

COMMENTARY OPEN ACCESS

Exploration and Practice of Hefei Botanical Garden in Biodiversity Conservation, Resource Utilization, and Public Education

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Received: 1 July 2025 | **Revised:** 7 September 2025 | **Accepted:** 13 October 2025

1 | Introduction

Biodiversity conservation and sustainable resource utilization are critical to addressing global challenges such as climate change, habitat loss, and food security. Botanical gardens play a pivotal role in these efforts by serving as hubs for plant ex situ conservation, scientific research, and public education [1–5]. As highlighted by Yao et al. in their study of Nanjing Botanical Garden, botanical gardens contribute significantly to germplasm preservation, industrial applications, and ecological restoration [6]. Building on this framework, this paper examines the contributions of Hefei Botanical Garden in biodiversity conservation, sustainable resource development, and nature education, showcasing its unique regional advantages and innovative practices.

Hefei Botanical Garden, located in the transitional zone between subtropical and temperate climates, boasts rich plant diversity and serves as a key institution for biodiversity research in East China (Figure 1). With over 5000 plant species, including 200 rare and endangered species, the garden has become a vital center for conservation and research. This paper explores the garden's progress in three areas: (1) Plant Resource Collection and Conservation: Focus on rare species and germplasm innovation. (2) Sustainable Utilization of Resources: Applications in medicine, agriculture, and ecological restoration. (3) Public Education and Outreach: Innovative programs to promote biodiversity awareness. By analyzing these aspects, this study aims to provide insights for the development of regional botanical gardens and contribute to global biodiversity strategies.

2 | Progress in Plant Resource Collection and Conservation

2.1 | Collection and Preservation of Plant Germplasm Resources

By 2024, Hefei Botanical Garden has collected and preserved over 4012 plant species (including cultivars). Hefei Botanical Garden has recorded a total of 1710 species and lower-level taxa across 187 families and 815 genera, including 25 subspecies, 82 varieties, and 2285 cultivars (Table 1). Among Bryophytes: 40 species across 14 families and 22 genera. Ferns: 17 species and lower-level taxa across 13 families and 16 genera, including 16 species and 1 variety. Gymnosperms: 7 families, 21 genera, 48 species and lower taxonomic ranks, including 31 species, 5 varieties, and 13 cultivars. Angiosperms: 153 families, 756 genera, 2593 species and lower taxonomic ranks, including 1623 species, 25 subspecies, 76 varieties, and 2092 cultivars.

2.2 | Specialized Garden Construction and the Collection, Breeding, and Promotion of Plant Varieties

After years (from 1992 to now) of effort, a specialized botanical garden has been established with a focus on collecting germplasm resources, featuring varieties of *Armeniaca mume*, *Osmanthus fragrans*, *Nelumbo nucifera*, *Punica granatum*, *Allium giganteum*, and legume (*Fabaceae*) plants. Building on this foundation, through surveys of domestic variety resources,

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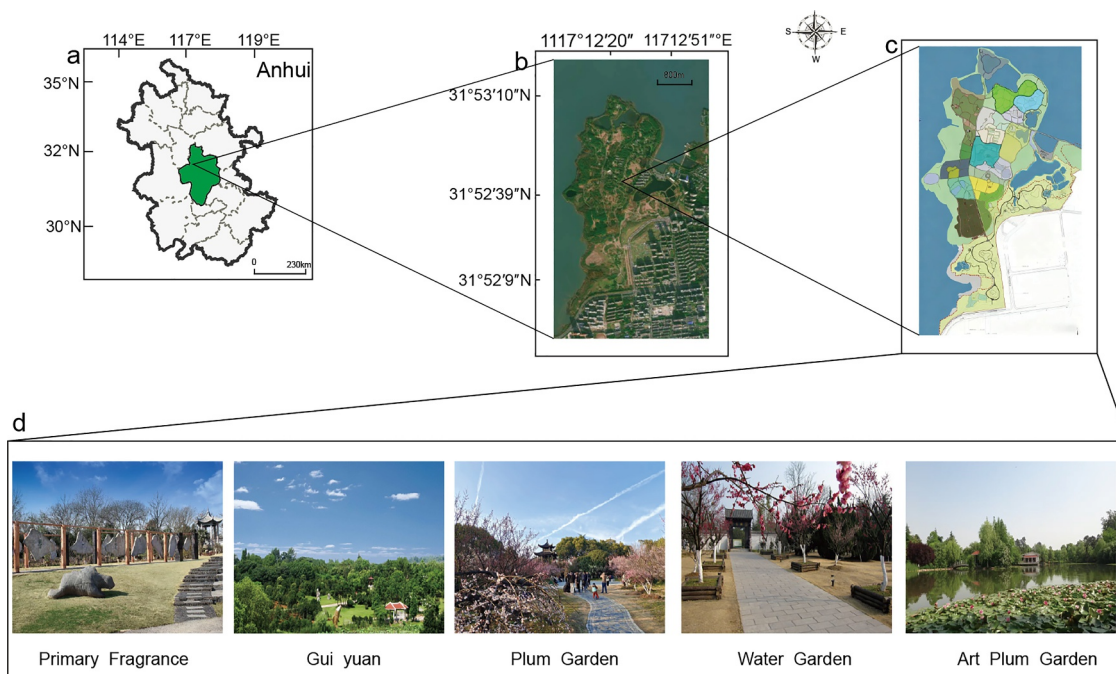


FIGURE 1 | Location and main attractions of Hefei Botanical Garden. (a) Anhui Province map; (b) Location of Hefei Botanical Garden; (c) Main attractions of Hefei Botanical Garden; (d) Photos of main attractions of Hefei Botanical Garden (Primary Fragrance, Gui yuan, Plum Garden, Water Garden, Art Plum Garden).

TABLE 1 | Plant germplasm resources of Hefei Botanical Garden.

Plant germplasm resources	Families	Genus	Species	Subspecies	Varieties	Cultivars
<i>Bryophytes</i>	14	22	40	0	0	0
<i>Ferns</i>	13	16	16	0	1	0
<i>Gymnosperms</i>	7	21	31	0	5	13
<i>Angiosperms</i>	153	756	1623	25	76	2182
Total	187	815		4012		

excellent varieties have been selected for introduction and on-site breeding of new varieties, enriching the collection of the specialized garden and promoting the application of new varieties. The plum garden at Hefei Botanical Garden was designed by Academician Junyu Chen and Professor Naiqin Yang. In February 1992, Mr. Chen, along with Professor Zhehui Jiang, then Deputy Director of the Standing Committee of the Anhui Provincial People's Congress, and Nian Long, then Vice Governor of Anhui Province, planted the first *Armeniaca mume* "You Long", marking the beginning of the plum garden's construction. After two expansions, the plum garden now covers over 6 ha. The garden houses nearly 200 varieties of *A. mume* from all 11 variety groups, as well as over 30 varieties of *Chimonanthus praecox*. Notable varieties include *A. mume* "Changrui Dansha", *A. mume* "Fenxue Liuguang", *A. mume* "Biejiao Huifen", *A. mume* "Wanjiao Yunsha", *A. mume* "Huizhou Duo'e fen", *C. praecox* "Hezhi Tanxiang", *C. praecox* "Luzhou Qianyun", *C. praecox* "Hezhi Suxin", and other newly bred varieties, making it one of the most important *A. mume* variety resource gardens in China. In 2008, Academician Chen Junyu donated some of his manuscripts and *A. mume* research materials to the Hefei Botanical Garden, leading to the establishment

of the *Art Plum Blossom Hall* and the *Chen Junyu Exhibition Hall*. The same year, the garden successfully hosted the 11th National *Armeniaca mume* and *Chimonanthus praecox* Exhibition.

Additionally, the Hefei Botanical Garden has collected over 300 varieties of *Nelumbo nucifera* and over 120 varieties of *Nymphaea tetragona*, such as *N. nucifera* "Lingyun", *N. nucifera* "Luzhou Hong", and *N. nucifera* "Luzhou Feng", among others. These innovative varieties have been widely promoted and applied in major parks, scenic areas, and rural regions across Hefei city.

2.3 | | Protection and Breeding of Endangered Species

Hefei Botanical Garden has achieved notable success in *ex situ* conservation of endangered plants, having collected a total of 73 species of nationally protected rare and endangered tree species, including nationally protected wild plants such as *Glyptostrobus pensilis*, *Ormospia henryi*, *Shaniodendron subaequale*, and *Pinus*

dabeshanensis. Based on the collection of over 10 species of *Styracaceae* plants, the garden has successfully propagated over 1000 individuals of the nationally protected wild plant *Sinojackia xylocarpa* (a second-class protected species in China). Through methods such as live plant collection and *ex situ* conservation, Hefei Botanical Garden has established a comprehensive plant resource conservation system, providing crucial materials for biodiversity research.

2.4 | | Ecosystem Restoration and Enhancement of Urban Biodiversity

Hefei Botanical Garden not only focuses on species conservation but also actively participates in the restoration of degraded ecosystems. Through the reconstruction of native plant communities, it optimizes the ecological functions of urban green spaces; implements wetland vegetation restoration projects to enhance water purification capabilities; conducts research on the selection, breeding, and application of groundcover plants to explore new models and directions for sustainable ecological landscaping; and promotes ecological landscaping concepts to facilitate the construction of urban biodiversity networks. Deeply implementing Xi Jinping's ecological civilization ideology, the garden has fully implemented the Forest Guardian System Demonstration Zone initiative. Since 2016, Hefei Botanical Garden has actively advanced expansion projects and water environment management engineering, undertaken urban village renovations, expanded the park area by 500 acres, renovated 500 acres of landscape zones, added 21,027 trees and shrubs, and increased groundcover by 252,879 square meters. The garden is fully committed to building an integrated urban comprehensive botanical garden combining germplasm resource conservation, scientific research and education, and tourism and recreation.

3 | | Sustainable Utilization of Plant Resources

3.1 | | Demonstration of Ecological Agriculture and Agroforestry

Hefei Botanical Garden is exploring a *Botanical garden + Agriculture* model, actively promoting technological poverty alleviation to support rural development. Since 2019, Hefei Botanical Garden has established a research and innovation base in Changzhuang Village, Shannan Town, Feixi County, constructing specialized gardens such as the Hundred Lotus Garden, Hundred Flower Garden, Hundred Fruit Garden, and Hundred Herb Garden to provide technical support for rural revitalization. In Changzhuang Village, the garden has successfully trialed-planted the 'Indian Red Water Lily' (*Nymphaea rubra*), achieving natural overwintering in the Hefei region. This not only enables large-scale ornamental use to support rural tourism but also provides edible stems, thereby increasing farmers' income. As part of the research project on "Introduction and Configuration of New and Superior Plants Under Forest Canopies," the garden has promoted ecological planting techniques for forest-based medicinal plants such as *Bletilla striata* and ornamental flowers such as *Hosta*

plantaginea, *Hemerocallis fulva*, and *Iris tectorum*, thereby advancing the protection of agricultural biodiversity and sustainable production.

3.2 | | Ecological Restoration

Implemented a comprehensive ecological restoration initiative by strategically utilizing native plant species such as *Taxodium ascendens* (commonly known as pond cypress) to effectively rehabilitate approximately 200 ha of severely degraded wetlands surrounding Chaohu Lake. This large-scale conservation effort focused on reconstructing the natural hydrological conditions and biodiversity of the wetland ecosystem, while simultaneously enhancing its water purification capacity and creating suitable habitats for various aquatic organisms and migratory birds. The project successfully transformed previously damaged wetland areas into thriving, functional ecosystems through careful species selection and systematic habitat restoration techniques. In addition, from 2018 to 2023, Hefei Botanical Garden spearheaded ecological restoration and water environment remediation efforts across a 33 ha area within its southern expansion zone, covering former urban village demolition sites (Figure 2). Through systematic remediation, water quality in this area improved significantly from substandard Class V to Class II–III standards, resulting in markedly enhanced ecological and environmental quality.

3.3 | | Medicinal and Economic Plants

In 2021, Hefei Botanical Garden prioritized surveying and introducing rare and endemic tree species from East China and Anhui Province. Key introductions included plants from the *Burseraceae* family (medicinal and economic plants), such as the *Sinojackia xylocarpa* Hu, *Meliiodendron xylocarpum* Handel-Mazzetti, *Styrax japonicus* Sieb., *Styrax confusus* Hemsl., *Styrax dasycarpus* Perkins, *Styrax faberi* Perk., and *Pterostyrax corymbosus* Siebold & Zucc (Figure 3). Through careful cultivation and management in recent years, these plants have thrived and significantly enhanced the garden's landscape.

4 | | Nature Education and Floral Culture Innovation

4.1 | | Science Education System Construction

Hefei Botanical Garden is a science education base at the national, provincial, municipal, and district levels. The garden features two main functional areas: the Science Museum and the Nature Education Center. The Science Museum houses over one thousand rare plant specimens, including dried leaves, seeds, and preserved specimens, and is equipped with an advanced augmented reality (AR) interactive explanation system to create an immersive science education experience. The Nature Education Center is a non-profit organization established in 2020 through a collaboration between Hefei Botanical Garden and the Founded by Society of Entrepreneurs and Ecology (SEE). It regularly hosts wetland-themed

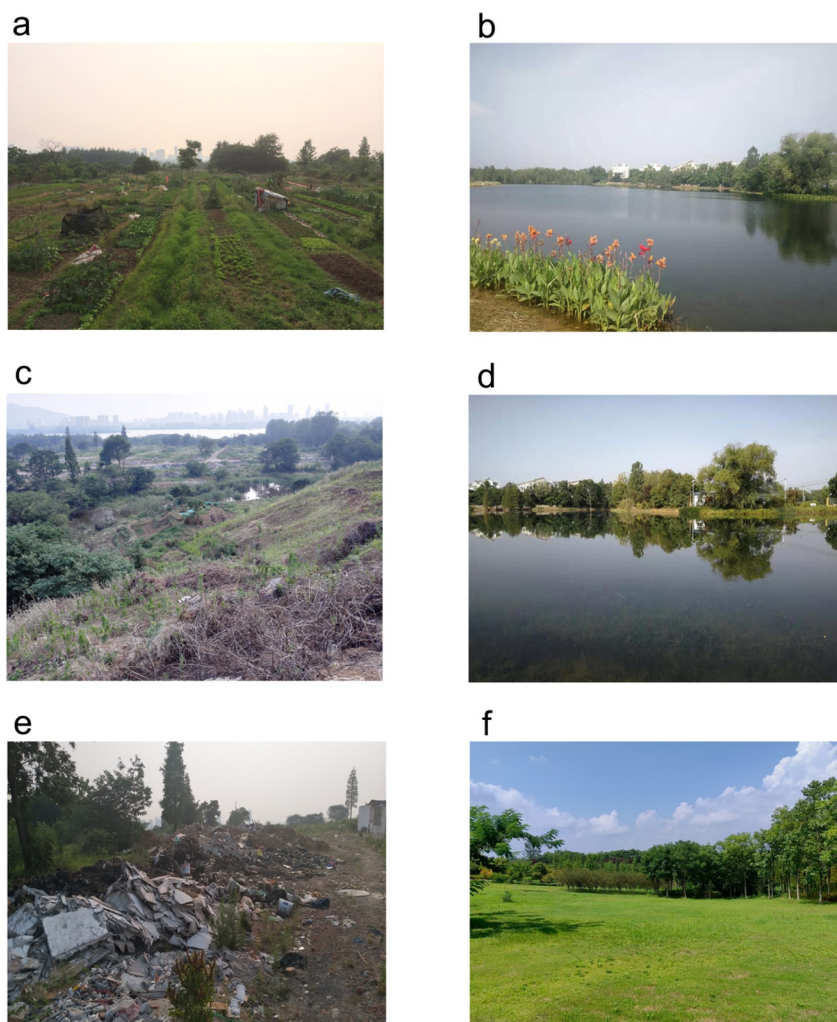


FIGURE 2 | Several ecological restoration cases at Hefei Botanical Garden. (a) Farmland before restoration; (b) Riverbank landscape after restoration; (c) Wasteland before restoration; (d) Water body landscape after restoration; (e) Abandoned building site before restoration; (f) Grassland landscape after restoration.

exhibitions, continuously launches a series of nature education courses, and annually organizes professional skill training for environmental volunteers. It offers diverse plant science education programs targeting different groups such as teenagers, and collaborates with non-profit organizations to host bird-watching activities, science lectures, and nature-themed photography and painting competitions. To date, it has recruited and trained nine batches of nearly 1000 environmental volunteers (registered volunteers), with a cumulative total of 2789 volunteer participants and a total service time of 14,083 h. It has hosted eight sessions of the Anhui Provincial Nature Carnival and regularly organizes science education activities for primary and secondary school students and parent-child families, such as *Seeking the Sounds and Colors of Spring*, *Knowing Autumn Through Leaves*, *The Wisdom of Plants Surviving Winter*, *The Wonderful World of Plant Stems*, and *Nature Treasure Hunt* science education activities for primary and secondary school students and family groups, reaching over 10,000 participants. The *Night Visit to the Botanical Garden* activity held in summer has been enthusiastically received by many family groups, establishing a comprehensive ecological education system.

Through public participation projects like *Plant Adoption*, Hefei Botanical Garden has encouraged over 5000 people to join in biodiversity conservation and monitoring efforts, thereby enhancing public awareness of ecological protection.

4.2 | Construction of a Flower Culture Innovation Base

Hefei Botanical Garden has actively promoted the development of a flower culture innovation base and was awarded the title of “National Key Flower Culture Base” in 2016. It has hosted numerous national-level exhibitions and events, such as the first national osmanthus flower exhibition in 2003; in 2008, the *Art Plum Pavilion* and *Chen Junyu Exhibition Hall* were completed, successfully hosting the 11th National *Armeniaca mume* and *Chimonanthus praecox* Exhibition; and the 24th *Nelumbo nucifera* Exhibition in 2010. The garden attracts an average of over one million visitors annually, making it one of Hefei residents' favorite attractions. It has also been recognized by the media as one of *Anhui's Ten Most Beautiful Places*.



FIGURE 3 | Several medicinal and economic plants at Hefei Botanical Garden. (a) *Sinojackia xylocarpa* Hu; (b) *Pterostyrax corymbosus* Siebold & Zucc.; (c) *Melliodendron xylocarpum* Handel-Mazzetti; (d) *Styrax japonicus* Sieb.; (e) *Styrax confusus* Hemsl.; (f) *Styrax dasyanthus* Perkins; (g) *Styrax faberi* Perk.; (h) *Styrax faberi* Perk.

5 | Domestic and International Exchanges and Cooperation

Hefei Botanical Garden continues to contribute to global botanical garden networks (such as BGCI) and participates in international biodiversity conservation programs. At the same time, it leverages the platforms of the Botanical Garden Branch of the Chinese Botanical Society and the Yangtze River Delta

Botanical Garden Science Popularization Alliance to maintain close cooperation with many domestic and foreign botanical gardens (such as Makino Botanical Garden in Japan, Heilongjiang Forest Botanical Garden, and Shanghai Chenshan Botanical Garden) and actively participate in domestic and international plant diversity conservation programs. It also conducts activities such as plant resource exchange and sharing and plant science popularization.

6 | | Future Outlook: Innovative Development in Biodiversity Research

Hefei Botanical Garden is not only an important base for biodiversity conservation in the Jianghuai region, China, but also an integral part of the national botanical garden system construction strategy. By continuously optimizing conservation strategies, promoting sustainable resource utilization, and strengthening public participation, Hefei Botanical Garden will play a greater role in national biodiversity governance and provide important support for ecological civilization construction. However, it still faces specific shortcomings such as relatively low germplasm coverage, underdeveloped technology transfer mechanisms, and limited scientific research output compared to top-tier botanical gardens (e.g., Royal Botanic Gardens, Kew; Missouri Botanical Garden; Singapore Botanic Gardens; Kirstenbosch National Botanical Garden; Xishuangbanna Tropical Botanical Garden; South China National Botanical Garden, and so on).

To address these gaps, future development will focus on the following key directions: enhancing the systematic collection and conservation of germplasm resources to improve representativeness and diversity; advancing molecular breeding programs and strengthening translational research to bridge the gap between scientific discovery and practical application; accelerating the construction of a smart botanical garden through AI and big data technologies to refine species management and operational efficiency; deepening community co-management models to align biodiversity conservation with rural revitalization initiatives; and expanding domestic and international partnerships to facilitate knowledge exchange and collaborative innovation. Through these efforts, Hefei Botanical Garden will further integrate into national biodiversity governance and contribute more effectively to ecological civilization construction.

Author Contributions

Jimei Zhang: conceptualization, investigation, data curation, methodology. **Xu Li:** conceptualization, writing – original draft, investigation. **Yuhua Ma:** writing – review and editing, conceptualization. **Fasih Ullah Haider:** writing – review and editing. **Yunfeng Zhou:** conceptualization, data curation, resources, writing – review and editing.

Acknowledgments

This research was funded by the Provincial Forestry Research and Innovation Research Project of Anhui “Research on Forest Plant Diversity Restoration Techniques,” the Grants from Chuzhou University (2023qd81), the Anhui Province University Natural Science Research Foundation (Grants 2024AH051402, 2022AH051123) and the Natural Science Foundation of China (Grant 42307055).

Ethics Statement

The authors have nothing to report.

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