

## **5. VERTICAL FARMING AN ALTERNATE TO TRADITIONAL FARMING**

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### **ABSTRACT**

*Pressure on agricultural land from a rising global population is necessitating the maximization of food production per unit area of cultivation. Attention is increasingly turning to Vertical Farming (VF) approaches in an attempt to provide a greater crop yield per square meter of land. However, this term has been used to cover a broad range of approaches, from personal- or community-scale vegetable and herb growing to vast skyscrapers for commercial production of a wide range of crops. This article summarizes the main categories of VF in order to help clarify this emerging but sometimes confusing area of agriculture and discusses how scientific investigation of the potential of VF is currently lacking and will be required to help determine its feasibility as a method to assist meaningfully in global food production.*

**KEY WORDS:** *Vertical farming, hydroponics, aeroponics, aquaponics*

### **I. INTRODUCTION**

The World Population is increasing at a steady pace, and many resources are needed for the survival of the living. The relation of population and food grains is of prime importance, an increasing number of people often drive up the demand of the food grains. To develop more resources is necessary, while prime agricultural lands are getting to be scarce and costly. Agriculture researchers are coming up with new

ideas to generate food production and one such researcher professor Dickson Despommier in 1999 came up with a concept of vertical farming; this farming utilizes less distance for growing more food. Unlike traditional farming, he also came up with new farming techniques such as Hydroponics and Aeroponics which has high production of food at less space and more yields.

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

Vertical Farming in easy words is farms piled (Stacked) together with one another, unlike traditional flat farming. We could even specify vertical farming since the custom of creating food and medication from vertically stacked layers, previously vertically inclined surfaces or incorporated into various structures. Some farmers are starting to employ vertical farming by utilizing abandoned warehouses, land which is infertile and fertile for farming to make vegetables, fruits with high returns. In vertical farming, it entails growing plants in piled layers reaching a number of stories packed with controlled environments like temperature, light, and nutrition inside. This idea of farming is largely used in small residential houses in Indian urban areas, while to make commercially it needs to be seriously regarded as this new brand farming technology is growing quickly in developed nations.

### **NEED TO GO FOR VERTICAL FARMING**

The population of the world is increasing at a very fast pace particularly in the urban areas. In accordance with the UN

population branch, the entire world population is expected to increase by 2 billion persons, i.e. from 7.7 billion to 9.9 billion in the next 30 years. While the population in the urban regions is increasing at an alarming rate and will reach 70% by 2050. 80 million people are added to the planet's population per annum. Agriculture creates is going down because climate changes along with foodborne diseases are increasing and are becoming scarce in many areas. Compounds are failing due to plant pathogens and insect pests. To feed countless mouths we need to generate enough food with the restricted land, water and nutrient sources and this is accomplished through vertical farming technology.

Vertical farming technologies use natural renewable resources to cultivate crops. For instance, much of these crops are grown under artificial sunlight. Various water systems and management are used to pump water through pipelines.

### **TYPES OF VERTICAL FARMING**

Hydroponics, Aquaponics, Aeroponic

## II. LITERATURE REVIEW

Literature reviews to examine the current agricultural practices were exhausting our natural resources, and whether it was sensible to explore other farming options.

Knowing the history and overview of urban agriculture. The history of urban agriculture was provided because it offered a sense of the history and development of the concept, its applications in the past and today, and the advantages and disadvantages associated

- **Purpose of vertical farming in India**

Their goal is to create a hydroponics model cultivating farm fresh unaffected by weather or soil / conditions. They will be grown in a protected, green house environment. Only an expert gardener knows how difficult it can be grow plants and how much extra care it takes with special attention to soil, fertilizer and light. One can't get the process right and expect good yields without getting

his/her hands dirty. But to make their work a lot easy and convenient, many startups in India are working on hydroponics farming. Hydroponics or growinral nutrient solutions in water solvent. Additionally, this indoor farming technique induces plant growth, making the process 50% faster than growth in soil and the method is cost affective. Mineral nutrient solutions are used to feed plants in water. G plants in water or sand, rather than soil, is done using mine

- **World scenario of vertical farming**

In 2013 the association for vertical farming was founded in Munich, Germany. As of 2014, vertical fresh farm was operating in buffalo, New York, specializing in salad greens, herbs and sprouts. In March the world's then largest vertical farm opened in Scranton, Pennsylvania, built by green spirit farms. Old, abandoned urban factories make for nice vertical farms. But they might be best suited for environments like the United Arab Emirates, where arable land is limited but sunshine, which can be used for clean energy, is nearly limitless.

- **Position of vertical farming in India**

Vertical farming is limited in India at present to high value crops only. Cultivation under playhouse and net house is done mostly in case of export oriented flowers and some vegetables. Vertical farming is also in vogue for production of disease free nursery in case of banana, sugarcane, citrus fruits and many flowering plants. Most common and successful vertical farming ex; mushroom cultivation. Temperature and humidity controlled condition are economically possible to be created at limited space. The scope of vertical farming is how ever increasing fast in India. The scheme has been reflected as one of the high priority area. Good technical and financial support is now available for establishing vertical farming units and protective agriculture

- **Vertical Farming VS Traditional Framing**

- Yields are approximately 20 times higher than the normal production volume of field crops.

- Vertical crops require only 8% of the normal water consumption used to irrigate field crops.
- High level of food safety due to the enclosed growing process.
- Significant operating and capital cost saving over field agriculture.

Crops	Yield in VF due to tech.(tons/ha)	Field Yield (tons/ha)	Factor increase due to Tech	Factor increase due to Tech and Stacking
Carrots	58	30	1.9	347
Radish	23	15	1.5	829
Potatoes	150	28	5.4	552
Tomatoes	155	45	3.4	548
Pepper	133	30	4.4	704
Strawberry	69	30	2.3	368
Peas	9	6	1.5	283
Cabbage	67	50	1.3	215
Lettuce	37	25	1.5	709
Spinach	22	12	1.8	820
Total (average)	71	28	2.5	516

### **Estimated Yield of a Vertical Farm compared to traditional agriculture**

#### **III. Types of Vertical Farming:**

##### **I. Hydroponics – Growing Plants without Soil**

Hydroponics is a predominant system of growth that is used in vertical

farming, and it is slowly but steadily, gaining importance. It involves the growth of plants in solutions of nutrients that are essentially free of soil. In this vertical farming innovation, the roots of the plants are submerged in a solution of nutrients. This is frequently circulated and monitored in order to ensure that there is the maintenance of the correct chemical composition in the nutrient solution

## 2) **Aeroponics – Growing Plants without Soil and Very Little Water**

This technique was then coined [Aeroponics](#) and was defined as "growing plants in an air/mist environment with no soil and very little water." However, these systems are yet to rise from an anomaly in the world of vertical farming even though they continue to create interest. It is undoubtedly the most efficient way in vertical farming as it uses a staggering 90% less amount of water than the most efficient hydroponics systems too. It has also been observed that the plants that are grown with the aeroponics system

uptake more vitamins and minerals, thus making the plants potentially healthier and more nutritious.

## 2. **Aquaponics – An Ecosystem that Promotes Plants and Fish Farming Together**

An Aquaponics System is much like the Hydroponics System but is only better. It aims to combine the fish and plants in the same ecosystem. In this system, fish grow in indoor ponds and produce a nutrient-rich waste that further acts as a food source for the plants grown in vertical farms. The plants, doing their part, purify and filter the wastewater that gets recycled directly to the fish ponds. Aquaponics is definitely used at a smaller scale than most vertical farming innovations. However, it is still used by many commercial vertical farms that wish to produce just a few fast-growing crops instead of including the component of aquaponics. As a result, the production and economics issues are simplified and it also maximizes efficiency

## IV. **RESEARCH METHODS:**

### **Data collection**

This is descriptive study based on secondary data. Various research journals, books, websites & various reports related to vertical farming were studied to draw the conclusions.

**Secondary data:** Secondary data was collected by different websites.

## V. Data analysis:

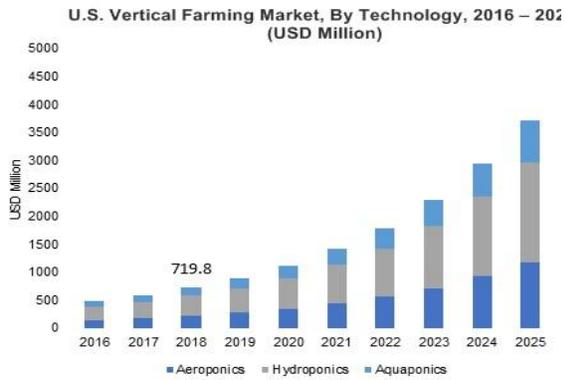
### SWOT Analysis for Hydroponic Farming in India

#### SWOT Analysis

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> <li>• Food companies as well as venture and growth equity firms are investing in vertical farming.</li> <li>• Farms such as AeroFarm, Ecopia Farms, Nuvege, Plant Lab etc. are economically viable, on an unsubsidized basis (Cho, 2011).</li> <li>• Uses old buildings by creating suitable warehouses equipped with the right infrastructure for vertical farming, negating the need to destroy old buildings (Despommier, 2017).</li> <li>• As crops are grown closer to the market, reduction in transportation cost of produce from rural farmlands to cities is evident (Lawson, 2015).</li> </ul>	<ul style="list-style-type: none"> <li>• Highly capital intensive to set up a vertical farm.</li> <li>• Energy cost, labour cost and maintenance cost are very high.</li> <li>• Space constraint limits what can be grown (Brennan and Galnick, 2015).</li> <li>• Difficult and high cost is involved to grow several varieties of crops in the same vertical farming facility.</li> <li>• Approach best works only for salad greens and herbs which have higher margins and can be grown in large quantities. Staple crops such as wheat, soybean, corn etc are not cost-effective options.</li> <li>• Due to lack of soil, the produce does not get an organic label even though it costs as much (Brennan and Galnick, 2015).</li> <li>• Scalability is the biggest challenge, needs to produce enough crops to sell at a profit at large grocery chains (Lawson, 2015).</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Vertical farm market is expected to grow at a CAGR of 24.8% from 2016 and reach USD 5.8 billion by 2022 (Markets and markets, 2017).</li> <li>• Vertical farms can be used to produce biologically active molecules for novel medical applications.</li> <li>• Demand for skilled workers in vertical farms will create future opportunities for education and training in this industry (Cho, 2011).</li> </ul>	<ul style="list-style-type: none"> <li>• The policy leaders do not have a clear knowledge of what a vertical farm actually is (Hepler, 2016).</li> <li>• Being a completely new industry there is a lot of uncertainty about the return on investment (ROI).</li> <li>• Proper management and investment in technology are highly crucial. Several start ups have struggled or failed in the past decade for these reasons (Lawson, 2015).</li> </ul>

**Table 1:** SWOT analysis from business perspective

**Vertical Farming Market** size surpassed USD 3 billion in 2018 and will exhibit a massive CAGR of over 27% from 2019 to 2026



## VI. OBJECTIVES OF VERTICAL FARMING

- Vertical Farming can help India in its food security especially in vegetables.
- Food Fortifications can help India in fighting the problem of Malnutrition.
- Since through Vertical Farming crops can be grown throughout the year so the seasonal variation of supply and inflation can be controlled.
- This can be done in urban households so every house can grow vegetables for its consumption.

- It also helps in oxygen emission and carbon dioxide absorption.
- Vertical Farming can also help to feed the space crew. The green environment has a good psychological impact on crew members.

## VII. ADVANTAGES OF VERTICAL FARMING

- It offers a plan to handle future food demands
- It allows crops to grow year-round
- It uses significantly less water
- Weather doesn't affect the crops
- More organic crops can be grown
- There is less exposure to chemicals and disease

## VIII. DISADVANTAGES OF VERTICAL FARMING

- It could be very costly to build and economic feasibility studies haven't yet been completed
- Pollination would be very difficult and costly
- It would involve higher labor costs

- It relies too much on technology and one day of power loss would be devastating

#### **IX. LIMITATIONS OF VERTICAL FARMING**

- No Established Economics
- Difficulties with Pollination
- Too Much Dependence on Technology

#### **X. FUTURE SCOPE**

- An endless source of food in smaller places
- Conservation at its best
- Bad weather will be a thing of the past
- More organic stuff coming our way
- Less occupational hazards

#### **XI. CONCLUSION AND RECOMMENDATION**

- To spread awareness among people about vertical farming and its advantages.
- Every farmer should know about Vertical Farming.
- The government should make a subsection of Vertical Farming into the agriculture department,

and provide the required information.

- To arrange seminars about Vertical Farming for students of Agriculture Study.
- The basic advantages of vertical farming is that it uses very minimal water. Since the water is used in a controlled manner, water losses is very minimal
- Vertical farming can reduce transportation cost as it will be cheaper for transportation since you can build vertical farm in cities, so you don't need to import the crops from other region.

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