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Vertical Farming: Farms for the Upcoming Generations

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Vertical farming, a technique that cultivates crops in vertically stacked layers, offers a promising approach to food production in a world facing land shortages and resource limitations. This method enables year-round farming in a controlled environment, reducing dependence on weather and reducing water use. Additionally, vertical farms can be located in urban areas, promoting local food production, reducing transportation requirements and potentially creating new employment opportunities. While challenges such as initial costs and limited crop selection remain, vertical farming holds significant potential for the future of agriculture, especially in urban settings.

Introduction

Our planet faces a looming crisis: a shrinking pool of arable land. Only a quarter of Earth's surface is land, with the rest being vast oceans. Even within this limited area, much of it is unusable for agriculture due to factors like mountains and deserts. Human activity has further strained this precious resource. A significant portion (nearly 57%) of productive land is now dedicated to food production, often at the expense of natural ecosystems. Rapid urbanization adds another layer of complexity. Cities sprawl outward, consuming fertile land and leaving less space for traditional farming. In many regions, cultivable land is nearing depletion, with expansion becoming increasingly difficult. This trend is particularly concerning in areas like India, where cultivable land has remained stagnant for years. Soaring land prices reflect this scarcity, making it challenging to expand traditional agriculture. Transporting perishable food items from rural areas to urban centres further strains resources. Vertical farming emerges as a potential solution. This innovative approach utilises stacked layers to maximise crop yields in a smaller footprint, alleviating the pressure on limited land resources. By producing food within cities, vertical farming offers a glimpse into a more sustainable future for agriculture.

Sustainable Vertical Farming Ventures in India

In India, vertical farming is not just a futuristic concept, it is already being used to grow a variety of crops! This includes mushrooms, nutritious green fodder for animals (grown hydroponically), and even some vegetables and fruits. Believe it or not, some poultry birds are even being raised in vertical farms!

Decorative versions of vertical farms are also becoming popular. These are known by various names like green walls, living walls, bio walls, or vertical gardens (Jain and Janakiram, 2016). Imagine a freestanding structure or even a section of a building completely covered in lush plants! These gardens can use either organic or inorganic materials as a base for the plants to grow in. The benefits of vertical farming and hydroponics are numerous. They allow us to grow safe, healthy crops that are free of pesticides and rich in antioxidants. Plus, they have a low carbon footprint and require less water than traditional farming methods (Pant *et al*., 2018).

1. MUSHROOM PRODUCTION: Mushrooms are a healthy meal that can grow in dim conditions, and they also help to recycle organic waste. Vertical farming has been used by mushroom farmers for much longer than it has by other plant producers. Several major cities and their suburbs are adopting the use of vertical beds for farming because of their suitability for urban agriculture. The cultivation of mushrooms is a model of efficient, cost-effective, and environmentally friendly vertical farming.

2. POULTRY: Layers (egg producers) and broilers (meat birds) are grown in multi-story buildings on floors or in battery cages. Making more money from the business is easier with battery cages since they can hold more birds. Popular in both urban and rural settings, it is not supported by animal rights groups.

3. GARDEN WALLING/BIO WALL: Garden walls, a form of vertical farming (garden), are all the vogue in India and all over the world. Many of India's major cities have installed vertical gardens in prominent public locations including airports, metro pillars/stations, river crossings, elevated highways, etc.

Plants suitable for bio wall: Climbers having faster growth and dense variegated foliage from ground to top, are the best like *Hedera helix, Parthenocissu squinquefolia, Parthenocissus tricuspidata (Japanese creeper), Lonicera japonica, Jasminum officinale, etc.*

Living wall: Plant species with dwarf nature, limited root volume, fibrous roots, resistant to wind, and good growth habit are ideal, *e.g., Dracaena marginata, Dracaena sanderiana, Hibiscus spp., Gardenia spp., Asparagus sprengeri, Kalanchoe spp.*, and even few vegetables like tomato, chillies, cucumber, lettuce, *etc*.

Exterior wall: Selected plants should perform well under full sun shine or partially shade conditions, e.g., *Lavendulaangus tifolia, Thymus serpyllum, Rosmarinus or Salvia splendens,* for full sunlight. *Rex begonia, Arum, Davallia, Asplenium nidus, Fuchia for* shady conditions.

Interior Wall: Selected plants should perform well both under full shade or partially shade conditions, e.g., *Philodendron, Epipremnum, Aeschynanthus, Columnea, Saintpaulia,* many species of *Peperomia and Begonia* or different ferns *like Nephrolepis* and *Pteris.*

4. HYDROPONIC FODDER: Hydroponics is used, with trays stacked vertically and supplied using the nutrient film technique inside of climate-controlled cabins. Green fodder can be successfully grown in hydroponic systems using barley, oats, and corn. The Ministry of Agriculture has not only approved the use of hydroponics for growing a variety of fodder crops; it has also created, tested, and certified a specific type of hydroponics equipment, the Ayurvet Pro Green Hydroponics Machines, for growing that fodder. Providing value-added green fodder for animals all year requires the backing of fodder banks at the village and farm levels equipped with a Certified Hydroponics Machine (both all-weather and make-shift).

5. STRAWBERRY VERTICAL FARMING: Commercial strawberry cultivation takes place in climate-controlled greenhouses, where several gutter systems are used, with each gutter spaced at around 100 cm from the next. Having a gutter system installed allows for an adequate quantity of drainage water to be used for irrigation purposes.

6. CUCURBITS/TOMATOES TRAINED VERTICALLY: It works great for growing indeterminate tomatoes, yard-long cow peas, and several types of beans. Cucumber, bottle gourd, sponge gourd, ridged gourd, snake gourd, and bitter gourd are all significant cucurbit crops for vertical farming.

7. MICROGREENS: Among health-conscious city dwellers, microgreens and baby greens are a new specialty that's quickly gaining popularity. These plants are vegetables and herbs that are harvested and eaten when still young. Popularity of microgreens from the genus Brassica, especially broccoli, has increased recently due to the plant's simple cultivation requirements (7 to 21 days). Microgreens are currently being grown commercially in greenhouses using the vertical approach and soilless media in tray cultivation. Hydroponic

microgreens are grown in troughs with capillary mats, much like a nutrient film technique setup.

8. AQUAPONICS: Aquaponics is a technique that integrates fish and plant cultivation; in this system, fish are cultivated in indoor ponds; their excrement provides nutrients to plants in vertical farms. The effluent is cleaned and filtered by the plants before being sent to the fish ponds for reuse. A Re-circulatory Aquacultures System (RAS) is required for use in vertical farming. A new method of vertical farming called pisciponics is emerging in Kerala. This method involves growing aquatic organisms like fish, prawns, and snails alongside land plants like vegetables, fruits, herbs, and flowers using a recirculating aquaculture system (RAS). There is a chance that this closed-cycle system could explode in popularity very soon.

9. COMMONLY GROWN CROPS IN VERTICAL FARMING: Although it is technically possible to grow any plant entirely indoors, the economics of vertical farming restrict it to a select few crops that either have a modest growing habit, are prolific producers (like indeterminate tomatoes), or can be grown and sold quickly (such as microgreens). Compatible crops for vertical agriculture today include lettuce, broccoli, spinach, chard, chive, palak (beet leaf), mustard greens, amaranths, parsley, coriander, mint, kale, basil, and other herbs (rosemary, fennel, thyme, oregano, and others), strawberries, mushrooms, micro greens and sprouts, summer squash, peppers, eggplants, tomatoes, cucumbers, muskmelon, algae, crop nurseries, ornamental foliage, and flower plants.

Vertical Farming a Possible Replacement for Conventional Farming in Future

If urban areas keep importing food from the countryside, the distance that food must travel before reaching consumers would grow exponentially as most of the food in cities is imported from far-off places. That means urban areas in the future will have to cultivate their own food supplies. In cities and the suburbs, however, where land is extremely expensive, conventional farming is not viable. The only realistic strategy and option for feeding urban populations in the future is vertical or rooftop farming, often known as zero-acreage farming.

Economics of Vertical Farming: Vertical farming envisions food production within walls, allowing cities to begin the process of becoming self-sufficient and less dependent on global and national food systems. Using recycled water, food spoilage and waste would be decreased, and fresh food would be readily available. These are merely a few of the environmental and social benefits that vertical farms aim to bring to urban residents. In addition, vertical farming would minimise agricultural runoff that threatens ocean biodiversity, eliminate weather and climate change-related crop failures, and return farmland to its natural state (restoring ecosystems). Despite these advantages, just a handful of effective vertical farms have been constructed in India, primarily because of the high building and maintenance costs (Banerjee, 2014).

Major Challenges in Adopting Vertical Farming

The major challenges in vertical farming include:

1. Take vertical farming into account as an alternative method of producing food.
2. Partial or nonexistent plant-environment interaction.
3. A high price tag for farming.
4. Insufficient resources and human knowledge.
5. Growing more adapted plant kinds and/or hybrids.
6. An unfavourable odour or fragrance is produced during the time (cannot be called a 100% environment-friendly technology).

Indian Perspective on Vertical Farming: India's vertical farming technology and its harvest are high-end yet not cheap. Consequently, the cost of modern geoponic agriculture is very competitive. The primary markets for vertical farming products are five-star hotels and affluent parts of India's metropolitan areas. The hospitality industry, which includes hotels,

controls most soilless vertical farms for greens and sells their produce to other businesses and affluent consumers. Research and development (R&D) and human resources (HR), the backbone of any successful business, are only getting started with this technology in India. Even whether it should be considered organic or inorganic is up for debate. The most essential crops for human sustenance cannot be grown on a vertical farm. Despite its limitations, the technology can increase yields from farmland by a factor of ten, and it can be incorporated into both the present and the future of agriculture and food consumption. This method is environmentally friendly because it requires fewer resources like water, fertilizer, and pesticide. Anywhere people live or work is a potential location for vertical farming, including lakes, under or above water, in space, in kitchens (micro greens), and elsewhere.

Conclusion

Growing food vertically is not an impossible dream, but it is also not a walk in the park. The need for sustainable and cost-effective vertical gardens is real. The production of food through vertical farming can be an option in places where traditional methods fail. In a world where natural resources are becoming scarcer and temperatures are rising, vertical farming presents a compelling solution. Successful vertical farming requires more investigation into both fundamental scientific questions and their practical applications in engineering, science, and technology. The time has come for India to adopt a policy that incorporates vertical farming as a central component of agricultural development at the appropriate level.

References

1. Ali F. and Srivastava C. (2017). Futuristic Urbanism-An overview of vertical farming and urban agriculture for future cities in India. *International Journal of Advanced Research in Science, Engineering and Technology*, 4 (4).
2. Jain R. and Janakiram T. (2016). Vertical gardening: a new concept of modern era. In: Commercial Horticulture, © 2016, Editors, N.L. Patel, S.L. Chawla and T.R. Ahlawat, *New India Publishing Agency*, New Delhi, India.
3. Pant T., Agarwal A., Bhoj A.S., Joshi R.P., Om Prakash and Dwivedi S.K. (2018). Vegetable cultivation under hydroponics in Himalayas- challenges and opportunities. *Defence Life Science J*., 3 (2):111-115.
4. Banerjee C. (2014). Up and Away! The Economics of Vertical Farming. *Journal of Agricultural Studies*, 2(1): 40-60