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HYDROPONICS – A NEW VERSION OF FARMING

Sainath Rao M[1*], M Ramanjineyulu[2] and N Narayana Reddy[3]

[1] Assistant Professor, Dept. of Spices, Plantation, Medicinal and Aromatic crops, Sri Krishnadevaraya College of Horticultural Sciences, Ananthapuramu, Andhra Pradesh, India

[2] Assistant Professor, Dept. of Agronomy, Sri Krishnadevaraya College of Horticultural Sciences, Ananthapuramu, Andhra Pradesh, India.

[3] Associate Dean, Sri Krishnadevaraya College of Horticultural Sciences, Ananthapuramu, Andhra Pradesh, India

**Corresponding Author Mail ID: sainath99sainath@gmail.com*

India requires food security, ensuring that every individual has both physical and economic access to safe and nutritious food to fulfill their dietary requirements. There is a pressing need to embrace agricultural technologies that promote water conservation and positively impact food production and availability. "Hydroponics" emerges as one such soilless cultivation method, offering enhanced water use efficiency compared to traditional systems of production. The global popularity of hydroponics is on the rise due to its efficient resource management and the production of high-quality foods. Advantages of this technique include faster crop growth, year-round production, reduced susceptibility to diseases and pests, and the elimination of labor-intensive tasks such as weeding, spraying and watering associated with conventional soil-based farming.

Using an inert medium (sand, gravel, vermiculite, rock wool, perlite, peat moss, coir, or sawdust) to give mechanical support is one method of growing plants in nutrient solutions or water that contains nutrients called hydroponics. The term 'hydroponics' originates from the Greek words 'hydro' meaning water and 'ponos' meaning labor. Other terms synonymous with hydroponics include 'Aquaculture', 'Hydroculture', 'Nutriculture', 'Soilless culture', 'Soilless agriculture', 'Tank farming', or 'Chemical culture'. A 'hydroponicist' refers to someone who engages in hydroponics, while a 'hydroponicum' is a structure or garden where hydroponics is practiced. Many plants, such as fruits, vegetables, flowers, and medicinal crops, can be cultivated in soilless or hydroponic environments.

Many hydroponic systems are automated, regulating water, nutrients, and light duration according to the needs of different plants. Hydroponics accommodates a variety of crops, including leafy vegetables, tomatoes, cucumbers, peppers, strawberries, and more. Europe stands out as the largest market for hydroponics. With population growth, urbanization, and industrialization reducing cultivable land, traditional farming methods face challenges from unpredictable climates. To sustainably feed the growing global population, innovative methods like hydroponics are essential. Switching to alternative growing mediums offers a solution for conserving dwindling land and water resources. Consequently, hydroponic systems are increasingly adopted worldwide.

Crop	Soil (avg per acre)	Hydroponics (avg per acre)
Lettuce	9-10 tons	300-400 tons
Strawberries	20-25 tons	50 tons
Cucumber	15-20 tons	200 tons
Tomato	10-12 tons	180-200 tons
Bell pepper	10-12 tons	120-140 tons
Potato	8-10 tons	60-70 tons
Cabbage	6-7 tons	10-12 tons

ADVANTAGES OF HYDROPONICS

- Hydroponics enables crop cultivation in areas where suitable soil is lacking or contaminated with diseases.
- Labor-intensive tasks like tilling, watering, and other operations are significantly reduced.
- It maximizes yields, making it economically viable in densely populated and expensive land areas.
- Efficient water and nutrient utilization leads to reduced pollution of land and streams.
- Soil-borne plant diseases can be effectively controlled.
- Precise environmental control is achievable, including nutrient feeding, irrigation, and greenhouse operations.
- Careful management allows for the use of water with high soluble salt concentrations.
- Harvesting hydroponically grown crops is easier compared to traditional methods.
- Hydroponically grown crops are often more palatable and of higher quality.
- Plants are shielded from UV radiation, similar to being in a protected structure.
- Robust root systems developed in hydroponic systems make plants resilient to contaminants, diseases, and pests.
- Off-season vegetable production is feasible, capitalizing on peak market prices.
- Vertical hydroponic gardening optimizes space usage.
- Local production reduces carbon footprint from transportation.

SOIL-LESS GROWING MEDIA UTILIZED IN HYDROPONICS MUST POSSESS THE FOLLOWING CHARACTERISTICS

a. Nutrient Source: The media should serve as a nutrient source to facilitate optimal plant growth and development.

b. Water Retention: It should possess excellent water-holding capacity to ensure consistent hydration of the plants.

c. Water and Gas Exchange: The media must facilitate the simultaneous supply of water and gases (such as oxygen) to the plant roots.

d. Structural Support: Adequate support must be provided to the plants by the media to promote healthy growth.

e. Growing media: Perlite, vermiculite, clay balls, coir pith, rockwool, gravel and pebbles, rice hull, Oasis cubes.

The hydroponic systems include the Wick method, which uses capillary action to supply water and nutrients to plants, suitable for lightweight crops. The Ebb and Flow method involves flooding the growing medium with nutrient solution and then draining it back into a reservoir, but requires caution due to potential root rot and algae growth. Deep Water Culture suspends roots directly in nutrient-rich water, requiring careful monitoring to prevent algae and mold growth. The Drip method provides water and nutrients to plant roots individually via a pump, suitable for various vegetable crops. Additionally, circulating methods like NFT (Nutrient Film Technique) and DFT (Deep flow technique) involve continuous flow of nutrient solution through channels or pipes to support plant growth. Plants need 17 essential elements for growth, including carbon, hydrogen, and oxygen, along with macro and micro nutrients. Nitrogen supports vegetative growth, while phosphorus and potassium aid in flowering and reproduction. Hydroponics simplifies nutrient control, ensuring optimal plant development. Controlling nutritional solutions, taking daily measurements of liquid nutrients to prevent excessive salinization, and managing microbiological illnesses and pests are all essential and effective ways to prevent any loss of productivity. Farming at heights, achieved through vertical hydroponic systems, maximizes output in limited space by utilizing marginal lands, warehouses, and water-scarce areas. In contrast to traditional soil-based farming, vertical hydroponics allows for greater productivity per cubic foot, making it a more profitable and efficient option.

PREREQUISITES OF HYDROPONIC SYSTEM

To effectively grow vegetable crops hydroponically, it's crucial to consider the following factors:

- The pH level of the solution should be maintained between 5.8 to 6.4, slightly acidic to neutral. To raise pH value, Potassium hydroxide added and while to decrease the pH value, Phosphoric acid is recommended to add to nutrient solution
- The electrical conductivity of the solution should fall within the range of 1.2 to 2.0 Ec
- The overall system temperature should not surpass 18 to 25 degrees Celcius. Elevated water temperature reduces level of dissolved oxygen and results in fluctuations in acidity, and low temperature impairs plants ability to absorb the nutrients given.

Using either hi-tech or low-cost devices for a short duration, hydroponic fodder production gets adapted. In India, maize grain is commonly used for hydroponic fodder production due to its health benefits, including palatability, digestibility, and nutritional value. This method allows farmers to produce fodder for their dairy animals, particularly in situations where conventional green fodder cannot be successfully cultivated. With a significant livestock population in India, including cattle, buffaloes, sheep, goats, and pigs, there is a growing demand for feeds and fodder, driven by the increasing trend in livestock population and intensive rearing systems. Hydroponic fodder production requires only 2-3 liters of water to produce one kilogram of lush green fodder, a stark comparison to the 60-80 liters needed in conventional fodder production systems. Hydroponic fodder production achieves fully grown plants of 25-30 cm height in just 7 days from seed germination, providing highly nutritious fodder. Additionally, the biomass conversion ratio is 7-8 times higher compared to traditional fodder production, which typically takes 60-80 days. Hydroponic fodder is abundant in essential nutrients such as vitamin A, vitamin E, vitamin C, thiamin, riboflavin, niacin, biotin, and free folic acid. It also contains antioxidants like β-carotene, offering a comprehensive nutritional profile. Hydroponically grown fodder surpasses conventionally grown fodder in succulence, palatability, and nutritional value, leading to increased milk and meat production.

Aquaponics is a sustainable agricultural system that combines aquaculture and hydroponics in a symbiotic environment. In aquaponics, fish and plants are cultivated together, forming a mutually beneficial relationship. The fish waste, rich in nutrients like ammonia, is converted by beneficial bacteria into nitrites and nitrates, which serve as fertilizers for the plants. In turn, the plants absorb these nutrients, purifying the water for the fish. This closed-loop system minimizes water usage and eliminates the need for synthetic fertilizers, making it environmentally friendly. It allows for the cultivation of a wide range of crops alongside fish, providing fresh produce and protein in a controlled and efficient manner. Overall, aquaponics represents a promising approach to address the challenges of food security and environmental sustainability in the face of a growing global population and diminishing natural resources.

Disadvantages of hydroponics include high construction costs per unit area, requiring proper training and understanding of plant growth and nutrition principles. Closed systems risk rapid spread of soil-borne diseases and nematodes, while available plant varieties may need extensive research and development. Daily monitoring is essential due to the rapid response of plants to nutritional changes, and growers must possess climate control knowledge for optimal growth within the structure.

CONCLUSION

India's megacities face a looming drinking water crisis exacerbated by heavy agricultural water consumption. Transitioning from traditional agriculture to water-efficient methods like hydroponics could save over 80% of water usage, redirecting it towards drinking water supply. Hydroponics, a highly intensive crop production method, is increasingly utilized in both developed and developing nations due to its ability to produce food in limited spaces while conserving water and being environmentally friendly. By providing constant and readily available nutrition, hydroponics enables crops to grow up to 50% faster than traditional soil methods, resulting in higher yields. The surge in hydroponic adoption has sparked increased experimentation and research, both indoors and outdoors, in this field. Hydroponics is becoming more and more well-liked worldwide, in both rich and developing nations, due to its low cost, lack of disease, and environmental friendliness. Along with high space research, it has a significant deal of potential in many nations to fill the gap in arable land when suitable cultivable land is unavailable. In order to meet the demand for nutrition worldwide and create a more advanced future, hydroponics would be a superior method for producing a variety of fruits, vegetables, and fodder. Hydroponics might be one of the new methods that feeds the world's population in the future. Encouraging commercial hydroponic farming necessitates the development of low-cost hydroponic technologies. These innovations should reduce reliance on human labor, thereby lowering both startup and operational expenses.

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