

Vertical Farming - An Overview

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Introduction

Vertical farming is a method of producing crops by growing them in stacked vertical layers within controlled environment. It is an advanced farming method used to produce food in managed environments such as buildings warehouses, and greenhouses. The core intention of vertical farming is to maximize plant growth while making efficient use of limited land resources. The modern concept of vertical farming was established by Dickson Despommier in 1999. He is widely regarded as “Father of vertical Farming” because he promoted the concept of cultivating crops in urban area to feed the rapidly increasing population. Vertical farming uses the innovative technological systems such as Hydroponics, Aquaponics and Aeroponics. These techniques manage nutrients, water, and light properly to ensure healthy and rapid plant growth. Because crops are grown indoors, natural factors such as pests, weather and soil constraints do not greatly affect production. This method decreases the dependence on traditional farming which uses extensive land and chemical inputs. It helps to attain sustainable agriculture by protecting the natural resources and lowering environmental impact. In modern times, vertical farming is becoming an important method to increase food production and supporting sustainable development.

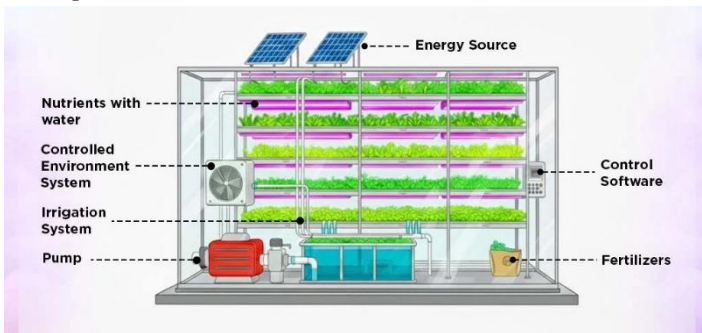


Fig 1: A vertical farming model [1]

Need for Vertical Farming

In recent years, vertical farming evolved as an transformative solution to deal with increasing demand for food by overcoming limitations of land and resources. Dependence on the weather condition is reduced, vertical farming to meet increasing demand in limited. Water efficiency is enhanced because drip irrigation systems are chiefly used in vertical farming. Crops are protected from extreme climatic conditions like floods, droughts and

snowfall. Pest and disease outbreak is reduced in this method of farming. Vertical farming lowers the transportation expenses and fewer the crop losses. In addition, vertical farming boosts the innovation and advancement in modern agriculture. Furthermore, it supports sustainable and eco-friendly farming practices.

Techniques of Vertical Farming

Hydroponics

Hydroponics is cutting edge approaches of agriculture that uses nutrient rich water solution for the crop production. The term Hydroponics is derived from Greek words “hydro” meaning water, and “ponos” meaning “growth”. As Hydroponics system rely on nutrient solution the roots of the plants are either immersed or secured by a liquid solution containing both micro and macronutrients. Macronutrients consist of nitrogen, potassium, phosphorous, calcium, magnesium and sulphur while Micronutrients consist of iron, manganese, zinc, copper, boron, chlorine and molybdenum. These nutrients are provided in precise concentration which enable faster growth and elevates the crop yield. It is an alternate to conventional farming system. Countries like Netherlands are leading in hydroponics adoption. Hydroponics reduces water requirement. It reduces soil related problems. And it is more beneficial in area with severe soil degradation.

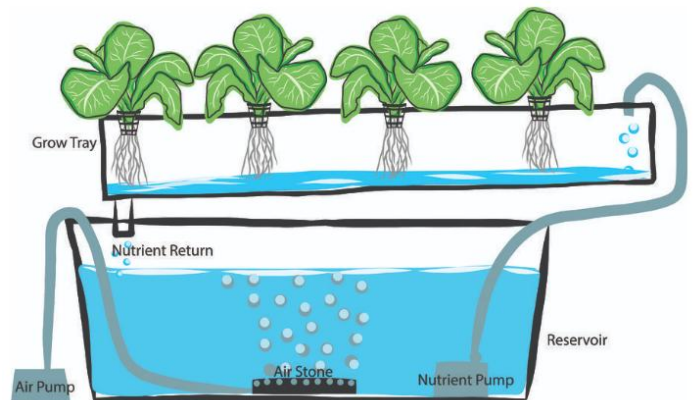


Fig 2: Growing soil free with hydroponics [2]

Aquaponics

Aquaponics is an improved form of hydroponics system that incorporates terrestrial plant cultivation with aquaculture in closed loop system, replicating natural ecosystems. In this system the fishes are reared in indoor environments, they excrete nutrient rich waste that serves as

a natural nutrient source for the plant nourishment. The nutrient rich wastewater from the fish tank undergoes filtration using solids removal unit and then transferred to biofilter, where toxic ammonia is biologically converted into nitrate, a safer and readily available for plant uptake. As vertical farming mainly focuses on fast growing crops the use of aquaponics is lesser than conventional hydroponics because aquaponics is incorporating both plant and aquaculture components.

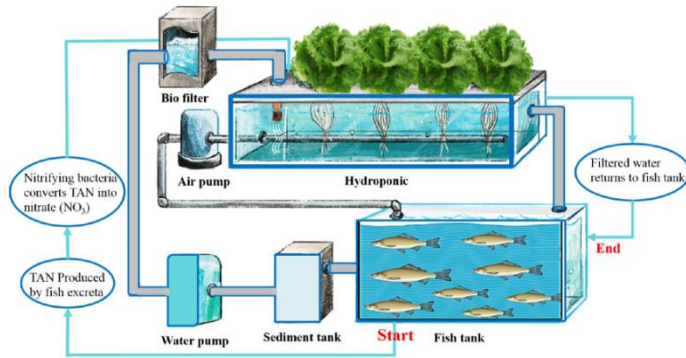


Fig 3:A model of aquaponics [3]

Aeroponics

The term aeroponics is derived from Greek word “aero” means air and “ponics” means growing. Aeroponics differs from hydroponics and aquaponics as it does not require any liquid or solid medium for plant growth. In this system a fine spray of nutrients is supplied into an air chamber where the plants roots are positioned. Aeroponics uses 90% less water than high performing hydroponics system. There will be rapid uptake of nutrients by the plants. Due to maximum availability of oxygen respiration and metabolic activity of the plants is enhanced. In present scenario aeroponics is not widely used because hydroponics still dominates vertical farming systems. Aeroponics is rapidly growing and seeking attention.

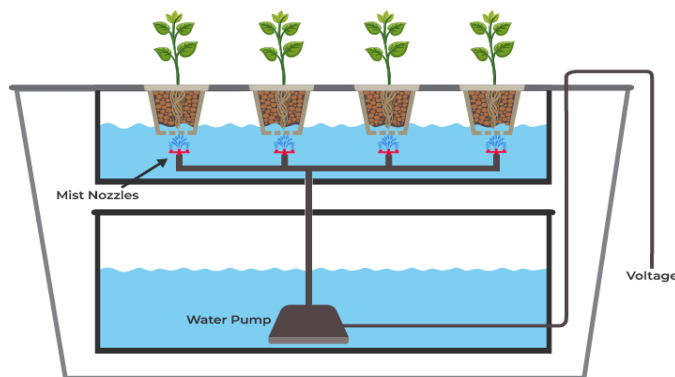


Fig 4: A model of aeroponics [4]

Challenges in vertical farming

1. Financial Challenges

One of the major problems of vertical farming is primarily due to high capital and operational costs. Installing

a vertical farm also involves high financial constraint in infrastructure building, crop cultivation units, growth media, nutrients delivery system, labour force, supplies, workforce, leasing property or purchasing urban land. Due to high initial investment and high maintenance cost will not be economically feasible for small scale farmers.

2. Technological Challenges

Vertical farming faces various technological issues specifically on automation, lighting, and sensors. Moreover, the system has highly difficult technologies like hydroponics, aeroponics and aquaponics as they require proper understanding thus making difficult for the traditional farmers adaptation. In addition, vertical farming needs highly skilled personnel with good knowledge in automation, system management etc., and insufficient expertise leads to lower efficiency.

3. Environmental Challenges

Though vertical farming is considered as environmentally sustainable, it encounters many environmental problems. Significant issue faced in vertical farming is high energy requirement. Vertical farming utilized 100 times more energy than conventional agricultural system, resulting in high global warming. Another point even though vertical farming system uses water and land optimally, the use of photovoltaic electricity for lighting making the land use by five to fourteen times higher than traditional farming. Excessive and improper use of nutrients in this system may lead to contamination of urban water quality systems.

4. Agronomic challenges

Agronomic challenges faced in vertical farming are mostly related to crop growth, pollination and crop variety. Due to limited natural pollinators in vertical farming the pollination is carried out manually making it tedious and labor- intensive process. Vertical farming is mainly suitable for leafy and herbs only whereas growing of cereals, fruits are not widely practiced.

Advantages in vertical farming

- It generates more yield per unit area gives nearly 80% higher output than conventional farming
- Crop production is done throughout the year because it is not dependent of weather conditions.
- Entirely it reduces the transportation cost and reducing the distance between the producer and consumer.
- Significantly it reduces the water use efficiency and promotes the use of sustainable water practices.
- As the crop is produced without using fertilizers, pesticides, herbicides and fungicides it is safer and chemical free food production.

- It delivers freshly harvested and ensured nutritional high quality food to the consumers.
- It enhances the greenery and air quality in urban areas by reducing heat and air pollution.

Disadvantages in vertical farming

- Initial cost for developing vertical farming is very high thus small farmers cannot afford it.
- It is not ideal for large crops it is only suitable for leafy vegetables.
- It requires expensive infrastructure.
- Technical issues or power failure can damage entire crops quickly.
- As there are no insects inside the vertical farming systems, crop pollination will be an issue.
- It requires skilled workforce but their availability is less.
- High energy cost as growing plant is entirely with artificial lights.

Conclusion

Vertical farming represents a revolutionary approach to modern agriculture by addressing the critical challenges of food security, land scarcity and environmental sustainability. Vertical farming making a promising approach to modern agriculture specifically in the face of urbanization, climate change and shrinkage arable land. As vertical farming uses advanced techniques such as hydroponics, aquaponics, aeroponics crop production is done throughout the year in a controlled environment with minimal dependence on natural condition. In addition, it reduces transportation costs and carbon emissions by bringing food production closer to urban consumers. It also brings the good quality produce with higher hygiene standard. If vertical farming

keeps on working on the advancements in technology, automation and proper management strategies, vertical farming has a strong capacity to become a more efficient in achieving sustainable development and resilient agricultural systems worldwide.

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