique***

It is a simple method for commercial and home gardens. The reservoir of the nutrient film technique contains nutrient-rich water and a motor. The water pump drives the nutrient-rich solution upwards to the sloping channel. Here, the grow tray appears as a **sloping channel**. The plants are put inside the net pots with or without the growing media. When the pressure rises, the motor push water to the grow tray for a predetermined time. Once the time is over, the motor switches off, and the excess nutrient solution gets back into the reservoir.



Advantages

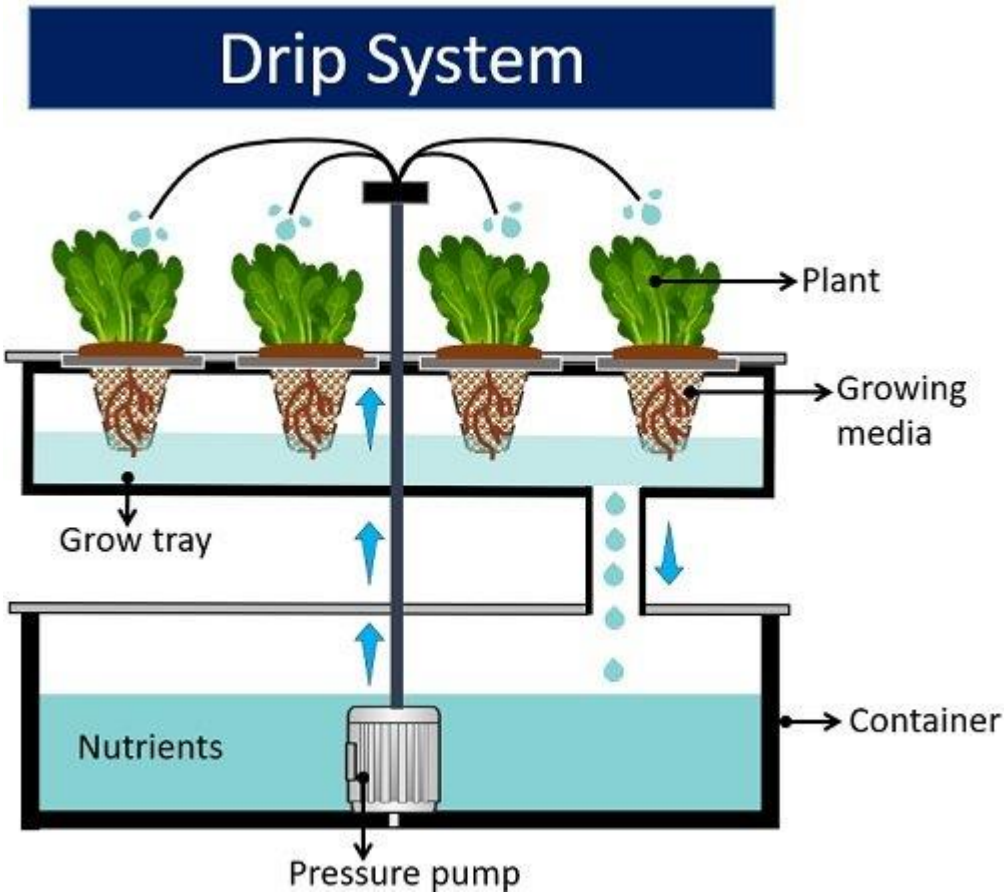
- It is a **low-waste** recirculating technique.
- To support the plant material, you do not need growing media.

Disadvantages

- **Overgrowth of roots** may occur that sometimes intertwine along the channel.
- **Malfunction** in the motor may occur after continuous operation.
- Recirculation of nutrient solutions can **clog pipes** and channels.

5) ***Drip Hydroponic Systems***

These are common in **commercial settings**. Like NFT systems, there is a separate channel holding up the plants. The plants are suspended in net pots over a thin layer of water and nutrient solution.
A **large tube** pumps the water over the growing channel at a constant rate. This improves oxygenation and nutrient uptake by the plants. The leftover solution flows back into the reservoir.
Drip systems can be circulating or non-circulating systems. **Circulating systems** drip rapidly with excess nutrients flowing back into the reservoir. **Non-circulating systems** drizzle slowly with adequate nutrients at a consistent rate.



Advantages

- Drip systems are **easy to use** and set up.
- It is an **efficient** technique for growing all types of plants.
- Drip systems efficiently control the **schedule of feeding**.
- For commercial spaces, it is an **inexpensive** and effective method.

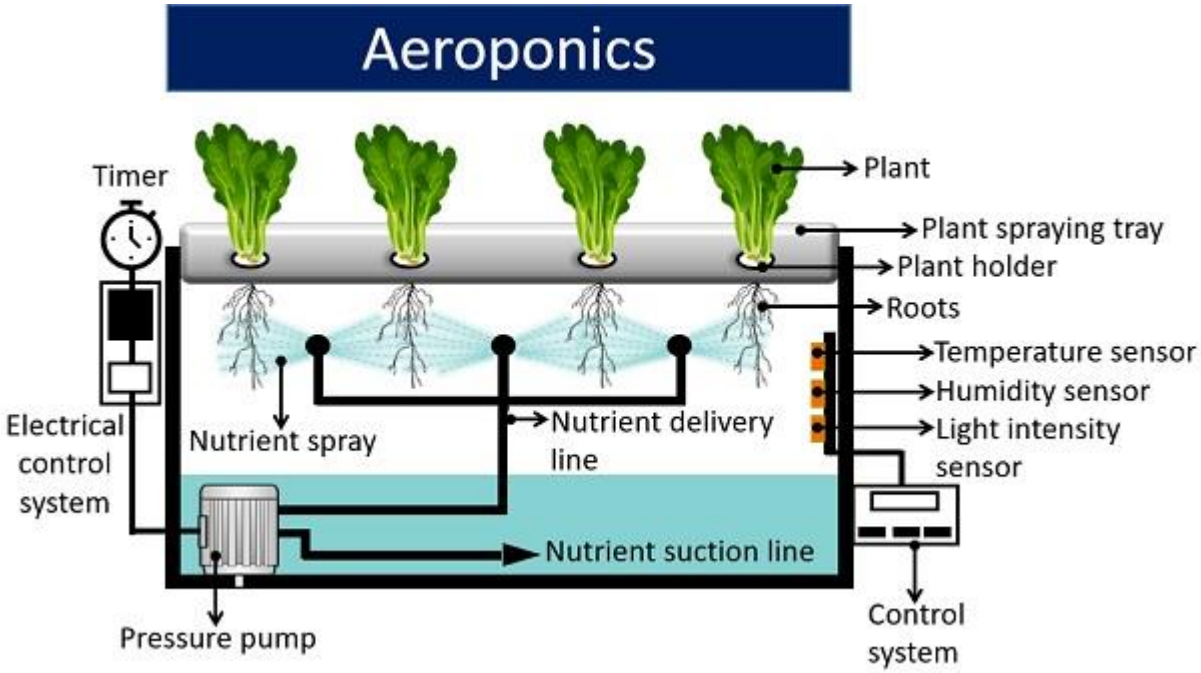
Disadvantages

- Drip systems need many moving parts that increase the cost for home gardeners.
- It requires **continuous tracking** of the pH and nutrient level to operate the drip system.
- A drip system is not a recirculation method, leading to a **high waste level**.

6) ***Aeroponics***

It is the easiest type of hydroponic system. Here, plants and their roots are suspended in the air. The water pump in the reservoir comprises several **mist nozzles**.

Misters give a **fine spray** of the nutrient solution onto the roots of each plant. The rest of the nutrient solution falls into the reservoir. To construct aeroponics, you must have an idea of the correct dimensions of the reservoir. For instance, a reservoir should be deep to grow larger plants. Plants in the aeroponic system get enough oxygen as they are suspended in the air.



Advantages

- Roots are exposed to **more oxygen**.
- The operation and maintenance of aeroponics are quite easy.

Disadvantages

- The system is a **cost-effective** and **high-tech** method to construct.
- The nozzle in the aeroponics system sometimes becomes **clogged**, which requires frequent cleaning.

Benefits of Hydroponics

The reasons for its widespread global adaptability are its numerous benefits. Humans are now confronted with a plethora of new demanding problems that are leading to significant changes in our worldwide lifestyles: climate change, threatening infectious diseases, rapid urbanization, and natural resource depletion. Hydroponic farming has the potential to significantly reduce the risks that these problems pose to our farming sector. Hydroponic farming as well minimizes greenhouse gas emissions, which makes it a significant step towards more sustainable agriculture. Furthermore, this is a boon in a country like India, where agriculture is heavily reliant on the monsoon. There are numerous advantages for farmers who really can grow crops out of season and provide more food and nutrition choices for consumers.

- **Plantation in the absence of soil:**

In hydroponics crops are grown without soil utilizing mineral nutrient solutions in an appropriate solvent. It is soil-less, water-based farming, may even be done in a small space. As opposed to utilizing soil to feed plants, crops have been given nutrient-rich water; we can grow plants in areas where land is scarce, non-existent, or contaminated. NASA has identified it as the future farming method for growing foods for astronauts in space. NASA has been experimenting with hydroponics for cultivating plants on long-term space missions in recent years. The programme is known as "Controlled Ecological Life Support System" (CELSS), and it has the potential to save astronauts' lives during long-term space missions.

- **High Yield:**

Hydroponics provides a higher calorie yield per growing region. This is one of the reasons for the implementation of hydroponic farming in areas of food scarcity in order to grow more crops and feed more

people. Furthermore, plants grown hydroponically can grow at least 20% faster than soil-bound counterparts. There is also the possibility of multiple crop cycles occurring in the same season which also increases the yield.

- **Using Less Water:**

Because most hydroponics use recirculation techniques to minimize waste, hydroponically grown plants consumes a less water (about 20%) than field-grown plants used in traditional cropping methods. The loss of water in traditional farming is due to the evaporation, inefficient irrigation, and soil erosion, etc. Even though hydroponics is not partof the natural water cycle, plants will absorb the required water, while run-off water will be collected and recycled back into the system. Water loss in this system will only occur through evaporation and system leaks.

- **Temperature regulation**:

In contrast to soil growing plants, where there are numerous influences (pH, light, air temperature, microorganisms and so on), hydroponic growing may be nearly controlled entirely. Hydroponic farmers have total control over the environment, which includes climate, temperature, humidity, light, and air composition. That is, why we can grow foods all year long, regardless of the season. Farmers can boost their profits by planting crops at the appropriate time.

- **Improved use of space and location:**

One of the primary advantages of hydroponics is that it can be used in a relatively small space. Farmers can grow food almost anywhere in homes, greenhouses, or any other type of indoor space. Plant roots normally spread out in the soil in search of food and oxygen, but in hydroponics, roots are immersed in an oxygenated nutrient solution with vital minerals. This allows growing plants closer together, which saves you a lot of space. Even desert climates can support hydroponic on a sufficient scale to meet local food requirements. Researchers are now even trying to use technology on the International Space Station in a facility known as "Veggie" to grow the food for astronauts in order for them to stay in space for longer missions.

- **Continuous Production:**

Continuous production is also possible with hydroponic technology. Plants may be grown and harvested throughout the year, increasing the supply and reducing the necessity of food preservation. The most significant advantages of hydroponic farming is the ability to grow crops indoors and crops could be grown anywhere on the planet at any time of year, regardless of the climate, soil conditions or availability of cultivable land. Unlike conventional agriculture, which mainly relies on large outdoor farmlands, hydroponics growers are really not impacted by the shifting seasons. The method requires less labour, and the yields are much higher because plants grow much faster than in traditional methods.

- **Nutrient utilization:**

The farmers have complete control over the nutrients that plants require with this technique. Farmers can determine what the plants require before planting, as well as the amount of nutrients required at various stages and the proportion at which they should be blended with water.

- **Fewer Toxins:**

The traditional agriculture relies heavily on herbicides and pesticides to protect crops from natural threats, the sooner we can the amount of pesticides in our food and environment, the better off our health and the world will be. Hydroponic system needs little to none of these harmful implementations. It provides a secure indoor growing environment that protects plants from harmful pests and microbial diseases which is another advantage.

Financial Challenges :

Although this technology looked promising and is getting popular, the preliminary expenses associated with starting a hydroponic farm are significantly higher than traditional farming. Hydroponic growing can save water, but it also necessitates significant infrastructure because it is typically done indoors. To begin a hydroponic project, you must be a technical expert. Entering the hydroponic farming world can be expensive for small, start-up farmers due to the costs of renting space, mortgage payments, renovating a building or space to

accommodate the hydroponic structures, initial costs for materials (such as watering and feed systems, LED lights and so on), labor and electricity to keep the farm running.
Besides that, the energy expenses involved with hydroponic farming and maintaining optimal growth environment for plants are really quite high. The combination of high-intensity LED lighting and climate monitoring and management systems leads to substantial electricity consumption at hydroponic farms. Crops must be monitored continuously. Power cuts can seriously damage hydroponic setups done in small spaces. It is crucial that hydroponic farms seek to supply their energy from renewable sources such as solar panels or wind energy. Some
other critical issue is a lack of knowledge and understanding among farmers regarding all of these concerns and technological advancements. Once these obstacles are tackled, hydroponics guarantee a fruitful and secure future of the farmers in India but we still have a long road ahead to go before this technology is widely adopted.

Conclusion:
Hydroponics may play an important role in feeding world, as we faces greater challenges from environmental degrdation and climate change. In a scenario where farmers are reliant on soil fertility in order to produce crops all year, this same hydroponic technique provides a way to ensure all-year-round crop production, resulting in increased farm incomes. So many startups throughout India are employing this method for cultivating organic food due to the obvious scarcity of land and the high cost of purchasing a large piece of land for business. Eeki Foods is an IIT alumni venture that provides nutritious and residue-free vegetables at affordable prices all year round. More startups are confined to enter the hydroponics space in India as well as globally. Regardless of its advantages and disadvantages, hydroponic agriculture is likely to persist and expand in the future.

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