



## Vertical Farming – The Future of Crop Production

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### Abstract

The vertical farm is a world-changing innovation. Imagine a world where every town has their own local food, grown in the safest way, where no drop of water or particle of light is wasted. Smart farming makes a tremendous contribution for food sustainability for 21<sup>st</sup> century. The reason is that the environmental and water management affects plant growth directly. Vertical farming is considered as a modern tool for feeding large world population by year of 2050. Erecting a farm that is in close proximity to the people which it serves by availability of cheaper, organic, disease-free crops alongside sustaining the limited natural resources.

**Keywords:** - Vertical farming, Hydroponics, Aeroponics, Aquaponics

### Introduction

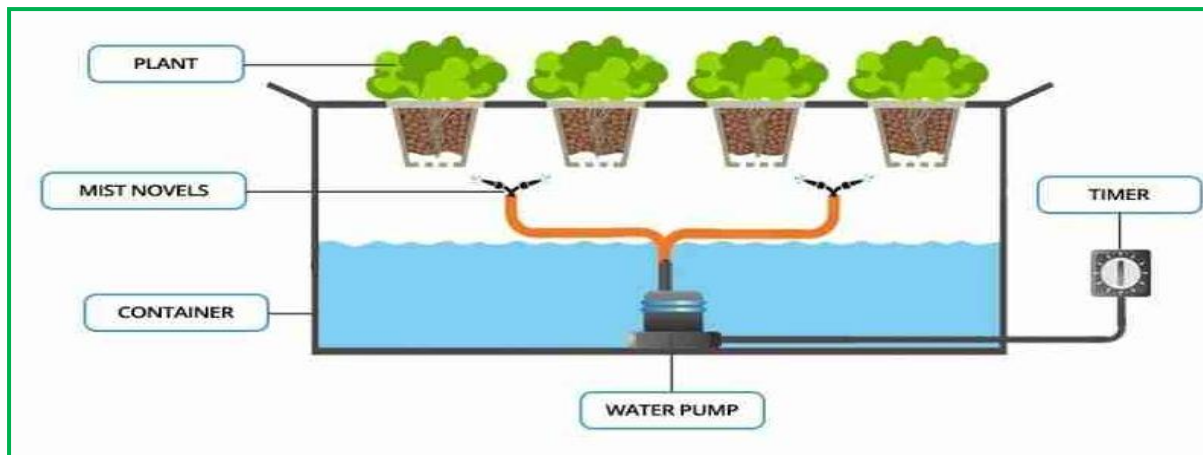
The method of planting crops in vertically stacked layers is vertical farming. Controlled environment agriculture, which seeks to maximise plant growth and soil amendment farming techniques such as hydroponics, aquaponics and aeroponics, is also included. Dickson Despommier, professor of Public and Environmental Health at Columbia University, proposed the modern idea of vertical farming in 1999. Prime land for agriculture can be scarce and costly. The need for both more food and more land to grow food is growing with global population growth. But some corporate executives and growers are starting to look up, not out for space for more food to expand. Vertical farming, with precise illumination, nutrients and temperatures, includes growing crops in regulated indoor environments. Growing plants are stacked in layers that can reach several levels tall in vertical farming.

### Techniques of vertical farming

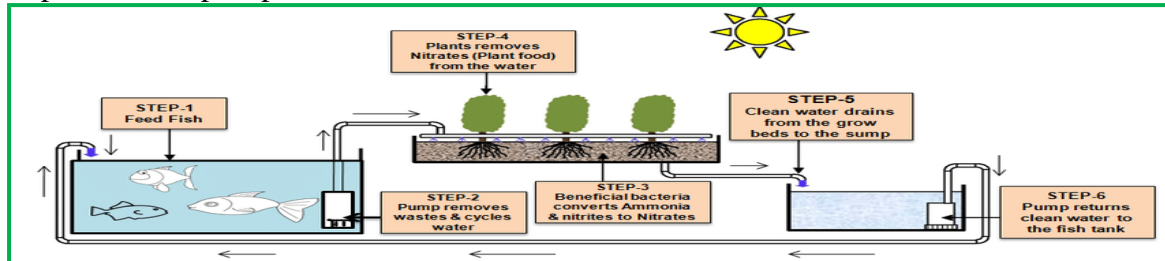
Vertical farming come in various shape and size, ranging from basic two-level or wall mounted structures to many storeys high in massive warehouses. But all vertical farms use one of three soil-free system, hydroponic, aeroponic, or aquaponic, to provide plant nutrients.

**The following information explains these three structures that are growing:**

- 1. Hydroponics:** It is a method for employing mineral nutrition solutions to grow food in water without needing dirt. The key advantages of this strategy are that it reduces concerns with soil-related agriculture, such as soil-borne diseases, pests, and insects.
- 2. Aeroponics:** Aeroponics was developed as a result of a NASA (National Aeronautical and Space Administration, USA) project in the 1990s to find a practical way to grow plants in space. In aeroponics, crop containers are not necessary because there is no growing medium. Aeroponics employs nutritious solutions or mist in place of water. Due to the plants' attachment to a support and nutrient treatment of the roots, it requires very little space, water, and no soil.



**3. Aquaponics:** The term aquaculture, which refers to fish farming and hydroponics, which describes the method of growing plants without soil, were merged in order to create symbiotic relationships between the plants and fish. The symbiosis is accomplished by feeding "fertigate," which is nutrient-rich waste from fish tanks, to hydroponic production beds. The hydroponic beds then act as bio-filters to rid the water of gases, acids, and impurities like phosphates, ammonia, and nitrates.



**4. Controlled-environment agriculture:** The alteration of the natural environment to increase crop yield or prolong the growing season is controlled-environment agriculture (CEA). Usually, CEA systems are hosted in enclosed structures such as greenhouses or buildings, where environmental factors such as air, temperature, light, water, humidity, carbon dioxide, and plant nutrition can be monitored. CEA is often used in vertical farming systems in combination with soil-free farming techniques such as hydroponics, aquaponics, and aeroponics.

### Types of vertical farming

**Building-based vertical farms:** Abandoned structures, such as a Chicago farm named "The Plant," which was converted from an old meatpacking plant, are frequently reused for vertical farming. New buildings, however, are also often built to house vertical farming systems.

**Shipping-container vertical farms:** An increasingly common alternative for housing vertical farming systems is recycled shipping containers. Often fitted with LED lighting, vertically stacked hydroponics, smart climate controls, and monitoring sensors, the shipping containers serve as standardized, modular chambers for growing a range of plants. In addition, farms can save even more space and achieve greater yield per square foot by stacking the shipping containers.

**Deep farms:** A "deep farm" is a vertical farm constructed from underground tunnels or abandoned mine shafts that have been renovated. As underground temperatures and humidity are usually temperate and constant, deep farms need less heating energy. Deep farms may also use groundwater nearby to minimize water supply costs. According to Saffa Riffat, chair of Sustainable Energy at the University of Nottingham, deep farming can generate 7 to 9 times more food than traditional farming above ground on the same land area, despite low costs.

**Why the Vertical Farming is needed?**

- ❖ To meet the food demand of over exploring population i.e. by obtaining more produce per unit area.
- ❖ To bring the sustainability and security in qualitative, nutritive food for future generation. Year round available of fresh produce and clean green gourmet (CGG) food.
- ❖ Expanding the agricultural land by adopting raising of the crops on high building.
- ❖ To conserve and efficient utilization of water, nutrients, energy, and other inputs. Reuse, recycle of harvested rainwater and nutrients and organic waste.
- ❖ To reduce the environmental stress/impact on the crops and protection from natural disaster.
- ❖ Maintaining the ecological balance and produce healthy foods and resilient to climate change

**How the Vertical Farming works?**

Vertical farming is one of the modern farming technologies that uses controlled environmental condition during crop production to make most of the indoor farming techniques. This method involves controlling temperature, lighting, water, humidity artificially, all of these can be done indoors. The main purpose of this modern farming technique is to increase the crop production in a small space. Now if we want to understand how the vertical farming works, we have to consider the four essential aspects: physical arrangements, lighting facilities, growth medium and sustainable qualities.

**The primary objective of vertical farming**

- To increase the food production per square metre. To achieve this target, crops are grown in tower-like living framework.
- To maintain optimum light level in the space by combining natural and artificial light.
- Instead of soil, vertical farming utilises hydroponic growing materials like coconut shells, sphagnum moss and other non-soil media.
- To balance the energy expenses of farming, vertical farming techniques incorporates several sustainable aspects such as aeroponics, hydroponics etc. In vertical farming, water consumption has decreased up to 95%.

**Advantages of Vertical Farming:**

- ❖ It is an efficient and sustainable way of producing food as it needs less water than a traditional farm would need.
- ❖ Controlled environment of vertical farming reduces the external environmental impact.
- ❖ It is not reliant on the weather, that's why fresh produce can grow all the time throughout the year.
- ❖ There is a drastically increase in the crop production if full-year stability is maintained during production, by implementing efficient methods.
- ❖ Crop output per unit area of land is maximized through vertical farming. Protection from animals and invasive plant species.
- ❖ Maximization of profit as production cost is low.

**The Future of Vertical Farming**

Vertical farming has been called “future farming” by many and definitely there is some good reason. According to the latest edition of the United Nations’ World Population Prospects, India is set to become the world’s most populous country (1.515 billion in 2030) by the end of the decade, overtaking China (1.426 billion in 2030). So, we must feed such a huge population with the limited amount of arable land. In these aspects vertical farming can play a major role by efficiently utilising land and water and by increasing the crop production.

### Limitations in Vertical Farming

- ❖ For vertical farming, cost is a big hurdle.
- ❖ Buying an urban real estate to build a vertical farming can also be expensive.
- ❖ Expert requirement to set up a vertical farming project.
- ❖ Wrong set up could lead to a spread of pests and diseases.
- ❖ Only suitable for limited type of crops and some vegetables.
- ❖ Technology issues may cause huge problems.

### Conclusion

Vertical farming is an emerging new technology aiming to increase crop yield per unit area of land in response to heightened pressure on agricultural production. This modern farming technique have numerous advantages over traditional farming, which includes more sustainability, adaptability, and efficiency, which is all made possible through controlled environmental system of vertical farming. In addition, vertical farming also provides new opportunities for architecture.