

Hydroponics: An Alternate Urban Farming

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Introduction

With rising population and purchasing power, demand for food and changing consumer preferences are building pressure on natural resources. According to United Nations World Food Programme, nearly 1 billion people worldwide are undernourished (FAO 2014). About 42% of these chronically hungry people live in India and China. Until 2050 the number of people living in urban areas are estimated to rise to more than 6 billion (UN, 2013) and our growing population will require 60% more food than we produce today (Alexandratos and Bruinsma, 2012; Tilman *et al.*, 2002; Green *et al.*, 2005). All this while 1.3 billion tons of global food production is lost or wasted annually (Gustavsson *et al.*, 2011). Arable land is also finite (FAOSTAT, 2012), and water is a scarce resource too (Gleick, 1993). Therefore, there is a need to find agricultural technologies that have neutral or positive impact on our environment.

Use of hydroponics as an alternate urban farming method in populated urban areas on large scale holds the promise of addressing these issues by enabling more food to be produced with less resource use and sale of these crops directly in city community, reducing transportation as opposed to the standard rural farming methods. The crop grown in hydroponic system uses small land, less water gives more yield than the conventional agricultural methods (Barbosa *et al.*, 2015) and hydroponically grown produce is high in nutritional quality (Buchanan *et al.*, 2013). This system can help to face the challenge of climate change and also helps in mitigating malnutrition.

In country like India, where urban conglomerate is growing each day, there is no option but adopting soil less culture to help improve the yield and quality of produce to ensure food security of our country.

What is Hydroponics?

The science of growing plants in a medium other than soil, using essential plant nutrient elements dissolved in water. A successful hydroponic system depends upon the media used for planting and nutrient solutions used to supply nutrients to the plants in a hydroponic system.

Different types of media used are Coco Coir, Rockwool, Perlite, Gravel whereas nutrient solutions include all the macro and micro elements which are dissolved in water and supplied to the plant.

History of Hydroponics

The early use of hydroponics system is dated back to Babylonians civilization but hydroponics became popular in 1920s when a scientist named Dr William F. Gericke of University of California demonstrated the laboratory experiments in plant nutrition on commercial scale. In doing so he termed these nutriculture systems as HYDROPONICS. The word was derived from the Greek words HYDRO meaning water and PONOS meaning labor, literally meaning “water working”.

Concept of Urban Farming

United Nations defines urban agriculture as “an industry that produces, processes and markets food and fuel, largely in response to the daily demands of consumers within a town, city or metropolis, applying intensive production methods, using and reusing natural resources and urban wastes to yield a diversity of crops and livestock”.

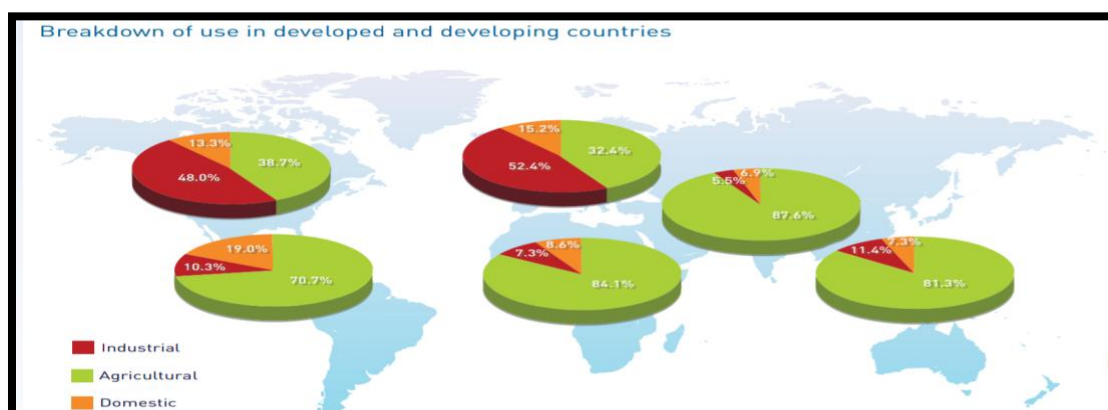
Urban farming is often confused with community gardening, home gardening, but what distinguishes urban agriculture is that in urban farming the element of commerce also becomes its major part which means that the vegetables or fruits that are grown in towns are not only used for personal consumption but large part of total produce is sold in the market for money.

Why Hydroponics as Urban farming?

1. Depleting Fresh Water Resources

World contains estimated 1,400 million cubic km of water out of which only 0.003% are what is called “fresh water resources”. In-fact only about 9,000-14,000 cubic km are economically available for human use. Agriculture is by far biggest user of water

accounting for almost 70% of all withdrawals. Under developed and developing countries Asian countries are the largest user of fresh water resources for agriculture accounting for about 87.6% of total water use. India comes under water stress conditions in terms of withdrawals for agriculture as a percentage of total renewable water resources (FAOWATER)



2. Food loss

Edible harvest is wasted at each stage in the food chain starting from the harvest stage to the consumption stage. Most of the harvest, processing losses are in Europe, post-harvest losses are high in South and SE Asia whereas consumption losses are highest in North America and Oceania regions. (UN FAO)

3. Population growth and limited arable land

World population is projected to reach about 11.2 billion until 2100. Growing food raising livestock for 6.8 billion people require land equal to the size of South America. By 2050 another Brazil's worth of area will be needed using traditional farming and that much arable land does not exist.



4. Negative effects of Agriculture

Conventional agriculture involves use of various pesticides, chemicals and fertilizers which on one hand increases the yield of produce but on the other hand also leads to soil pollution, soil degradation, agricultural runoff and ocean acidification which in return reduces the availability of nutrients from soil and degrades the quality of water making it unfit for human use.

Advantages of Hydroponics

1. Hydroponics requires less space

Hydroponics can be used in places where in-ground agriculture or gardening are not possible. Hydroponics setup can range from most basic hydroponic system that is “hydroponic bottle system” where plants are grown hydroponically in a one litre bottle using wick system (Munoz *et al.*, 2005, Perez *et al.*, 2008) to one of the most commercialized hydroponics system known as “Vertical hydroponic system.” Vertical gardening is best idea when enough horizontal space is not available. It can be practised in a compact area like indoor walls, front yard walls, terraces and backyards. In vertical hydroponic farming system there are several stacked levels with planting pockets and the plants are grown at each level. There are several methods of vertical hydroponic farming but NFT (Nutrient Film Technique) is the best as there is a constant thin stream of water (nutrient solution) flowing over the root system below the plants and water will be circling to and fro thus making it a completely automated system which reduces maintenance. Advantages of vertical hydroponic system includes less space requirement, high productivity as in a space required for one plant in horizontal gardening one can grow three plants in this system and low maintenance cost.

2. Hydroponics Potentially Produce Higher Crop Yields

Vegetables and fruits produced by hydroponics may potentially yield higher (Mugandhan *et al.*, 2011). A report by HGTIPL, India (2018) which consisted comparison between average yield per acre of different fruits and vegetables grown hydroponically and in soil agriculture showed significantly high yields in case of hydroponically cultivated vegetables and fruits as compared to that of conventionally



grown vegetables and fruits. Yield in hydroponics agriculture ranged from twenty to forty times more than soil grown agriculture.

This increase in yield in hydroponic agriculture is because:

- a) Year-round gardening means more crops per year. Since greenhouse and hydroponic crops are grown indoors, there is no or less effect of nature on the crop, therefore crops can be cultivated year-round
- b) Hydroponics allows high density planting in one or more ways like plants can be planted together, vertically or in layers which leads to increased yields
- c) Variety or type of crop chosen to grow hydroponically influences the hydroponics yield for example planting leafy crops like lettuce, kale, chard produce great yields as compared to crops like watermelon which are somewhat difficult to grow hydroponically.

3. Hydroponic system uses less water

Field grown crops are susceptible to droughts and inconsistent rain patterns which may destroy the crops, whereas water can be managed much more efficiently with hydroponics

4. Use of minimal pesticides and fertilizers

In hydroponic system there is constant and continuous flow of nutrient solution through the roots of plant which allows plants to get the correct nutrients they need in right amount and at right time. Having direct access to water and nutrients, plants grown in hydroponic system do not need to develop large root systems and will therefore offer the grower a shorter harvest time.

How hydroponics can be used as alternate urban farming method?

1. Hydroponics as a technology is growing:

The hydroponics market is estimated to be valued at USD 8.1 billion in 2019 and is projected to grow at a CAGR of 12.1% through 2025. The growing acceptance of controlled environment agriculture and increasing technological advancements in hydroponics system support the growth of the hydroponics market. The European hydroponics market is projected to be the largest market size during the forecast period whereas Asia Pacific market is projected to grow at the highest CAGR.

2. Vertical farms and Rooftop hydroponic farm:

Vertical farms, rooftop hydroponic farms could be in a densely populated urban area, where a majority of food is needed, cutting down on transportation costs as well as pollution. A farm of this type would provide a large amount of local, economical produce to city dwellers. Some successful examples of vertical farms are Vertical Harvest Jackson Hole, Wyoming (2016), Sky Greens Vertical Farm Singapore and some successful examples of rooftop hydroponic farms are Gotham Greens, Brooklyn, New York, Montreal based Lufa Farms.

3. Food parks:

The food parks are a new idea currently emerging which offers great promise for increasing urban food production. Hydroponic food park system has been proposed as possible solution for increasing urban food supply while decreasing the ecological impact on the farming. The primary advantage of hydroponic growing is the high-density production and fewer resources as compared to conventional agriculture. These food parks will combine vertical farming, hydroponics and greenhouse production into an integrated commercial production system. These Hydroponic Greenhouses set up in the food parks will be able to reduce thousands of tons of world class nutritious food in small acreages. Recommended produce to start with: Lettuce, Bell pepper (CV Prakash (CEO, HGTIPL Bangalore)2018)

4. New innovations in the field of Hydroponics:

i. Rotary Hydroponics

✚ **Rotary Volksgarden:** Designed to accommodate space for up to 80 plants. It is chain driven and rotates a constant 24 hours a day and watering and light timers are installed in it.

✚ **The Green Wheel:** This model of hydroponic system is developed by NASA for space programs. The amount of light, the temperature and water level can be controlled with a smart phone. Inside the wheel are vases made of coco fibre that provide support for roots.

ii. PLANTUI : The first Hydroponic Smart Garden

Plantui is the first hydroponic smart garden that enables to grow plants and vegetables like tomatoes, chilies, cucumber etc at home, Key features:



- ✚ Optimized light spectrum for the photosynthesis, germination and flowering
- ✚ Low power consumption with minimal excess heat (approx. 10\$ of operating cost per year)
- ✚ It detects the plant height and optimizes the irrigation and light intensity and spectrum to the growth phase of a plant

The future of Urban Hydroponics

- **Floating Farms by JAPA Design Firm:** Loop shape enables the vertical structure to receive more sunlight without having significant shadows. System aims for zero food wastage by using data management system to track how much food people are buying, so the farm can automatically adjust production.
- **DRAGONFLY designed by Vincent Callebaut:** 132 stories of hydroponic urban farming with room for cattle, poultry and 28 different types of crop. It will include superstructure of offices, research labs, housing, orchards, farms and production rooms.

Success stories:

1) Vertical Harvest (Jackson Hole, Wyoming)

It is a three story, 13,500 square foot hydroponic green house and has capacity to produce 37,000 pounds of greens, 44,00 pounds of herbs, 44,000 pounds of tomatoes. Crops produced are sold to local restaurants, grocery stores and hospitals.

2) Sky Greens Vertical Farm Singapore

World's first low carbon, hydraulic driven vertical farm which uses minimal land, water and energy resources. It is 10 times more productive than conventional farming and uses only 360\$/month (3\$/tower) on electricity with capacity to produce 1 ton of fresh veggies every other day

3) Gotham Greens, New York

It is 15000 square feet rooftop farm which uses hydroponicsystem re-circulating techniques to maintain precision plant nutrition and is 100% renewable electricity powered urban rooftop greenhouse. Yield 20% more than traditional farming.

Hydroponics in India:

1) LetcetraAgritech



- It is Goa's first, indoor hydroponics farm which Produces over 1.5 to 2 tons of vegetables like lettuce, herbs in 150 sq metre area
- The star-up is founded by Ajay Naik, a software engineer turned hydroponic farmer.

2) Green Rush Organics (Chennai)

- Grows over 6,000 plants in 80 sq. ft space
- Grows basil, spinach, lettuce, kale and leafy greens
- In first month, he was able to cater to over 450 families in Chennai
- He explains advantages as:
- Hydroponic system requires 90% less water than traditional farming
- Plants grow 50% faster as well have better yield in hydroponics
- He explains with example that "lettuce grown conventionally require 60 days whereas hydroponically it require 28-30 days
- 1,500 plants require 200 litres of water a day but with hydroponics only 20 litres of water are enough

Hydroponics in Himachal Pradesh:

- **Khan Mushroom Farm, Una**

Yussouf Khan who specialised in mycology and plant pathology experimented on hydroponic cucumbers by developing his own formulation .He explains that initial cost of production is high, but productivity per plant is more (7-8 kg)

Conclusion

Hydroponics as a technology is growing at a fast rate. Use of hydroponics as an alternate urban farming method in populated urban areas on large scale holds the promise of addressing issues like food security, water scarcity, resource depletion by enabling more food to be produced with less resource use and sale of these crops directly in city community, reducing transportation as opposed to the standard rural farming method. Hydroponic agriculture fulfils every objective of urban farming starting from growing of food in heavily populated town, preventing soil degradation, water depletion, marketing of produce at large scale, improving skills, providing jobs in big hydroponic farms, improving food quality and adding aesthetic value to town or cities by creating green space hence, making it a suitable alternate of urban farming. People living in crowded city, without



gardens can grow vegetables and barren lands can be made productive at relatively low cost. Progress has been rapid and results obtained in various countries have provided proof that hydroponics is practical and has very definite advantages over conventional methods of crop production.

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