

Fostering Sustainable Tourism through Adoption of Green Technologies and Appliances: An Empirical Study in Dooars Region

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ABSTRACT

In ecologically sensitive areas like the Dooars, where tourism heavily depends on the preservation of natural beauty, the need for sustainable practices has become increasingly vital. As tourism booms in the Dooars, significant proliferation of homestays is observed. Rapid growth of homestays creates job opportunity and economic dividend for sustainable livelihood in the economically backward Dooars areas. On the flip side over-mushrooming of homestays in these eco-fragile areas led to resource exploitation. Thus to conserve and preserve natural resources sustainable tourism practices plays a crucial role. Homestays, although perceived as environmentally friendly, lack technical knowledge, financial capacity and institutional support to systematically adopt and implement various green technologies in their operations. Challenges related to high operational costs, institutional constraints and compliance-driven sustainability measures might hinder genuine environmental commitment. Thus this empirical study intends to observe and examine effective green interventions in homestays of Dooars and also to gauge the challenges faced regarding green interventions. With the help of both secondary and primary data collected from registered 210 homestays randomly selected from Alipurduar and Jalpaiguri district of Dooars by administering structured questionnaire and analysed by using appropriate statistical tools especially descriptive analysis, the present study reveals that homestays have generally adopted and implemented low-cost and locally managed green practices. The findings indicate that to implement various sustainable modernised green technologies monetary constraints play a significant role and thus sustainable finance mechanisms like concessional loans may be helpful to promote implementation of green practices, parametric insurance to provide rapid financial protection from climate-induced disruptions.

Keywords: *homestays, sustainable tourism, green technologies, implementation*

1. INTRODUCTION

Tourism has emerged as a strategic sector in India's development trajectory due to its potential to generate employment, stimulate regional economies, preserve cultural heritage and promote inclusive growth. However, tourism is also a resource-intensive industry, significantly influencing land use, water consumption, energy demand and waste generation. These impacts are particularly pronounced in ecologically sensitive regions, where tourism development often intersects with fragile ecosystems and climate vulnerability.

The Dooars region of West Bengal, situated in the foothills of the Eastern Himalayas, is characterized by dense forests, river systems, tea plantations and rich biodiversity. Owing to its natural and cultural attractions, the region has experienced a steady increase in tourist inflows. This growth has led to rapid expansion of accommodation facilities, including hotels, resorts and homestays. While tourism has created livelihood opportunities in this economically backward region, it has also intensified pressure on natural resources through unregulated construction, deforestation, excessive water extraction, plastic pollution and inadequate waste management.

In response to these challenges, sustainable tourism has gained prominence as a framework that balances economic benefits with environmental conservation and social wellbeing. Adoption of green technologies and environment friendly appliances may be considered as the environmentally responsible practices to reduce the ecological footprints in accommodations in a tourist destination. Studies have shown that eco-friendly accommodations enhance destination competitiveness while aligning with the growing environmental consciousness of travellers (Amandeep, 2017). Homestays have gained popularity as an alternative form of accommodation that is community-based, small in scale and culturally embedded. In theory, homestays are well positioned to adopt sustainable practices due to their close integration with local environments. However, the unregulated growth of homestays has significantly intensified environmental pressures.

2. STATEMENT OF THE PROBLEM

The rapid expansion of tourism-driven homestays in the ecologically sensitive Dooars region has generated livelihood opportunities and economic benefits for local communities; The increasing number of homestays has led to higher energy

consumption, inefficient use of electricity and renewable energy systems, and a growing carbon footprint associated with accommodation-related activities.

In addition, the proliferation of homestays has contributed to environmental pollution in multiple forms. Rising dependence on single-use plastics, inadequate waste segregation and recycling facilities, open burning of waste and firewood for cooking and heating have aggravated solid waste accumulation and air pollution. Increased tourist activity has also resulted in noise pollution, particularly in forest-adjacent and rural settlements, posing risks to wildlife habitats and local community well-being.

Despite policy emphasis on sustainable tourism, the adoption of green technologies and structured environmental management practices among homestays remains uneven and largely informal. Financial constraints, limited technical awareness, weak institutional support and inadequate regulatory monitoring restrict systematic adoption of environmentally responsible practices. Consequently, while homestays are often perceived as eco-friendly accommodation alternatives, their growing numbers without effective sustainability interventions risk undermining the ecological integrity of the Dooars region. This underscores the need for an empirical assessment of green technology adoption, associated challenges and policy measures to foster sustainable and climate-resilient tourism.

3. REVIEW OF LITERATURE

Tourism development in ecologically sensitive regions has increasingly raised concerns regarding resource consumption, environmental degradation and climate vulnerability. While tourism contributes significantly to local livelihoods, its accommodation sector is a major consumer of energy and water and a generator of solid waste and pollution (Gossling, 2002; Becken & Patterson, 2006). Studies have shown that unregulated growth of small accommodation units, including homestays, can intensify pressure on fragile ecosystems through increased electricity use, plastic waste generation, open burning of waste, water over-extraction and noise pollution, particularly in forest-adjacent and rural areas (Nepal, 2003; Gossling et al., 2011).

The concept of sustainable tourism emphasises minimising negative environmental impacts while maximising socio-economic benefits for host communities (UNWTO, 2018). In this context, the adoption of green technologies and environmentally responsible practices in accommodation facilities has been identified as a critical pathway toward sustainability. Energy-efficient lighting, solar energy systems, water-saving devices, waste segregation, composting and reduced

plastic usage are widely recognised as effective tools to lower the ecological footprint of tourism establishments (Mensah, 2006; Bohdanowicz, 2006). However, empirical evidence suggests that the adoption of such technologies remains uneven, especially among small and informal accommodation providers. Research on green practices in the hospitality sector has largely focused on hotels and resorts, highlighting drivers such as regulatory pressure, customer demand, cost savings and corporate image (Bohdanowicz & Martinac, 2007; Chan et al., 2014). In contrast, homestays and small tourism enterprises receive comparatively less scholarly attention, despite their growing presence in rural and nature-based destinations. Existing studies indicate that homestays are often perceived as environmentally friendly due to their small scale and community-based nature; however, this perception does not always translate into systematic adoption of green technologies (Shukor et al., 2014; Yusof et al., 2020).

Several studies highlight that homestay operators tend to adopt low-cost and easily manageable environmental practices such as LED lighting, rainwater harvesting and organic waste composting, while avoiding capital-intensive or technologically complex solutions (Mensah, 2014; Ahmad et al., 2017). Advanced practices such as grey water reuse, sensor-based fittings, energy-efficient appliances and structured waste recycling systems are often poorly understood or completely absent, primarily due to financial constraints, limited technical knowledge and lack of institutional guidance (Kasim, 2009; Yusof et al., 2020). This supports the argument that sustainability adoption in homestays follows a “low-investment pathway”.

Environmental pollution associated with tourism accommodations has also been widely documented. Plastic waste generation from food packaging and tourist amenities poses serious environmental and health risks in rural tourism areas where formal waste management infrastructure is weak (Gossling et al., 2015; Pandey et al., 2022). Additionally, reliance on firewood and open burning of waste contributes to air pollution, while noise pollution from increased tourist activities disrupts wildlife habitats and local community life in eco-sensitive regions (Nepal & Chipeniuk, 2005). These issues are particularly pronounced in hill, forest and tea garden regions similar to the Dooars.

Another critical strand of literature emphasises the role of sustainable finance and institutional support in enabling green transition within tourism. Access to concessional green loans, insurance products and incentive-based eco-certification schemes has been shown to positively influence adoption of

environmentally responsible technologies (UNEP, 2019; OECD, 2020). However, studies indicate that small accommodation providers, including homestays, are often excluded from formal green finance mechanisms due to lack of awareness, procedural complexity and weak policy outreach (Filimonau et al., 2018). As a result, sustainability efforts remain voluntary and fragmented rather than structured and resilient.

The existing literature establishes that while homestays possess strong potential for sustainable tourism development due to their community-based nature, their increasing numbers without appropriate technological, financial and governance support can exacerbate environmental degradation. There is limited empirical research examining the adoption of green technologies and appliances specifically within homestays located in ecologically sensitive rural regions of India, particularly from a quantitative perspective.

Despite growing literature on sustainable tourism and green hospitality, empirical studies focusing on green technology adoption, environmental management practices and financial constraints of homestays in eco-sensitive regions like the Dooars remain scarce. This study addresses this gap by empirically analysing the adoption of green technologies and appliances in homestays, identifying associated challenges and suggesting policy interventions to foster sustainable and climate-resilient tourism.

4. OBJECTIVES OF THE STUDY

The objectives of the study are as follows:

- Examine environmental management practices adopted by homestays in the Dooars region.
- Analyse the extent of adoption of green technologies and appliances by homestays.
- Identify challenges faced in adopting green technologies and appliances.

5. RESEARCH METHODOLOGY

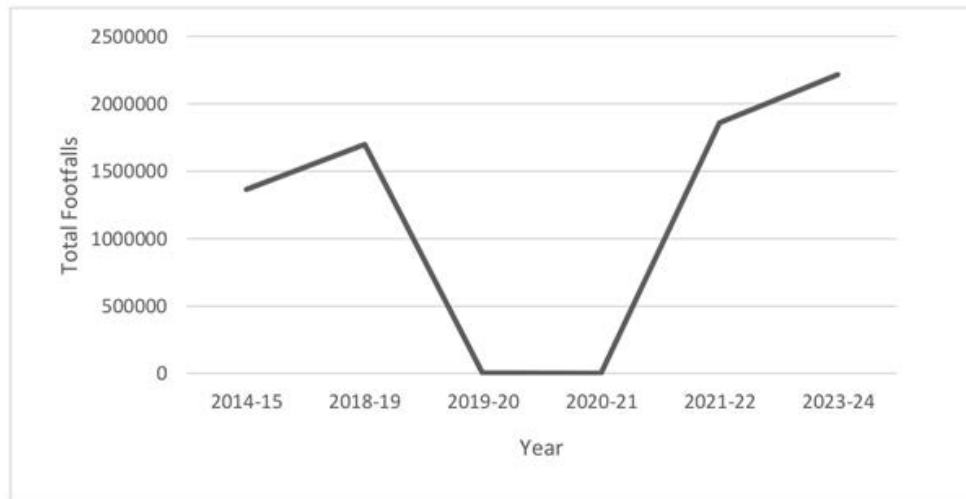
Study Design

The study adopts an empirical research design based on both primary and secondary data. Primary data were collected using a structured questionnaire administered to homestay operators. Secondary data were sourced from academic journals, government reports, tourism policy documents and official publications of relevant departments.

Study Area and Sample

The study covers Jalpaiguri and Alipurduar districts of the Dooars region. The area has been chosen as it is considered as the emerging tourist destination and recognized for increasing tourist footfall over the years.

FIGURE 1: Footfalls in Tourist Destination in Dooars



Source: Annual Final Report of Tourism Survey for the State of West Bengal
Himalayan Hospitality and Tourism Development Network

To accommodate such huge tourist footfall lots of homestays are grown up. As of April 2025, the total number of registered homestays are accounted for 389. Thus, the population include owners/operators of those 389 homestays. Using Slovin's formula with a 5% margin of error, a sample size of 197 was derived. To account for incomplete responses, the sample size was increased to 210. Thus, the sample size includes owners/operators of 210 homestays. A random sampling technique was employed to attain the objectives.

Data Collection and Data Analysis

To investigate the adoption levels of green technologies and practices primary data has been collected from the homestay operators/managers. Data has been collected by using the structured questionnaire. The criteria for collecting data were chosen based on different guidelines and regulations applicable to homestays. Mean scores and Z-scores were computed to compare relative intensity of sustainability adoption across variables. The data has been collected using five-point Likert's scale, where,

‘2’ = ‘very high’, ‘1’ = ‘high’, ‘0’ = ‘neutral’, ‘-1’ = ‘low’, and ‘-2’ = ‘very low’. The neutral midpoint ($\mu = 0$) represents neither adoption nor rejection of a green practice.

6. FINDINGS AND DISCUSSION

The present study examines the extent of environmental responsibility and green technology adoption among homestays in the Dooars region by identifying key environmental practices related to resource-efficient technologies and appliances. These practices emphasise the reduction of energy consumption, promotion of renewable energy sources, conservation of water resources and minimisation of environmental pollution associated with tourism activities. The selected indicators capture both modern technological interventions and traditional eco-friendly practices adopted by homestays, reflecting their contribution towards sustainable and climate-resilient tourism development. TABLE 1 presents the major environmental practices regarding green technologies and appliances considered in the study.

TABLE 2: Environmental Practices Regarding Green Technologies and Appliances

Sl. No.	Environmental Practices	Description of Green Technology / Appliance
1	Energy-efficient lighting	Use of LED lighting systems to reduce electricity consumption
2	Energy-efficient electrical appliances	Adoption of 3*, 4* and 5* (star) rated geysers, refrigerators, air conditioners and televisions
3	Power-saving systems	Use of power-saving card-key systems to control electricity usage in rooms
4	Environment-friendly power backup	Use of green generators designed to minimise fuel consumption and emissions
5	Renewable energy adoption	Use of solar energy for lighting, water heating and supplementary power requirements
6	Water-efficient fittings	Installation of sensor-controlled taps and fittings in wash basins to reduce water wastage

7	Eco-friendly cooking practices	Use of “Green Chula” (woven traditional cookstoves) for energy-efficient and low-emission cooking
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Source: West Bengal Tourism Policy

In order to fulfil the objectives of the study, a field survey was conducted covering 210 homestays (n = 210) using a structured questionnaire focusing on the adoption and practice of green technologies and environmentally friendly appliances. The survey collected primary data on various energy-efficient, water-saving and renewable energy practices implemented by homestay operators. The results derived from the survey responses are presented and analysed in TABLE 2, which highlights the extent and pattern of green technology and appliance usage among the sampled homestays.

H_0 : Mean score of adoption of green technologies (MS_{ia}) = 0

H_1 : Mean score of adoption of green technologies (MS_{ia}) $\neq$ 0

Where,

i = respondents

a = statements related to adoption

TABLE 2: Adoption of Green Technologies and Practices (n = 210)

Variable	Mean	SD	Z-score
LED lighting adoption	1.42	0.63	2.25*
Solar panel installation	0.88	0.74	1.19
Rainwater harvesting	1.01	0.71	1.42
Waste segregation & composting	0.73	0.69	1.06
Plastic reduction practices	0.96	0.72	1.33
Low-flow water fixtures	-0.78	0.81	-0.96
Grey water reuse	-1.06	0.77	-1.38
Star-rated appliances	-0.72	0.84	-0.86
Awareness of green technologies	-0.55	0.76	-0.72
Access to sustainable finance	-1.12	0.68	-1.65
Eco-certification participation	-1.35	0.61	-2.21*

The hypothesis testing based on the bipolar Likert scale reveals a clear asymmetry in sustainability adoption among homestays in the Dooars region. The null hypothesis is rejected for LED lighting adoption (mean=1.42) and eco-certification participation (mean= -1.35), indicating statistically significant

deviation from neutrality (as the absolute z-score values 2.25 and 2.21 respectively are greater than 1.96). This suggests that while basic, low-cost green practices are firmly embedded, institutional sustainability mechanisms remain largely absent. Practices such as solar energy use, rainwater harvesting, waste segregation and plastic reduction show positive mean values but statistically insignificant Z-scores, implying voluntary, uneven and non-systematic adoption. These practices are largely driven by traditional knowledge and moral responsibility rather than formal sustainability frameworks.

On the other hand, negative mean values for grey water reuse, low-flow fixtures, star-rated appliances and access to sustainable finance highlight structural barriers, particularly financial constraints, limited technical awareness and weak institutional support. The significantly negative Z-score for eco-certification participation reflects the absence of incentive-based sustainability governance in the region.

The overall findings indicate that homestays in the Dooars region follow a “low-cost sustainability pathway”, adopting environmentally responsible practices only when they are affordable and locally manageable. The study finds that homestays in the Dooars region largely adopt low-cost and locally manageable green practices, with widespread use of LED lighting and moderate adoption of solar energy systems, though their operational efficiency remains uncertain. Rainwater harvesting is the most prevalent water conservation measure, while awareness and adoption of advanced water-saving technologies and grey water reuse remain limited due to technical knowledge gaps. Waste management practices are primarily informal yet environmentally conscious, characterised by composting and reduced plastic use, with limited recycling and absence of structured segregation systems. Adoption of energy-efficient star-rated appliances is constrained by high initial costs, weak regulatory oversight and lack of incentives. A critical constraint is the near absence of sustainable finance mechanisms, including concessional green loans, parametric insurance and eco-certification programmes. Despite these limitations, homestay operators exhibit strong environmental intent and express support for financial and institutional interventions to foster sustainable and climate-resilient tourism in the region.

7. CHALLENGES IN ADOPTING GREEN TECHNOLOGIES AND APPLIANCES

Despite growing awareness of sustainable tourism principles, homestays in the Dooars region face multiple interrelated challenges that hinder the systematic adoption of green technologies and environmentally responsible practices.

Financial Constraints

The most critical challenge is the lack of access to sustainable finance. Homestay operators reported limited availability of concessional green loans, subsidies and insurance products tailored to small accommodation providers. High upfront costs associated with solar energy systems, star-rated appliances, water-efficient fittings and waste management infrastructure discourage investment, particularly in the absence of financial incentives or repayment flexibility. As a result, sustainability adoption remains restricted to low-cost measures.

Limited Technical Awareness and Knowledge

Another major challenge is inadequate technical awareness regarding advanced green technologies. While basic practices such as LED lighting and rainwater harvesting are well understood, knowledge about grey water reuse, sensor-based fittings, energy-efficient appliances and integrated waste recycling systems is minimal. The absence of training programmes, demonstration projects and technical guidance limits operators' ability to implement and maintain such technologies effectively.

Informal and Fragmented Waste Management

Waste management practices among homestays are largely informal. Although composting and reduction of plastic use are commonly observed, systematic waste segregation, recycling and reuse of plastic remain limited due to weak infrastructure and lack of institutional coordination. Open burning of waste and dependence on firewood leads air pollution and environmental degradation.

Weak Institutional and Regulatory Support

The study reveals limited regulatory monitoring and institutional engagement in promoting sustainability among homestays. Environmental guidelines are either weakly enforced or absent and sustainability compliance is rarely integrated into homestay registration and renewal processes. The lack of eco-certification programmes and performance-based incentives reduces motivation for adopting structured green practices.

Absence of Incentive-based Governance Mechanisms

Eco-certification schemes, green branding and market-linked incentives are largely unavailable or inaccessible to homestay operators. Without tangible benefits such as tax relief, marketing support or preferential tourism listings, sustainability remains a voluntary activity rather than a strategic business decision.

Rising Environmental Pressures from Tourism Growth

The increasing number of homestays has intensified energy consumption, plastic waste generation, noise pollution and pressure on local ecosystems. Without coordinated sustainability planning, the cumulative environmental impact of small accommodation units risks undermining the ecological integrity of the region.

8. CONCLUSION

The study empirically examines the adoption of green technologies and environmentally responsible practices among homestays in the Dooars region using a bipolar Likert scale framework. The findings reveal a dualistic pattern of sustainability adoption. Low-cost, easily manageable practices such as LED lighting, rainwater harvesting and plastic reduction exhibit positive deviation from neutrality, reflecting environmentally conscious behaviour rooted in traditional knowledge and moral responsibility.

In contrast, technology-intensive practices and institutional sustainability mechanisms including grey water reuse, star-rated appliances, access to sustainable finance and eco-certification display negative mean values and Z-scores, indicating structural constraints related to finance, awareness and governance. The statistically significant lack of eco-certification participation underscores the absence of incentive-based sustainability frameworks in the region.

The study concludes that homestays in the Dooars region operate within a low-investment sustainability model, wherein environmentally responsible practices are adopted primarily when they are affordable, informal and free from regulatory or technological complexity. Although homestay operators demonstrate strong environmental intent and community-oriented responsibility, the adoption of advanced green technologies remains constrained by financial limitations, inadequate technical awareness and weak institutional support. The findings underscore the need to move beyond voluntary sustainability by strengthening sustainable finance mechanisms, enhancing capacity-building initiatives and establishing supportive governance frameworks to promote resilient and climate-

responsive tourism. By providing empirical evidence on green technology adoption in rural and ecologically sensitive tourism destinations, the study contributes to the existing literature and offers policy-relevant insights for fostering sustainable tourism development.

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