

Vertical Farming : Optimizing Agriculture Landscape in Chhattisgarh

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Abstract - "Vertical Farming: Architectural Innovation for Agricultural Landscape Optimization" explores the revolutionary potential of vertical farming as a sustainable agricultural approach by fusing cutting-edge technologies with creative architectural solutions. This study looks into the advantages of vertical farming, as well as the problems it attempts to solve and its guiding ideas. The study investigates the viability and benefits of vertical farming in Chhattisgarh, considering the climate, socioeconomic circumstances, and agricultural terrain of the area. The study's support for vertical farming and its execution through governmental support are intended to improve Chhattisgarh's agricultural sustainability. Innovative architecture and state-of-the-art technology come together in vertical farming, which presents a viable way to maximize agricultural output while reducing environmental effect. The goal of this study is to raise knowledge and comprehension of the possibilities of vertical farming in Chhattisgarh, with a focus on how it might contribute to the development of a resilient and sustainable agricultural system going forward.

Key Words: *hydroponics, LED light, sustainable, agriculture.*

1.Introduction

Vertical Farming - Vertical farming is exactly what it sounds like: farming rather than traditional, horizontal agriculture.

Vertical farming is a modern way of growing crops indoors, stacking them on shelves or layers. It's like building a garden inside a tall building. With special lights and water systems, plants grow without soil, using less water and space. This type of farming can happen in cities, making fresh produce available nearby all year round. It helps reduce pollution from transporting food and uses fewer chemicals, making it better for the environment. Overall, vertical farming is a smart solution for growing food sustainably, even in crowded urban areas.

2. Methodology

The secondary data used in this study on vertical farming was gathered from a few sources, including relevant publications, research papers, reports, and government of India documents. Furthermore, information was obtained from the websites of Technology Mission for Integrated Development of Horticulture and more.

3. Background

3.1 Agricultural in Chhattisgarh

3.2 Challenges faced in traditional agriculture in Chhattisgarh.

Traditional agriculture in Chhattisgarh is facing many difficulties because of the state's limited land supply brought about by urbanization, soil degradation, water scarcity, and climate change-related unpredictable weather. Small markets and fluctuating pricing make it difficult to reach the market, which is further worse by a labour shortage. Resources are further strained by environmental issues including pollution and deforestation. Controlling illnesses and vermin gets harder and harder. In this situation, traditional agriculture finds it difficult to satisfy the needs of an expanding population and shifting environmental parameters.

4. Need of vertical farming in Chhattisgarh

Vertical farming is crucial in Chhattisgarh because of the state's small land area, paucity of water, unpredictable climate, need for food security, need for economic diversification, environmental concerns, urbanization, and resilience to pandemics. In addition to maximizing space and conserving water, Vertical Farming also ensures stable output, boosts food security, generates jobs, reduces environmental effect, serves urban areas, and strengthens the resilience of the food supply in times of crisis. (Deo), n.d.)

5. How it is sustainable ?

Increased Land Use: Vertical farming increases food production in a tiny footprint in densely populated cities where land is expensive and scarce. **Reduced Food Miles:** Since vertical farms can be set close to cities, food doesn't have to travel as far from the farm to the plate. This reduces the energy use and emissions from transportation associated with long-distance food supply networks. **Conservation of Natural Resources:** When compared to conventional agricultural practices, Vertical Farming consumes a lot less water. When compared to soil-based agriculture, hydroponic or aeroponic systems may save up to 90% of the water used since they cycle water. Additionally, Vertical Farming promotes ecologically sustainable agricultural methods by doing away with the need for chemical pesticides and herbicides.

6 How vertical farming can bring change in agriculture ?

Creating Economic Opportunities: Encourages economic diversification and produces jobs.

Fostering Technological Innovation: Promotes the study and creation of environmentally friendly agricultural techniques.

Overcoming the Challenges of Urbanization: Vertical Farming can be used to supply fresh food in cities.

Enhancing Resource Efficiency: Makes the best use of nutrients, energy, and water.

Vertical Farming's controlled conditions serve as a mitigating factor against climate-related concerns.

3.	Organic waste management	- Reduced landfill waste	- Quality improvement in food and consumer health	- Converting waste to asset
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4.	Job creation	- Reduced ecological footprints	- Building local workforce and social networks	- Financial benefits for locals
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4. Related theory

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5.	Reduced pesticide use	- Ecological well-being improvement	Improved food quality and consumer health	- Cost savings
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4.1 Advantages of vertical farming.

Vertical farming offers a multitude of advantages that make it a compelling solution to various challenges faced by traditional agriculture. Through maximizing land use, conserving natural resources, and providing year-round production, vertical farming addresses key concerns such as food security, environmental sustainability, and economic viability.

6.	Enhanced productivity	- Requires less space	- More time for meaningful activities	- Higher yields
7.	Resilience to natural disasters	- Reduce ecological harm and clean-up efforts	Improved food security	- Eliminating economic losses

Table 1: Advantages of vertical farming

S. No.	Benefits	Environmental	Social	Economical
1.	Decreased travel distances	- Lowering pollution levels in the air	Improved air quality and human health	- Lowered energy, packaging, and fuel costs for transport

2.	High-tech irrigation and wastewater reuse	- Reduced surface runoff to traditional farms	- Water security	- Cost reduction
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8.	Year-round produce management	- Produce as per seasonal requirements	- Meet seasonal demands	- Continuous economic activity throughout the year
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4.2 Working principal of vertical farming.

Technology and Infrastructure: This refers to the tools and setups needed for vertical farming, like LED lighting, climate control systems, hydroponic or aeroponic systems, and vertical towers.

Growth Media and Delivery of Nutrients: Soilless growth methods such as hydroponics and aeroponics, in which plants get their nutrients from water solutions, are commonly used in vertical farming. It is essential to

comprehend how these systems function and how nutrients are supplied to plants.

Energy Use and Lighting: Vertical farming relies heavily on artificial lights to simulate sunshine. It's critical to comprehend the many kinds of lighting that are employed, how energy-efficient they are, and how they affect plant growth.

Crop Selection and Physiology of Plants: The needs of crops differ with respect to space, light, and nutrients. A thorough understanding of plant physiology and the selection of appropriate crops for vertical farming are prerequisites for successful production.

4.3 Modern technique as per the climate of Chhattisgarh

Hydroponics - Advantage: precise control over nutrients and water, making it ideal for areas with poor soil or limited water supplies.

Suitable for Chhattisgarh: It is ideally suited for regions with low soil quality and the varied topography of Chhattisgarh.

Aeroponics - Advantage: Optimizes oxygenation and nutrient absorption, uses water and nutrients very efficiently.

Suitable for Chhattisgarh: Water-constrained areas might benefit from its reduced water consumption, which is adaptable to changing environmental circumstances.

Vertical stack system - Advantage: Grows vertically to maximize space efficiency and is appropriate for areas with limited land availability.

Suitable for Chhattisgarh: ideal for locations with limited space or metropolitan settings where land may be scarce.

LED lighting - Advantage: LED lighting includes precise control over light intensity and duration, energy efficiency, and customizable light spectrums.

Suitable for Chhattisgarh: Vital in regions with erratic or inadequate solar radiation, permitting.

Plants	Recommended growing conditions	Expected Yield (per square meter)	Market Demand
Leafy greens	Temperature:18-24°C; Humidity: 60-70%	4-6 kg	High
Tomato	Temperature:20-30°C; Humidity: 50-70%	8-12 kg	High
Cucumber	Temperature:20-30°C; Humidity: 70-80%	6-10 kg	Moderate
Bell pepper	Temperature:20-30°C; Humidity: 50-70%	4-8 kg	Moderate
Strawberries	Temperature:15-25°C; Humidity: 60-80%	1-2 kg	High
Herbs (basil, mints etc)	Temperature:18-24°C; Humidity: 50-70%	0.5-1 kg	High

Table 2 : Plants as per Requirement

4.4 Plants suitable as per the weather conditions and demand

By concentrating on these crops and employing suitable vertical farming methods, farmers in Chhattisgarh can maximize yields, curtail resource consumption, and satisfy the local market's need for fresh, locally produced produce. Yield guidelines also guarantee consistent production and quality, which supports the long-term viability and financial success of vertical farming operations in the area.

5. Policy implication in vertical farming in Chhattisgarh

These programs are essential for increasing agricultural yield, encouraging sustainability, and stimulating the horticultural industry's economy.

Table 3 : Policies and Guidelines

Aspect	NHM	TM-IHD
Objectives	Sustainability, quality, productivity	Productivity, earnings, tech adoption, infrastructure, capacity building
Emphasis Areas	Across-crop productivity and quality	Infrastructure, capacity building, tech adoption
Finance	Government support, scheme contributions	Government support, scheme contributions
Promoting Dev.	Financial support, direction, capacity building	Infrastructure, capacity building, tech adoption
Technology Acceptance	Encourages best practices, current technology	Strong focus on technology adoption
Infrastructure	Supports post-harvest, irrigation, logistics	Prioritizes infrastructure development
Building Capacity	Funds skill development, capacity building	Places a focus on capacity building

While TM-IHD places more emphasis on infrastructure development, technology adoption, and capacity building to increase productivity and profitability, NHM places more emphasis on sustainability, quality, and productivity with an emphasis on across-crop productivity and quality. To encourage comprehensive agricultural growth, both projects rely on government assistance and contributions to the schemes.

6. Case study

6.1 Sky green : Singapore

Singapore-based Sky Greens uses cutting edge technology in its vertical farming operations. Their A-Go-Gro system makes use of revolving towers to maximize sunshine

exposure and make efficient use of available space. The towers' rotation guarantees that every plant receives enough sunshine, which fosters wholesome growth.

Sky Greens prioritizes lush vegetables like kale, spinach, and lettuce when choosing crops. These crops grow quickly and are in high demand, making them ideal for vertical farming. Furthermore, year-round production is made possible by Sky Greens' vertical farming techniques, guaranteeing a steady supply of fresh produce for the market.



Source - A Sky Green farm tower. Photo: Kalinga Seneviratne/IPS.

The versatility of the A-Go-Gro system is one of its main advantages. It is adaptable to many climates and situations, making it appropriate for a wide range of locations. Because of its flexibility (Dongxian He, 2019), Sky Greens can optimize agricultural productivity while reducing land usage, which is important in cities with limited space.

Moreover, Sky Greens emphasizes sustainability heavily. Compared to conventional farming methods, they use less water and pesticides when using vertical farming techniques. Furthermore, by using an inventive farming (Seneviratne, 2012) preserve natural resources.



Source - A Sky Green farm tower. Photo: Kalinga Seneviratne/IPS.

6.2 Aero farms : United states

Aero Farms, a leading indoor vertical farming company in the United States, employs state-of-the-art aeroponic technologies and LED lighting in their facilities, ensuring precise control over growing conditions. Aero Farms maximizes the use of water and nutrients by using aeroponics, which entails growing plants in a mist atmosphere without soil. This results in excellent agricultural yields in their controlled indoor environment.

To optimize yields and quality, Aero Farms carefully chooses crops that are suited for their facilities, with a concentration on leafy greens, herbs, and microgreens. Continuous cultivation is made possible by the controlled indoor environment, which is not influenced by the weather or the season outside.

Aero Farms' technology's scalability is one of its main advantages. Their climate- and urban-adaptable indoor vertical farming systems flexibility in satisfying local demand for fresh vegetables. (Aero farms, 2020)



Source – Aero farm.

Aero Farms places a high priority on water conservation and energy savings in terms of sustainability. Aeroponics minimizes water usage by circulating water throughout the system. Furthermore, their establishments make use of LED lighting that is energy-efficient, which lowers energy usage in comparison to conventional farming techniques. Aero Farms places a strong emphasis on sustainability to reduce their environmental effect.



Analysis of case studies

Both make use of flexible technology that fits the terrain of Chhattisgarh. They concentrate on in-demand crops that are perfect for local markets, such as leafy greens. They provide sustainability and scalability with their modular systems. These methods fit Chhattisgarh's requirements for both economic expansion and resource-efficient farming.

7. Conclusion

In summary, our research has shed light on the possibilities of vertical farming and how it may be implemented in Chhattisgarh. By looking at several factors, such as infrastructure, technology, crop choice, and sustainability, we have outlined the advantages of vertical farming in terms of improving agricultural methods. Significant benefits of vertical farming include year-round crop production, optimized land usage, and less environmental impact from reduced pesticide and water consumption. The case studies of Green Spirit Farms and Sky Greens have shown how adaptable and sustainable vertical farming methods are, and how well they work in Chhattisgarh's agricultural environment. Additionally, the significance of coordinating vertical farming projects current agricultural programs has been underscored by our examination of efforts such as the National Horticulture Mission (NHM) and the Technology Mission for Integrated Development of Horticulture (TM-IHD). These programs offer financial support, encouragement to adopt new technology, and infrastructure development—all essential for Chhattisgarh's vertical farming projects to succeed.

8. Recommendation

Invest in Research & Development to adapt vertical farming techniques to Chhattisgarh's climate and agricultural conditions.

Provide workshops and training courses to enlighten farmers on best practices and techniques for vertical farming.

Encourage the use of suitable technology for vertical farming, such as aeroponics and hydroponics.

Establish regulations and laws that will encourage vertical farming and advance sustainable methods.

References

- (2019). Retrieved from <http://www.fao.org/3/CA2176EN/ca2176en.pdf>
- (2023). Retrieved from <https://agriportal.cg.nic.in/horticulture/HortiEn/Default.aspx>
- (2024, may). Retrieved from <https://agriwelfare.gov.in/>
- Aero farms*. (2020). Retrieved from <https://www.aerofarms.com/>
- Catani, L. e. (2021). Evaluation of Different Types of Vertical Farming Systems under the Same Environmental Conditions.
- Deo, (. S. (n.d.). Retrieved from https://spc.cg.gov.in/sites/default/files/SPC%20BOOK%20DIF-compressed_11zon.pdf
- Dongxian He, T. K. (2019). Retrieved from https://www.researchgate.net/publication/330240746_Light-Emitting_Diodes_for_Horticulture_Materials_Processes_Devices_and_Applications
- Mielcarek, A. (2023). Water Nutrient Management in Soilless Plant Cultivation versus Sustainability.
- Mohd Salim Mir, N. B. (2022). Retrieved from https://www.researchgate.net/publication/358749034_Vertical_farming_The_future_of_agriculture_A_review
- Purabi Barui, P. G. (2022). Retrieved from https://www.researchgate.net/publication/364823355_VERTICAL_FARMING_AN_OVERVIEW
- Seneviratne, K. (2012). Retrieved from <https://ourworld.unu.edu/en/farming-in-the-sky-in-singapore>
- Tolga, T. N. (2022, januray). Retrieved from https://www.researchgate.net/publication/356091078_Vertical_Farming_Under_Climate_Change_Effect
- Türker, H. B. (n.d.). 2022. Retrieved from [https://www.researchgate.net/publication/357688782_The_role_of_urban_agriculture_in_adapting_to_climate_change_for_sustainable_cities#:~:text=Urban%20agriculture%20provides%20many%20functions,\(UHI\)%20effect%2C%20etc.](https://www.researchgate.net/publication/357688782_The_role_of_urban_agriculture_in_adapting_to_climate_change_for_sustainable_cities#:~:text=Urban%20agriculture%20provides%20many%20functions,(UHI)%20effect%2C%20etc.)
- Wormald, J. (2023). Retrieved from <https://www.archdaily.com/1007303/how-to-use-vertical-farming-for-sustainable-living>
- Yee, H. &. (2018). Vertical Farming: A Review on Plant Factory.