

## Vertical Farming

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### Introduction

Agriculture stands as the paramount occupation globally, for without it, our world cannot endure. It serves as the linchpin for sustainability on our planet. However, the expanse of arable land is diminishing at an alarming rate, and the younger generation exhibits waning interest in farming. This disinterest stems from various factors, including substantial losses incurred in farming, the impactful consequences of climate change on the agricultural sector, low income, and the strenuous nature of fieldwork.

The agricultural landscape is continually evolving with the introduction of numerous technologies and the widespread adoption of advanced traditional and indigenous practices. Amidst these diverse farming techniques, vertical farming emerges as a notable contender. This article delves into the intricacies of vertical farming, shedding light on its principles and applications. It is our hope that this exploration will serve as a valuable resource, enriching your understanding of vertical farming and its potential impact on sustainable agriculture.

### Vertical Farming

In 1915, Gilbert Bailey introduced the term "vertical farming" in his book of the same name. Bailey delved into the intricacies of farming, emphasizing a special interest in soil origin, nutrient content, and plant life viewed as vertical life forms, including insights into underground root structures. However, the contemporary concept of vertical farming took a significant leap in 1999 when Professor Dickson Despommier, a faculty member in public and environmental health at Columbia University, proposed a groundbreaking idea.

Professor Depommier focused on rooftop farming, and his vision for vertical farming gained traction. Subsequently, government bodies and developers embraced and implemented his innovative approach. Cities such as New York, Bangalore, Beijing, Dubai, and Abu Dhabi have enthusiastically adopted vertical farming techniques. The collective investment in vertical farming start-ups skyrocketed, reaching around \$18 billion between the years 2014 and 2020. This substantial investment underscores the growing recognition and support for the potential of vertical farming in addressing modern agricultural challenges.



### **What is Vertical Farming?**

The term "vertical farming" refers to the cultivation of crops in vertically stacked layers. At times, it involves controlled environment agriculture to enhance plant growth. This method also incorporates soilless farming techniques such as hydroponics, aeroponics, and aquaponics. Vertical farming is implemented in various structures, including skyscrapers, warehouses, buildings, and shipping containers.

### **Types of Vertical Farming**

#### **1. Mixed use skyscrapers**

Architect Ken Yeang conceived and developed the idea that plants should be cultivated in open-air mixed-use skyscrapers instead of employing hermetically sealed, Mars-inspired agriculture for climate control and consumption. The primary aim of this particular form of vertical farming is to provide sustenance for personal households or communities, rather than catering to wholesale production and distribution.

#### **2. Depommier's skyscrapers**

Ecologist Professor Dickson Despommier proposed that plants can be cultivated in skyscrapers on a large commercial scale. This approach proves beneficial in mitigating the impacts of climate change, minimizing toxic exposure, and reducing the risk of parasitic threats to natural landscapes. The reclaiming of farmland for its original state, such as forests, contributes to environmental restoration. Furthermore, growing crops on skyscrapers is touted to consume less embodied energy compared to other conventional farming methods. Professor Despommier introduced this visionary concept in 1999.

### 3. Stackable shipping containers

Utilizing stacked shipping containers as standardized, modular environmental chambers for crop cultivation is an innovative approach. This method enables the cultivation of more crops within a limited space, leading to increased production. However, challenges arise in ensuring effective and affordable access to the stacked levels. Several examples illustrate this concept:

- ❖ Greenery by Freight Farms: A comprehensive farm-to-table system equipped with vertical hydroponics, control environment facilities, and LED lighting. The shipping container has dimensions of 12m×2.4m.
- ❖ Podponics Vertical Farm in Atlanta: This initiative involved the development of 100 stacked "grow pods."
- ❖ Terrafarms 40 ft. Shipping Containers: Equipped with features like artificial neural networks, remote access, and monitoring, these containers entered the commercial realm in 2017.

### 4. Deep Farming

Vertical farming conducted in abandoned mine shafts is referred to as 'Deep Farming.'

The objective of this farming technique is to achieve:

- ❖ A consistent underground temperature.
- ❖ A location near or within urban areas.
- ❖ Easily accessible groundwater, thereby reducing water costs.

### Techniques of Vertical Farming

1. **Hydroponics:** It is a method of cultivating plants using a water-based nutrient solution rather than soil. In this approach, plant roots are immersed in a solution containing



essential elements such as magnesium, nitrogen, potassium, and calcium. This supports the roots, leading to higher yields and a reduced reliance on water. Hydroponics demonstrates significant efficiency, utilizing 13 times less water while achieving an 11-fold increase in yield compared to conventional farming.

Various growing media or aggregate substrates, such as coconut coir or perlite and vermiculite, are commonly employed in this technique. Hydroponics is particularly favored by small-scale farmers, hobbyists, and for commercial purposes due to its efficiency and resource optimization.

- 2. Aquaponics:** represents an advanced variation of hydroponics. In this innovative method, crops are cultivated alongside aquatic organisms within a closed-loop system, closely mimicking the dynamics of nature.
- 3. Aeroponics** is a cultivation method that deviates from traditional solid or liquid mediums. Instead, it employs air as the medium for plant growth. In this approach, a nutrient-rich liquid solution is sprayed into the air, allowing plants to absorb the essential nutrients required for their growth.

### **Advantages of Vertical Farming**

- 1.** Vertical farming demonstrates superior efficiency in terms of yield compared to conventional methods, allowing year-round cultivation of crops.
- 2.** Vertical farming provides heightened weather resistance by operating within a controlled environment, shielding crops from potential threats such as floods, droughts, and wildfires.
- 3.** Vertical farming contributes significantly to environmental conservation by conserving water, preserving soil, and facilitating the creation of forests.
- 4.** Efficient space utilization is achievable through vertical farming.
- 5.** The controlled conditions of vertical farming facilitate year-round food production.
- 6.** Vertical farming remains unaffected by adverse weather conditions.
- 7.** Vertical farming entails lower labour costs.
- 8.** Sustainable practices are inherent in vertical farming methods.
- 9.** Water use is minimized in vertical farming practices.
- 10.** Vertical farming does not contribute to soil degradation.
- 11.** Food can be grown in urban areas, reducing dependence on distant sources.

12. Reduction in transport costs is a benefit of localized food production in vertical farming.
13. Vertical farming minimizes crop contamination by diseases and pests.
14. Vertical farming eliminates the need for chemical or pesticide use, promoting healthier and more sustainable agricultural practices.

### **Disadvantages of Vertical Farming**

1. Vertical farming involves a higher initial investment cost compared to traditional methods.
2. Vertical farming is linked to increased energy consumption, attributed to the provision of supplemental light and the maintenance of a controlled environment.
3. Reduced pollination occurs in vertical farming, as the process is hampered without insects.
4. Dependence on technology, including the control of lights, temperature, and humidity, is a potential drawback in vertical farming.
5. Vertical farming can have repercussions on communities, particularly those belonging to the Below Poverty Line (BPL) category.

### **Conclusion**

In conclusion, vertical farming emerges as a promising solution to the myriad challenges facing traditional agriculture in the contemporary world. With the constant decrease in farming areas, the disinterest of the younger generation due to various factors, and the adverse effects of climate change on agriculture, vertical farming provides a ray of hope for sustainable food production. Originating from the visionary concepts of Gilbert Bailey in 1915 and later championed by Professor Dickson Despommier in 1999, vertical farming has evolved into a multi-billion-dollar industry with global acceptance. The diverse types of vertical farming, including mixed-use skyscrapers, Depommier's skyscrapers, stackable shipping containers, and deep farming in abandoned mine shafts, showcase the versatility of this innovative farming technique. Employing techniques like hydroponics, aquaponics, and aeroponics, vertical farming optimizes resource utilization, reduces water dependency, and enhances crop yields. Despite its advantages, the approach is not without challenges, such as high initial investment costs, energy consumption, and potential impacts on communities, particularly those in vulnerable economic conditions. Nevertheless, the benefits of vertical farming cannot be overlooked. From efficient space utilization and year-round food production





to resistance against adverse weather conditions, environmental conservation, and reduced transport costs, vertical farming aligns with sustainable practices. It minimizes water use, avoids soil degradation, and eliminates the need for chemical pesticides, contributing to a healthier and more ecologically balanced farming system.

As we stand at the intersection of technological advancements and the imperative need for sustainable agriculture, vertical farming presents itself as a transformative force. While addressing some challenges, it opens avenues for further research, innovation, and policy integration to make this farming method more accessible, affordable, and inclusive for communities across the globe. The future of farming may very well be vertical, ushering in an era where agriculture meets the demands of a growing population without compromising the health of our planet.

#### References

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