

Integrated Community Empowerment For Sustainable Agriculture Through Agro-Eco-Edu- Tourism (AEET): The Seameo Biotrop Model

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Abstract

This paper presents a comprehensive model for empowering local communities through sustainable agricultural practices led by SEAMEO BIOTROP. The Agro-Eco-Edu-Tourism (AEET) framework, which evolved from the earlier SMARTS-BE initiative, integrates ecological agriculture, education, entrepreneurship, and community engagement. Supported by the national agenda and rooted in educational ecosystems. This study employs a qualitative approach, using a literature review, focus group discussions (FGDs), participatory workshops, and site analysis to examine the development and implementation of AEET. The study highlights a research gap in integrated education-driven agricultural empowerment models that simultaneously link biodiversity conservation, community learning, and local economic development within a scalable framework in Southeast Asia. Ultimately, the paper emphasizes the role of education-driven agricultural empowerment as a long-term strategy for inclusive and climate-resilient development.

INTRODUCTION

Southeast Asia's pursuit of sustainable agriculture, biodiversity conservation, and inclusive community development faces complex challenges amid rapid urbanization, climate change, and shifting socio-economic dynamics. In Indonesia, these challenges are particularly pressing, as the country strives to harmonize agricultural productivity, ecological integrity, and human well-being within its national development agenda (Yani, Hati dan Hardianti, 2024). Addressing these issues requires innovative frameworks that integrate education, ecological practices, and local participation to generate long-term, replicable impacts on sustainability.

Within this context, the Southeast Asian Regional Centre for Tropical Biology (SEAMEO BIOTROP) has pioneered education-based community empowerment through the development of the *Agro-Eco-Edu-Tourism* (AEET) framework. The AEET concept is an evolution of the earlier SMARTS-BE (School-Based Eco-Edu Farm) initiative, which was

designed to integrate biodiversity education and practical farming within school-based ecosystems. While SMARTS-BE focused on *school-centered learning for sustainable agriculture*, AEET expands its scope into *community-centered and tourism-based learning*, linking education with biodiversity conservation and local economic development. In other words, AEET transforms SMARTS-BE from a didactic school model into a dynamic experiential platform that engages schools, farmers, and visitors through ecological learning, agribusiness innovation, and participatory conservation (Perdinan *et al.*, 2023).

AEET combines the principles of agrotourism, ecotourism, and edutourism to promote agricultural productivity, environmental stewardship, and knowledge transfer. Developed through multi-stakeholder collaboration among local governments, vocational schools, universities, and farming communities, AEET serves as a *field-based learning model* and a *showcase for biodiversity education*. The implementation resulted in several integrated prototypes, including the Aquatic Garden, Stingless Bee Garden, Sensory and Therapeutic Garden, Smart-Agriculture Hydroponic, Mushroom House, and the BIOTROP Science and Technology Expo. These living laboratories demonstrate biodiversity conservation and adaptive farming practices (Perdinan *et al.*, 2024, IOP Conf. Ser. Earth Environ. Sci.). These prototypes function as interactive laboratories that demonstrate sustainable technologies, promote appreciation of biodiversity, and foster entrepreneurial skills among students and communities alike.

Empirical evidence from AEET implementation demonstrates the potential of education-driven tourism to generate local income, enhance environmental literacy, and strengthen collaboration between academic institutions and community organizations (Kongdit & Ratanapongtra, 2021; Kumar *et al.*, 2021). The AEET initiative aligns with Indonesia's *Medium-Term National Development Plan 2020–2024* (Perpres No. 18/2020) and supports the United Nations' Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), and SDG 11 (Sustainable Cities and Communities).

Building upon AEET's success, SEAMEO BIOTROP has proposed the Geopark Educational Model (GEM) for 2026–2028, a regional initiative designed to further integrate *geodiversity, biodiversity, and cultural heritage* into educational and empowerment frameworks. GEM envisions geoparks as *living laboratories* that advance place-based education, participatory conservation, and community entrepreneurship. The program's phased implementation—beginning with pilot activities at the Rinjani Geopark—includes developing operational guidelines, training modules, and policy briefs to support curriculum integration and intergenerational knowledge transfer.

The conceptual evolution from SMARTS-BE to AEET and now GEM demonstrates SEAMEO BIOTROP's progressive trajectory in linking ecological science, vocational education, and social empowerment. Collectively, these initiatives embody a long-term strategy to cultivate inclusive, education-driven, and climate-resilient development across Indonesia and Southeast Asia.

Among AEET's field applications, urban farming training initiatives have become a prominent example of its community empowerment strategy. Conducted in both urban and peri-urban areas, these training sessions promote sustainable food production, reduce household expenditure, and enhance communities' adaptive capacity to climate variability. The program also builds environmental awareness among youth and women, reinforcing the social dimension of sustainability through inclusive participation (Hanifa *et al.*, 2025; Devi *et al.*, 2023). As part of its forward-looking strategy, SEAMEO BIOTROP plans to extend the AEET framework into a Geopark-based Education and Empowerment Program beginning in 2026. This new initiative, known as the Geopark Educational Model (GEM), connects geodiversity, biodiversity, and cultural heritage through education-driven activities. GEM aims to position

geoparks as *living classrooms*—spaces where environmental learning, cultural preservation, and community innovation converge (SEAMEO BIOTROP, 2025; UNESCO, 2023).

Despite the growing literature on agro-ecotourism, biodiversity education, and community-based agriculture, most studies address these components separately. Limited research has examined an integrated model that combines ecological agriculture, experiential education, community empowerment, and tourism within a unified and replicable framework. Furthermore, empirical evidence from Southeast Asia on education-driven agricultural empowerment linked to biodiversity conservation remains scarce. This study addresses this gap by presenting AEET as a holistic, operational model that integrates education, sustainability, and community development.

This paper, therefore, has three main objectives. First, it outlines the key components of the AEET framework, emphasizing its theoretical foundations and operational mechanisms. Second, it documents field experiences, particularly those from urban farming and community-based capacity-building initiatives implemented under AEET. Third, it introduces the new Geopark Educational Model (GEM) as a strategic continuation of AEET's educational innovation. Ultimately, this paper underscores the role of education-driven agricultural empowerment as a long-term strategy for fostering inclusive, participatory, and climate-resilient development across Southeast Asia.

LITERATURE REVIEW

The Agro-Eco-Edu-Tourism (AEET) model rests upon four interconnected principles: sustainability, education, participation, and innovation. These principles together shape an approach to community empowerment that is both educationally grounded and ecologically responsive. Conceptually, AEET evolved from the SMARTS-BE program developed by SEAMEO BIOTROP, which initially focused on school-based ecological learning. AEET extends this vision to a broader community context, integrating biodiversity conservation, sustainable agriculture, and entrepreneurship within a single framework (Perdinan *et al.*, 2023).

Sustainability and Ecological Integration

At its core, AEET aligns with the global discourse on sustainable livelihoods and education for sustainable development (ESD) (Chambers & Conway, 1992; Tilbury, 2011). Sustainability within this model is understood not merely as environmental protection but as a balance between ecological integrity, economic viability, and social inclusion. In Southeast Asia, a growing body of evidence indicates that ecotourism and agroecological practices can protect biodiversity while generating livelihood opportunities—provided they are managed through participatory, community-based approaches (Kongdit & Ratanapongtra, 2021; Kumar *et al.*, 2021).

Indonesian experiences further substantiate this relationship. Agro-edutourism initiatives in regions such as Malang and Yogyakarta have shown measurable success in enhancing environmental literacy, strengthening local food systems, and diversifying community income sources (Devi *et al.*, 2023). These models exemplify how sustainable agricultural tourism can serve as a conduit for environmental education and social transformation.

Global studies complement these findings. Blanton (2024) emphasizes that biodiversity-based tourism can effectively support conservation and community welfare when grounded in inclusive governance. Similarly, Libosada (2009) and Stronza, Hunt, and Fitzgerald (2022) argue that participatory ecotourism models mitigate ecological degradation while preserving cultural continuity. Within AEET, such ecological integration forms the backbone of its sustainability dimension, linking environmental stewardship with socio-economic empowerment.

Education as the Foundation of Transformation

Education represents the transformative axis of AEET. Drawing on Transformative Learning Theory (Mezirow, 2000) and Place-Based Education (Gruenewald & Smith, 2014), AEET views learning as an experiential, context-specific process that fosters critical reflection and behavioral change. It positions education not only as a mechanism for knowledge transfer but also as a catalyst for cultivating ecological consciousness and agency among learners.

Empirical studies consistently reveal that experiential, field-based education enhances environmental understanding, problem-solving ability, and civic responsibility (Tilbury, 2011; UNESCO, 2022). In Indonesia, SEAMEO BIOTROP's interventions through SMARTS-BE and AEET demonstrate that biodiversity-focused education—when embedded in both formal and non-formal settings—significantly improves students' scientific literacy and vocational competencies (Perdinan *et al.*, 2023).

By transforming school gardens, hydroponic facilities, and urban farms into “living laboratories,” AEET concretizes the notion that education extends beyond the classroom. These spaces encourage learners to engage directly with ecological processes, thereby reinforcing the interdependence between human development and environmental resilience.

Participation and Empowerment

Participation constitutes a defining feature of AEET's operational design. The model emphasizes collective ownership and multi-stakeholder collaboration, ensuring that communities are not passive beneficiaries but active co-creators. Empirical findings indicate that the success of empowerment programs is strongly influenced by information accessibility, the strength of local leadership, and institutional support mechanisms (Susilowati *et al.*, 2023). In parallel, Doustmohammadian *et al.* (2022) found that participatory approaches in community agriculture directly contribute to improved food security outcomes. AEET incorporates these insights by facilitating joint planning between schools, local governments, and community farmer groups. This process not only strengthens institutional capacity but also anchors conservation and education initiatives in the lived realities of the people they serve (Perdinan *et al.*, 2023).

The participatory ethos of AEET resonates with the Sustainable Livelihoods Framework (Chambers & Conway, 1992), which conceptualizes empowerment as the strengthening of human, social, and natural capital. Through inclusive partnerships involving academia, civil society, and local enterprises, AEET promotes adaptive governance and reinforces long-term community resilience.

Innovation and Replicability

Innovation represents AEET's forward-looking dimension. The model integrates smart agricultural technologies—such as hydroponics, IoT-based monitoring, and digital mapping—with ecological education and tourism. These innovations transform AEET sites into hubs for climate-smart, adaptive learning, thereby fostering local entrepreneurship and creative economic opportunities (Perdinan *et al.*, 2023).

A key measure of AEET's success lies in its replicability. The model's structured yet flexible design has enabled its adaptation across diverse contexts, from urban schools to rural communities. This adaptability provides the foundation for SEAMEO BIOTROP's next strategic initiative—the Geopark Educational Model (GEM) (SEAMEO BIOTROP, 2025). GEM extends AEET's educational and ecological principles into the broader geopark landscape, linking geodiversity, biodiversity, and cultural heritage through place-based education and empowerment activities (UNESCO, 2023). GEM thus represents a natural progression from AEET, scaling educational innovation from localized eco-learning environments to territorial frameworks for sustainable development.

The reviewed literature underscores that educationally driven, participatory, and ecologically grounded models such as AEET play a critical role in fostering sustainable community development. By bridging environmental education, biodiversity conservation, and socio-economic innovation, AEET demonstrates how experiential learning can drive behavioral transformation and long-term ecological stewardship.

Anchored in the foundational lessons of SMARTS-BE and extended through the forthcoming GEM program, AEET exemplifies SEAMEO BIOTROP's commitment to education as a strategic pathway toward inclusive and climate-resilient growth. Collectively, these frameworks reinforce Indonesia's national priorities and the broader Southeast Asian agenda for sustainability, resilience, and community empowerment.

RESEARCH METHODOLOGY

The development of the *Agro-Eco-Edu-Tourism* (AEET) framework employed a qualitative research approach, supported by descriptive quantitative indicators, and combined a literature review, focus group discussions (FGDs), participatory workshops, and site analysis conducted between 2020 and 2022.

Literature Review

A literature review was conducted to synthesize relevant theories and best practices in sustainable agriculture, education for sustainable development (ESD), and community-based ecotourism. The review covered regional and international case studies, including the earlier SEAMEO BIOTROP initiative SMARTS-BE, which provided the conceptual foundation for AEET. This step identified theoretical linkages among biodiversity education, urban farming, and participatory empowerment.

Focus Group Discussions (FGDs)

Two major FGDs were organized at SEAMEO BIOTROP. Participants included researchers, representatives of the Regional Development Planning Agency (Bappeda), vocational school teachers, farmer groups, and private-sector partners.

- The first FGD identified BIOTROP's internal potentials and existing resources—such as the *Stingless Bee Garden*, *Aquatic Garden*, and *Tissue Culture Laboratory*—that could be integrated into the AEET framework.
- The second FGD formalized institutional collaboration and established a shared action plan for pilot implementation and educational outreach

Site Analysis and Zoning

A spatial and ecological assessment was performed on SEAMEO BIOTROP's 12-hectare campus in Bogor to determine its suitability as a living laboratory for AEET. The analysis examined landscape features, accessibility, vegetation structure, and existing facilities. Based on this assessment, the AEET campus was zoned into three functional areas:

- Agrotourism Zone – focusing on sustainable agriculture and food crop innovation.
- Ecotourism Zone – emphasizing biodiversity conservation and environmental interpretation; and
- Edutourism Zone – dedicated to experiential learning, training, and community interaction.

Participatory Workshops and Data Collection

Workshops were conducted with local educators, students, and farmer communities to design field-based learning modules, develop eco-tourism interpretation materials, and test participatory learning approaches. Data collection employed three complementary techniques:

- Observation, focusing on community interaction, visitor engagement, and operational practices.
- Documentation, involving visual and textual records of project development; and

- Participatory evaluation, which enabled stakeholders to collaboratively assess implementation outcomes and challenges.

Data Analysis

Qualitative data were analyzed using descriptive and thematic approaches to identify emerging patterns, success factors, and implementation constraints. Themes were coded around AEET's four core components—sustainability, education, participation, and innovation. Quantitative indicators such as visitor demographics and participation levels were also used to complement qualitative insights. The analysis outcomes informed the refinement of AEET's operational framework and the formulation of strategic recommendations for scaling up, including the planned integration with the *Geopark Educational Model (GEM)* for 2026–2028.

RESULTS AND DISCUSSION

SEAMEO BIOTROP has successfully developed six *Agro-Eco-Edu-Tourism* (AEET) prototypes within its 12-hectare campus: (1) Aquatic Garden, (2) Stingless Bee Garden, (3) Sensory and Therapeutic Garden, (4) Smart Agriculture Hydroponic, (5) Mushroom House, and (6) BIOTROP Science and Technology Expo. These prototypes serve as field-based learning centers and biodiversity demonstration areas, integrating ecological science, education, and community empowerment.

Data on visitor numbers, prototype outcomes, and school engagement for 2022–2024 are sourced from SEAMEO BIOTROP internal monitoring and AEET field reports (2024–2025), ensuring transparency and traceability. Visitor records from 2014–2021 indicate that 65% of AEET participants were students from schools, 18% from universities, and 12% from public institutions, confirming AEET's position as an educational tourism hub linking biodiversity conservation and experiential learning. From 2022 to 2024, AEET recorded 5,041 visitors, including 163 international participants, and facilitated 202 internship students and 10 research projects, while generating nine mini-research studies on biodiversity education and sustainable agriculture.

AEET Masterplan and Prototype Learning Modules

The AEET initiative was structured through a comprehensive masterplan, dividing SEAMEO BIOTROP's campus into Agrotourism, Ecotourism, and Edutourism zones, each serving distinct ecological and pedagogical purposes:

- Agrotourism Zone: Promotes sustainable farming and food innovation.
- Ecotourism Zone: Focuses on biodiversity conservation and environmental interpretation.
- Edutourism Zone: Facilitates experiential learning through workshops and teacher-community training.

SEAMEO BIOTROP developed learning modules and prototype manuals on hydroponics, composting, stingless bee cultivation, waste recycling, and biodiversity observation—providing practical guidance for teachers, students, and local farmers to apply sustainability-based practices. The AEET framework was introduced at the FiSAED 2023 International Conference (Frontier in Sustainable Agromaritime and Environmental Development) and published in a Scopus-indexed proceeding, underscoring its academic relevance and replicability across the Southeast Asian context.

Community and School Training Programs

Beyond campus-based prototypes, SEAMEO BIOTROP has expanded AEET principles through community and school training programs across Indonesia. These activities aim to strengthen urban food security, develop eco-friendly learning environments, and empower educators and students to practice sustainable agriculture. The training programs implemented in collaboration with schools, local governments, and education offices combine

urban farming practices, hydroponic cultivation, composting, and biodiversity education. They target both general and special education schools (SLBs), promoting inclusive environmental learning and positioning agriculture as a form of therapy, character education, and life-skills development for students with diverse abilities.

These nationwide training initiatives have been conducted across multiple provinces, engaging hundreds of teachers, students, and community representatives. Through this participatory approach, SEAMEO BIOTROP reinforces its role in building resilient and sustainable school ecosystems, in which teachers serve as change agents and students become young innovators for food sovereignty. This community-based expansion of AEET reflects BIOTROP's long-term goal to integrate learning-by-doing principles into formal and non-formal education systems. It bridges ecological knowledge with local empowerment, transforming the AEET framework into a grassroots movement for sustainability education. Regional Replication of AEET

In 2024, AEET entered a regional replication phase, beginning at Universiti Sains Malaysia (USM) in Penang. A benchmarking visit on 24 May 2024 and a Focus Group Discussion (7 June 2024) with USM and the Institute of Brunei Technical Education (IBTE) identified potential modalities and institutional readiness for replication. According to the AEET–USM Mid-Term Monitoring Report (Jan–Jun 2025), the collaboration has successfully developed prototypes, conducted teacher training, and established partnerships with the State Education Department and Malaysia's Ministry of Natural Resources and Environment (SEAMEO BIOTROP & Universiti Sains Malaysia, 2025). The program's success has inspired upcoming replications in the Philippines and Brunei Darussalam, demonstrating AEET's scalability and regional adaptability.

Educational and Community Impacts

AEET contributes significantly to teacher capacity building, student engagement, and community resilience. Key impacts include:

- Increased technical competence in hydroponics, waste management, and biodiversity observation.
- Enhanced food security and school self-sufficiency through garden-based learning.
- Strengthened collaboration among schools, local governments, and the private sector.
- Broader community participation in environmental action and innovation.

These outcomes align with those of Doustmohammadian et al. (2022), who found that participatory and experiential education build community resilience and foster sustainable behavioral change. Moreover, Tilbury (2011) and Sterling (2010) argue that transformative learning—linking knowledge, values, and practice—is essential to sustainability education. AEET embodies these principles through its fusion of ecological literacy, entrepreneurship, and cultural engagement.

Challenges and Adaptive Strategies

Despite significant achievements, AEET's expansion faces challenges related to financial sustainability, limited human resources, and constraints on digital monitoring. Similar issues were observed in AEET–USM's implementation, highlighting the need for long-term funding mechanisms and full-time educational coordinators (BIOTROP & USM, 2025). To ensure sustainability, SEAMEO BIOTROP adopts an open innovation strategy, promoting multi-sectoral collaboration among local governments, private partners, and educational institutions. Schools are encouraged to develop self-sustaining green enterprises, such as selling hydroponic produce or eco-products, to sustain AEET activities independently.

Transition from AEET to GEM

In 2025, SEAMEO BIOTROP launched the Geopark Educational Model (GEM) as an evolution of AEET. Using the Logical Framework Approach (LFA), GEM integrates four pillars:

1. Teacher Capacity Building
2. Curriculum Integration
3. AEET as a Pedagogical Platform
4. Multi-Stakeholder Collaboration

GEM positions geoparks as integrated learning laboratories that interconnect biodiversity, geodiversity, and cultural heritage—consistent with UNESCO Global Geopark principles and the Sustainable Development Goals (UNESCO, 2023; SEAMEO BIOTROP, 2025). This transition represents SEAMEO BIOTROP’s continued commitment to advancing education for sustainable development (ESD) across Southeast Asia. The AEET–GEM continuum illustrates how education can catalyze sustainability transformation. Through community engagement, teacher training, and regional replication, AEET has evolved from an institutional innovation into a regional learning ecosystem linking ecology, education, and entrepreneurship. Together, AEET and GEM reflect SEAMEO BIOTROP’s mission to foster inclusive, climate-resilient, and education-driven community empowerment, ensuring that biodiversity learning contributes not only to knowledge creation but also to sustainable livelihoods and resilient societies.

Table 1. AEET Field-Based Learning Prototypes and Educational Functions

No.	Prototype / Learning Area	Educational Function
1	Aquatic Garden	Introduces freshwater ecology, aquatic biodiversity, and sustainable fish culture systems.
2	Stingless Bee Garden	Promotes pollinator conservation and through meliponiculture (stingless bee keeping).
3	Sensory and Therapeutic Garden	Integrates horticultural therapy, education, and plant-based learning for students.
4	Smart Agriculture Hydroponic	Demonstrates IoT-based agriculture, precision irrigation, and resource-efficient plant cultivation.
5	Mushroom House	Introduces sustainable mushroom cultivation, compost utilization, and circular economy practices.

Each AEET prototype integrates STEM learning, ecological literacy, and entrepreneurial education. Collectively, they form a living laboratory that supports hands-on, inquiry-based learning both for formal and community education.

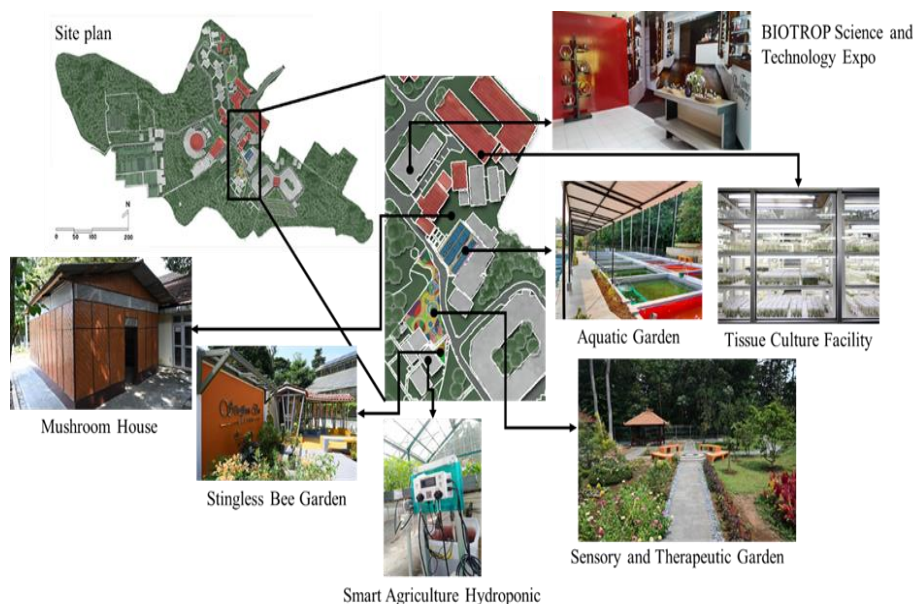


Figure 1. AEET Field-Based Learning Prototypes and Educational Functions

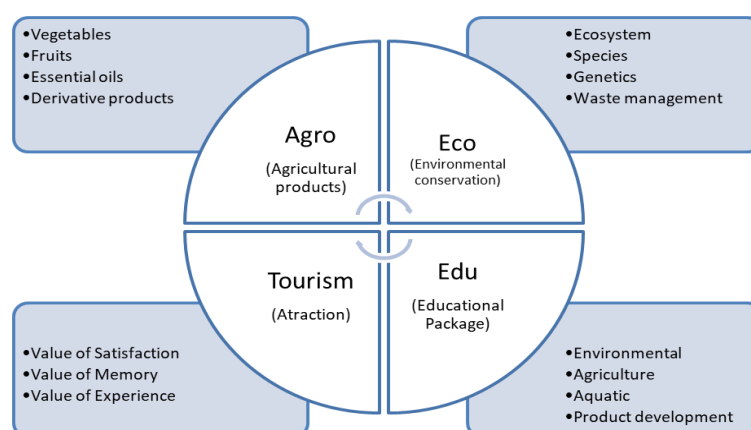


Figure 2. AEET Framework Model Developed by SEAMEO BIOTROP

This model positions AEET as an interdisciplinary bridge between agricultural productivity, ecological conservation, and educational transformation — aligned with SEAMEO’s *Education for Sustainable Development* goals.

CONCLUSIONS AND SUGGESTION

The AEET model demonstrates that sustainable agriculture, education, and tourism can be effectively integrated for biodiversity conservation and community empowerment. By involving schools, farmers, and local governments, AEET fosters long-term climate-resilient education and ecological awareness. Recommendations include: (1) integrating genetic conservation principles, (2) adopting open innovation for scaling, (3) strengthening local organizations, (4) adapting AEET principles to Geopark education, and (5) developing participatory evaluation systems for food security and sustainability monitoring.

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