

Biodiversity Restoration and Allied Green Marketing Opportunities on Higher Education Campuses: A Seven-Year Service-Learning Model from Union Christian College, India

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DOI: <https://doi.org/10.47772/IJRISS.2026.10190032>

Received: 22 January 2026; Accepted: 26 January 2026; Published: 14 February 2026

ABSTRACT

Biodiversity loss driven by human-induced environmental degradation is a global concern with profound ecological, social, and economic implications. Higher education institution (HEI) campuses, often functioning as semi-protected landscapes, offer unique opportunities for biodiversity conservation, ecological restoration, and sustainability-oriented learning. This paper reports on a seven-year biodiversity restoration and service learning initiative undertaken at Union Christian College (UCC), Aluva, Kerala, India, across its 24-hectare campus. The initiative emerged in the aftermath of the catastrophic Kerala floods of 2018, during which the campus hosted over 13,000 displaced people, resulting in localized ecological stress and biodiversity loss.

Beginning in 2019 and formally structured from 2022 onward, the program integrated ecological restoration with curriculum-embedded service learning, community engagement, and allied green marketing possibilities. Key interventions included the establishment of fruit tree gardens, conservation of rare and endangered plant species, grafting and propagation of historically significant plant stock (notably *Mangifera indica* 'Gandhimavu' planted by Mahatma Gandhi in 1925), ethnobotanical documentation, vegetation waste recycling, and the development of campus-based green products such as plant-derived mementos. The initiative employed a multidisciplinary methodology combining classroom instruction, field surveys, herbarium development, nursery management, and reflective learning practices.

Outcomes indicate measurable improvements in campus biodiversity, enhanced ecological resilience, enriched student learning experiences, and emerging livelihood and marketing opportunities rooted in biodiversity stewardship. The model demonstrates how HEI campuses can function as living laboratories for biodiversity conservation, sustainability education, and local green entrepreneurship, directly contributing to the United Nations Sustainable Development Goal 15 (Life on Land).

Keywords: Campus biodiversity, service learning, ecological restoration, ethnobotany, green marketing, higher education, SDG 15

INTRODUCTION

Global Context of Biodiversity Loss

Biodiversity loss is widely recognized as one of the most critical environmental challenges of the 21st century (Kalkuta, 2025). Accelerated by deforestation, land-use change, pollution, climate change, and unsustainable consumption patterns, biodiversity decline threatens ecosystem stability, food security, climate resilience, and cultural heritage. While global and regional assessments dominate conservation discourse, biodiversity degradation also manifests at micro-scales, including urban spaces, institutional campuses, and community landscapes (Pérez-Hämmerle, 2023).

Higher education institutions (HEIs), traditionally viewed as centers of knowledge production, increasingly bear responsibility for addressing sustainability challenges not only through research and teaching but also through

campus operations and community engagement (Yarime, 2012). University campuses often harbor remnant ecosystems, old-growth trees, and culturally significant plant species, positioning them as strategic sites for biodiversity conservation and education.

HEI Campuses as Living Laboratories

The concept of campuses as “living laboratories” emphasizes experiential learning (Rogers, et. al., 2023), where students engage directly with real-world sustainability challenges. Biodiversity-focused initiatives on campuses enable interdisciplinary collaboration across natural sciences (Oliveira, 2025), social sciences, humanities, and management studies. Such initiatives can integrate ecological restoration with service learning, skill development, and social responsibility.

Despite growing interest in campus sustainability, biodiversity-centered programs—particularly in the Global South—remain under-documented. There is limited empirical literature examining how biodiversity restoration initiatives on HEI campuses can simultaneously support ecological recovery, pedagogical innovation, and allied economic activities (Ul Hassan, Murtaza, & Rashid, 2025).

Context of Union Christian College, Kerala

Union Christian College (UCC), established in 1921, is situated on a 24-hectare campus along the Periyar River in Aluva, Kerala, India. The campus hosts a mosaic of academic buildings, hostels, open spaces, and green areas containing over 300 standing trees representing both indigenous and alien species.

In August 2018, Kerala experienced one of the worst floods in its recorded history. UCC served as a major relief center, accommodating over 13,000 displaced individuals within a short period. While this humanitarian response highlighted the institution’s social commitment, it also exerted immense pressure on campus ecosystems, leading to soil compaction, vegetation damage, waste accumulation, and biodiversity stress.

Objectives of the Study

This paper documents and analyzes a seven-year biodiversity restoration and service-learning initiative at UCC with the following objectives:

1. To assess the role of HEI campuses in biodiversity restoration at a micro-ecological scale.
2. To examine the integration of biodiversity conservation with service-learning pedagogy.
3. To explore allied green marketing and livelihood possibilities emerging from campus biodiversity initiatives.
4. To evaluate the initiative’s contribution to environmental sustainability and SDG 15 (Life on Land).

LITERATURE REVIEW

Biodiversity Conservation in Institutional Landscapes

Institutional landscapes, including university campuses, are increasingly recognized as important nodes in urban and peri-urban biodiversity networks. Studies indicate that campuses can function as refugia for native species, pollinators, and threatened flora when managed intentionally (Bocsi, 2019; Kraskauskaite & AlbrechtMallinger, 2024; Pearce, et. al., 2025). Conservation strategies in such spaces often include tree inventories, habitat restoration, invasive species management, and community participation.

Service Learning and Environmental Education

Service learning integrates community service with academic instruction and reflection. In environmental education, service learning fosters ecological literacy, civic responsibility, and problem-solving skills. Biodiversity-centered service learning enables students to connect theoretical ecological concepts with hands-on conservation practices (Nayagam, 2025).

Ethnobotany and Traditional Ecological Knowledge

Ethnobotanical knowledge—rooted in indigenous and local traditions—plays a crucial role in biodiversity conservation. Documenting traditional uses of plants for medicine, food, and rituals enhances conservation value and cultural continuity (Ogwu & Osawaru, 2022). HEIs can act as custodians of such knowledge by integrating ethnobotany into curricula and conservation practice.

Green Marketing and Biodiversity-Based Enterprises

Green marketing refers to the promotion and commercialization of products and services that are environmentally sustainable (Garg, 2015). Biodiversity-based products such as saplings, grafted plants, herbal preparations, and eco-friendly mementos can create revenue streams while reinforcing conservation ethics. However, ethical considerations and ecological limits must guide commercialization efforts.

Study Area and Institutional Background

Geographic and Ecological Setting

UCC is located in Aluva, Ernakulam District, Kerala, characterized by a humid tropical climate, high rainfall, and rich biodiversity. The campus lies within the Western Ghats biogeographic influence zone, one of the world's biodiversity hotspots. Seasonal flooding from the Periyar River contributes to soil fertility but also poses ecological risks.

Campus Vegetation Profile

Prior to the initiative, the campus supported over 300 mature trees, including mango (*Mangifera indica*), jackfruit (*Artocarpus heterophyllus*), banyan (*Ficus benghalensis*), neem (*Azadirachta indica*), and several exotic species. However, systematic documentation and management were limited.

Historical and Cultural Significance

A unique feature of the campus is the presence of a mango tree planted by Mahatma Gandhi in 1925, locally known as “Gandhimavu.” This tree represents both biological and cultural heritage, forming a focal point for conservation and propagation efforts.

METHODOLOGY

Research Design

This study adopts a qualitative-dominant mixed-methods approach, combining ecological surveys, participatory observation, curriculum analysis, and reflective documentation over a seven-year period (2018–2025).

Biodiversity Assessment

Biodiversity assessment under the initiative involved the systematic preparation of a tree and plant species inventory across the campus, followed by the identification and classification of indigenous, endemic, rare, and alien species. Seasonal monitoring of plant health, growth patterns, and natural regeneration was also carried out to assess ecological changes over time and to inform adaptive management and conservation strategies.

Restoration Interventions

The restoration interventions implemented as part of the initiative included the establishment of fruit tree gardens to enhance species diversity and ecosystem services, the development of dedicated conservation plots for the protection of rare and endangered plant species, and the grafting and propagation of heritage plant varieties of ecological and cultural significance. In addition, soil improvement measures such as mulching and organic enrichment using composted vegetation waste were systematically adopted to enhance soil health, moisture retention, and overall plant survival, thereby supporting long-term ecosystem restoration.

Service-Learning Integration

Students from botany, zoology, environmental science, commerce, and social work actively participated in the initiative through hands-on fieldwork and nursery management, systematic herbarium preparation, ethnobotanical surveys documenting traditional plant knowledge, and the completion of reflective journals and project reports that linked academic learning with practical conservation experience.

Community Engagement

Local farmers, traditional healers, alumni, and self-help groups contributed knowledge, planting material, and labor, fostering co-learning and ownership.

RESULTS

Biodiversity Enhancement

The initiative increased plant species diversity, improved tree survival rates, and enhanced habitat complexity (Fig 1). Fruit tree gardens attracted pollinators and birds, contributing to ecosystem services.



Fig. 1.a. *Dalbergia latifolia*



Fig. 1.b. *Santalum album*



Fig. 1.c. *Cinnamomum camphora*



Fig. 1.d. *Saraca asoca*



Fig. 1.e. *Magnolia champaca*



Fig. 1.f. *Garcinia mangostana*

(a-f). Valuable campus tree collections from UCC campus

The UCC campus hosts a diverse collection of fruit-bearing trees with varying production capacities. There are 15 jackfruit trees on campus, each producing approximately 50 to 200 fruits on average. Mango trees are well represented with 50 trees, yielding around 50 to 200 fruits per tree. The campus also has 100 Musa (banana) plants, each producing about 45-85 fruits.

Papaya trees number 120, with an average production of 40 to 70 fruits per tree, while 30 chikoo trees yield roughly 80 to 200 fruits each. There are 15 citrus trees, producing between 30 and 110 fruits, and 32 guava trees with an average output of 60 to 90 fruits per tree. The campus includes 7 cocoa trees, each yielding about 70 to 110 pods.

In addition, 17 jambos trees produce approximately 150 to 250 fruits per tree, while 18 jamun trees are among the most productive, yielding around 300 to 550 fruits each. Mangosteen is limited to 3 trees, with production ranging from 5 to 80 fruits, whereas 8 rambutan trees yield about 120 to 350 fruits per tree. There are also 7 mulberry trees, producing 70 to 110 fruits on average.

The campus has 2 yellow mangosteen trees, yielding 110 to 240 fruits, and 78 coconut trees, each producing approximately 30 to 110 coconuts. Bilimbi trees number 12 and show high productivity, yielding 200 to 650 fruits per tree, while 6 tamarind trees produce around 240 to 450 fruits each.

Other fruit trees include 4 sweet hog plum trees yielding 60 to 80 fruits, 9 gooseberry trees producing 150 to 500 fruits, and 25 noni trees with an average yield of 220 to 350 fruits per tree. The campus also has 5 star fruit trees, yielding 150 to 350 fruits, and 4 peanut butter fruit plants, producing around 55 to 100 fruits each. Finally, 3 miracle fruit trees are present, with a modest production of 35 to 50 fruits per tree. The data is based on the last 7 year production and total production per plant.

The bulk of the fruits produced by the trees on the UCC campus is effectively utilized within the campus community, reflecting the open and sustainable nature of the campus. Since UCC is an open campus, a significant portion of the fruits is freely accessed and consumed by students. In addition, large quantities are regularly supplied to the hostels, where they are served to students, especially during breakfast, ensuring fresh and nutritious food as part of daily meals.

A considerable share of the harvest is also utilized by campus workers, supporting their nutritional needs and strengthening the sense of shared resources within the campus ecosystem. From 2023 onwards, a portion of the fruit produce has been marketed through Thanalidam, the campus thrift shop. This initiative has not only helped prevent wastage of surplus fruits but has also contributed to generating modest income while promoting sustainable practices.

Many of the fruits harvested on campus are processed and served to guests, highlighting the campus's commitment to offering fresh, locally sourced food. Fruits are also regularly used in the campus canteen, where they form an integral part of daily menus. One of the major attractions of the UCC canteen is the preparation of pickled young fruits, particularly mango, gooseberry, and bilimbi, which are highly popular among students, staff, and visitors.

Bananas harvested from the Musa plants are used to prepare banana fry, a favorite snack on campus. In addition, a variety of innovative snacks and food items are prepared using underutilized fruits, ensuring maximum use of the campus produce. These value-added preparations are widely enjoyed by students, staff, and workers alike, further strengthening food security, reducing waste, and showcasing the campus's sustainable and community-oriented approach to resource utilization.

Table 1. Essential oil yielding plants of UCC campus

Si No	Name of the plant	Local name/use
1	<i>Cocos nucifera</i> L.	Thengu-Velichenna
2	<i>Azadirachta indica</i> A Juss.	Neem-Neem oil
3	<i>Eucalyptus</i>	Eucalyptus-Eucalyptus oil
4	<i>Santalum album</i> L.	Chandanam-Santal oil
5	<i>Melaleuca alternifolia</i> (Maiden & Betche)	Tea tree-Melaleuca oil
6	<i>Piper nigrum</i> L.	Kurumulaku-Pepper oil
7	<i>Cinnamomum camphora</i> (L.)J Presl	Karpooram-Camphor oil
8	<i>Chrysopogon zizanioides</i> (L.)Roberty	Ramacham-Vetever oil
9	Cinnamon	Cinnamon-Cinnamon oil

10	<i>Zingiber officinalis</i> Roscoe.	Inji-Ginger oil
11	<i>Jasminum</i> sp	Mulla-Jasminum oil
12	<i>Cymbopogon citratus</i> (DC.)Stapf	Injapullu-Lemon grass oil
13	<i>Curcuma longa</i> L.	Manjal-Turmeric oil
14	<i>Myristica fragrance</i>	Jathikka-Nut meg oil

Conservation of Heritage and Rare Species

Successful grafting of Gandhimavu enabled both in-house planting and limited commercial distribution, ensuring genetic continuity. Several rare medicinal plants were conserved and documented. 85 % success was recorded from the two trials performed (Fig. 2.).



Fig. 2. Stages in the grafting of Gandhimavu planted by Mahatma Gandhi in UCC campus during March 1925

Waste Recycling and Circular Practices

Vegetation waste was processed into compost and mulch, reducing disposal costs and improving soil health. This closed-loop approach strengthened campus sustainability. Each year, three to five Botany undergraduate students actively undertake research projects focused on rooting, cultivation techniques, and the recycling of various types of organic waste generated on the UCC campus. These projects are designed not only to meet academic requirements but also to address practical, campus-based ecological challenges, thereby integrating learning with real-world sustainability practices.

Since 2018, this sustained effort has resulted in the successful production of approximately 500 to 800 plantlets annually. The students experiment with different propagation methods and organic waste inputs, converting biodegradable campus waste into valuable growing media and compost. This hands-on research enhances their understanding of plant physiology, soil biology, and sustainable horticultural practices.

The rooted ornamental plants produced as outcomes of these undergraduate research projects are not confined to laboratory or nursery settings. Instead, they are actively utilized for landscaping and greening initiatives across the campus. These plantlets are transplanted into gardens, pathways, and open spaces spread across the 24-hectare UCC campus, significantly contributing to the aesthetic appeal and ecological enrichment of the area.

Through this initiative, academic research directly supports campus development by reducing waste, promoting recycling, and increasing green cover. At the same time, students gain valuable experiential learning, while the

campus benefits from a continuous supply of healthy ornamental plants. This program stands as a strong example of how undergraduate research can play a meaningful role in sustainability, biodiversity conservation, and environmental stewardship within the UCC campus (Fig. 3.).



Fig. 3. Students engaged in rooting and cultivation studies - recycling used tea dust waste collected from UCC canteen as a new additive for plant propagation.

Learning Outcomes

Students demonstrated improved ecological literacy, practical skills, interdisciplinary understanding, and environmental ethics. Service learning bridged theory and practice effectively. UCC has been well known for its Service-Learning Centre since 2012, offering a one-month international service-learning course designed especially for international students. This program combines academic learning with community engagement and experiential activities, creating meaningful cross-cultural and environmental learning opportunities. As part of this initiative, three to five students from Japan visit the UCC campus every year and participate in a fully residential learning program, engaging closely with campus life, faculty, students, and the surrounding community.

One of the key components of the service-learning course is the study of biodiversity on the UCC campus. During this activity, students are introduced to the wide variety of plants and trees that yield fruits, nuts, and vegetables typical of the South Indian region. Through guided walks, observations, and interactions with faculty and gardeners, the students learn about the ecological, nutritional, and cultural significance of these species, many of which are unique to tropical climates.

As part of their learning outcome, the students document their observations and prepare a wall journal, creatively presenting information about plant diversity, uses, and conservation practices based on their field studies (Fig. 4). This visual and reflective exercise helps them synthesize their learning while also serving as an educational resource for the campus community.

An important reflective element of the program involves comparing plant diversity in Japan with that of Kerala. Students analyze differences in climate, vegetation types, cropping patterns, and biodiversity richness between the two regions. This comparative approach deepens their understanding of global biodiversity, environmental adaptation, and sustainable practices across cultures. Overall, the service-learning program at UCC not only enhances international exposure but also fosters environmental awareness, intercultural understanding, and a deeper appreciation of regional biodiversity.



Fig. 4. Japanese students engaged in plant diversity studies of our campus – July 2023

Allied Marketing Initiatives

Eco-friendly mementos, saplings, and plant-based products were developed for institutional use and limited sale, showcasing ethical green marketing potential. Eco-friendly mementos, saplings, and plant-based products have been thoughtfully developed at UCC for institutional use as well as limited public sale, highlighting the campus’s commitment to sustainability and ethical green marketing. These initiatives aim to replace conventional, non-biodegradable souvenirs with meaningful, environmentally responsible alternatives that also create awareness about conservation and green living.



Fig. 5. a – b. Garden based value added Products developed for marketing by students



Fig. 6. From the plant based mementos marketing

One of the key initiatives includes the generation of indoor plants, which are cultivated on campus and used as in-house mementos during college functions, seminars, workshops, and official events. These living mementos not only serve as lasting reminders of the occasions but also promote the idea of nurturing nature beyond the campus (Fig 5. a - b & Fig. 6.). A portion of these indoor plants is also made available for sale, encouraging wider adoption of greenery in homes and offices.

In addition, saplings of ornamental, fruit, and shade plants are prepared and offered for sale to staff members and the general public. This initiative supports tree planting efforts beyond the campus while fostering a sense of environmental responsibility among the community. The sale is carried out in a limited and mindful manner, ensuring quality and sustainability rather than commercial mass production.

UCC has also developed eco-friendly cards and framed art materials using plant-based and recycled resources. These products are creatively designed and utilized as green marketing materials during institutional events, outreach programs, and awareness campaigns. By integrating art, nature, and sustainability, these materials effectively communicate UCC's environmental values.

Together, these efforts demonstrate how academic institutions can integrate sustainability into everyday practices. The development of eco-friendly mementos and plant-based products at UCC not only reduces environmental impact but also serves as a model for ethical green marketing, blending education, environmental stewardship, and community engagement in a meaningful way.

DISCUSSION

Ecological Resilience at Micro-Scales

The UCC case clearly illustrates that well-planned, targeted interventions can play a significant role in restoring biodiversity even within disturbed institutional landscapes that have experienced intense anthropogenic pressure. Following the ecological stress caused by the 2018 Kerala floods and subsequent large-scale human occupancy, the campus ecosystem faced soil degradation, vegetation loss, and habitat disruption (Krishnan, & George, 2023). Through deliberate actions such as native and fruit tree planting, conservation of rare and heritage species, soil restoration using composted biomass, and protection of existing mature trees, the campus gradually regained ecological functionality. These interventions improved microclimatic conditions, enhanced soil moisture retention, and increased habitat availability for birds, insects, and other organisms. As a result, the restored green spaces contributed to greater ecological resilience, enabling the campus to better withstand climatic extremes such as heavy rainfall, heat stress, and seasonal flooding. The experience at UCC demonstrates that even small, localized ecosystems, when managed scientifically and inclusively, can serve as effective buffers against climate variability while simultaneously supporting biodiversity conservation and sustainability education.

Pedagogical Innovation

Embedding biodiversity restoration within the academic curriculum transformed the UCC campus into a dynamic experiential learning space where education extended beyond classrooms into living ecosystems. By integrating restoration activities with coursework in botany, environmental science, social work, and commerce, students engaged directly with ecological processes such as species identification, nursery management, grafting, soil improvement, and biodiversity monitoring (Pérez-Hämmerle, 2023). This hands-on involvement enabled learners to connect theoretical concepts—such as ecosystem services, conservation biology, and sustainable resource management—with real-world applications and societal needs. Reflective practices, including field journals, herbarium preparation, and project-based assessments, further deepened critical thinking and environmental ethics (David, 2025). As a result, biodiversity restoration became both a pedagogical tool and a sustainability intervention, reinforcing the alignment between higher education, community engagement, and broader sustainability goals, particularly those articulated in the United Nations Sustainable Development Agenda (Saxena, et. al., 2021).

Green Marketing with Ethical Boundaries

While biodiversity-based marketing initiatives added economic and educational value to the campus restoration program, their implementation was carefully guided by strict ecological principles to ensure that conservation

remained the primary objective. Activities such as the sale of grafted saplings, development of garden-based mementos, and limited distribution of plant material were designed not as profit-driven ventures but as extensions of conservation awareness and sustainability education. Clear guidelines governed species selection, propagation limits, and harvesting practices, prioritizing native, non-threatened, and regenerable resources. Revenue generated was reinvested into nursery maintenance, habitat restoration, and student-led conservation activities, creating a closed-loop sustainability model. This balanced approach prevented overextraction or commercialization of biological resources, demonstrating that ethical green marketing (Boyapati, & Muthukumarappan, 2025), when aligned with ecological thresholds and educational values, can support biodiversity conservation without compromising environmental integrity (Garg, 2015).

Alignment with SDG 15

The initiative directly supports the United Nations Sustainable Development Goal 15 (Life on Land) (Fitawek, & Hendriks, 2024) by translating its global targets into tangible, local-scale actions within the campus landscape. Through sustainable land-use planning, the project prioritized the protection of existing green spaces, restoration of degraded areas, and integration of native and fruit-bearing species that enhance ecosystem services. Systematic biodiversity conservation efforts, including the safeguarding of rare, endemic, and heritage plant species, contributed to the preservation of biological diversity (Huang, 2011), and genetic resources. Ecosystem restoration measures such as soil regeneration, organic waste recycling, and habitat enhancement improved ecological functioning and resilience. By embedding these practices within an educational institution, the initiative demonstrates how localized, institution-led interventions can meaningfully contribute to SDG 15 while fostering environmental stewardship, community participation, and long-term sustainability awareness (Deshpande, Sen, & Vaidya, 2017).

Challenges and Limitations

Balancing infrastructure development with conservation emerged as a persistent challenge (Despotovic, Mistic, Petkovic, 2023), as the expanding academic and residential needs of the campus often competed with the preservation of green spaces and mature trees. Ensuring long-term maintenance beyond specific project cycles also required continuous institutional commitment, as biodiversity initiatives are inherently long-term and cannot rely solely on short-term funding or student cohorts. Another critical concern was avoiding the overcommercialization of biological resources; while allied marketing activities added educational and economic value, strict ethical and ecological boundaries were necessary to ensure that conservation objectives remained paramount (Robinson, 2011). Additionally, the absence of robust quantitative biodiversity indices during the early phases of the initiative limited the ability to measure baseline conditions and long-term ecological change with greater precision, highlighting the need for more systematic monitoring frameworks in future phases.

CONCLUSION

The seven-year biodiversity restoration and service-learning initiative at Union Christian College demonstrates the transformative potential of HEI campuses as hubs for ecological conservation, education, and sustainable innovation. By integrating biodiversity restoration with service learning, ethnobotanical knowledge, and ethical green marketing, the initiative offers a replicable model for institutions seeking to align academic excellence with environmental responsibility.

As biodiversity loss intensifies globally, such campus-based micro-interventions can collectively contribute to macro-level sustainability transitions, reinforcing the role of higher education in achieving the United Nations Sustainable Development Goals.

ACKNOWLEDGEMENTS

The authors acknowledge the students, faculty, local communities, and volunteers of Union Christian College whose sustained efforts made this initiative possible.

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