

ESTABLISHING A SUSTAINABLE BOTANIC GARDEN FOR TEACHING AND RESEARCH AT FEDERAL COLLEGE OF EDUCATION TECHNICAL, EKIADOLOR, BENIN CITY, EDO STATE, NIGERIA.

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Author's contributions

This study was a collaborative effort of the authors. The authors reviewed and approved the final version of the manuscript for publication.

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ABSTRACT

The study presents the establishment of a botanic garden at the Federal College of Education Technical, Ekiadolor, Benin City, Nigeria as a living laboratory to promote environmental education, biodiversity conservation, sustainable landscaping, and hands-on learning for students and the surrounding community. A phased methodological approach involving site assessment, stakeholder consultation, infrastructure development, and plant acquisition was adopted. The garden comprised over 30 plant species organized into thematic sections including medicinal, ornamental, and indigenous plant collections to support curriculum delivery in Biology, Environmental Science and Agricultural Education. Data were collected over a period of five (5) months from six (6) lecturers and thirteen (13) students through structured observation and participation, using observation checklists to assess learning engagement. Findings revealed improved practical teaching effectiveness, enhanced student engagement, increased institutional visibility, and contributions to campus aesthetics and biodiversity conservation. Despite challenges such as maintenance demands, the project demonstrated that sustainable botanic gardens can be successfully integrated into teacher education institutions. The study recommends the adoption of botanic gardens as essential educational infrastructure in colleges of education to bridge the gap between theoretical knowledge and practical application.

Keywords: *Botanic Garden, Biodiversity Conservation, Environmental Education, Sustainable Development, Nigeria, Tertiary institution.*

INTRODUCTION

Botanic gardens have historically served as vital institutions for education, conservation, research, and public engagement worldwide. These living laboratories provide diverse collections of plant species that facilitate taxonomic studies, ecological investigations, horticultural practices, and environmental awareness (Primack, 2020). In educational settings, particularly teacher training institutions, botanic gardens offer unparalleled opportunities for experiential learning, bridging the gap between theoretical knowledge and practical application. The Federal College of Education Technical, Ekiadolor, located in Benin City, Edo State, Nigeria, plays a crucial role in training educators in Biology education and Agricultural Education. Situated within the tropical rainforest zone, the institution benefits from rich biodiversity and fertile soils suitable for diverse plant cultivation. However, despite its strategic location and academic mandate, the college currently lacks a dedicated botanic garden or structured outdoor learning facility. This absence limits students' exposure to biodiversity and restricts opportunities for hands-on learning in plant identification, cultivation techniques, and ecosystem management. It also constrains the institution's capacity to support environmental education, research, community engagement, and alignment with national sustainability goals. The establishment of a botanic garden is therefore essential to enhance practical teaching, promote conservation awareness, and create opportunities for research, ecotourism, and institutional partnerships. Such a facility would serve as a centre for ecological innovation while enriching the academic experience of both students and staff.

Against this backdrop, this study aims to identify and evaluate plant species representative of native and exotic flora suitable for inclusion in a botanic garden, with emphasis on their relevance to Biology and Agricultural Education curricula, as well as their economic and ecological importance within Edo State. It further assesses the suitability and organization of thematic garden zones, including taxonomic groupings, medicinal plant sections, ecological zones (rainforest and savanna elements), horticultural displays, and propagation areas. In addition, the study examines the role and effectiveness of educational and interpretive resources such as signage, plant labels, and informational materials in enhancing learning outcomes and visitor engagement. A conceptual garden layout is also developed and evaluated to support practical teaching, field-based learning and student research activities. Furthermore, the feasibility and potential impact of establishing a plant propagation and nursery unit for sustainable garden management and outreach are analysed, alongside an evaluation of the garden's potential contributions to institutional aesthetics, visibility, funding opportunities, partnerships, and academic engagement.

This project holds significant implications for multiple stakeholders. For students, it provides hands-on learning opportunities that enhance understanding of plant diversity, morphology, physiology, and ecology. For staff, it facilitates research on plant conservation, ethnobotany, and sustainable utilization of plant resources. For the institution, it enhances academic offerings, institutional visibility, and potential revenue generation through guided tours and partnerships. For the community, it serves as an educational outreach centre promoting awareness about plant life and biodiversity conservation. At the national level, this initiative contributes to Nigeria's commitments under the Convention on Biological Diversity and the Sustainable Development Goals.

Botanic gardens have long been recognized as essential educational resources in tertiary institutions worldwide. According to Akinbode et al. (2013), school gardens not only enhance aesthetic value but also promote experiential learning, particularly in biology, agricultural science, and environmental studies. Their study of Nigerian tertiary institutions revealed that students exposed to practical garden-based learning demonstrated significantly improved comprehension of plant-related concepts compared to those receiving only classroom instruction. The educational value of botanic gardens extends beyond formal curriculum delivery. Dosumu (2018) documented how the University of Ibadan Botanic Garden serves as a resource for public education, hosting school visits, workshops, and community outreach programs. Similarly, Obiora and

Nwosu (2020) highlighted the role of botanic gardens in promoting environmental literacy among non-science majors in Nigerian universities

Botanic gardens play a critical role in ex-situ conservation, particularly for threatened and endangered plant species. The Global Strategy for Plant Conservation emphasizes their contribution to preserving plant diversity. (CBD, 2012). Wyse Jackson and Sutherland (2017) estimated that botanic gardens collectively maintain over one-third of known plant species, many of which are rare or endangered taxa.

In Nigerian, Borokini (2014) documented the conservation efforts by institutions such as the National Centre for Genetic Resources and Biotechnology (NACGRAB) and various university botanic gardens, while noting significant gaps in coverage, particularly in the South-South region where Edo State is located. In preserving indigenous plant genetic resources. However, there is a noted significant gap in coverage, particularly in the South-South region where Edo State is located.

The integration of Education for Sustainable Development in teacher training institutions has gained global recognition. UNESCO (2020) highlights its importance in achieving the Sustainable Development Goals. Botanic gardens provide practical platforms for delivering such education. Adedokun *et al.* (2019) found that Nigerian colleges with functional green spaces demonstrate stronger student engagement with environmental issues. International best practices emphasize systematic planning, stakeholder engagement, and sustainable management. The Botanic Gardens Conservation International (BGCI) provides guidelines for garden establishment (BGCI, 2018). However, studies such as Adeyemi and Ogunwale (2021) identify challenges including inadequate funding, poor maintenance culture, limited technical expertise in Nigerian botanic gardens. Despite their importance, there is limited research on botanic garden development in Nigerian colleges of education, particularly technical institutions. Most studies focus on universities, leaving a gap in understanding the context-specific needs. Furthermore, research on botanic garden development in Edo State remains scarce. This study addresses these gaps by presenting a comprehensive and replicable model for establishing a botanic garden in a technical teacher training institution.

MATERIALS AND METHODS

Research Design

This study represents an implementation-based participatory action research project, where the botanic garden was physically established and evaluated within six (6) months of the study period. The study adopted a participatory action research design, which involves the active involvement of stakeholders in the research process to ensure practical relevance and collaborative decision-making. In this study, participants included lecturers in Biology and Agricultural Education, as well as selected students of the Federal College of Education Technical, Ekiadolor, Benin City, Edo State. These participants were actively involved in key stages of the study, including site selection plant species identification, garden layout planning and planting activities. Decisions were made collectively through consultations, group discussions, and expert input from relevant academic staff. This collaborative approach ensured that the proposed botanic garden design reflected both academic requirements and practical feasibility within the institutional context.

Study Area

The study was conducted at Federal College of Education, Technical, Ekiadolor, Benin-City, Edo State. The selected site for the botanic garden was situated within the college premises, chosen based on accessibility, soil suitability, drainage conditions and exposure to sunlight.

Participants

Six (6) lecturers and Thirteen (13) students were involved in the data collection for a duration of five (5) months through structured observation.

Site Selection, Assessment and Preparation

Site Identification: A suitable plot of land was identified following a preliminary survey of the college. Sites within the Federal College of Education Technical, Ekiadolor, Benin City, Edo State. were identified for evaluation and a plot of land opposite the laboratory was approved.

Assessment Criteria: Sites were evaluated using the following criteria derived from BGCI guidelines (BGCI, 2018) and adapted to local conditions:

- Sunlight exposure: Adequate daily sunlight for diverse plant species
- Soil quality: Fertility, drainage, and structure
- Accessibility: Proximity to academic buildings and ease of student access
- Topography: Terrain characteristics and erosion risk
- Disturbance levels: Human and vehicular traffic patterns
- Security: Visibility and institutional protection
- Water availability: Access to irrigation sources
- Expansion potential: Space for future development

Soil Assessment: Soil quality was assessed based on texture and drainage, and organic manure was incorporated to improve fertility and support plant establishment.

Site Preparation: The land was prepared through ploughing and levelling.

Garden Design and Layout

This project employed a participatory action research design, combining site assessment, stakeholder consultation, and phased implementation planning. The approach ensured alignment with institutional goals while incorporating diverse perspectives from faculty, students, and administrative staff.

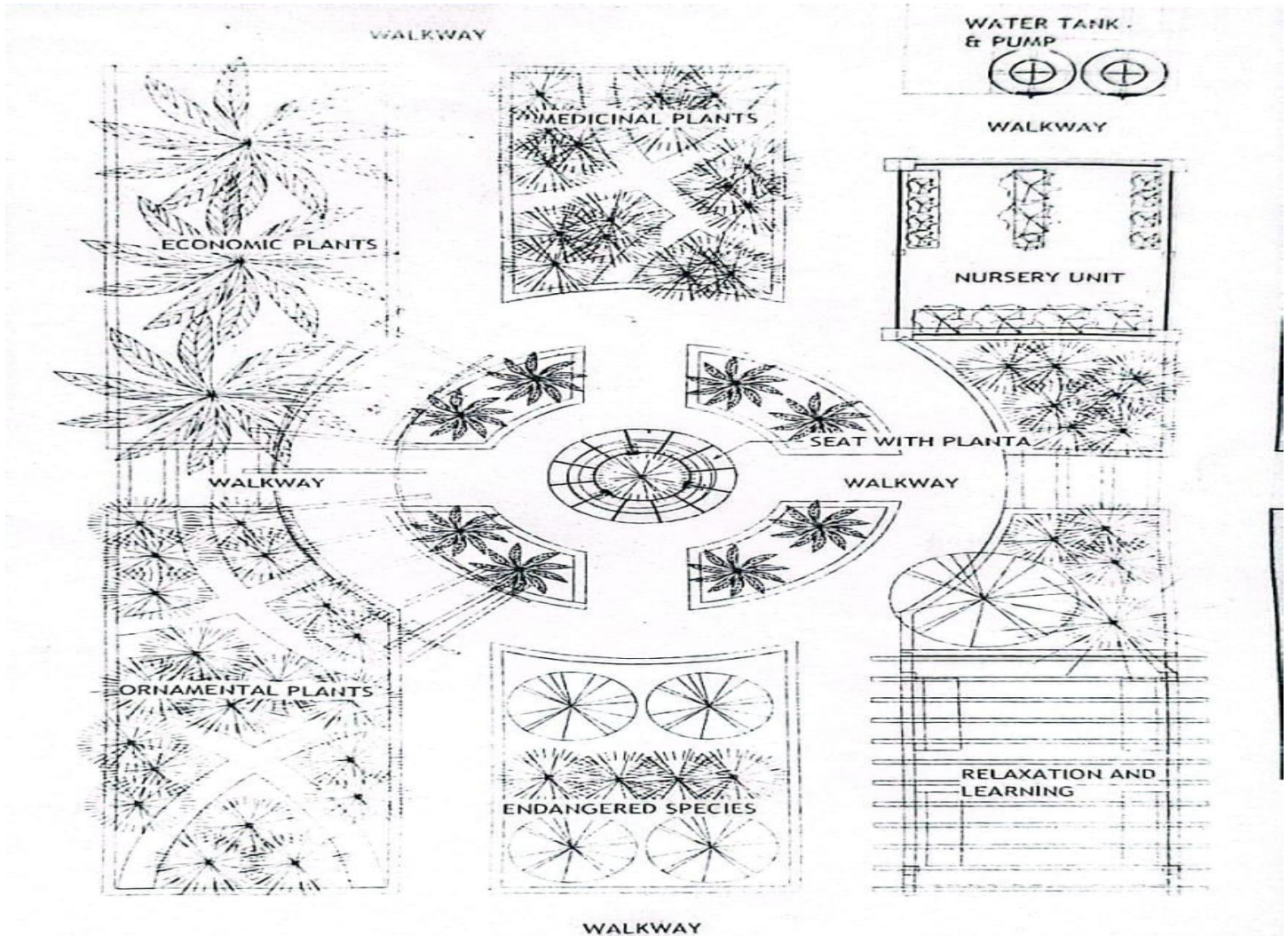


Fig 1: Botanic Garden Layout

The infrastructure development plan includes:

- **Shade house:** 3m × 6m structure using bamboo frames and palm frond thatching.
- **Nursery area:** Fenced section with potting benches and polybag accommodation.
- **Pathways:** 1m wide gravel or compacted laterite paths connecting zones.
- **Irrigation system:** 2,000L water tank with pipe network and drip irrigation components.
- **Signage:** 30 educational labels and directional signs.
- **Seating:** Two wooden bench installations for relaxation and observation.
- **Fencing:** Chain-link fencing with concrete poles for garden perimeter protection.

A prioritized list of plant species was developed using the following criteria:

- **Curriculum relevance:** Plants featured in Biology and Agricultural Education curriculum.
- **Ecological significance:** Native species important for local biodiversity.
- **Economic value:** Plants with food, medicinal, or economic importance.
- **Educational value:** Species illustrating key botanical concepts.
- **Conservation status:** Threatened or endangered species requiring ex-situ conservation.
- **Aesthetic appeal:** Ornamental plants enhancing garden attractiveness.
- **Adaptability:** Species suitable for local climatic and soil conditions.

Phased Implementation Plan

The project was structured into five phases:

Phase 1: Planning and Design (Month 1)

- Detailed site survey and mapping
- Stakeholder consultation and needs assessment
- Development of master plan with thematic zones
- Creation of scaled drawings and layout designs

Phase 2: Site Preparation and Infrastructure (Month 2)

- Land clearing and vegetation management
- Establishment of nursery section.
- Installation of irrigation system

Phase 3: Plant Acquisition and Planting (Month 3)

- Propagation of plants in nursery
- Strategic purchase of specimens from reputable nurseries
- Planting according to master plan specifications
- Installation of temporary plant labels

Phase 4: Architectural Layout and Design

- Implementation of thematic zone delineation
- Proper spacing and planting technique application
- Garden size implementation:

Phase 5: Educational Resources and Maintenance (Months 4-5)

- Design and installation of permanent signage
- Development of interpretive materials (brochures, leaflets)
- Establishment of maintenance schedule and protocols
- Curriculum integration planning with Department of Biology

Data Collectionn

Data for this study were collected through direct field observation and physical counting. Site assessment data were obtained by evaluating environmental factors such as soil condition, sunlight exposure, and drainage. Plant species data were collected through identification and documentation of all plant species established in the garden. The number of species and individual plants in each section were counted and recorded. Data on plant distribution were obtained by categorizing plants into ornamental, medicinal and economic sections. Establishment success was determined by recording the number of plants that survived and those that failed to establish during the study period.

Data Analysis

Data obtained from the planting trials were analyzed using descriptive statistics. The survival rate of plant species was calculated as a percentage of the total number of plants established during the study. A total of (100) were planted across the study area, out of which (95) survived, while (5 plants) did not survive as shown in Table 3. The survival rate was therefore calculated as:

Survival Rate = (Number of surviving plants / Total number of plants planted) x 100 = (95/100) x 100 =95%

This approach provided a simple quantitative measure of plant establishment success within the study area.

RESULTS

Site Assessment Outcomes

The comparative evaluation of the garden revealed distinct characteristics summarized in Table 1.

Table 1: Comparative Site Assessment Results

Criteria	Site (opposite the Lab)
Dimensions	16.7 x 23.6 m
Sunlight exposure	Excellent (full day)
Soil type	Loamy, well-drained
Topography	Flat
Accessibility	High
Traffic level	Moderate
Security	Good
Water access	Accessible

A total of 30 plant species were selected and cultivated, comprising trees, shrubs, and herbaceous plants and the garden was organized into distinct sections, including a medicinal plant section, ornamental plant section, economic plants section, nursery section and a demonstration section allocated for relaxation and teaching practical plant science. An overall plant establishment success rate of approximately 95% was observed across the garden. However, a few cases of plant mortality were observed during the early establishment phase, particularly among certain introduced species such as cucumber hybrids, which showed poor establishment.

Table 2: Distribution of Plant Species Across Garden Sections

SECTIONS	NUMBER OF SPECIES	EXAMPLES
Medicinal	6	<ul style="list-style-type: none"> · <i>Ocimum gratissimum</i> (Scent Leaf) · <i>Aloe vera</i> · <i>Carica papaya</i> (Pawpaw) · <i>Vernonia amygdalina</i> (Bitter Leaf) · <i>Cymbopogon citratus</i> (Lemongrass) · <i>Bryophyllum pinnatum</i> (Miracle Leaf)
Economic	8	<ul style="list-style-type: none"> <i>Telfairia occidentalis</i> (Fluted Pumpkin/Ugu) · <i>Amaranthus hybridus</i> (Green Leaf) · <i>Solanum melongena</i> (Garden Egg) · <i>Capsicum annuum</i> (Pepper) · <i>Abelmoschus esculentus</i> (Okra) · <i>Citrus sinensis</i> (Orange) · <i>Ananas comosus</i> (Pineapple) <i>Cucumis sativus</i> (Cucumber)
Ornamental	12	<ul style="list-style-type: none"> <i>Hibiscus rosa-sinensis</i> · <i>Duranta erecta</i> (Green bush/Yellow bush) · <i>Dyopsis lutescens</i> (Golden palm) · <i>Ixora coccinea</i> (Dwarf Ixora) · <i>Murraya paniculata</i> · <i>Thunbergia grandiflora</i> · <i>Veitchia merrillii</i> (Queens palm)

		<ul style="list-style-type: none"> · <i>Delonix regia</i> (Steppe tree/Flamboyant) · <i>Codiaeum variegatum</i> (Croton) · <i>Dracaena trifasciata</i> (Snake plant) · <i>Tradescantia pallida</i> (Purple heart) · <i>Euphorbia milii</i> (Crown of thorns)
Nursery	4	<i>Ixora spp.</i> , croton and about 50 plant stems were propagated.

Based on the assessment, the selected site was chosen due to its superior accessibility for students, lower disturbance levels, excellent security, and proximity to existing water infrastructure. The dimensions were set at 16.7× 23.6m for the initial phase, allowing for future expansion into the remaining area.

Table 3; Plant Survival in the Botanic Garden

Plant Species	Total Planted	Survived	Not Survived	Survival Rate (%)
<i>Ocimum gratissimum</i> (Scent Leaf)	1	1	0	100
<i>Aloe vera</i>	3	3	0	100
· <i>Carica papaya</i> (Pawpaw)	1	1	0	100
· <i>Vernonia amygdalina</i> (Bitter Leaf)	3	3	0	100
· <i>Cymbopogon citratus</i> (Lemongrass)	2	2	0	100
· <i>Bryophyllum pinnatum</i> (Miracle Leaf)	2	2	0	100
<i>Telfairia occidentalis</i> (Fluted Pumpkin/Ugu)	3seeds	3	0	100
· <i>Amaranthus hybridus</i> (Green Leaf)	1	1	0	100
· <i>Solanum melongena</i> (Garden Egg)	1	1	0	100
· <i>Capsicum annum</i> (Pepper)	2	2	0	100
· <i>Abelmoschus esculentus</i> (Okra)				
· <i>Citrus sinensis</i> (Orange)	2	2	0	100

· <i>Ananas comosus</i> (Pineapple)	1	1	0	100
<i>Cucumis sativus</i> (Cucumber)	2	2	0	100
	5	0	5	0
<i>Hibiscus rosa-sinensis</i>	2	2	0	100
· <i>Duranta erecta</i> (Green bush/Yellow bush)	2	2	0	100
· <i>Dyopsis lutescens</i> (Golden palm)	2	2	0	100
· <i>Ixora coccinea</i> (Dwarf Ixora)				
· <i>Murraya paniculata</i>	2	2	0	100
· <i>Thunbergia grandiflora</i>	2	2	0	100
· <i>Veitchia merrillii</i> (Queens palm)	2	2	0	100
· <i>Delonix regia</i> (Steppe tree/Flamboyant)	2	2	0	100
· <i>Codiaeum variegatum</i> (Croton)	1	1	0	100
· <i>Dracaena trifasciata</i> (Snake plant)				
· <i>Tradescantia pallida</i> (Purple heart)	1	1	0	100
· <i>Euphorbia milii</i> (Crown of thorns)	2	2	0	100
Other species including the Nursery.	2	2	0	100
	48	48	0	100

TOTAL	100	95	5	95
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A total of 100 plants were established within the botanic garden. As shown in table 3, 95 plants survived, while 5 plants did not survive, representing an overall survival rate of 95%. Among the plants that failed to establish was *Cucumis sativus*, which did not survive under the prevailing environmental conditions. The high survival rate demonstrates that the study area provides suitable conditions for supporting a diverse range of plant species, which is essential for the successful establishment of a functional botanic garden.

Expected Outcomes

The project anticipates both short-term and long-term outcomes:

Short-term Outcomes (Year 1):

- Functional botanic garden with 30+ plant species established.
- Integration of garden into Biology and Agricultural Education practical sessions.
- Trained student assistants in garden maintenance.
- Development of educational materials and signage.

Long-term Outcomes (Years 2-5):

- Expanded plant collection to 50+ species
- Established plant propagation program supplying specimens to community
- Published research on plant conservation and education
- Recognized centre for environmental education in Edo State
- Revenue generation through guided tours and plant sales
- Partnerships with conservation organizations and educational institutions.

DISCUSSION

The findings of this study demonstrate a high plant survival rate of 95%, indicating that the environmental conditions within the study area are suitable for the establishment of a botanic garden. This suggests that the soil quality, climatic conditions, and basic management practices support plant growth and sustainability. This result aligns with Akinbode *et al.* (2013), who reported that practical exposure through garden-based learning enhances students' understanding of plant-related concepts. The successful establishment of plant species in this study further supports the role of botanic gardens as effective tools for experiential learning in biology and agricultural education. Similarly, Adedokun *et al.* (2019) observed that institutions with functional green spaces demonstrate stronger engagement with environmental education and sustainability education within the institution. The inclusion of both native and exotic plant species highlights the ecological adaptability of the study area and supports the feasibility of developing thematic garden sections such as medicinal, ecological, and horticultural zones. Overall, the findings confirm that a botanic garden can serve as an effective tool for experiential learning, biodiversity conservation, and institutional development within the college.

CONCLUSION

This study evaluated the feasibility and importance of establishing a botanic garden at the Federal College of Education Technical, Ekiadolor, Benin City. The findings revealed a high plant survival rate, indicating that the environmental conditions of the study area are suitable for sustaining a diverse range of plant species. The study also highlights the potential of a botanic garden to enhance practical teaching, support student research, and promote environmental awareness within the institution. Therefore, the establishment of a botanic garden

in the college is both feasible and beneficial at the institutional level. Further studies may explore broader applications across similar institutions in Nigeria.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

- There is a need for increased institutional and governmental support for the development of botanic gardens in teacher training institutions. This aligns with the recommendations of UNESCO (2020), which emphasize the integration of Education for Sustainable Development into educational systems, and Botanic Gardens Conservation International (2018), which highlight the role of botanic gardens in biodiversity conservation, education, and sustainable development.
- Integrate garden usage formally into Biology and Agricultural Education curriculum through revised course outlines and practical schedules.
- Consider accreditation or affiliation with Botanic Gardens Conservation International (BGCI) to enhance visibility and access to international resources.

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