Chapter 17
Hydroponic Farming as a Contemporary, Dependable, and Efficient Agricultural System: Overview

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1 Introduction

The current world population is estimated to be about 7.3 billion people, with India accounting for 1.39 billion of them. The world's population is expected to exceed ten billion people by 2050, with India accounting for 1.67 billion people [1, 2]. According to the United Nations' Sustainable Development Goal 2 (UN 2017), about 66% of the world's population is expected to reside in urban areas, implying that their food requirements must be fulfilled [1]. To meet the world's food need for the constantly growing population, agricultural production must also rise. As a consequence, the food needs of the extra 2–3 billion people must be fulfilled, or to put it another way, food output must increase by approximately 50% (FAO 2017) by 2050 to feed the extra 2–3 billion people. As a consequence, we may consider increasing the output of agricultural goods utilizing conventional manufacturing techniques. Traditional agricultural techniques, on the other hand, have a number of drawbacks, including environmental conditions, soil quality, temperatures, water needs, and a range of other variables. Agriculture relies on the availability of grazing pastures, groundwater, electricity, and fertilizers, and the current use or degradation of these resources on a worldwide scale exceeds their global regeneration [3, 4]. The soilless

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agricultural technique is not new; it was first utilized commercially in 1967 [5, 6] when it was originally described and was used to improve food output and efficiency.

2 Related Works

The hydroponic system has grown in popularity in recent years, especially in urban areas, and much research is being conducted to improve it and make it even more efficient. Yang et al. [7] presented their research on hydroponic agricultural nutrition and lettuce growth, as well as the impacts of ozone-treated home sewing. Mupambwa et al. [8] used a deep water culture technique to show the ineffectiveness of biogas digestates nutrient solution for a hydroponically grown tomato plant. Its study focused on the effects of biogas digestates on agricultural toxicants as well as their nutrient fertilizing capability in hydroponic tomato production.

Magwaza et al. [9] conducted a thorough investigation on the effect of nitrogen absorption on hydroponically grown tomatoes plants fed partially treated household wastewater as a nutrient source. Sipos et al. [10] conducted research using a hydroponic system in an indoor environment with LED lighting to find the best method to grow basil plants. Also included is an overview of LED light use, light intensity and duration, light treatment on vegetative metrics and nutrient content, and sensor features. Salazar et al. [11] used Nordic microalgae to study nutrient removal from hydroponic sludge. Because of the severe winters in the Nordic countries, the bulk of the population relies on greenhouses to guarantee continuous agricultural production throughout the year. In order to create an automated harvesting system, Wang et al. [12] studied the mechanical and physical properties of lettuce grown hydroponically. Based on the Internet of Things, Ezzahoui et al. [13] provided a comparative study of the Aquaponic and Hydroponic agricultural systems (IoT). Hydroponic and aquaponic farming are two of the most innovative agricultural methods.

3 Materials and Methods

3.1 Hydroponic Farming

Because of its great efficiency and ease of setup without the need for professional help, the hydroponics system is one of the most popular and extensively utilized soilless agricultural systems. The phrase "soilless cultivation" is used in the area of horticultural agriculture to describe any structure that allows plants to grow in soilless settings by supplying water and nutrients via solution culture, both with and without the use of a developing medium [14, 15].

3.2 Advantage of Hydroponics

Hydroponic is a low-cost and highly lucrative method for food production [16]. It is possible to measure the advantages of a hydroponic system more accurately than the benefits of conventional farming on six different criteria. These parameters are land and labor; climate; fertilizer; water; consistency; and consistency [17].

4 Types of Hydroponic

There are many kinds of hydroponics available in the Indian market, some of which are economically viable, while others are more of a passion endeavor. So when we talk about the many sorts of hydroponic farming techniques, there are essentially six different kinds of hydroponic farming methods [18].

4.1 Wick System

The wick system, which is made of a synthetic fiber such as nylon, feeds plants and crops via capillary action. It is considered suitable for indoor cultivation and the development of a single plant [19]. Hydroponic wick systems are composed of four fundamental components: a growing container, a reservoir for the nutrient solution, a growing medium, and wicks. The wick method is inefficient for hydroponic gardening. The main disadvantage of this method is that huge plants may eat up the fertilizer solution quicker than the wicks can replenish it [19].

4.2 Water Culture Method

Water culture (also known as deep water culture (DWC)) is a method of growing plants in water. A large container filled with the nutrient solution is placed in the water and a raft is placed on top of the container. Deep water cultivation in a hydroponic system may be a viable choice in areas where water is not a problem, and where there are no problems with electric dependence or energy [18, 20].

4.3 EBB and Flow Method

The flood and drain (F and D) system is another name for the ebb and flow system. Thus, that is, how it works: By briefly flooding the growing tray with nutritional solutions and then draining the solution back into the reservoir. Flood and drain (F and D) action is typically performed using a submersible pump controlled by a timer. Ebb and flow systems need a significant initial investment of money; therefore, for commercial purposes, you can expect to incur significant capital expenditures.

4.4 Drip System (Recovery and Non-recovery)

In a drip system, the timer controls the pump's ON and OFF intervals, and the nutrient solution is dripped into the roots of each plant via a tiny drip line at the base of each plant. In a recovery drip system, the surplus nutrient solution from runoff is collected and returned to the reservoir for re-use of the nutrients. In a non-recovery system, the runoff is not collected and returned to the environment [18].

4.5 Nutrient Film Technique (NFT)

This technique is the most popular and efficient method among all hydroponic farming**.** In an NFT system, a submersible pump is placed beneath the nutrient solution, pushing the water into the pipes. The NFT is very cost-effective when compared to other kinds of hydroponic systems because of its vertical, multilevel, and matrix farming. Additionally, it is climate-resistant, requires less labor, reduces land usage, requires less fertilizer, and requires less water. It may be utilized on a local or big size, as well as on a commercial basis. Figure 1 depicts the structure of the nutrient film technique (NFT) technique and the aeroponic system [18].

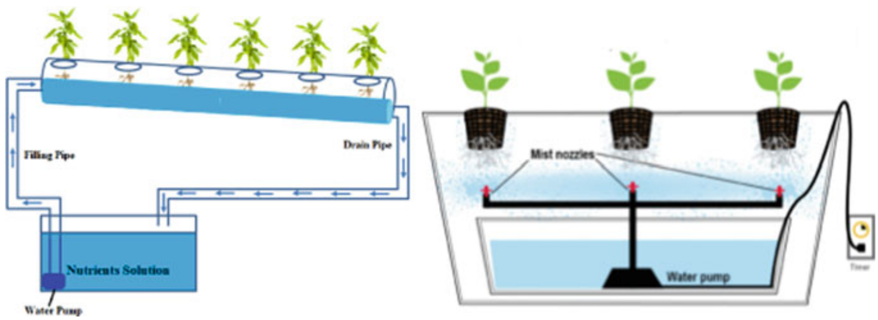

Fig. 1 Nutrient film technique (left) and aeroponic system

4.6 *Aeroponic System*

Aeroponic farming is the most advanced and technically complex kind of hydroponic system available. Also known as integrated farming methodology, it is a method of incorporating plant-based agriculture with other forms of aquaculture, such as fish farming. As a result, the combination of plant production and aquaculture may result in an advanced ecologically sustainable system in which water and nutrients are used in an optimal manner [21].

5 Nutrients Consumption

Table 1 gives the consumption and control of nutrients by leafy and fruity vegetables in terms of electrical conductivity (EC), pH value, and total dissolved solids (TDS) in parts per million [22].

Table 1 Utilization of EC, PH, and TDS in leafy and fruity vegetables

Vegetable name	EC	pH	PPM
Leafy vegetables			
Watercress	0.4–1.8	6.5–6.8	280–1260
Cauliflower	0.5–2.0	6.0–7.0	1050–1400
Lettuce	0.8–1.2	5.5–6.5	560–840
Parsley	0.8–1.8	5.5–6.0	560–1260
Basil	1.0–1.6	5.5–6.5	700–1120
Spinach	1.8–2.3	5.5–6.6	1260–1610
Swiss chard	1.8–2.3	6.0–6.5	1260–1610
Chives	1.8–2.4	6.0–6.5	1260–1680
Celery	1.8–2.4	6.3–6.7	1260–1680
Mint	2.0–2.4	5.5–6.0	1400–1680
Fruity vegetables			
Pea	0.8–1.8	6.0–7.0	580–1260
Strawberries	1.0–1.4	5.5–6.5	500–700
Sage	1.0–1.6	5.5–6.5	700–1120
Watermelon	1.5–2.4	5.8	1050–1680
Cucumber	1.7–2.5	5.8–6.0	1190–1750
Pumpkin	1.8–2.4	5.5–7.5	1260–1680
Squash	1.8–2.4	5.0–6.5	1260–1680
Melon	2.0–2.5	5.5–6.0	1400–1750
Tomato	2.0–5.0	5.5–6.5	1400–3500
Brinjal	2.5–3.5	5.5–6.5	1750–2450

6 Conclusion

In this article, we have discussed the many kinds of hydroponics agricultural systems, as well as their benefits and drawbacks, in detail. On the basis of their use in hydroponic farming, the six most important factors have been discussed: land, labor, water, climate, consistency, and fertilizers (among others). As a result of all of the analysis and comparison, it has been determined that the hydroponics system is economical, less complex, requires less labor, is not dependent on climate conditions, consumes less water, requires less land, consumes less fertilizer, produces more at a faster rate, is more profitable, and is more useful for commercial purposes. Furthermore, the NFT technique is the most efficient and cost-effective of all the hydroponics systems available, and it can be utilized for both commercial and non-commercial reasons.

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