



## Vertical Farming

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In 2050, it was estimated that the population of India reaches to 1.7 billion (Anonymous 2022a). With increase in population, urbanization rate and industrialization has also increased. The growing population requires the increased demand of food, water and arable land area. But due to urbanization and industrialization arable land areas are at greater risk in India. The arable land area in India declined from 163.46 million ha in 1990 to 156.42 million ha in 2018 and this land would be insufficient to provide the required amount of food to sustain increased human population (Anonymous 2022b). To feed the growing population the only option left to us will be the utilization of vertical space instead of horizontal space. So vertical farming can be the solution to such problems.

### Vertical farming

Vertical farming is the practice of growing crops in vertically stacked layers or integrated into other structures with the use of less water and no soil (Royston and Pavithra 2018). The term "Vertical Farming" was coined for the first time by Gilbert Ellis Bailey in 1915 and he also wrote a book titled "Vertical Farming" (Sonawane 2018). The modern concept of vertical farming was first proposed by professor Dickson Despommier in 1999. The main idea behind the concept of Dickson Despommier is that people in cities should grow their food which can save water, land and time required for transportation. In vertical farming, soilless farming techniques like hydroponics, aeroponics and aquaponics can be used.

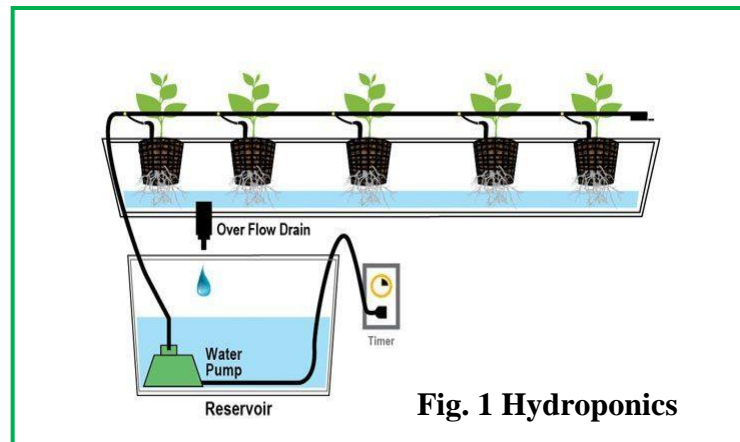
### Need for vertical farming

- 1. Crop production throughout the year:** With vertical farming, we can grow more crops on a given square foot of land. Despommier claims that when the number of crops per season is taken into account, an acre indoor vertical farm may provide yield equivalent to 30 acres of farmland (Birkby 2016).
- 2. Reduction in water use:** In vertical farming techniques 70-95 percent less amount of water is used for the production of crops as compared to traditional farming.
- 3. Resilient to abnormal weather conditions:** In vertical farming, crops are mainly grown in controlled environmental conditions so crops are less prone to natural disasters like cyclones, flooding, droughts and heavy rainfall.
- 4. Less disease incidence:** In vertical farming crops are grown in soilless media which ultimately reduces the incidence of soil-borne diseases to crops.
- 5. Increased organic production:** Vertical farming allows us to grow pesticide-free and organic crops because crops are cultivated in a well-regulated controlled environment without the use of agrochemicals.
- 6. Employment generation:** Protected cultivation has the potential to create jobs and economic opportunities for students.

## Techniques used in vertical farming

In vertical farming mainly three techniques are used i.e., hydroponics, aeroponics and aquaponics.

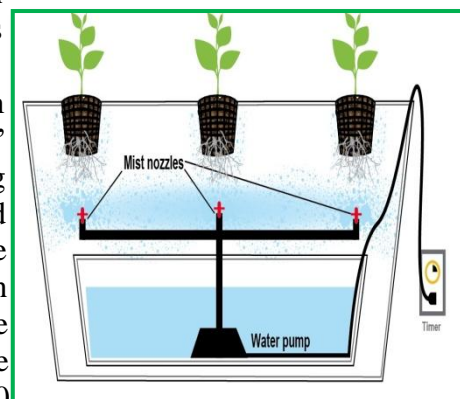
**a. Hydroponics:** The term “Hydroponics” has been derived from the Greek words “hudor” which means for water and “ponos” for work, so it essentially means “water-working.” The hydroponic technique was invented by William Frederick in the early 1930s at the University of California, Berkeley. Hydroponics is a method of



**Fig. 1 Hydroponics**

growing plants in nutrient solutions rather than soil. It is the most predominant method used in vertical farming. In this method, crops are grown in inert materials such as perlite, vermiculite, peat moss and coconut coir which provide support to the root system. This method provides the advantage over soil cultivation because in this method crops are grown on a soilless medium thereby preventing soil-borne diseases.

**b. Aeroponics:** The word “Aeroponic” is derived from the Latin word “aero” which means air and “ponos” means labour (work). Aeroponics is growing vegetation without soil, but the roots are suspended and sprayed with nutrient solution (Fig. 2). The nutrient solution is sprayed or misted onto roots in growing chambers where roots are suspended in the air. An aeroponic system is found to be more efficient than hydroponic systems and utilizes 90 percent less water.



**Fig. 2 Aeroponics system**

**c. Aquaponics:** The word “Aquaponics” is derived from two words ‘aquaculture’ (raising aquatic animals in tanks) and ‘hydroponics’ (growing plants in soilless media). An aquaponic system takes the hydroponic system one step further, combining fish and plants in the same ecosystem (Fig. 3). This system works on the symbiotic relationship between crops grown and fish. Fish are raised in indoor ponds and the excrement they produce is nutrient-rich, serving as a source of food for crops grown. The water used by plants is then filtered and recycled back to the fish pond.



**Fig. 3 Aquaponics system**

## Challenges and solutions

**1. Initial investment:** In vertical farming, the initial investment cost is very high. Urban buildings, for instance, might be very expensive locations for vertical farms. Therefore, abandoned buildings, abandoned warehouses, abandoned ships, etc., may be more cost-

effective for construction in that circumstance and high yields produced by high-value crops quickly offset such expenditures in the first three to four years.

2. **Energy use:** In vertical farming, energy use and expenses are more because crops are grown in artificial light. The solution to this challenge is that every vertical farm has to spend money on effective ventilation systems thereby promoting effective temperature and humidity on the vertical farm required for plant growth. With the use of LED lights energy consumption can be reduced because it maintains an optimal balance between plant growth and minimal heat generation.
3. **Technical knowledge and skilled person:** Skilled persons are needed to carry out the tasks involved in vertical farming. Farmers, students and urban people can have access to vertical farming techniques only when training on vertical farming techniques will be organized at the school level, by organizing camps in urban areas and through Kisan melas.
4. **Limited crop choices:** In vertical farming, only a limited number of crops are taken into consideration like high-value and rapid-growing crops (lettuce, spinach, kale, small woody herbs, etc.) whereas cereals are not grown. Researchers and scientists are working on the development of crops like potatoes through aeroponic, raising sugarcane and paddy nurseries through hydroponic techniques, but it needs field validation trials.
5. **Pollination problem:** Pollination is another challenge in vertical farming. Crops requiring insects for pollination are not benefitted because insects are completely excluded from the environment. In that case, manual pollination will be allowed.

## Conclusion

To sum up, vertical farming is an effective technique for growing crops in urban areas. The increased demand for food in urban areas can be fulfilled by vertical farming. Technologies for vertical farming are still very new. The efficiency of vertical farming is influenced by the supply and demand for food, the population of metropolitan areas, technical advancement, the availability of water and electricity and the weather. Although it is not yet widely used or well developed and has significant limitations in terms of advantages but soon it will become as common as traditional agriculture.

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