



The Vertical Garden Canvas: Nature's Living Art

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Vertical gardening is a creative, space-efficient method of growing plants vertically rather than on flat surfaces, often on walls, fences, or other upright structures. It employs various techniques such as trellises, tiered planters, hanging pots, and custom modular systems to facilitate plant growth. Suitable for both indoor and outdoor settings, vertical gardening is particularly beneficial in urban environments with limited horizontal space. This approach accommodates a variety of plants, from decorative flowers to vegetables, herbs, and even small fruit-bearing species. Major advantages include enhanced air quality, energy savings through natural insulation, aesthetic improvements, and better accessibility for individuals with mobility challenges. Additionally, vertical gardening supports sustainability by optimizing the use of water, sunlight, and available space.

Keywords: Vertical gardening, Urban environments

Introduction

A vertical garden is a type of garden that is set up against vertical structures rather than laid out in rows on the earth's surface. The term "vertical garden" covers a wide range of vertical gardening arrangements. This is evident since container vertical gardens go by many different names: Living wall, Green wall, Vertical wall, Moss wall, Plant wall. The four characteristics that remain constant are a vertical structure, a container, a plant, and soil

The absence of greenery in cities, resulting from urban development, diminishes quality of life by negatively impacting both aesthetics and attractiveness. One proposed solution is the installation of vertical gardens on both the inside and outside of buildings. These methods make efficient use of space while enhancing visual appeal, offering environmental advantages, and promoting health. Though vertical gardens come with higher construction and maintenance costs compared to traditional landscaping, their environmental contributions, such as increasing green spaces and reducing pollution, help justify the investment.

Objectives

- **Maximizing Limited Space:** Vertical gardens allow for the cultivation of plants in small or urban spaces, making it possible to grow vegetation in areas where horizontal space is limited.
- **Aesthetic Appeal:** Vertical gardens are visually attractive, often used to beautify walls, urban settings, or interiors with lush greenery, flowers, or cascading plants.
- **Improving Air Quality:** Plants in vertical gardens help to filter pollutants, improve air quality, and reduce carbon dioxide levels in both indoor and outdoor environments.

- **Temperature Regulation:** Vertical gardens act as natural insulators, cooling down walls by reducing the impact of direct sunlight and providing shade, which can lower indoor temperatures and energy costs.
- **Urban Farming:** Vertical gardens support sustainable urban agriculture by allowing people to grow edible plants, herbs, and vegetables in confined urban settings, promoting local food production.
- **Environmental Benefits:** Vertical gardening can reduce stormwater runoff, improve biodiversity by providing habitat for beneficial insects and birds, and contribute to environmental sustainability.
- **Efficient Use of Resources:** They promote the efficient use of water and nutrients through systems like drip irrigation and hydroponics, reducing waste and optimizing plant growth.
- **Noise Reduction:** Vertical gardens can act as sound barriers in noisy urban environments, absorbing and reducing noise pollution.
- **Health and Well-being:** Being around plants in vertical gardens can reduce stress, enhance mental well-being, and improve indoor environments by creating a soothing atmosphere.

Importance of Vertical Gardening

- Saving the Space
- Diversity of plants
- Environment Protection
- Reduce the Plant Stress
- Recycle Waste Material

Types of vertical gardening system

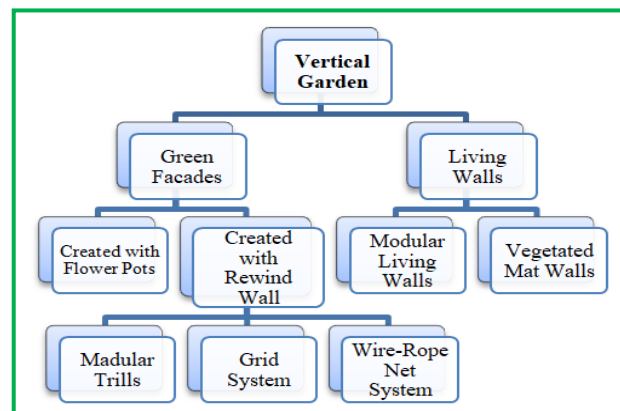
Green façade: Vertical green walls are a type of green wall system in which vines or climbing plants are trained to cover purpose-built support structures. These plants are securely rooted at the base of the structure, either in the ground, within intermediate containers, or until they fully cover the designated area. Vertical green walls can be affixed to existing walls or designed as independent units, such as columns or

fences.

Created with Flower Pots: plants living in pots fixed to the wall, hanging baskets, or on ladders or steps, giving depth to patios, driveways and small spaces.

Created with Rewind Wall: A type of vertical garden that uses a modular trellis, grid system, or wire rope net.

Green walls / Living walls: A living wall system consists of pre-vegetated panels, either in vertical modules or as planted mats, which are mounted onto a vertical structure or framework. These panels are typically made from materials such as plastic, expanded polystyrene, or synthetic fabrics, and they accommodate a diverse range of plant species, including ferns, ground covers, perennials, and even edible plants.



Modular green wall: Vertical Garden Modules are made from recycled polypropylene, offering a durable and visually attractive design that is easy to install. They provide a quick and effective way to create a garden in your home.



Vegetated mat wall: This innovation, developed by Patrick Blanc, features a structure made up of two layers of artificial textile enclosures, each containing pockets that hold plants and their growing medium. The textile barriers are held up by a supporting structure and are protected by a waterproof barrier against the exterior of the building. Supplies of nutrients and water are supplied via an irrigation system positioned at the top of the structure.



Building and installation of Green walls

Green wall system greatly varies in their design and construction in different kinds of vertical gardens. Following are the elements of green wall system:

- Structures and components for green wall system
- Suitable Plants
- Growing media
- Irrigation and plant nutrition
- General considerations for green walls

Structures and components for green wall system

- Front panel
- Bottom drainage tray
- Geo textile pouch
- Stabilizers
- Side panel
- Hanging hook

Suitable Plants: Ideal plants for vertical gardens are dense, compact, and relatively short. It's essential to choose plant species that suit the wall's exposure. For instance, a sun-drenched wall requires drought-tolerant plants, while a shaded location, such as beneath a pergola or verandah, is better suited for shade loving plants like ferns.

For Indoor green walls/For shaded areas

Herbaceous perennials	<i>Pepromia, Syngoniums, Philodendron, Epipremnum, Begonia, Anthuriums, Chlorophytum, Pilea, Rheo discolor, Fittonia, Spathiphyllum, Schefflera</i>
Shrubs	<i>Schefflera, Ficus spp</i>
succulents	<i>Rheo discolor, Zebrinapendula, Setcreaseapurpurea</i>
Ferns	<i>Nephrolepis</i>

For Outdoors/Exterior Green walls

Herbaceous perennials	<i>Asparagus spp., Pileamicrophylla, Alternanthera, Mentha spp.</i>
Succulents	<i>Jade plant, Sedums, Portulaca</i>
Shrubs	<i>Dusty miller, Cuphea</i>
Ground covers	<i>Baby's tear, Callisarepens</i>
Grass like foliage forms	<i>Ophiophogon, Dianellatasmanica</i>

Growing media: The expanding substrate is the key element that determines the effectiveness of a vertical garden setup. The rising expenses of these substrates and the scarcity of certain mineral substrates such as peat, perlite, and vermiculite are driving the need to seek out appropriate substitutes from natural fertilizers and hydrogel solutions for plant pots in vertical garden systems.

There are three types of growth media used in living walls:

i. Loose medium: These systems are commonly known as "soil-on-a-shelf" or "soil-in-a-bag" designs. They work by spreading soil in a loose medium on a shelf or within a bag, which is then mounted against the wall. It's crucial to refresh the soil annually for outdoor installations and every two years for indoor ones. These setups are not recommended for earthquake-prone areas, as replenishing soil in gaps within the wall is both difficult and messy.

ii. Mat type systems: These systems typically use coir fiber or felt mats. Even with multiple layers, the matting is quite thin, which limits its ability to support the deep root systems of mature plants for more than three to five years. Over time, the roots penetrate the mat, making it harder for water to pass through. Repairing these systems requires removing and replacing large sections of the mat by cutting it from the wall and installing a new one.

iii. Structural media: These systems use solid growth medium "blocks" that are neither loose nor mats, but instead combine the advantages of both. They come in various sizes, shapes, and thicknesses and can last up to 10 to 15 years without breaking down. The blocks can be customized to retain more or less water, depending on the plant species, and tailored to meet the plants' specific pH and EC requirements.

Irrigation and plant nutrition: The moisture level of the soil, as well as the acidity and nutrient content of the water source. These settings can be adjusted as needed; for example, the irrigation cycles might be lengthened on warmer days. In hydroponic setups, plants receive their nutrients through a system that injects fertilizers at precise intervals into the water supply (fertigation). Handling these fertigation systems and the rate of nutrient delivery demands specialized expertise, as it is more intricate than applying fertilizers to soil or growing media. Hydroponic systems need constant attention to the pH, hardness of the water and the amount of total dissolved solids (TDS), making adjustments as necessary. For hydroponic green wall systems, the fertigation system may apply 0.5-20 liters of irrigation solution per square meter per day.

Benefits of Vertical gardening

- Aesthetic effects
- Acts as natural insulation for hot and cold air and a save energy for your building
- Conserves water and watering takes less effort
- Sound absorption and noise absorption
- Improves thermal insulation and energy efficiency
- Provides protection to buildings from adverse temperature and hence improves the life expectancy of the buildings
- Mitigate urban island heat effect
- It holds rain water, providing food and shelter for wildlife

Risks of Vertical Garden

1. Maintenance frequency and difficulty: Vertical gardens need regular maintenance because they operate as living ecosystems (Mir, 2011). The level of upkeep depends on the type of vertical garden, the surrounding climate, and the plant species chosen. Typically, the panels and materials used in vertical gardens are built to endure environmental conditions, so maintenance is generally focused on the plant varieties and the irrigation systems used to support them.

2. High cost: Costlier components of the project, intended for use on a vertical wall, are more costly compared to those used on a horizontal wall.

- Carrier profile
- Isolation material
- Irrigation System Components

- Drainage System
- Plant Growth Media
- Plant Species
- Routine Maintenance Costs (Maintenance of irrigation system, drainage system and plant species).

3. Irrigation system problems: Different issues within the irrigation system might lead to problems related to both time and money. Therefore, it is important to perform routine upkeep on the irrigation system, especially focusing on actions to prevent frost damage, which is common in irrigation systems during the winter season.

Conclusion

Horticultural knowledge is crucial, varying by region, and necessitating more data for sustained success. Vertical gardening requires continuous care and could give rise to a new type of gardener; it calls for skilled workers and the integration of multiple ideas. As vertical gardening is still in its infancy, collaboration is key to advancing new solutions to environmental challenges.

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