

# Opportunities and challenges of vertical farming

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**Abstract:** The world's population is increasing at a faster rate, and consumer preferences purchasing power, and demand for food, are also changing. These changes are building pressure on existing resources. Therefore, the Vertical Farming method can be helpful in reducing environmental pollution as it consumes very less water than traditional farming practices. The vertical Farming technique also meets the demands of the increasing population by utilizing less water, chemicals, pesticides, and land to grow healthy crops. However, the prices of products are higher compared to the conventional farming method. Vertical Farms are not a substitute for traditional farms, but together they can help each other to meet future needs or demands for food. It is environmentally friendly, technology-oriented, and most importantly, it can produce a good yield.

**Keywords:** Vertical farming, Indoor farming.

## I. INTRODUCTION

Vertical Farms are encouraged to grow crops in a controlled, closed-loop environment. These farms would eliminate the need and use of harmful herbicides, pesticides, and insecticides to save the crops and maximize their nutrition and food value. Researchers intend to develop, refine, and adapt these systems to be ultimately deployed anywhere globally and provide maximum production and minimize impacts on the environment. They represent a paradigm shift in farming and food production. These systems and associated technologies are rapidly evolving, diversifying, and improving because of their potential.

In Vertical Farming, crops are grown by artificially stacking plants vertically above each other, either in skyscrapers or using the third dimension of space. Indoor Farming is also referred to as CEA, Controlled Environment Agriculture. CEA has rapidly evolved into a commercially viable approach for the large-scale production of various crops close to, or even within, urban centers. Controlled Environment Agriculture includes Plant factories/Container Farms/Indoor Farms: A system for growing plants and vegetables under fully or partially controlled conditions to allow crops to be grown throughout the year. These systems are soilless and can control light, temperature, moisture, and sometimes carbon dioxide artificially. Vertical Farms are indoor farms but in vertically stacked layers to maximize growing space/m<sup>2</sup>.

## II. OBJECTIVES OF THE STUDY

- 1) To understand the various factors affecting Vertical Farming.
- 2) To compare the traditional farming method and Vertical Farming method.
- 3) To list out the benefits of the Vertical Farming Technique.
- 4) To provide suggestions on Vertical Farming method.

## III. FACTORS IMPACTING THE MARKET GROWTH

Some significant factors impacting market growth are listed below:

### i. Increase in popularity of organic foods

Organic food refers to the products cultivated through the farming system that does not use synthetic fertilizers, pesticides, and growth regulators. Presently, people worldwide have become increasingly aware of the source of food they consume daily and have switched from the food grown using chemicals and pesticides to organic food. The demand for organic food supply increases every year; thus, Vertical Farming is being adopted rapidly.

### ii. Optimum use of vertical space and balanced energy utilization

Vertical Farming is a paradigm shift in conventional agriculture methods. Many uninhabited properties and buildings can be rehabilitated into food production facilities, reducing the construction cost required in the agriculture center. The vertically growing structure of these farms eliminates extensive spending on purchasing the land, and the optimum use of vertical space increases productivity. For example, 1-acre indoor vertical space is equivalent to 4-6 acres of outdoor space

### iii. Ease of crop monitoring and harvesting

The technologies used in Vertical Farming are used in remote research stations and refugee camps in flooded or earthquake-affected areas—various growth mechanisms used in Vertical Farming help for the crop's artificial growth in a controlled environment. Moreover, using the Internet of Things in Vertical Farming components reduces human intervention, tracks crop development, and reduces labor cost and material wastage.

## IV. BENEFITS

Various benefits of Vertical farming are listed below:-

- High yields.
- Year-round growth.
- High harvestable yield.

- Agricultural Efficiency.
- Resistance to Weather.
- Year-round demand.
- Limited labor requirement.
- High Productivity.
- Not susceptible to external environmental conditions.
- It reduces the cost of transportation.
- Reduced use of fossil fuels.
- 70 to 95 % less water usage compared to traditional farming.
- 90% less or no soil in Vertical Farming.
- Pesticide-free or organic food.
- Because of the reduced food supply chain, consumers get fresh produce with all its original nutrient qualities.
- It helps in building green urban areas and reducing the rising temperatures and mainly the air pollution in cities.

## V. TRADITIONAL FARMING V/S VERTICAL FARMING

Reasons to shift from conventional to Vertical Farming:

**a) The exponential increase in population:** The population of India is increasing day by day, and it will cross china population very soon. These present a significant challenge with natural resources such as water and arable land becoming scarce. Vertical Farming, indeed, is the most favorable solution for this.

**b) Scope of quality food production:** A Vertical Farm makes farming within the confines of a city, and when the farms are nearby, the product is quickly delivered and always fresh, when compared to the refrigerated produce usually available at supermarkets.

**c) Negligible wastage of water:** Agricultural industry, across the globe, is one of the biggest polluters using up to 90% of the world's water. But that could change with Vertical Farming. Due to the regular circulation of water, Vertical Farms use, in some cases, 95% less water.

**d) Optimum use of energy:** Solar energy is used in Vertical Farms and leads to energy savings

In traditional farms, fruits and vegetables take a lot of time to grow. This method incorporates a lot of labor and time. With the development of agricultural technology, modern Vertical Farms use Controlled-Environment Agriculture (CEA) technology. It controls all environmental plant factors, such as light, humidity, temperature, and gases, by a small workforce. It allows vertical farms to grow fresh and nutrient-rich food more efficiently. Instead of transporting food from thousands of miles on freeways and the need for storage, vertical farms make locally-grown produce possible anywhere. Therefore, crops from vertical farms will have a much smaller carbon footprint and more efficient water and land use.

Vertical Farming is essential. It can solve issues like food shortages and environmental problems associated with the urban development process and determine the potential monetary values of different crop types. For most places, growing food outdoors is not possible throughout the year. Only 10% of the world's land is arable, so increasing demand for local food is one of the main reasons behind the annual growth of indoor agriculture.

The Vertical Farm needs expertise and knowledge of technology and crop, which can be challenging to achieve by practicing traditional agricultural practices. Vertical Farms produce more yields compared to the traditional method. This farming method doesn't promote the use of pesticides, fertilizers, or insecticides. The waste generated on the farm; is used for water supply, saving the environment from degrading water quality. The protected Controlled Environment Agriculture technology protects the crop from external weather conditions like droughts, floods, and heavy rains. It also lowered the product's transportation cost as the crops grown and sold at nearby places.

However, with the high return comes the high cost associated with Vertical Farms. Because the price is so high, crops in Vertical Farms must be valuable to keep the ecosystem economically sustainable, making only a few varieties of crops viable to be produced in this controlled environment, such as lettuce, flowers, and herbs. The dependence on technology is another shortcoming of Vertical Farming. A Vertical Farming system will not be sustainable without a reliable and consistent power supply. If the power cuts off, all the growing crops will not survive since they depend on the artificial atmosphere, which provides its requirements for the crops and maintains the environmental factors at a stable temperature and constant humidity. To overcome this power supply issue, vertical farms are now keeping the roof and other glass walls, which help them, collect the maximum required sunlight. So installing solar panels can be a better solution for this. The location of a Vertical Farm is critical because it is related to the local market's demand. Vertical Farms need to be sustainable to continue to exist as an ecosystem. Vertical Farms require consistent investment for producing crops. Also, a Vertical Farming operation requires a team. To make the labor work, local farmers need a reliable, capable workforce to help them with daily tasks like planting, harvesting, and packaging to provide a healthy working environment on a Vertical Farm. Farms need to know more than just experience, and they need to learn more about what they are growing and how to monitor the plants by using advanced tools. Finally, pricing the products at a reasonable cost is another challenge for Vertical Farms; making the product affordable yet profitable can ensure its development.

## VI. CROP CHOICE

Crop range in Vertical Farming systems is currently limited, with most producers cultivating salad leaves and other small leafy vegetables. These crop types are well suited for cultivation in Vertical Farming systems because small-size plants can be grown in

large numbers and produce more income per unit area horizontally. These crops also show rapid growth and a short time frame from germination of the crop to harvest; increasing the number of crops further maximizes profitability.

The most common products now produced in Vertical Farms are:- lettuce, leafy greens, herbs, strawberries, tomatoes and cucumbers.

## VII. CHALLENGES

### **Lack of skilled workforce and technical advancement, and limited crop range**

Vertical Farming involves advanced solutions such as cameras, sensors, automated systems, artificial intelligence, hydroponic, aquaponics, or aeroponic systems. To operate, a knowledgeable and skilled workforce is essential. Maintenance of machines and computers requires people who are technically well-trained and equipped with all upgrading know-how. Lack of a skilled labour has affected different areas globally, and vertical farming is not an exception. Also, most farmers venture into this market with their systems, which are inefficient in design and costly. Vertical Farms need to be up-to-date in different farming aspects to sustain and remain competitive in the market.

### **Air circulation in a vertical farm**

Maintaining air circulation everywhere within the Vertical Farm to create a uniform growing environment is a significant challenge for the growers. As the racks in Vertical Farms close together, it is difficult to make uniform conditions everywhere. In horizontal flow, the plants might obstruct the flow of air from one point to another, resulting in temperature, humidity, and airspeed differences from one end of the rack to the other. The air circulating across the shelves picks up heat from the light and the moisture from plants, making it more hotter and humid along its path.

### **The substantial initial investment to set up a vertical farm**

Most farmers worldwide cannot adopt technology quickly, and changing with the trend is difficult for them. Setting up a vertical farm requires a substantial initial investment that most of them cannot afford. Setting a farm's initial days is problematic because they need to understand the mechanism and work accordingly. It also has a low rate of returns in the initial period, which is a significant issue to attract more and more investors.

### **Identifying the absolute market location and distribution channel**

Before setting up a Vertical farm, it is essential to study the start-up's feasibility because understanding the market and then serving the consumer's needs is always essential. To perform this proper distribution channel is to identify to reach the end-users.

## VIII. FINDINGS

- A huge Initial investment is required to start a Vertical Farm.
- The excess nutrients used in the farming technique can contaminate the water system.
- LED lighting systems that emit heat can create the problem of maintaining the inside temperature. Value-added pesticide-free organic products are gaining popularity.
- Vertical Farming requires initial support to propel the local food economy by the various institutions.

## IX. SUGGESTIONS

- Proper waste management and disposal system are essential on every farm.
- Renewable energy sources can be used to make the farm more profitable.
- Selection of crops based on the production and demand is necessary.
- Identifying the proper market location and distribution channel
- As vertical farms have a low risk of crop failure, it increases consumer responsiveness.
- The high selling price of farm produce can be reduced by selecting a nearby location to set up a farm, and it will also reduce the transportation cost.

## X. CONCLUSION

Vertical farming focuses more on production using limited resources. Vertical Farming is a promising solution to the drawbacks of traditional agriculture. Compared to conventional Farming, it can produce healthier and higher yields in a relatively short amount of time. The quality of the produce is guaranteed because the system is resilient to climate change. Depending on the use, size, and primary techniques used in a Vertical Farm, however, most of Vertical Farm's common goal is to increase the yield sustainably.

However, the initial investment for setting up a farm is higher as it requires a skilled workforce and technology incorporating controlled environmental conditions.

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