

SCOPE OF VERTICAL FARMING IN MODERN FIELD CROP

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Introduction

Vertical farming is the practice of growing crops in vertically stacked layers or integrated in other structures (such as in a skyscraper or old warehouse) with use of less water and no soil. Vertical farms are immune to weather and other natural elements that can abort food production. Crops can be grown under well-monitored conditions where environmental factors can be controlled such as artificial control of light, humidity and temperature that ensure optimal growth rates for each species of plant year- round (the vertical farm: feeding the world in 21st century). The vertical farm strategy aims to significantly increase productivity (Benke *et al.*, 2017). The artificial control of temperature, light, humidity, and gases makes producing foods and medicine indoor possible. Closed growing systems prevent the leaching of chemicals into the environment (Van Os, E.A. 1999). In 1915 Gilbert Ellis Bailey coined the term vertical farming and also wrote a book titled “Vertical Farming”. The modern concept of vertical farming was proposed by Dickson Despommier in the year 1999. He is also known as the father of vertical farming. In many ways, vertical farming is similar to greenhouses where metal reflectors and artificial lighting augment natural sunlight. Today farmers are facing various challenges. On a long term average, 220 million persons are exposed to drought annually with maximum vulnerability (Sankhalkar *et al.*, 2019). Nearly 20,000 people in developing countries die each year because of pesticide consumption through their food. Due to rapid urbanization and industrialization not only the cultivable

land is decreasing but also conventional agricultural practices causing a wide range of negative impacts on the environment. To sustainably feed the world's growing population, methods for growing sufficient food have to evolve. Modification in growth medium is an alternative for sustainable production and to conserve fast depleting land and available water resources. In the present scenario, soil less cultivation might be commenced successfully and considered as alternative option for growing healthy food plants, crops or vegetables (Benke and Tomkins 2017). Agriculture without soil includes hydro agriculture (Hydroponics), aqua agriculture (Aquaponics) and aerobic agriculture (Aeroponics) as well as substrate culture. Among these hydroponics techniques is gaining popularity because of its efficient management of resources and food production.

NEED FOR VERTICAL FARMING

1. Preparation for Future: By 2050, around 68% of the world population is expected to live in urban areas, and the growing population will lead to an increased demand for food under shrinking landholding system. The efficient use of vertical farming may perhaps play a significant role in growing food under urban area where mostly landless labourers reside.

2. Increased and Year-Round Crop Production: Vertical farming allows us to produce more crops from the same square footage of growing area. Additionally, year-round crop production is possible in a controlled indoor environment which is completely controlled by vertical farming technologies.

3. Less Use of Water In Cultivation: Vertical farming allows us to produce crops with 70% to 95% less water than required for normal cultivation.

4. Not Affected by Unfavorable Weather Conditions: Crops in a field can be adversely affected by natural calamities such as torrential rains, cyclones, flooding or severe drought events which are becoming increasingly common as a result of global warming. Indoor vertical farms are less likely to feel the brunt of the unfavorable weather, providing greater certainty of harvest output throughout the year.

5. Increased Production of Organic Crops: As crops are produced in a well-controlled indoor environment without the use of chemical pesticides, vertical farming allows us to grow pesticide-free and organic crops.

6. Human and Environmentally Friendly: Indoor vertical farming can significantly lessen the occupational hazards associated with traditional farming. Farmers are not exposed to hazards related to heavy farming equipment, diseases like malaria, poisonous chemicals and so on. As it does not disturb animals and trees inland areas, it is good for biodiversity as well.

TYPES OF VERTICAL FARMING

1) HYDROPONICS

It is growing of Plants in nutrient solutions that are free of soil. The plant roots are submerged in a nutrient solution which is frequently monitored and circulated to ensure that the correct chemical composition is maintained. Cultivation of plant without soil allows good control over environment, plant growth and development. (Van Os *et al.*, 2002). There has been massive growth in hydroponic cultivation in a number of forward thinking countries. Largest commercial hydroponics facility in the world is “Eurofresh” Farms in Wilcox, which has sold 125 million pounds of tomatoes in 2005. In 2008, about seven farmers in south Gujarat have adopted this technology. Mr. Kumar Patel of ‘Best Roses’. He currently produces 10 million rose stems worth about Rs 5 crore. The India Hydroponics Market is also showing increasing trend during the forecasting period (2020-2027).

2) AEROPONICS

Aeroponics is growing vegetation without soil, but the roots are suspended and sprayed with water and/or nutrient solution. The word aeroponic is derived from the Latin word ‘aero’ (air) and ‘ponic’ means labour (work). Nutrient solution sprayed or misted onto roots in growing chambers where roots are suspended in air. Excellent aeration is the main advantage of aeroponics. Plants in a true aquaponics apparatus have 100 % access to the CO₂ concentrations ranging from 450 ppm to 780 ppm for photosynthesis. High rate of crop growth and uses 70% less water than hydroponics.

3) AQUAPONICS

Aquaponics is a food production system that combines aquaculture with hydroponics. Aquaponic systems use 10% or less of the water used in conventional soil based horticulture systems. These systems can be established in urban or harsh rural environments where land is very limited or of very poor quality. This advantage applies also to hydroponics and recirculating aquaculture systems. This is the core rationale for aquaponics and a significant

advantage in those countries or locations where nutrient enrichment is a problem. The fish and plants in most aquaponic systems capture roughly 70% of the nutrients input in the form of fish feed and the residual solid waste is relatively easy to manage and may be applied to fruit trees or conventional horticultural crops (Singh *et al.*, 2020).

CROPS SUITABLE FOR VERTICAL FARMING IN INDIA

S.No	Categories	Crops
1	Some Small Size Vertical Crops	Lettuce, Broccoli, Amaranthus & Tuber crops
2	Some Medium Size Vertical Crops	Cabbage, Cauliflower Tomato & Brinjal
3	Some Big Size Vertical Crops	Maize & Sorghum

VERTICAL FARMING IN SOME VEGETABLE CROPS

1) Tomatoes

These are a favorite among gardeners of almost every stripe. Easy to cultivate, they do well in a wide range of plant hardiness zones. Training your tomato vines to grow up a support system of stakes, trellises, or cages minimizes the garden space you need, while at the same time it safeguards your plants against soil-borne disease.

2) Peas

Both the garden variety and snow peas, enjoy cool temperatures (70 degrees Fahrenheit at most). They do not need a great deal of water or fertilizer, but should be provided with a trellis or poles for climbing.

3) Cucumbers: One advantage of Growing Cucumbers Vertically is that you can avoid a common problem of fruit rot associated with cucumber cultivation. It happens when fruits sit in the moist soil for a prolonged period. When you allow cucumber vines to grow up vertically, it improves the air circulation around the plant that prevents fungal diseases. Cucumber plants have a sprawling habit, and growing cucumbers vertically allow their leaves to absorb more sun, which results in healthy plant and large cucumbers. One more key benefit is that you can harvest the fruits more easily and on time.

4) Greens like lettuce, kale, and basil

These also have a place in your vertical garden. Leafy herbs and salad greens prefer at least partial shade, so you can tuck them under large sun-loving plants. Or grow them in a shady

corner using vertical planters created from pallets, stacked or hanging pots, shelves, or garden pockets.

VERTICAL FARMING IN MODERN FIELD CROP PRODUCTION

1) Rice

For many centuries, rice has been one of the most eaten and known foods worldwide. This happens due to its high nutritional value and relatively low cost that allowed it to be eaten by both the rich and poor. But with the advancing drought and water scarcity worldwide, growers are wondering that can they grow rice using vertical farming techniques. Rice can be grown hydroponically. Rice is known for being one of the high water-consuming crops, if not the highest. This high consumption will lead to a massive problem because of the continuous decrease in the clean water supply that happens as a result of global warming and the contamination of already existing water sources. The main reason that will put growers down is its poor economics of rice cultivation, which will lead most growers to lose a considerable amount of money trying to produce just a fraction of the original yield grown in soil. Right now rice is not an economical crop for vertical farming but droughts and shortage of water supply will lead to increasing world hunger and with the integration of vertical farming and hydroponics, rice could be an economic crop due to its increased yield and the advancement of hydroponic technology.

2) WHEAT

The hydroponics cultivation is no doubt a costly and labour intensive venture but it can be used for uniform germination of wheat seedlings where they can be further transplanted in fields to realize maximum benefits. This can be crucial for crossing blocks and for seed multiplication. Singh *et al.*, (2020) has also in his study which was based upon growing of wheat in hydroponic system (Hoagland solution) and in tap water system revealed that hydroponic planting system has a better effect than tap water system as it made plants heights grow faster.

3) POTATOES

Crops propagated vegetatively, especially potatoes, are very sensitive to both bacterial and viral diseases. Traditional seed potato production contributes to the accumulation of disease, which greatly decreases crop yields. During the growing season, if the mother plant is

infected with a disease, each new tuber may also be infected. The aeroponic system is therefore the best system for producing potatoes. Using this approach, plant roots can be quickly nourished under controlled conditions. This can produce up to 10 times the yield of conventional production systems (Otazú, 2010). Aeroponics techniques are credited for making potato production more efficient .

3) HYDROPONIC FODDER

Method of hydroponic fodder production date back to the 1930s. Fodder can be grown hydroponically much same as vegetables, flowers and other plants. Hydroponic fodder systems are generally used to sprout cereal grains. Green fodder plays major role in feed of milch animals. Non availability of irrigated land for fodder production, high labour cost and small land holdings has left dairy farmers with many challenges for milk production. Hydroponic fodder system involves supplying cereal grains with necessary moisture and nutrients to enable germination and plant growth in the absence of a solid growing medium. There are a range of chemical and structural changes that take place within the cereal grains through the hydroponic growing process. The amount of sprouts produced (yield) and quality of the fodder is influenced by a number of factors including grain, environment, Management of system etc.

WEAKNESS OF VERTICAL FARMING

Crops require space, light, carbon dioxide and water, which is available freely in nature. In case of Vertical farming all these need to be supplied at a cost. Structure need to be built, generating additional costs.

- 1. It Can Lead to Potential Job Loss:** As a new agricultural industry, vertical farming could replace a lot of traditional farming jobs. Food demands will be met by urban vertical farming, and the demand for traditional farmers could go down. This can result in a loss of jobs.
- 2. Less Pollination:** As you probably know at this point, Vertical farming is performed in a controlled, indoor environment. While this comes with many advantages, it also hinders the entry or advent of insects. That means the process of pollination is almost entirely hindered.
- 3. Technology Dependent:** Vertical farming does not just use one specific technology. Instead, it is dependent on a range of technologies for lighting, regulating temperature, managing humidity, and more. Even a single issue with either of these technologies can hinder the process of vertical farming.

CONCLUSION

Vertical farming technology allows for growing where no one has grown before, be it underground, or above, in space or under the oceans this technology will allow humanity to live where humanity chooses. If used for our own survival, vertical farming is and will be a major part of our collective future. In recent years Vertical farming is seen as a promising strategy for growing different crops. As it is possible to grow crops like fodder maize, potato and some other short duration crops like vegetables round the year in very limited spaces with low labour, so vertical farming can play a great contribution in areas with limitation of soil and water and for the poorer and landless people. In India, the vertical farm industry is expected to grow exponentially in near future. To encourage commercial vertical farm, it is important to develop low cost vertical farming technologies such as low - cost hydroponic technologies that reduce dependence on human labour and lower overall startup and operational costs.

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