Review article

Ecology Journal

ISSN (Print): 2957-4471, ISSN (Online): 2957-448X, Website: https://journal.esbangladesh.org
Ecol. J. (2025) 7 (1) : 75-86

Aesthetic horticulture for conservation of nature and natural resources in the context of climate change: A perspective view

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Received: 06 March 2025, revised: 11 April 2024, accepted: 14 April 2024, DOI: https: //doi.org/10.59619/ej.7.1.10

Abstract

Aesthetic horticulture, the art and science of cultivating plants for beauty and functionality, has emerged as a vital tool in addressing climate change and conserving natural resources. This paper explores the role of aesthetic horticulture in promoting biodiversity, enhancing ecosystem services, and mitigating the adverse effects of climate change. Through a review of existing literatures and analysis of secondary data, the study highlights how integrating aesthetic horticulture into urban and rural landscapes can improve carbon sequestration, reduce urban heat islands, and conserve water resources. Findings reveal that aesthetic horticulture makes significant contributions to biodiversity conservation, water efficiency, urban greening, and climate resilience. The paper recommends policy interventions, community engagement, awareness programs, and sustainable landscaping practices to maximize environmental benefits and achieve ecological sustainability.

Keywords: Aesthetic horticulture, climate change, carbon sequestration

Introduction

Aesthetic horticulture is a comprehensive field that integrates ornamental plant science, landscape architecture, and ecological awareness (Sumalatha *et al.* 2024), is progressively acknowledged as a viable and sustainable methodology for tackling environmental issues amidst the rapid progression of climate change (Pandey and Ghosh 2023). This discipline involves the cultivation and organization of flora not solely for aesthetic appeal but also for extensive ecological benefits, including atmospheric purification, microclimate management, enhancement of biodiversity, and the promotion of psychological health (Naimuzzaman *et al*. 2024, Priya and Senthil 2024). In light of the ongoing and significant impact of climate change on natural ecosystems, exemplified by increasing temperatures, irregular precipitation patterns, and habitat depletion, there is an urgent necessity for innovative methodologies aimed at environmental conservation (Change 2007).

Within this framework, aesthetic horticulture emerges as a powerful tool that integrates ecological restoration with cultural and aesthetic values (Adeyela *et al*. 2016). Unlike traditional horticulture, which focuses on productivity or ornamental features, aesthetic horticulture integrates building natural systems and providing landscaping to plants serving ecosystems to strengthen them against climatic stresses (Mahesh *et al*. 2025). Such species, including indigenous and adaptive plants, help reduce the need for irrigation, soil erosion, and the active insects, enhancing the green cover of the area, which increases the sustainability of freshwater resources in urban and peri-urban environments (Dagar *et al*. 2023).

More importantly, conservation of natural resources in terms of water, soil, and biodiversity may be significantly enhanced through climate-responsive horticultural practices, e. g. xeriscaping, rain gardens, and vertical greening systems (Ryan and Browning 2020). Plants such as xeriscaping, rain gardens, and vertical greening strategies maximize the use of natural resources to reduce urban heat island effects and enhance carbon sink capacities (Hefnawy 2024). Such efforts go beyond developing measures for climate adaptation and serve as an example of environmental ethics and stewardship by promoting a more humane, human-natural relationship

(Wolf *et al*. 2013).

Moreover, in urbanized and densely populated settings, the integration of aesthetic horticulture into public infrastructures such as parks, rooftops, highways, and urban districts offers multifunctional landscapes that enhance environmental resilience and human health (Ogwu *et al*. 2025). Empirical evidence has indicated that close interaction with well-designed green spaces promotes physiological (e.g., cognitive) functioning as well as overall life quality, leading to the conclusion that there is a connection between horticultural aesthetics, ecosystem services, and social well-being (Selanon and Chuangchai 2023).

As such, aesthetic horticulture has the potential, when well aligned with conservation biology and climate change action initiatives, to transform landscapes into regenerative, carbon-neutral ecosystems. This study contends for the unique contribution aesthetic horticulture has made to conservation biology and natural resource management, and also offers insights into how aesthetic management practices can serve as tools to mitigate climate change's various consequences for biodiversity, while also providing opportunities for positive environmental and human impacts.

Role on biodiversity conservation

Human activity promotes the growth of species. To support the existence of pollinators, flora, and fauna, biodiversity is essential. By supporting the health of pollinators, flora, and fauna, we create a harmonious ecosystem on our planet; a healthy ecosystem is necessary for the health of our planet. As with an appealing diversity in a garden, a heterogeneous ecosystem is more resistant to loss and change in the environment.

Habitat creation and the building of complex ecosystems are thus necessary to increase biodiversity in addition to plant yield. Pollinators are a large group of diverse insects that contribute to the reproduction of over 80% of flowering plants, leading to their importance in biodiversity conservation and food security (Kaur and Kaleka 2022). As habitat loss and the application of pesticides have adverse impacts on pollinators, solutions such as the restoration of habitats and plant feeding are needed to manage this population effectively (Jarpla *et al*. 2023). On the basis of evidence synthesized during field studies, diverse plant species should increase the abundance of pollinators as well as improve plant yield in cases exemplifying flower strips that boost the population of bumblebees and plant seed production by more than 200% when planted near floral margins. To this end, planting diverse habitats increases pollinator health and promotes plant resilience against environmental fluctuations (Jarpla *et al*. 2023).

Role on carbon sequestration

Trees and shrubs absorb carbon and reduce atmospheric levels of carbon. Trees and shrubs are important for taking in carbon from the atmosphere and helping to offset the effects of climate change. Carbon sequestration occurs when trees and shrubs absorb carbon from the atmosphere. Carbon sequestration is important in preventing global warming and improving air quality. By learning about and getting involved in carbon sequestration, people can help work toward preserving the planet.

Trees and shrubs have a major role in climate change mitigation by absorbing CO_2 and, thus, reducing atmospheric carbon levels. Urban trees can store large amounts of carbon. A study in Tehran showed that the urban trees' storage capacity in each year is 60, 102 tons. This shows the importance of building urban green infrastructure (Rasoolzadeh *et al*. 2024). Diverse ecosystem communities, including forests, wetlands, and marine environments, offer greater carbon storage capacity than monocultures. Host habitat restoration has greater carbon capture capacity (such as mangroves were restored to exfoliate and remold on site, while carbon accumulation was carried out over 40 years) (Bourgeois *et al*. 2024). Biodiversity as well as carbon storage should be considered interrelated because heterogeneous ecosystems are more resilient to natural change. Therefore, the benefits of different organisms in an ecosystem are matched and balanced and balanced to all individuals (Parida *et al*. 2024). To promote biodiversity

and climate change mitigation, by restoration of habitats and developing sustainable forestry practices, ecosystems have to be adapted and conserved (Kasim and Ghassan 2023).

Role on water conservation: Xeriscaping, this strategy reduces the amount of water we're actually using for irrigation by encouraging drought-tolerant landscaping that conserves water. Other approaches to water efficiency include rainwater harvesting and drip irrigation, collecting rainwater where it falls naturally and directly directing it to plants without waste, which makes for pleasing gardens while conserving water.

In addition, modern methods such as precision farming and smart irrigation strategies apply data and real-time monitoring to achieve the best water efficiency (Sankari *et al*. 2024). Innovative practices such as hydrogel application (better soil moisture retention) and graywater recycling further promote the sustainable water use (Abdelhak 2024). Hence, not only do these approaches contribute to fighting water scarcity, but they also increase environmental responsibility and contribute to the sustainability of agriculture. (Eyvaz *et al*. 2022).

Role on urban cooling: Vegetation is important in cooling urban areas; urban climates are more livable, and it reduces the urban heat island effect. Planting trees and greenery not only improves microclimates but also improves public health and environmental quality.

Recently several research papers have demonstrated that blue-green infrastructure (BGI) such as trees and plants directly affect urban climate by influencing the surface energy balance and that it has resulted in average cooling effects (0. 20 K) in cities over the past 20 years, and even city centers have experienced as much as 1. 01 K reductions (Xu *et al*. 2024). The structural and layering of plant communities in cities, especially the presence of tree canopies, increases the efficiency of this cooling (Yu *et al*. 2024). In addition, the cooling performance of urban tree canopies follows a power-law distribution, so this allows for scalable temperature predictions that can be used in urban design. Incorporating diverse types of vegetation and strategically placing them across urban space can maximize the cooling benefits, thus contributing to the comfort and well-being of city dwellers (Xu *et al*. 2024).

Role on soil conservation: Protecting soil is crucial to keep it healthy and stop erosion. This matters for farm success and a healthy environment. Methods like conservation tillage, cover cropping, and using organic nutrients help make soil more fertile. They do this by improving its structure, organic content, and biodiversity (Omer *et al*. 2024). Seaweed extracts are part of the broader classification of agricultural bio stimulants, which possess the ability to effectively augment farming systems encompassing diverse soil (Rahman *et al*. 2024). Humic acid increases nutrient availability, promotes root growth, and improves soil structure (Rahman *et al*. 2024). These sustainable methods don't just cut down on erosion. They also make farm ecosystems stronger, which supports long-term food security without hurting the environment.

On top of that, new solutions like nanomaterials and advanced irrigation tech help conserve soil and water even more. This shows how new ideas play a part in managing land in a sustainable way (Abdelhak 2024). Just like we take care of ourselves, we need to make soil health a priority. This is key to keep producing food and maintain balance in nature for future generations (Singh *et al*. 2024)

Role on community engagement: Getting the public involved in gardening projects has a big impact on raising environmental awareness and making people feel responsible for nature. Studies show that when people take part in urban green spaces (UGSs), it not only makes these areas easier to access but also helps fix social and environmental inequalities by giving communities a sense of ownership and responsibility (Bressane *et al*. 2024).

Projects like the Sungai Jernih Geo Park show how more community involvement can lead to successful conservation. This proves how powerful it is when people work together to protect fragile ecosystems (Kassim *et al*. 2024). When local communities have a say in decisions made by non-profit organizations like the Kenya Wildlife Conservancies Association, it improves how resources

are used, increases accountability, and makes things more sustainable in the long run (Awuor 2024).

In places such as Cikelat Village, environmental projects led by the community have resulted in people adopting more eco-friendly practices. This shows how involvement at the local level can promote sustainable development (Sidik *et al*. 2024). All these examples highlight how public participation is crucial to foster care for the environment and to support lasting positive changes.

Recent works on aesthetic agriculture

The idea grew out of the need to blend farming with eye-catching design and city living. New studies have shed light on "productive aesthetics," where farm areas are designed to be both useful and pretty, matching green and long-term goals (Liu *et al*. 2020). These landscapes often have strips of flowers, gardens with fruit trees, food-producing forests, rows of bushes, gardens that grow up walls, and art made from farm stuff (Thacker 1985).

Urban and suburban farming projects have incorporated these visual elements to improve community health, build stronger social connections, and even raise property values (Lovell 2010, Table 1). Community gardens across the U.S., Europe, and Asia, where they use bright flower displays, straight planting rows, and designs that reflect local culture.

New tech like drones, AI landscape planning software, and high-precision farming systems now help to create farm settings that look good and work well for nature. This "smart farm design" mixes seasonal plant colors, bloom timing, and eco-friendly buildings with regular farm output.

Harnessing aesthetic horticulture for nature conservation and sustainable resource management in the era of climate change

Gardening with style takes a big part in fighting and getting used to climate change. Features like green spots in cities, gardens on walls and roofs, and large plant parks help cool down the extremely hot areas in cities, absorb carbon, and make the air cleaner (Gill *et al*. 2007, Table 2). Placing local plants that can withstand the weather in beautiful gardens is beneficial for pollinators and promotes a greater variety of living organisms, while also conserving water and labor (Majewska and Altizer 2020). Garden with plants that don't need much water, ground that lets rain through, and little gardens made just to catch rainwater, it can manage stormwater better and help water get back into the ground. This does a lot of good for nature and still looks amazing (Steiner and Domm 2012).

Aesthetic gardening pushes for resource saving by doing stuff like piling up organic mulch turning yard junk into compost, and cutting down on chemicals. These moves make dirt healthier, keep water in the soil, and cut down on nasty pollution and gases heating up the planet (Rossi *et al*. 2024). But it's not just about what it does for Mother Nature. Aesthetic gardening also gets folks to care more about the planet. Places like botanical gardens and city parks turn into spots where people learn and want to do better by nature, helping to grow communities that think about the earth first (Westwood *et al*. 2021).

Table 1. Recent developments and benefits of aesthetic agriculture

Innovation/Focus	Outcomes
Aesthetic preferences in urban agriculture	Enhanced citizen engagement, biodiversity, and urban green value
Continuous Productive Urban Landscapes (CPULs)	Integration of beauty, food, and ecology in urban planning
Human health and green space exposure	Aesthetic farms are linked to reduced stress and improved mental health
Flower strips in agricultural landscapes	Increased pollination, pest control, and landscape beauty
Agro-art and cultural expression through farming design	Strengthened rural tourism and heritage preservation

In our fast-moving climate change times, making gardens pretty is more than just about looks now. It's a smart, do-it-all approach for dealing with weather woes, protecting all kinds of living things, and helping to use stuff without wasting it. If city folks put this kind of gardening into the mix when they plan and make rules, they can make their cities tougher against Mother Nature's mood swings, push forward with goals for keeping the planet healthy, and just make life better for the people living there.

Key factors influencing the impact of climate change on horticultural practices and biodiversity: Climate alteration brings real problems to gardens and wildlife. It does so with higher heat uneven rain extra big storms, and more CO_2 in the air. These elements mess up how much food we grow and play tricks on nature's harmony and efforts to save species. Here's what shapes how much this climate shifting touches our plant growing and creature variety.

Extreme temperatures and shifting agro climatic zones: Global warming has caused the average temperature to rise by about 1.1°C since the pre-industrial era (Change 2007), which has shifted climate zones and has an impact on crop suitability (Fig. 1). Temperature changes affect many fruit and vegetable crops. Heat stress can result in poor pollination, fewer fruits, and shorter growing times. (Hatfield and Prueger 2015). To give an example, farmers now grow apples and cherries at higher latitudes or elevations because these crops need less cold exposure. (Atkinson *et al*. 2013).

Rainfall variability and water scarcity: Shifts in rainfall patterns have an impact on water supply and irrigation techniques. More unpredictable weather leads to both dry spells and floods, harming crops with shallow root systems (Lesk *et al*. 2016). In places such as South Asia and Sub-Saharan Africa, erratic monsoon behavior is already lowering vegetable yields (Jagtap and Chan 2000).

Rising CO_2 levels: Now that CO_2 levels have gone beyond 420 ppm, it has an impact on plant growth in tricky ways (Soeder 2022). C_3 plants might at first do better with more CO_2 because of faster photosynthesis, but this often results in less nutrient-rich plants when it comes to proteins, iron, and zinc (Singh *et al*. 2024). This "nutrient thinning" puts food quality and people's health at risk.

Increased pest and disease pressure: Climate changes have an impact on how pests and diseases spread making them more widespread. When it gets warmer, pests from tropical areas can move into cooler regions, which brings new challenges to pest control (Deutsch *et al*. 2018). Pests like *Tuta absoluta* have expanded their reach, and this has a big effect on tomato growing in places that didn't have this problem before (Maharjan 2024).

Pollinator loss and ecosystem disruptions: Bees that pollinate plants are at great risk due to changes in climate. Rising temperatures and habitat fragmentation have an impact on flower blooming times and pollination periods.

Table 2. Key contributions of aesthetic horticulture in the climate change era

Aspect	Contribution	Outcome
Urban Greening	Reduces urban heat islands, captures carbon	Lower ambient temperatures, improved air quality
Native Plant Landscaping	Supports local flora/fauna, requires less water	Biodiversity conservation, reduced maintenance
Rain Gardens & Green Roofs	Manages storm water, reduces runoff	Prevents urban flooding and groundwater recharge
Organic Mulching & Composing	Enhances soil fertility and water retention	Sustainable soil management
Educational Horticulture	Public awareness of sustainability	Increased community engagement in conservation

This causes a disconnect between plant flowering and pollinator activity.

Habitat degradation and biodiversity erosion: Changes in land use due to climate and extreme events play a part in destroying habitats, which has an impact on the natural reserves of wild crop relatives. These wild relatives are key genetic resources to breed varieties that can withstand climate changes (Benlioğlu and Adak 2019, Jordanovska *et al*. 2020). When we lose biodiversity, it weakens how stable ecosystems are and makes it harder for them to adapt.

Socioeconomic challenges and adaptive limitations

The ability of farmers to deal with climate risks depends on their access to resources, technology, and support systems. Small-scale fruit and vegetable growers in developing areas face extra challenges. They often lack basic infrastructure, better crop types, and money services (Morton 2007). This makes it harder for them to handle climate-related problems. Model presented in Figure 1 reflects the socioeconomic challenges and adaptive limitations in aesthetic agriculture (Manzoor *et al*. 2024).

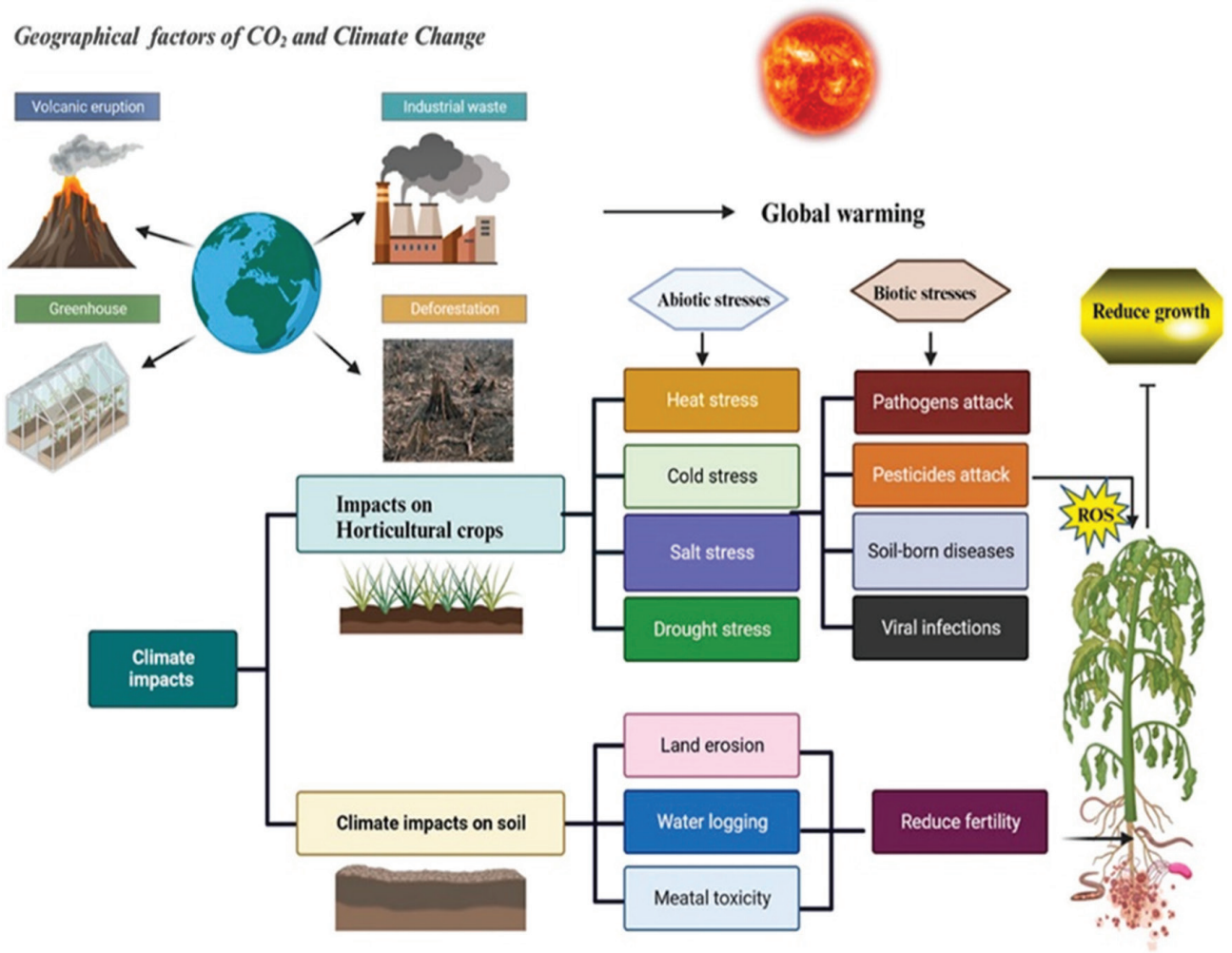


Figure 1. Geographical factors of CO_2 and climate change that influence the adaptation of aesthetic agriculture (Manzoor *et al*. 2024).

Salt stress is a common environmental challenge that has a big impact on how well crops grow and produce. This issue affects farming all over the world. Scientists looked at using nitrobenzene treatments to help plants deal with salt stress. They found that certain amounts of nitrobenzene seemed to help plants grow better at first. These treatments also appeared to reduce the harmful effects of salt stress. This suggested that nitrobenzene could be useful in managing crops under salty conditions (Haque *et al*. 2024). Increasing the toxicity of HMs to ecosystems, soils, and plants. HMs' toxicity significantly reduces plant development and modifies several physiological and molecular alterations in several plant species (Roy *et al*. 2023). Through symbiotic relationships, plant growth-promoting fungi (PGPF) provide a promising way to improve plant growth, nutrient uptake, and stress tolerance (Naimuzzaman *et al*. 2024).

Climate change has a big impact on how we grow plants and on the variety of living things around us. It causes many problems, from less food and lower food quality to unstable ecosystems and money worries. To tackle these issues, we need to use several methods together. These include growing plants that can handle changing weather using water, helping bees and other pollinators, and keeping different types of plant genes safe. By doing all this, we can help protect our plants and the world around us from the harm caused by our changing climate.

The role of horticultural therapy in promoting environmental awareness and conservation amid climate change

Horticultural therapy has an influence on raising environmental awareness and has an impact on advancing conservation as we face climate change. These programs build a stronger link between people and nature when schools like universities put them into action. They boost mental and physical health while encouraging eco-friendly habits (Li *et al*. 2024). Horticultural therapy projects can also teach people, showing them climate-tough gardening methods. These include ways to save water when watering plants and managing pests without harming the environment, key strategies to adapt gardening to our changing climate (Devrani and Tiwari 2024).

Also, botanical gardens have an important role in climate research and public outreach. They offer insights on how plants react to climate stressors and get communities involved in conservation work (Primack *et al*. 2021). In places like India that are vulnerable to climate change, methods based on horticultural therapy can be helpful. They give small farmers adaptive knowledge and practices to better handle environmental pressures (HR *et al*. 2024). In the end, horticultural therapy not only boosts individual well-being but also fosters a shared commitment to sustainability and caring for the environment.

Future outlook of aesthetic horticulture

The future of aesthetic horticulture has an impact on how we blend it with sustainable growth, city toughness, and people's well-being. As cities grow bigger, aesthetic horticulture is ready to make a big difference. It will help to put green structures into city plans. These include gardens on roofs, plants growing up walls, green spaces to heal, and paths that help wildlife. (Gaston *et al*. 2013).

Breakthroughs in plant science and ecological design will help create ornamental plants that look good and suit the climate. These plants will clean the air, cool down cities, and boost people's mood (Wootton-Beard *et al*. 2016). More people now like biophilic design, showing a change in culture. This design uses pretty plants to reconnect with nature encourage care for the environment, and keep cultural landscapes intact (Beatley and Newman 2013). As taking care of the environment becomes crucial aesthetic horticulture will change. It will stop being just for decoration and become a complex field that brings together knowledge of ecology, cultural identity, and the ability to handle climate change.

Aesthetic horticulture practices in south and southeast Asia

In Southeast Asia, artistic design, care for nature, and cultural heritage come together in garden-making to create lively, meaningful green areas (Holden 2003). The region, rich in plant and animal life and with deep spiritual roots, shows how gardening goes beyond just

making landscapes look nice (Hutterer 1983). Gardening for beauty in this area has deep ties to religious meanings, smart planning for the climate, and work to make cities greener (Austin 2014). People often see gardens as more than just pretty spaces. They view them as holy and shared havens that boost mental health and cultural identity (Elior 2014). The choice of plants often has symbolic value (Rival 2021). For example, many people grow lotus *(Nelumbo nucifera)* in Vietnam and Thailand (Zhou *et al*. 2022). In Buddhist traditions, this flower stands for purity and spiritual growth (La-Ongsri *et al*. 2009).

Singapore shows how good-looking gardening can teach people about nature and help cities deal with climate change (Sharath and Peter 2019). Big projects like the Super Tree Grove and Gardens by the Bay don't just attract tourists. They also cool down the city and boost plant and animal life (Kaprielian 2025). At the same time, the Philippines and Malaysia have started using gardens on walls and roofs (Tang *et al*. 2023). This helps them handle their crowded cities and limited space (Sheweka and Magdy 2011, Table 3) presents an overview of aesthetic horticultural traditions across Southeast Asian countries, highlighting their botanical richness, cultural symbolism, and regional diversity.

Suggestions to strengthen aesthetic horticulture Bangladesh

To get the most out of aesthetic horticulture's environmental perks and tackle climate change and resource conservation issues, here's what we suggest:

Policy interventions and development: Governments need to create and put into action policies that encourage the use of aesthetic horticulture in city planning, farming, and urban growth plans. These policies should push for green landscaping in both public and private areas, making sure horticultural practices are adopted.

Community engagement and public awareness: We

Table 3. Aesthetic horticulture practices in south southeast Asia

Country	Common Practices	Popular Plants	Cultural Significance
Indonesia	Balinese garden design, water gardens, tropical landscaping.	Frangipani (Plumeria), Orchids, Hibiscus.	Gardens reflect harmony with nature and spirituality through the Tri Hita Karana philosophy.
Malaysia	Rooftop gardens, and bonsai cultivation	Bougainvillea, Heliconia, Pitcher Plants.	Incorporate Islamic motifs that emphasize peace and tranquility.
Thailand	Temple gardens	Lotus, Jasmine, Golden Shower Tree.	The lotus symbolizes purity in Buddhism and gardens are an integral part of temple design.
Philippines	Urban vertical gardens, natural landscaping	Sampaguita, Anahaw, Waling-waling Orchid.	Sampaguita, the national flower.
Vietnam	Zen gardens, bonsai	Lotus, Bamboo, Areca Palm.	Lotus denotes enlightenment, bamboo symbolizes resilience.
Singapore	Supertree Grove, vertical gardens, urban green spaces	Orchids *(Vanda Miss Joaquim)* Ferns, Bougainvillea.	Orchids are national symbols, gardens support.
Myanmar	Monastery gardens, tropical gardens, floating garden	Padauk, Orchids	Padauk, the national flower.
India	Mughal gardens, temple gardens, urban terrace gardens.	Marigold, Lotus, Neem, Jasmine.	Gardens reflect spiritual, medicinal, and aesthetic values; marigolds and lotuses are used in religious rituals.
Bangladesh	Courtyard gardens, rooftop gardens, floating gardens.	Water Lily, Mango Tree, Bamboo.	Water lily is the national flower; gardens are tied to agrarian traditions and seasonal festivals.

should get local communities involved in horticulture projects through info campaigns, hands-on workshops, and learning programs. Helping people understand the benefits of aesthetic horticulture can lead to better environmental care and community-led conservation efforts.

Research and innovation: We need more research to come up with new gardening methods. This includes plants that can handle tough weather, ways to water plants using less water, and landscaping that's good for the environment. Putting money into research will help us get the most out of aesthetic horticulture's benefits for the environment. It will also help us tackle challenges specific to different areas.

Education and training: We should start educational programs at different levels to teach professionals, people who make policies, and the general public about the basics and practices of aesthetic horticulture. This will help build skills and make sure we can put horticultural strategies into action.

Collaboration and partnerships: Strong partnerships between horticulturists, environmentalists, policymakers, and urban planners play a crucial role in putting aesthetic horticulture into action. Team efforts can boost knowledge sharing, help allocate resources better, and make sustainable practices more widespread.

Integration into urban development: Urban development plans should include aesthetic horticulture as a key part. This means adding green roofs, vertical gardens, urban forests, and bioswales to city designs. These projects can make cities more resilient, cut down on heat islands, and improve city life overall.

Conclusion

The successful integration of aesthetic horticulture into environmental conservation and climate change mitigation strategies needs a multi-faceted approach. Policymakers, communities, researchers, and environmental agencies must team up to push for sustainable practices, boost awareness, and come up with groundbreaking solutions. By putting these suggestions into action aesthetic horticulture can have a big impact on creating resilient and appealing landscapes helping to build a sustainable future.

Acknowledgements

The authors gratefully acknowledge the College of Business Administration and College of Agricultural Sciences, International University of Business Agriculture and Technology, Dhaka 1230, Bangladesh for supporting in carrying and this piece of were.

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