Hydroponics: An Overview Of Advanced Growing Approaches

Jayanti Ballabh[1], Mansi Nautiyal[2], Raja Joshi[3*], Mahipal Singh[4], Guarav Jain[5], Neha Saini[6]

[1]School of Agriculture, Uttaranchal University, Dehradun-248007, Uttarakhand, India Email: Jayantiballabh1987@gmail.com
[2]Department of Agriculture, Tula's Institute, Dehradun-248197, Uttarakhand, India Email: mansinautiyal94@gmail.com
[3*]School of Agriculture, Uttaranchal University, Dehradun-248007, Uttarakhand, India Email: rajajoshi63262@gmail.com
[4]School of Agriculture, Uttaranchal University, Dehradun-248007, Uttarakhand, India Email: drsinghudr@gmail.com @gmail.com
[5]Department of Agriculture, Tula's Institute, Dehradun-248197, Uttarakhand, India Email: gauravj888@gmail.com
[6]School of Agriculture, Uttaranchal University, Dehradun-248007, Uttarakhand, India Email: neha.saini783@gmail.com

***Corresponding Author:** Raja Joshi
rajajoshi63262@gmail.com

Abstract
Many man-made factors, like industrialization and urbanisation, have made soil-based farming more challenging. Soil fertility and quality are also diminished by unchecked chemical usage in agriculture, climate change, and abrupt events in nature. Because of this need, researchers have come up with a new method of growing plants: hydroponics, which does not use soil. Growing plants in a nutrient-rich water solution is called hydroponics. Hydroponics allows for the cultivation of a wide variety of plants and crops. In comparison to conventional farming methods that rely on soil, hydroponic farming often results in superior harvests in terms of quality, flavour, and nutritional content. Worldwide, in both developed and developing nations, this cultivation is becoming more popular because to its low cost, lack of diseases, and environmental friendliness. In areas where suitable cultivable land is in short supply, it has the potential to supplement high-altitude research and alleviate the shortage of arable land. To fulfil the future nutrition requirement on a worldwide scale and cultivate a wide variety of fruits, vegetables, and feed, hydroponics is the way to go. Hydroponics is a new technology that has the potential to feed the world's population in the future.

Keywords: Urbanisation, hydroponics, soil, conventional

Introduction

Hydroponics is the practice of cultivating plants in water instead of soil (Savvas, 2017). Hydroponics is the method of cultivating plants without soil, using chemically inert substrates like sand, gravel, or liquid water, to which nutrients are added. Hydroponics is a soilless technique of plant cultivation (Maharana and Koul, 2011). Professor William Gericke coined the word "hydroponics" in the early 1930s to refer to the method of cultivating plants by immersing their roots in water containing mineral fertilisers. It is often believed that the European Union is the largest hydroponics market, where, top three producers are France, Spain, and the Netherlands, with the Asia-Pacific region and the United States of America following suit. An increasing number of countries are adopting these systems, and the most recent report (Jensen and Collins, 1985) projects that the global hydroponic market will increase by 18.8% between 2017 and 2023, reaching $490.50 million by that year.Growers assert that hydroponic systems are the only viable means of achieving continuous production, which entails year-round output within a condensed growing period, minimal space requirements, and the ability to cultivate plants in confined spaces while maintaining a controlled environment.

Growers frequently respond that hydroponics consistently enables them to achieve greater yields and productivities, unrestricted by weather and climate conditions (Sarah, 2017). Furthermore, producers frequently assert that hydroponic produce is of superior quality due to its utilisation of a strictly regulated environment, which facilitates a more uniform yield while preventing water and nutrient loss. Furthermore, hydroponics operates without reliance on seasonal variations; consequently, its annual productivities are consistently high and uniform (Okemwa, 2015). Additionally, it is frequently mentioned by cultivators that hydroponic production methods are more convenient and lightweight, as they do not necessitate cultural practices like tillage, weeding, soil fertilisation, and crop rotation (Nguyen et al., 2016). Managing nutritional solutions and measuring liquid nutrients daily may help prevent over salinization and microbial illnesses and pests, which in turn can keep output from dropping (Barbosa et al., 2015). However, farmers often state that this method helps reduce waste and opens the door to the potential of growing better food.

Lettuce is the most widely farmed crop in the world that is grown hydroponically. Its leaves are almost 100% viable and may be sold for about 40% more than conventionally grown lettuce, demonstrating a significant decrease in waste (Barbosa et al., 2015). Additionally, hydroponics improves the chances of bringing fresh product to market because of

the increased acceptability and average nutritional quality of the produce (Mehra et al., 2017). Furthermore, farmers have noted that hydroponics helps to mitigate some of the drawbacks of traditional farming practices, such as excessive water usage, inefficient land utilisation, pesticide and nutrient concentrations, and soil erosion and degradation (Treftz and Omaye, 2016; Horrigan et al., 2002). A growing body of evidence shows a protective correlation between regular vegetable consumption and a reduced risk of numerous chronic and degenerative diseases, including cancer, heart disease, and neurological disorders (Kris et al., 2002), which has piqued the interest of consumers around the world in purchasing fresh vegetables in a more sustainable manner. The content of health-promoting chemicals is becoming an increasingly important factor for fruit and vegetable farmers as a result of this growing customer interest.
Light, temperature, humidity, and atmospheric CO2 are a few of the critical environmental variables that might affect these helpful chemicals. Several writers have argued that hydroponic farming, in contrast to traditional methods, allows for the modification of nutrients, leading to crops with higher concentrations of certain beneficial nutrients.

Enhancement of quality with hydroponics

The yield quality of hydroponically and traditionally produced lettuces differed significantly (Murphy et al., 2011). Hydroponic systems improved tomato flavour and acidity, as well as carotenoids and vitamins (Gruda, 2009). A combination of 80% pumice, 10% perlite, and 10% peat medium produced 30% more tomatoes than soil (Mastouri et al., 2005). Hydroponically produced tomatoes were thought to be softer and tastier than standard growth methods.
Consumption of fruits and vegetables significantly reduces the incidence of several forms of chronic illness in humans (Giovannucci et al., 2002; Dorais et al., 2008. Several bioactive molecules or nutrients found in vegetables, such as beta-carotene and antioxidants, have favourable impacts on health. As a result, utilising green techniques like as hydroponics may boost the health-promoting substances and improve the quality of fruits and vegetables. It is widely employed in protected agriculture to manage the environment and eliminate uncertainty in soil water and nutrient status.

Crops cultivated in hydroponic systems

Using this method, it is possible to cultivate everything from vegetables and fruits to fodder and crops. It is practically conceivable to do so. Hydroponically produced flowers have a more vibrant bloom and colour than those cultivated on soil. Because a hydroponics system may be automated, it is able to maintain a high level of control and is superior for the collection of finished products. The cultivation of a variety of plants, including vegetables, fruits, flowers, and medicinal crops, may be accomplished with the use of soilless or hydroponics culture (Sardare and Shraddha, 2013).

Cultivation of fruits and vegetables by the use of hydroponics

The demand for healthy food began to exceed the supply of food, which is indication that food security began to become increasingly significant. Plants are subject to a wide range of effects as a result of global warming and climate change, including but not limited to drought, heavy rain, flood, high temperature, and pests. In comparison to conventional soil-grown vegetables, hydroponic vegetable production is more dependent on the availability of natural resources, the fertility of the soil, and the quality of the water. According to Wattanapreechanon and Sukprasert (2016), farmers prefer the hydroponic approach to the traditional growth method for specific crops, such as temperate lettuce and herbs, which are often imported. As well as for several other common food crops, farmers favour hydroponic farming.

Table.1 Major hydroponic system varieties and their attributes, as identified by farmers, cultivators, and scientists

Hydroponic system	**Description**
Deepwater culture (DWC)	Deep water culture suspends plant roots in nutrient-rich water, with an air stone providing direct air to the roots. The hydroponic bucket system is a famous example of this technique. Plants are put in net pots, and their roots are suspended in nutritional solution, allowing them to develop rapidly in vast masses. Algae and moulds may develop fast in the reservoir, thus it is necessary to monitor oxygen and nutrient concentrations, salinity, and pH. This technique is ideal for bigger, fruit-producing plants, such as cucumbers etc.
Drip system	In this technique, the nutrient solution is stored in a reservoir while the plants are cultivated separately on a soilless media. The pump delivers water or nutrient solution from the reservoir to individual plant roots in the proper proportion (Raphael and Colla, 2005). Drip systems administer nutrients at a slow pace via nozzles, and any excess solutions may be collected and recirculated, or let to drain. This technique allows the simultaneous growth of many types of plants.
Nutrient film technique (NFT)	Dr. Alen Cooper created NFT in the mid-1960s in England to address the limitations of the ebb and flow method. The nutrient film technique (NFT), like aeroponics, is the most widely used hydroponic system. This approach involves continually pumping a nutritional solution via pipes containing plants (Domingues et al., 2012). When the nutritional solutions reach the end of the channel, they are returned to the start of the system..

Wick system	This is the most basic hydroponic system, as no electricity, pump, or aerators are required (Shrestha and Dunn, 2013). A nylon wick extends from the roots of the plants through an absorbent medium such as coco coir, vermiculite, or perlite that contains a reservoir of nutrient solution. Plants receive nutrient solutions and water via capillary action. This system is effective with seasonings, herbs, and tiny plants.

(Sources: Nguyen *et al*., 2016; Lopes *et al*., 2008)

The positive aspects of hydroponics in comparison to conventional agricultural techniques

Enhanced growth rate

Sufficient nourishment at the optimal time and in the precise quantity required by a plant will likely result in its optimal genetic development. In hydroponics, this is precisely the case, as an area enclosed by four walls can easily be transformed into an artificial environment by incorporating lighting or air conditioning. By establishing an environment that is optimally adapted to the specific requirements of each plant, superior outcomes can be achieved in terms of the produce becoming more palatable, environmentally friendly, and fresher.

Farming at heights

Vertical farming maximises space efficiency by producing a high yield of goods in a smaller area. Hydro farms may be extended vertically in areas like marginal farmland, warehouses, and places with water shortages. Geoponics is not suitable for this task because to its limitations. Hydroponics has been shown to be more profitable and efficient than geoponics, producing a higher yield per cubic foot (Goenka, 2018).

Pesticide-free

Growers often employ fertilizers and pesticides to improve crop quality, resulting in non-organic, medicated, and inferior product. This issue does not arise with hydroponics. The farmer does not need to apply fertiliser to the nutrient-rich water since the crop obtains the necessary minerals. Additionally, it has been shown that hydroponically grown greens have a superior flavour. Hydroponics has an advantage over geoponics in this regard (Goenka, 2018).

Water conservation

Producing one kilogramme of lush green fodder takes just 2-3 litres of water, compared to 60-80 litres in the standard manner of fodder production.

Scarcity and surpluses

Urbanisation is leading to a decrease in available land, exacerbating issues of surplus and scarcity. Individuals are lacking sufficient living space in the urban area. Moreover, with the growing urban population, the need for food is also on the rise. Mike Segar from Reuters has described this as "People are hungry everywhere." This highlights the disparity between the demand and availability of food and emphasises the crucial need to secure more food resources. Geoponics, which involves cultivating on extensive area, does not seem to be a feasible choice in this situation. Therefore, people are attempting to transition to hydroponics as a way to produce food in a more confined area.

Palatability

Hydroponically produced fodder increases milk and meat output because it is more succulent, tasty, and Nutritious than traditionally grown fodder.

Reduced work requirement

Hydroponics only requires two or three hours of labour each day, compared to the continuous heavy effort necessary for traditional feed production.

Conclusion

The hydroponics approach leads to greater yield quality and creates a "new" door in science for increased crop production for food, feed, and ornament (Putra and Yuliando, 2015). In areas with a high population density, hydroponics has the potential to produce a large quantity of locally grown crops, such as green vegetables or flowers. Every plant and crop could be cultivated Maharana and Koul (2011), hydroponics shows potential as a method for managing food production and agriculture. According to De Kreij et al. (1999), hydroponics has been used by Japan to cultivate rice for human consumption. Huge quantities of berries, oranges, and bananas are grown in Israel's dry and parched climate using hydroponics. Sincerity requires me to admit that hydroponics methods might have use in both urban and rural settings, not to mention on advanced space stations. Growing food in extreme environments, including mountainous regions, deserts, or even polar cities, could be possible using hydroponics.

According to Trejo-Téllez and Gómez-Merino (2012), the use of hydroponics in farming has become more popular in both developed and developing countries. on Earth if hydroponics technology could be upgraded. Hydroponics offers a potential solution to the food, water, and land scarcity problems faced by millions of people in Africa and Asia. In

summary, hydroponics is rapidly expanding across the world, and with it comes a plethora of new opportunities for growers and shoppers to enjoy nutritious, bioactive veggies.

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