Hydroponics: A Revolutionary and Creative Approach to Farming in the Future

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ABSTRACT

The entire world's population must be able to be sustained by agriculture. The percentage of farmed and arable land is steadily declining as a result of increased urbanization and industrialization, as well as other natural and man-made reasons. At the same time, the world's population is still growing steadily. Because of these two considerations, it is anticipated that the same area of land will be able to feed an increasing number of people as the population grows. Under the current paradigm of the open field system of agricultural production, these conditions portend a very challenging future. Feeding the world's population is probably going to become impossible in the near future. It is frequently believed that in order to meet this always rising demand for agricultural products, there must be an abundance of land, water, and sunlight, all of which contribute to more productive farming. In particular, it is recognized that soil is not a necessary element for productive farming. Furthermore, plants only require a portion of the entire spectrum of sunlight rather than true sunlight. The actual needs include high-quality seeds, water, and nutrients, according to recent studies and their application. Around the world, improved soilless culture techniques for food production that save space and water have shown some encouraging outcomes. Because of this, hydroponics and aeroponics have gained popularity.

INTRODUCTION

Fig.1: A hydroponics structure (source: Author's own)

Hydro, which means water, and ponos, which means labor, are the origins of the word hydroponics. Thus, hydroponics is the technique of growing crops without soil in any nutrient-containing medium, whether it be liquid or solid. A mineral-nutrient solution, an inert substrate like gravel, sand, wool, perlite, or even rice husks can be used as the media. Aeroponics, on the other hand, is very similar to hydroponics except that it uses a thin mist of liquid fertilizer solution rather than a solid or liquid medium. (Ellis, N. K. *et al.*, 1974).

The advantages of vertical farming may be fully utilized for increased efficiency with the same amount of land if the drawbacks of soil are eliminated. Furthermore, the soil might not be favorable or appropriate for the plant being grown. Degradation from erosion results in an avoidable drop in fertility, and other issues such soil compaction and inadequate drainage may also arise. Evidently, soils present significant barriers to plant growth generally, making it difficult for farmers to choose between requiring a lot of space and reducing plant growth and, consequently, output. At the moment, hiring workers for open-field agriculture is challenging. The introduction of soilless cultures, like as hydroponics and aeroponics, has significantly reduced these issues. Regardless of the weather or other environmental variables, the technology-driven approach maintains optimal conditions throughout the year, increases crop yield, and speeds up growth rates. Furthermore, smart farming reduces waste production, encourages environmentally friendly pest management techniques, and reduces the need for organic chemical inputs. By promoting regionalized food production, improving food security, and incorporating more resilient farming methods, this innovative approach has the potential to drastically transform the agricultural industry. In addition to covering recent developments in smart farming systems including domotics, data acquisition, remote cultivation, and automated artificial intelligence systems, this thorough overview explores current trends in hydroponics. (Beibel, J. P., 1960)

Benefits of hydroponics

1. **High yield:** The healthiest crops with the highest yields per unit area are grown hydroponically. It is possible to accelerate plant development, increase yields, and enable year-round growth by utilizing nutritional solutions, artificial lighting, heaters, and other equipment.

2. **Conservation of water:** The largest benefit of hydroponics over conventional crops is water conservation. Because hydroponics allows for water recirculation, leftover water can be recycled back into a reservoir for later use. Compared to a typical agricultural crop, plants only need around 10% of the water.

3. **Reduced usage of fertilizers:** The cost of nourishment can be decreased by controlling the amount of nutrients that plants should receive. Since it is a closed system, water cannot escape with nutrients. Comparing an efficient hydroponic farm to a conventional open agricultural system,

the former consumes only 25% of the fertilizer. Additionally, this stops eutrophication, which is the growth of aquatic plants (such as algae) on rivers and lakes due to fertilizer and plant nutrients that have leached into the water. (Singh, and Singh,2012)

4. Minimal Environmental Impact: Because hydroponic vegetables have the least environmental impact, they can be cultivated closer to consumers, lowering transportation-related emissions and enabling people to purchase fresher products.

5. **Less occurrence of pests and diseases:** Hydroponic planting systems have less pests and diseases and are considerably easier to manage. Weed infestation, disease attack, and soil-borne insect pests are all eliminated. There are no soil pests, and natural predators may manage insect pests in enclosed greenhouses without the need for pesticides.

6. **Crops grow faster:** Because nutrients are sent straight to the roots, plants with smaller roots grow more quickly.

7. Growing crops is very simple and clean.

8. Hydroponics need less room (higher density planting) to grow plants.

Limits of hydroponics

Despite its many benefits, hydroponics has certain drawbacks.

1. To grow crops hydroponically on a commercial scale, technical expertise is needed, which is either more expensive or difficult to obtain.

2. A substantial initial investment is necessary.

3. Because hydroponics is expensive, only high-value crops are cultivated for large net returns.

4. To operate the system, high energy inputs are required.

Methods for cultivating without soil

1. Considerations for choosing appropriate hydroponics techniques

The choice of a practical hydroponics application method is heavily influenced by a variety of elements. Although there are many different hydroponics cultivation methods available, these aspects must be taken into account before choosing an appropriate method. (Kreij, Voogt, and Baas,1999)

- The cost and availability of space and other relevant resources
- A appropriate growth medium is available.
- The anticipated profitability yield.
- Anticipated output from the existing approach.
- Quality, such as crop size, colour, and appearance, that is anticipated from the use of hydroponics.

2. Technique classification

a. **Liquid Hydroponics**: In liquid hydroponics, the minerals are delivered to the plant solely by a mineral solution. The nutrition solution might be either passive, stagnant, or flowing. In order to replenish the soil nutrients, the solution must also include both organic and inorganic materials.

(i) Continuous flow solution culture and circulating procedures (closed system) (Butler & Oebker, 2006)

- Deep flow technique (DFT)
- Nutrient film technique (NFT)

(ii) Non-circulating method (open systems)/ Static solution culture

- Root dipping technique
- floating technique
- capillary action technique

b. **Media culture:** This technique involves anchoring roots in a solid media. The inert medium is typically the source of the culture's name. Sand, gravel, and rock are examples of abiotic media; rice husk, wool, and coir are examples of biotic media. For every medium, there are two primary variations: top-irrigation and sub-irrigation. (Maharana & Koul, 2011)

List of crops that can be grown commercially using hydroponic technology

Leafy vegetables: Sweet Basil, Parsley, Lettuce, and Mint

Vegetables: Cauliflower, Cucumbers, Melons, Radishes, Onions, Tomatoes, Green Beans, Beets, Winged Beans, Bell Peppers, and Cabbage

Flower crops: Roses, Carnations, Chrysanthemums, Marigolds

Cereals: Rice and Maize

Fruits: Strawberries

The technology's possible applications

Even though it may not hold a significant portion of the market, hydroponics is the fastest-growing agricultural industry. It is anticipated to take over all food production worldwide in the future. As more and more land is destroyed by improper agricultural management and abuse, leading people to turn to more modern, creative techniques of farm production, hydroponics is expected to flourish. Since Japan is an island nation with a shortage of arable land and growing land costs, some nations have already taken a proactive approach to these technologies. The majority of hydroponics in Japan is carried out using sand/gravel or NFT techniques. For hydroponic rice cultivation, the Japanese have developed better and more productive plants using bio-technological methods like hydroponics. Instead of the customary one harvest per year, four harvests can be carried out in a single year due to environmental control. Cities like Indianapolis are investing in more local food production systems as the world's population grows more urbanized. These systems use 90% less water than conventional farming methods, provide opportunities for economic development, and lower a city's carbon footprint. (Savvas, and Gizas, 2002). There has also been a great deal of agricultural innovation in desert regions like Israel. The nation has started growing berries and bananas hydroponically in shipping containers due to its desert climate and overall water scarcity. Even though these fruits can't be cultivated in that climate, they can nevertheless produce 1,000 times more. The benefits of hydroponic systems have already been recognized by some major corporations. In the spring of 2017, Target, a huge chain of stores, started a series of experiments in which hydroponic gardens were set up at certain sites. With very little water, these gardens can supply customers with extremely fresh herbs and veggies. Cities in India are investing more in local food production systems that use 90% less water than conventional farming methods, provide chances for economic development, and lower the city's carbon footprint. There has also been a great deal of agricultural innovation in desert regions like Israel. The nation has started growing berries and bananas hydroponically in shipping containers due to

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CONCLUSIONS

In a world where food and fresh water resources are becoming increasingly limited, hydroponics shows up as a significant means of addressing these issues in a sustainable and environmentally responsible manner. The hydroponics sector is predicted to expand rapidly in the future, particularly as soil-based growing conditions become more challenging. Soil-less culture will eventually overtake conventional agriculture in a nation like India where urbanization is outpacing all expectations in order to increase the amount and quality of product and guarantee the nation's future food security. However, greater attention through government action and research institute focus can speed up the development of hydroponics.

REFERENCES

Beibel, J. P. (1960). Hydroponics-The science of growing crops without soil. Florida Department of Agric. Bull. p. 180.

Butler, J. D. and Oebker, N.F. (2006). Hydroponics as a hobby-growing plants without soil. Circular 844. Information Office, College of Agriculture, University of Illinois, Urbana, IL 61801.

De Kreij C., Voogt, W. and Baas, R. (1999). Nutrient solutions and water quality for soilless cultures. Research Station for Floriculture and Glasshouse Vegetables (PBG), Naaldwijk, The Netherlands, Brochure 196.

Ellis, N. K., Jensen, M., Larsen, J. and Oebker, N. (1974). Nutriculture systems-growing plants without soil. Station Bulletin No. 44. Purdue University, Lafayette, Indiana.

Maharana, L. and Koul, D. N. (2011). The emergence of hydroponics. Yojana (June), 55: 39-40.

Savvas, D. and Adamidis, K. (1999). Automated management of nutrient solutions based on target electrical conductivity, pH, and nutrient concentration ratios. Journal of plant nutrition, 22(9):1415-1432.

Savvas, D. and Gizas, G. (2002). Response of hydroponically grown gerbera to nutrient solution recycling and different nutrient cation ratios. Scientia Horticulturae, 96(1-4): 267-280.

Singh, S. and Singh, B. S. (2012). Hydroponics -A technique for cultivation of vegetables and medicinal plants. In proceedings of 4th global conference on -Horticulture for food, nutrition and livelihood options, Bhubaneshwar, Odisha, India. p.220.