

# VERTICAL FARMING: A NEW ERA OF MODERN AGRICULTURE

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# INTRODUCTION:

"Why can't we farm vertically if we can live vertically?"... The activity of growing crops in vertically stacked layers or integrated into other structures- like skyscrapers or abandoned warehouses- while using less water and no soil is known as vertical farming. The absence of vegetation in urbanized regions due to human settlements has a direct impact on people's quality of life, both aesthetically and physically. The vertical farm is an invention that will change the world, and its time has come. Imagine a world in which no drop of water or particle of light is wasted, and where each community has its local food source farmed as safely as possible. For the 21st century, smart farming is a huge help with food sustainability. Vertical garden construction is advised for building exteriors, particularly for internal spaces. Any type of space can be utilized to its full potential by implementing these technologies, yielding aesthetically pleasing results that are beneficial to both the environment and human health.

The term "vertical farming" often refers to the practice of growing crops- mostly vegetables, ornamentals, and herbs- indoors on shelf racks using artificial light and nutritional solutions in the absence of much soil and sunshine. Since these farms are not reliant on seasons or a controlled climate, they may increase production year-round with a low risk of crop failure. They also save labour, which is currently a valuable resource, and produce high-quality fresh fruit without depending on favorable weather, rich soil, or heavy water usage. Vertical farming, especially in urban areas, has the potential to feed the world's expanding population with the help of nutrient-rich supplements. It is either already well-known or well-established to produce mushrooms vertically, as well as some fruits and vegetables, chickens, and green fodder cultivated in hydroponic systems. Green walls, living walls, bio walls, and vertical gardens are other names for decorative horticulture's vertical farming.



# WHY VERTICAL FARMING IS IMPORTANT?

- ❁ **Food stability:** Food security has grown to be a serious worry in the modern world. Demographers predict that over the next few decades, there will be a major increase in the number of people living in cities. Agronomists, ecologists, and geologists are among the professionals in the field of land use who claim that there is a rising shortage of farmland. The biggest problem is the rising population's increased demand for food, which is exacerbated by the ever-diminishing amount of arable land. High-yield farming practices that feed our massive population are known for their unstable use of the soil, fossil fuels, and freshwater resources we have. That's why vertical farming is important.
- ❁ **Urban density:** In contrast to "horizontal" urban farming, "vertical" urban farming makes it possible to occupy more area for urban activities (such as housing more people, services, and amenities). Studies have demonstrated that urban agriculture lengthens commutes by lowering population density. These heights will serve as future farmlands, and countries with little to no arable land can develop them to become top food producers, converting those that are currently unable to farm. A different supply of sustainable food production units for the needs of the present and future generations in cities is created by vertical farming. That's why we need to transform our farming vertically.
- ❁ **Health:** Traditional farming methods frequently cause harm to the natural and human surroundings since they are not given enough attention. This leads to soil erosion, contamination, and massive water waste. According to a WHO study, over half of farms worldwide still use raw animal dung as fertilizer, which can attract flies and serve as a source of weed seeds or diseases that can infect plants. Such food consumption hurts people's health. Furthermore, if crops were grown indoors under controlled conditions, the need for pesticides and herbicides- which contaminate agricultural runoff- could be decreased. That's why vertical farming is important.
- ❁ **Ecosystem:** Agriculture has already allowed people to encroach on natural ecosystems for millennia. Dickson Despommier asserted that "more than any other activity, farming has impacted the Earth's ecosystems". For agricultural purposes, the Brazilian rainforest has lost about 1,812,992 km<sup>2</sup> of hardwood forest during the previous 50 years or so. By invading



these old ecosystems, Despommier claims that human activity is hastening climate change. Indoor vertical farming is one way to reduce the harmful effects of climate change and restore biodiversity. Vertical farms could produce just 10% of the land currently used by cities, which would be enough to cut CO2 emissions to encourage the creation of new technologies that would eventually benefit the biosphere. If fertilizer runoff were stopped, the quality of the water in rivers and coastal areas would improve, and the number of wild fish would increase. The strongest argument in favour of switching to vertical farming



for the majority of food production appears to be the possibility of restoring ecological services and functions.

✿ **Economics:** Furthermore, the food produced by the vertical farm will be offered at competitive costs, according to its supporters. The cost gap in traditional farming is decreasing quickly since input costs are going up. Vertical farms, for example, might be advantageously located in cities so that produce can be sold directly to the consumer, cutting costs by sixty percent. Vertical farms are capable of producing much more in addition to using intensive farming techniques and state-of-the-art technologies. Scientists have been adjusting temperature, CO2 levels in the air, soil, water, light, colour, intensity, and humidity levels for years to optimize indoor farming. Vertical farming can also help the local economy. Furthermore, growing vegetables indoors can be more pleasurable due to its high-tech nature. As a result, the practice has drawn a younger, more tech-savvy population, producing a new generation of farmers. Using the vertical farming approach has many advantages, one of which is the advancement of new agricultural technologies. Finally, it might make it possible for city dwellers to reconnect to the real world through farming.

## PAST STORY ON VERTICAL FARMING:

Vertical plant growth is said to have originated with Babylon's hanging garden. The idea of towering, multi-story buildings for indoor agriculture was first applied by American geologist Gilbert Ellis Bailey in 1915. The concept of vertical farming was developed in 1999 by Dickson Despommier, an Emeritus Professor of Microbiology at Columbia University. He notes that hydroponic crops could be grown on the upper floors, while fish and chickens that consume plant waste would be suited for the lower floors. This was made possible by technological advancements.

# TECHNIQUES OF VERTICAL FARMING:

The physical layout, the lighting, the growing medium, and the sustainability aspects are the four key components of knowing how vertical farming operates. Here are the different techniques of hydroponic systems, each with its advantages and considerations:

## Hydroponics:

Hydroponics is a combination of two different words where 'hydro' means water and 'ponos' means labour. Plants can be grown soilless using a technique called hydroponics. In contrast to conventional farming, which requires 70% more water, hydroponic farming employs an inert growing medium such as cocopeat to support and nourish the plant roots instead of soil. Hydroponic systems range in complexity from a small glass of water with pebbles and fertilizer to a big greenhouse with beds of clay pellets or troughs with cocopeat that are regularly topped off with nutrient solution. These days, many commercial farmers use the nutrient film technique, or NFT, another type of hydroponic farming. Hydroponics has been recognized as a viable method of producing vegetables (tomatoes, lettuce, cucumbers, and peppers) as well as ornamental crops such as herbs, roses, freesia, and foliage plants. Due to the ban on methyl bromide in soil culture, the demand for hydroponically grown produce has rapidly increased in the last few years.

## Growing system:

Hydroponic systems can either be liquid or aggregate. Liquid systems have no supporting medium for the plant roots; whereas, aggregate systems have a solid medium of support. Hydroponic systems are further

categorized as open (once the nutrient solution is delivered to the plant roots, it is not reused) or closed (surplus solution is recovered, replenished, and recycled).

## Liquid Hydroponics System:

They are closed systems.

- ✓ Nutrient Film Technique (NFT): Plants are arranged in a polyethylene tube with holes drilled in it to accommodate the roots. This tube is used to pump nutrient solution.
- ✓ Floating Hydroponics: On a floating raft made of enlarged plastic, plants are raised.
- ✓ Aeroponics: The roots of the plants are left hanging in a growing chamber that is walled off, and they are misted with a nutritional solution just sometimes-typically every few minutes.

## Aggregate Hydroponic System:

### ✿ Open system:

- ✓ Rockwool Culture: It is the hydroponics media that is most frequently utilized. The material used to make rock wool is heated basalt rock that has been crushed up and spun into threads. It's frequently offered in cube form and is quite light. For the best root growth, rockwool can retain enough air space (at least 18 percent) and contain water.

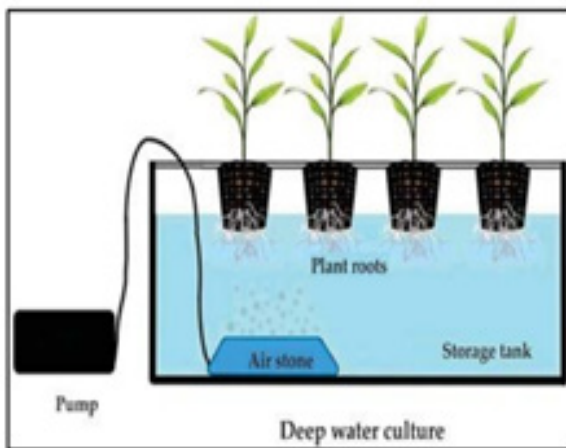
### ✿ Closed System:

- ✓ Gravel
- ✓ NFT and Rockwool: Small slabs of rockwool placed in channels filled with repurposed fertilizer solution are used to establish plants.

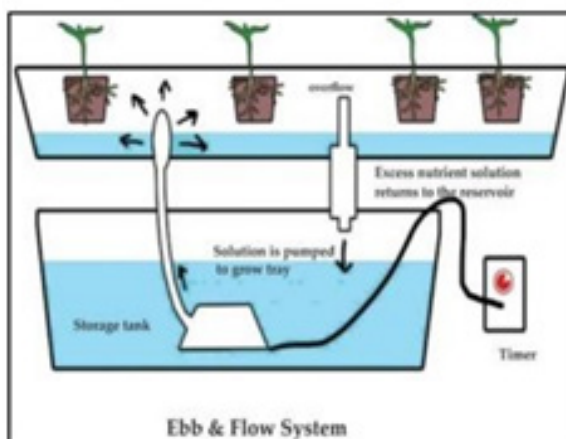
**These systems are further categorized into:**

- 1. Passive systems:** A wick and growing material with a high capillary action are used in passive systems. Water can now be drawn to the roots of the plant as a result. The most basic kind of hydroponic system is the Wick System.
- 2. Active systems:** A nutrient solution is actively passed over the roots of your plants via active systems. For example, consider: multiple times a day.

**The Water Culture System:** Of all the active hydroponic systems, this one is the most straightforward. Typically constructed of Styrofoam, the plant platform floats right on top of the nutritional solution. Air is supplied by an air pump to the air stone, which causes the nutrient solution to bubble

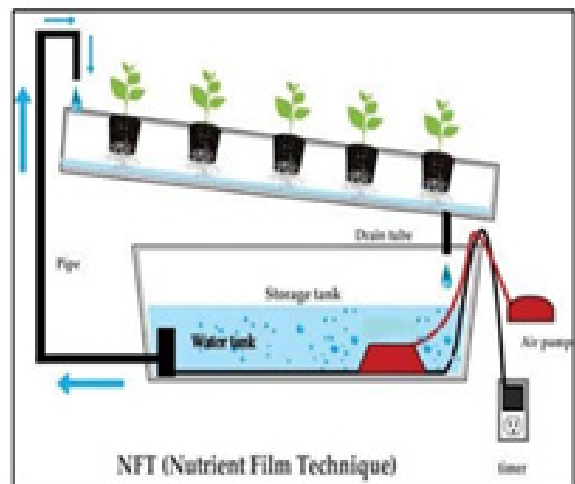


**The Ebb and Flow System:** It functions by briefly filling the grow tray with nutrient solution, which is subsequently drained back into the reservoir. Usually, a timer-connected submersible pump is used for this operation. Depending on the size and type of plants, temperature, humidity, and growing media type, the timer is programmed to turn on



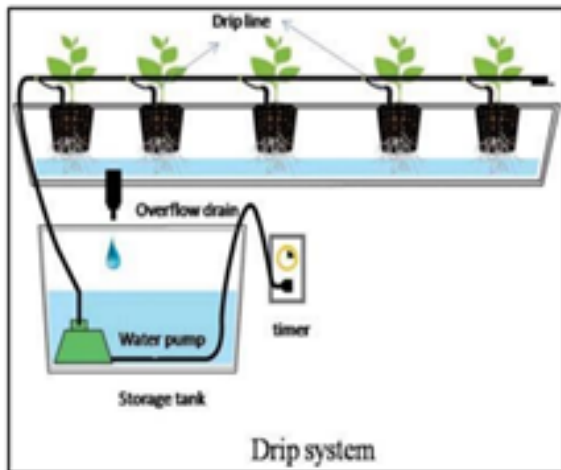
**Nutrient Film Technique (NFT):**

To introduce nutrients into the growth tray, tubes or pipes are utilized. After passing over the plant roots, they drain out. To address issues with the ebb and flow method, Dr. Alen Cooper developed the NFT system in the 1960s. Through the use of a water pump without a timer, water or a nutrient solution is circulated throughout the system and into the growing tray. The nutrient solution uses a slightly tilted mechanism to make its way back to the reservoir after passing through the roots. Plants grown hydroponically have roots hanging down a tube or channel. The roots are susceptible to fungal infection even though they are continuously wet or nourished. This technique works well for growing a wide variety of leafy greens, including lettuce,



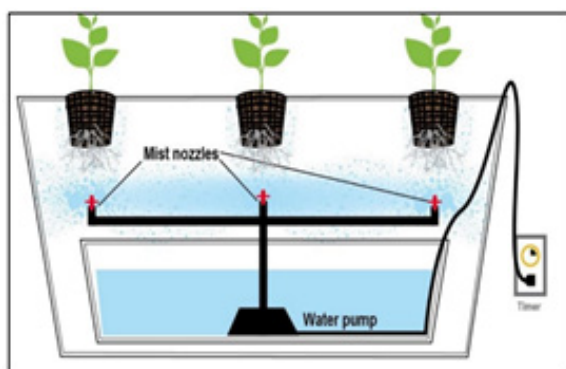
which is why the commercial lettuce sector uses it so extensively.

**Drip System:** They are most likely the kind of hydroponic system that is utilized the most extensively worldwide. A submerged pump is operated by a timer. A tiny drip tube

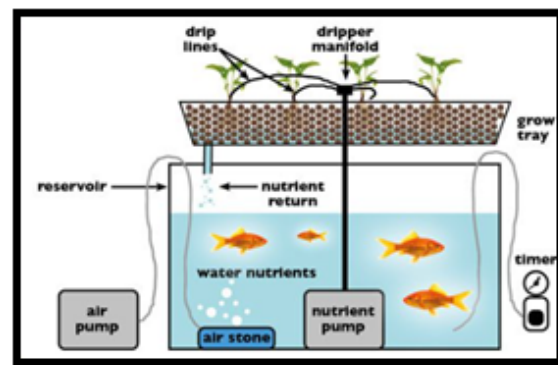


drops fertilizer solution onto each plant's base when the timer activates the pump.

**The Aeroponic System:** It is most likely the most advanced kind of hydroponic farming. Similar to other hydroponic system types, the aeroponic system requires a short cycle timer to run the pump for a few seconds every few minutes. This timer controls the nutrient pump. In this method root is not dipped in a nutrient solution, it is misted by the nutrient solution.



**Aquaponics:** Hydroponics, or growing plants in water without soil, and aquaculture, or raising fish, are combined in aquaponics, a recirculating system, to produce an effective closed-loop system. These two are combined in a symbiotic way in aquaponics, where plants are fed the waste or outflow of the aquatic animals. The veggies give back this cleaning power to the water that the fish drink. Microbes are crucial to the nutrition of the plants, along with the fish and their waste. These helpful bacteria congregate in the crevices between the plant roots and transform the sediments and fish waste into elements that the plants may utilize for growth. The outcome is a harmonious union of gardening and aquaculture.



# VERTICAL FARMING V/S TRADITIONAL FARMING:

1. Yields are roughly 20 times higher than field crops' typical output volume.
2. Just 8% of the typical water used to irrigate field crops is needed for vertical crops.
3. A high degree of food safety as a result of the enclosed growth method
4. Considerable savings on capital and operating costs compared to field agriculture.

## SCOPE AND POTENTIAL:

1. Less deforestation and land use. This means less erosion and less flooding.
2. Abandoned or unused properties will be used productively.
3. Crops will be protected from harsh weather conditions like floods, droughts, and snow.
4. Reduction in vehicular transport as the crops produced are easily consumed.
5. Less CO2 emission and pollution by decreasing reliance on coal-burning products.
6. Overall wellness as city wastes will be channelled directly into farm buildings.
7. Water is used more effectively.
8. No weeding or cultivation required.
9. Faster growth due to more available oxygen in the root area.
10. Elimination or reduction of soil-related insects, fungi, and bacteria.
11. Transplant shock is reduced.

## CONSTRAINTS:

Though it has promise, vertical farming has drawbacks. One obstacle may be the high initial expenses associated with establishing sophisticated infrastructure and keeping controlled settings. Lighting and climate control systems can consume large amounts of energy, and their operation requires specialized staff. Furthermore, there are still some areas that require research and improvement, such as reproducing natural sunlight for specific crops and making sure pollination techniques are up to date.

## CONCLUSION:

By effectively utilizing resources and space to grow crops indoors, frequently in urban environments, vertical farming offers a revolutionary technique in modern agriculture. Enhanced crop yields, less water use, lower transportation costs, and year-round production are some of its benefits. Vertical farming has the potential to address issues with food security and sustainability in agriculture in the future, despite obstacles including high initial investment and energy usage.