

Assessing the Role of Green Microfinance in Poverty Alleviation and Sustainable Livelihood Development: An Empirical Study of Rural Households

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ABSTRACT

This study examines the role of Green Microfinance in poverty alleviation and sustainable development in the least literate districts of Uttar Pradesh, India. Green Microfinance combines access to financial services with environmentally sustainable practices, aiming to enhance livelihoods, promote ecological resilience, and address socio-economic disparities. Primary data were collected from 102 rural households through a bilingual (Hindi and English) structured questionnaire, using a multi-stage stratified sampling technique, and supplemented with secondary sources. Analytical methods focused on Principal Component Analysis (PCA), a component of factor analysis, employing Varimax rotation to extract key dimensions of impact. The PCA results identified four principal factors Income and Asset Creation, Environmental Sustainability, Capacity Building, and Social Empowerment which together explained 64.7% of the total variance. These findings underscore the multidimensional benefits of Green Microfinance, revealing its capacity to foster economic growth, encourage environmentally responsible practices, and strengthen community resilience. The study offers strategic implications for policymakers, microfinance institutions, and non-governmental organizations seeking to design and implement inclusive, sustainable financial interventions in socio-economically disadvantaged regions.

Keyword: Green Microfinance, Poverty Alleviation, Sustainable Livelihoods and Rural Households

INTRODUCTION

Poverty alleviation and sustainable development remain two of the most pressing challenges in the 21st century, particularly in developing countries like India, where a significant portion of the population resides in rural areas and remains economically marginalized (Gupta 2024). Traditional development models have emphasized economic growth and infrastructure expansion, yet these approaches often fall short in addressing the dual needs of social equity and environmental sustainability (Mekha et al., 2023). In response, microfinance has emerged as a powerful instrument for empowering economically weaker sections by facilitating access to credit and other financial services (Mishra & Chowdhary 2024). It has played a crucial role in enabling self-employment, supporting small enterprises, and enhancing the socio-economic status of rural populations (Rathi et al., 2025). However, the environmental implications of microfinance interventions have often been overlooked, thereby necessitating a more integrated approach that combines financial inclusion with ecological responsibility (Rizwan et al., 2025).

In recent years, the concept of green microfinance has gained momentum as a strategy that not only addresses poverty but also contributes to environmental sustainability (Huybrechs et al., 2019). Green microfinance refers to the provision of microloans and financial services for environmentally beneficial activities such as the adoption of renewable energy systems, sustainable agriculture, organic farming, water conservation, and eco-friendly housing (Katuwal 2024). By supporting such green initiatives, microfinance institutions (MFIs) can facilitate a transition toward sustainable livelihoods, particularly for rural communities that are highly dependent on natural resources (Paul 2025). This shift is especially significant in the context of climate change, where poor households are disproportionately affected by

environmental degradation and lack the means to adapt (Rahman et al., 2025).

India, being one of the world's most populous and diverse countries, faces complex developmental challenges (Kumar & Shobana 2025). Rural regions, especially in states like Uttar Pradesh, are characterized by high poverty rates, low literacy levels, limited infrastructure, and heavy reliance on agriculture (Kumar et al., 2023). These communities are particularly vulnerable to economic shocks and environmental risks such as droughts, soil erosion, and declining agricultural productivity (Mujeeb et al., 2024). While microfinance has made inroads in improving access to credit in these regions, the integration of green finance into microfinance models remains at a nascent stage (Meyer 2011).

Many MFIs are beginning to explore the promotion of clean energy products (such as solar lanterns and cookstoves) and sustainable farming practices through targeted loans, yet empirical evidence on their effectiveness remains limited (Baita et al., 2024). Despite the theoretical benefits of green microfinance, several challenges hinder its adoption and impact (Alhammedi 2024). First, awareness about green products and practices is often low among rural clients, who may prioritize immediate economic needs over long-term sustainability (Sharma 2024). Second, the cost and availability of green technologies can be prohibitive without proper financial and technical support (Malik et al., 2019). Third, the operational capacity of MFIs to design, deliver, and monitor green financial products is often constrained (Sinha & Ghosh 2022). These issues point to the need for a deeper, data-driven understanding of how green microfinance functions in real-world rural settings and how it contributes to both poverty alleviation and environmental outcomes (Tripathi et al., 2022).

This study aims to empirically assess the role of green microfinance in alleviating poverty and promoting sustainable livelihood development among rural households in selected districts of Uttar Pradesh. It examines whether access to green microfinance improves socio-economic indicators such as income, health, education, and asset ownership, while also fostering environmentally sustainable practices. The research further explores levels of awareness, adoption, and perceived benefits of green financial products among microfinance clients. As India advances toward achieving key Sustainable Development Goals particularly SDG 1 (No Poverty), SDG 7 (Clean Energy), SDG 8 (Decent Work), and SDG 13 (Climate Action) this study offers timely, policy-relevant insights. Positioned at the intersection of financial inclusion, environmental sustainability, and rural development, it highlights green microfinance as a dual-purpose tool for both economic empowerment and ecological resilience. By integrating empirical evidence with policy analysis, the findings aim to inform the design and scaling of green microfinance interventions across rural India and similar contexts globally. The study seeks to identify the most important Green Microfinance strategies adopted for poverty alleviation in backward areas of Uttar Pradesh by Microfinance Institutions (MFIs).

REVIEW OF LITERATURE

Green microfinance plays a transformative role in alleviating poverty by empowering low-income households to adopt sustainable technologies and eco-friendly income-generating activities (Fernandez, 2025). Unlike traditional microfinance, which primarily focuses on financial inclusion and entrepreneurship, green microfinance integrates environmental sustainability into development strategies offering financial products and services that promote access to renewable energy (Sakti et al., 2021), climate-resilient agriculture, clean water, and eco-friendly technologies (Upadhaya et al., 2018). It is designed not only to increase income and reduce vulnerability but also to ensure that the means of economic development are environmentally sustainable (Hariram et al., 2023). One of the most immediate ways green microfinance alleviates poverty is by reducing household expenditure through access to clean energy (Sonkar et al., 2024). Technologies such as solar home systems and improved cookstoves lower reliance on costly and polluting fuels like kerosene, diesel, and firewood (Akram et al., 2020). By minimizing fuel costs, rural households can save a significant portion of their income, which can then be diverted to health care, education, or business expansion (Sharma & Dash 2022). This shift in expenditure contributes to improved living standards and alleviate poverty from a region (Khan & Sahu 2025). Moreover, microloans that support sustainable agricultural practices such as organic farming, agroforestry, rainwater harvesting, and drip irrigation not only enhance agricultural productivity but also contribute to poverty alleviation by increasing crop yields, reducing input costs, ensuring food security, and generating surplus income for smallholder farmers (Meena et al., 2024). These practices not only lead to increased income and food security for smallholder farmers but also protect natural resources like soil, water, and biodiversity, which are critical for sustained rural livelihoods (Tiwari et al., 2024). Green

microfinance also promotes diversification of income sources by enabling borrowers to invest in climate-friendly enterprises such as solar-powered cold storage, composting units, biogas plants, and eco-tourism initiatives, all of which provide alternative livelihood options and reduce over-dependence on a single income stream (Rajeev & Chakraborty, 2023). This diversification is particularly important for households vulnerable to climate shocks, which frequently disrupt agricultural incomes in rural regions (Mehandi et al., 2024).

Another key pathway through which green microfinance alleviates poverty is through health improvement (Sonkar et al., 2024). Clean energy solutions such as improved cookstoves significantly reduce indoor air pollution, a major cause of respiratory illness and premature death in poor households (Deepthi et al., 2025). With reduced smoke exposure, particularly for women and children, families experience better health outcomes, lower medical expenditures, and fewer lost workdays thereby increasing labour productivity and income potential (Ahmad et al., 2016). The time saved from gathering firewood and dealing with health issues also enables women and girls to engage more actively in education, productive activities, or community leadership, thereby reinforcing gender empowerment and intergenerational poverty alleviation (Bhallamudi & Lingam, 2019). Women, in particular, are central beneficiaries of green microfinance. Many microfinance institutions prioritize female clients, recognizing their role in managing household energy, food, and health (Thapa, 2024). Access to green credit enables women to invest in sustainable microenterprises, such as selling solar lanterns, running organic food stalls, or managing water purification units (Maharjan, 2025). These income-generating activities enhance their financial independence, social status, and bargaining power within households and communities (Mukherjee et al., 2025). Furthermore, evidence suggests that women are more likely than men to reinvest income in family well-being, thereby amplifying the developmental impact of microfinance interventions (Gupta et al., 2025). Green microfinance thus not only supports women's economic inclusion but also contributes to broader social and familial outcomes (Waseem et al., 2025). Most green microfinance models incorporate training and awareness programs that educate borrowers on environmental conservation, energy efficiency, and sustainable consumption (Abdur Rouf, 2012). These non-financial services are vital for promoting behavioural change, increasing adoption of green technologies, and ensuring long-term impact (Qazi et al., 2020). Without such support, finance alone may not lead to lasting poverty alleviation, as high upfront costs, limited awareness, weak infrastructure, and low technical capacity often hinder the widespread adoption of green technologies (Raman et al., 2025). Additionally, the poorest households may lack access to green microfinance due to low creditworthiness, which necessitates the design of inclusive financial products with flexible terms, subsidies, and grant components, supported by partnerships with NGOs, government schemes, and private entities (Agarwal & Mukti, 2025). While concluding, it is evident that green microfinance offers a comprehensive pathway to poverty alleviation by enhancing livelihoods, promoting sustainability, and empowering rural communities.

RESEARCH METHODOLOGY

The present study employs a combination of descriptive and inferential statistical techniques to examine the role of green microfinance in poverty alleviation. Designed as both descriptive and explanatory, the research aims to capture existing conditions while uncovering underlying causal linkages. Data was gathered from both primary and secondary sources. Primary data collection involved administering a structured bilingual questionnaire (Hindi and English) to rural households in five least literate districts of Uttar Pradesh namely Shravasti, Bahraich, Balrampur, Budaun, and Rampur. These districts were deliberately selected for their markedly low literacy rates, which fall well below the state average of 67.7%, as reported in official government statistics, and which serve as a major indicator of poverty. The target respondents were rural households belonging to the Economically Weaker Sections (EWS) with some prior engagement in microfinance or green finance initiatives. A pilot sample of 102 respondents was determined using the sample size estimation approach proposed by Viechtbauer et al. (2015), ensuring the adequacy of the instrument for larger-scale application. The survey instrument was structured around single principal constructs i.e., Poverty Alleviation Indicators including household income, employment generation, health improvements, and access to clean energy. Secondary information was compiled from credible sources such as RBI, NABARD, NITI Aayog publications, Census of India reports, peer-reviewed journals, institutional studies, and research databases including SCOPUS, Google Scholar, and Springer. Data analysis was conducted using SPSS Version 20. Descriptive statistics were applied to profile respondents, while Multiple Linear Regression was employed to evaluate the influence of green

microfinance strategies on poverty alleviation outcomes. This methodological design anchored in targeted sampling, validated measurement, and rigorous analysis provides a nuanced understanding of how green microfinance interventions can serve as effective tools for poverty reduction in low-literacy, high-poverty regions of Uttar Pradesh.

ANALYSIS OF DATA

Sample Profile

The present study draws on primary data collected from 102 respondents belonging to five districts of Uttar Pradesh Shravasti, Bahraich, Balrampur, Budaun, and Rampur selected for their relatively low literacy rates and high socio-economic vulnerability. These districts, situated in some of the most underdeveloped regions of the state, are characterized by inadequate infrastructure, limited industrial activity, and a predominant dependence on agriculture and allied sectors. Such conditions often correlate with limited financial literacy, restricted access to formal banking services, and fewer livelihood diversification opportunities. By focusing on these areas, the study aims to investigate the transformative role of green microfinance in enhancing poverty alleviation and sustainable livelihood development in socio-economically marginalized contexts. To ensure inclusivity and comprehension, data was collected through a structured bilingual questionnaire in both Hindi and English, accommodating the linguistic needs of respondents and reducing barriers to participation. The sample represents a mix of male and female respondents across diverse age groups, ranging from below 25 years to above 50 years. The gender distribution is nearly balanced, with women forming a substantial segment of the sample. This is significant, as women have historically been at the forefront of microfinance participation, often channelling credit towards household welfare, education, and income-generating activities. Their involvement in green microfinance programs holds particular promise for fostering environmentally sustainable practices at the grassroots level. The age profile of respondents enables a comparative understanding of generational differences in awareness, adaptability, and openness to innovative financial solutions. Younger respondents, especially those below 25 years, may be more receptive to adopting modern green technologies, while older individuals often rely on traditional livelihood methods. These generational contrasts can influence the uptake and long-term sustainability of green microfinance initiatives. Educational attainment among the respondents varies widely from illiterate individuals to those with graduate and above qualifications reflecting stark disparities in access to formal education. This variation plays a pivotal role in shaping awareness, comprehension of loan processes, and the perceived benefits of green investments. In districts with low literacy rates, limited formal education can hinder the understanding of financial products, repayment obligations, and environmental benefits, thereby necessitating complementary awareness and capacity-building interventions alongside credit provision. Occupational diversity is another notable feature of the sample. A considerable proportion of respondents are engaged in agriculture, either as smallholder farmers or agricultural laborers, with incomes highly susceptible to seasonal fluctuations and climatic uncertainties. Agriculture-dependent households often face acute financial stress during off-seasons or poor harvest years, making them both in need of and well-positioned to benefit from green microfinance solutions aimed at enhancing resource efficiency and climate resilience. Beyond agriculture, a segment of respondents is self-employed in micro and small-scale enterprises such as tailoring, petty shops, dairy farming, handicrafts, and other cottage industries. These occupations often provide supplementary income and can benefit significantly from eco-friendly production methods and sustainable resource use. Additionally, wage laborers whose livelihoods are dependent on daily earnings form a vulnerable segment with minimal savings, making them highly sensitive to income shocks. A smaller proportion is engaged in service-sector jobs, mainly in lower-tier positions, reflecting the limited formal employment opportunities in the study areas. Marital status distribution indicates a predominance of married respondents, which holds implications for household financial decision-making. Married individuals, especially those with dependents, often prioritize stable income generation and long-term security in their borrowing and investment choices. In contrast, unmarried respondents may display higher risk tolerance and willingness to experiment with newer livelihood models. Household income levels among respondents span a broad spectrum, ranging from below ₹5,000 per month to above ₹20,000. This income diversity is a crucial variable in assessing repayment capacity, determining eligibility for larger credit amounts, and evaluating the feasibility of investing in green technologies such as solar-powered irrigation pumps, biogas units, or organic farming inputs. The socio-economic heterogeneity captured in this sample allows for a nuanced analysis of the

factors influencing awareness, adoption, and effective utilization of green microfinance. Low literacy and economic vulnerability present dual challenges: on the one hand, they limit comprehension of sustainable finance mechanisms; on the other hand, they highlight an urgent need for such interventions to break cycles of poverty and environmental degradation. By capturing variables such as gender, age, education, occupation, marital status, and income, the demographic profile not only contextualizes the study but also provides a basis for interpreting the differential impacts of green microfinance across population subgroups. In essence, this diverse demographic composition reflects the lived realities of communities that stand to gain the most from well-designed green microfinance programs. The inclusion of economically disadvantaged districts ensures that the findings are grounded in contexts where policy interventions and financial innovations are most urgently needed. The demographic insights thus serve as a foundational layer for assessing how socio-economic characteristics influence the uptake of environmentally sustainable financial products and, in turn, how such products can catalyse poverty alleviation and livelihood improvement in rural Uttar Pradesh.

Test Applied

In this study, Factor Analysis was applied to identify the key underlying dimensions influencing awareness, adoption, and perceived benefits of green microfinance among rural households. This statistical technique is highly effective for data reduction, as it groups together interrelated variables into smaller, meaningful factors while retaining most of the original information. The dataset comprised variables related to awareness levels, accessibility of green microfinance, perceived socio-economic benefits, and adoption of eco-friendly practices. Before conducting factor extraction, the suitability of the dataset was verified through the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett’s Test of Sphericity. A KMO value exceeding the threshold of 0.6 and a statistically significant Bartlett’s test ($p < 0.05$) confirmed that the dataset was appropriate for factor analysis. Principal Component Analysis (PCA) was used as the extraction method, as it effectively identifies patterns and condenses the information into a reduced set of components. To enhance interpretability, Varimax Rotation was applied, which redistributed the factor loadings to maximize the variance between factors and minimize overlap among them. Factors with eigenvalues greater than 1 were retained for analysis, following the Kaiser Criterion. To improve the interpretability of extracted factors, Varimax Rotation, an orthogonal rotation method, was applied. This technique maximizes the variance of squared loadings within each factor, ensuring that variables load highly on a single factor while having minimal loadings on others. This enhances the clarity and distinctiveness of the factors, making them more meaningful for analysis. The Rotated Component Matrix provided the final structure of factor loadings after rotation. It clearly grouped related variables under specific factors, enabling a more straightforward interpretation of the underlying constructs. By redistributing the variance, rotation preserved the total variance explained while simplifying the factor structure. This step was crucial in identifying distinct dimensions such as awareness, perceived benefits, and accessibility in green microfinance, thereby aiding in the development of targeted policy recommendations for the study area. Rotation enabled clearer identification of factors such as awareness levels, perceived benefits, ease of access, and policy support in green microfinance. By improving interpretability, it facilitated the formulation of targeted interventions and recommendations for policymakers, microfinance institutions, and community organizations, ensuring that findings are both statistically robust and practically relevant to rural socio-economic development. Applying factor analysis not only simplified the dataset but also provided deeper insights into the structural relationships between various indicators.

Table 1 KMO and Bartlett's Test

| | | |
|--|--------------------|---------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .751 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 652.819 |
| | Df | 105 |
| | Sig. | .000 |

Complied by Researcher

Table 1 displays Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy for this study which was 0.751, indicating a middling to good level of sampling adequacy (Kaiser, 1974). This suggests that the proportion of variance among variables that might be common variance is sufficiently high, making the dataset appropriate for factor analysis. Bartlett’s Test of Sphericity produced an approximate Chi-Square value of 652.819 with 105 degrees of freedom and a significance level of 0.000. The highly significant p-value (<0.05) confirms that the correlation matrix is not an identity matrix, meaning that the variables

share enough common variance to justify the use of factor analysis. Together, these results confirm the suitability of the dataset for further extraction and rotation procedures, ensuring that the identified factors will be meaningful and statistically reliable in explaining patterns related to green microfinance awareness and socio-economic variables in the study area.

Table 2 Total Variance Explained

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|-----------|---------------------|---------------|--------------|-------------------------------------|---------------|--------------|-----------------------------------|---------------|--------------|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.140 | 34.266 | 34.266 | 5.140 | 34.266 | 34.266 | 3.636 | 24.238 | 24.238 |
| 2 | 1.831 | 12.206 | 46.472 | 1.831 | 12.206 | 46.472 | 2.592 | 17.282 | 41.519 |
| 3 | 1.675 | 11.168 | 57.640 | 1.675 | 11.168 | 57.640 | 2.066 | 13.770 | 55.289 |
| 4 | 1.060 | 7.064 | 64.704 | 1.060 | 7.064 | 64.704 | 1.412 | 9.415 | 64.704 |
| 5 | .979 | 6.529 | 71.233 | | | | | | |
| 6 | .808 | 5.388 | 76.621 | | | | | | |
| 7 | .724 | 4.827 | 81.448 | | | | | | |
| 8 | .609 | 4.059 | 85.507 | | | | | | |
| 9 | .550 | 3.665 | 89.173 | | | | | | |
| 10 | .440 | 2.932 | 92.104 | | | | | | |
| 11 | .313 | 2.087 | 94.191 | | | | | | |
| 12 | .285 | 1.898 | 96.090 | | | | | | |
| 13 | .237 | 1.581 | 97.671 | | | | | | |
| 14 | .186 | 1.240 | 98.911 | | | | | | |
| 15 | .163 | 1.089 | 100.000 | | | | | | |

Extraction Method Principal Component Analysis

Compiled by Researcher

The Total Variance Explained table summarizes the results of the Principal Component Analysis (PCA) conducted using the extraction method of Principal Component Analysis. This table provides insight into how much variance in the dataset is captured by each component before and after rotation. In the Initial Eigenvalues section, the first four components have eigenvalues greater than 1, which is the common criterion (Kaiser's rule) for retaining components. Specifically, Component 1 explains 34.27% of the total variance, Component 2 explains 12.21%, Component 3 explains 11.17%, and Component 4 explains 7.06%. Together, these four components account for 64.70% of the cumulative variance, indicating that they retain the majority of the information from the original dataset. Components 5 onward have eigenvalues less than 1 and explain relatively small amounts of variance, making them less significant in the final factor solution. The Extraction Sums of Squared Loadings show the same total variance percentages for the first four components as in the initial eigenvalues because PCA extraction retains only components with eigenvalues above 1. This confirms that the retained components capture substantial and meaningful variance. The Rotation Sums of Squared Loadings redistribute the variance across the components to achieve a simpler and more interpretable factor structure. After applying Varimax rotation a common orthogonal rotation method the variance explained by Component 1 reduces from 34.27% to 24.24%, while the variance explained by Components 2, 3, and 4 increases to 17.28%, 13.77%, and 9.42%, respectively. This indicates that rotation spreads the explanatory power more evenly across the retained components, which helps in clearer factor interpretation without changing the total variance explained. Overall, the results suggest that the data structure can be effectively represented by four underlying components, which together explain 64.70% of the total variance. The rotation process ensures that each factor has a clearer pattern of loadings, making it easier to interpret which variables contribute most strongly to each factor. This improves the theoretical and practical utility of the PCA results.

Table 3 Rotated Component Matrix

| | Component | | | |
|---|-----------|-------|-------|-------|
| | 1 | 2 | 3 | 4 |
| I agree that Green microfinance has improved my household's income and financial stability. | .697 | .278 | .061 | .300 |
| I agree that Green Microfinance helped my family move from subsistence to sustainable livelihood. | .252 | .166 | .574 | .484 |
| I agree that access to Green microcredit has reduced my dependence on moneylenders or informal borrowing. | .330 | .112 | .644 | .267 |
| I agree that Green microfinance has enabled us to invest in productive, income-generating assets. | .889 | .117 | .072 | -.053 |
| I agree that Green microfinance improved housing, food security, or health due to green microfinance support | .159 | .798 | .127 | -.047 |
| I agree that Green financial services have helped us cope better with economic shocks (e.g., illness, crop loss). | .496 | .400 | .283 | .162 |
| I agree that Green microfinance has created self-employment or job opportunities in our community. | .773 | .025 | .343 | -.197 |
| I agree that Green Microfinance has enhanced women's participation in household and community-level economic decisions. had an Impact on economic status of a person. | .024 | .010 | .827 | -.003 |
| I agree that Green Microfinance supported small businesses in our village (e.g., solar repair, organic farming, biofuel production). | .847 | .065 | .112 | .069 |
| I agree that Green microfinance has helped lift us above the poverty line. | .370 | .574 | .159 | -.085 |
| I agree that Green Microfinance improved access to basic services such as education, electricity, or water. | .609 | .300 | -.181 | .523 |
| I agree that Green Microfinance supports long-term income growth while preserving natural resources | -.105 | .749 | .078 | .133 |
| I agree that people waste less energy and water because of green microfinance solutions | .054 | .358 | .531 | .016 |
| I agree that Green Microfinance had improved standard of living | .271 | .701 | .051 | -.160 |
| I agree that Green microfinance has significantly contributed to reducing poverty in my area | -.056 | -.244 | .227 | .786 |
| Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 8 iterations. | | | | |

Complied by Researcher

The rotated component matrix, derived using Principal Component Analysis with Varimax rotation, reveals four distinct components capturing the multidimensional impacts of green microfinance on rural households. Component 1 reflects strong loadings on variables related to income generation, asset creation, and small business support, indicating that green microfinance has significantly enhanced financial stability, entrepreneurial activities, and productive investments. Component 2 captures improvements in quality of life, including better housing, food security, and sustainable resource use, alongside increased long-term income growth while preserving natural resources, highlighting its socio-environmental benefits. Component 3 represents empowerment and social transformation, with high loadings on women's participation in decision-making, reduction in dependence on moneylenders, and adoption of resource-efficient practices, pointing toward enhanced social equity and sustainable livelihoods. Component 4 is primarily associated with substantial poverty reduction, suggesting that green microfinance initiatives directly address the economic upliftment of marginalized communities. The convergence within eight iterations confirms a clear factor structure, and the results collectively indicate

that green microfinance interventions in regions like Shravasti, Bahraich, Balrampur, Budaun, and Rampur contribute holistically to economic empowerment, social inclusion, and environmental sustainability. This multifaceted impact underscores the role of green microfinance not only as a financial tool but also as a driver of socio-economic transformation, gender equality, poverty alleviation, and ecological resilience in rural settings, ensuring long-term, inclusive, and sustainable development outcomes for disadvantaged households.

DISCUSSION

The findings confirm that green microfinance contributes significantly to poverty alleviation among residents of the least literate districts of Uttar Pradesh, as supported by qualitative insights gathered from the target population. The analysis not only validates but also extends prior research by illustrating how green finance initiatives and strategies contribute to alleviate poverty as well as leads to financial inclusion of least literate district of Uttar Pradesh. Statistical tests employed in the study highlight complex interrelationships among key determinants, underscoring the transformative potential of green microfinance in enhancing socio-economic status and fostering sustainable rural development.

The factor analysis test revealed that Green Microfinance factors indeed contribute to alleviating poverty within the region (Kumari, 2021). The extracted components demonstrated significant influences on income generation, quality of life, empowerment, and environmental sustainability (Gautam & Bhalla, 2024). These results strongly support the conclusion, as the statistical evidence aligns with field observations and respondents' qualitative feedback, confirming that targeted green microfinance interventions not only enhance financial stability but also foster social inclusion and ecological resilience (Armah et al., 2025). The convergence of quantitative and qualitative findings underscores the reliability of the analysis and validates that green microfinance serves as a comprehensive tool for driving sustainable rural development and uplifting marginalized communities in the least literate districts of Uttar Pradesh (Rastogi, 2025).

The factor analysis revealed four critical dimensions through which Green Microfinance positively influences rural households in the least literate districts of Uttar Pradesh (Yadav et al., 2024). The first factor focused on income generation, asset creation, and small business support, reflecting improved financial stability and entrepreneurial growth (Mason & Brown, 2014). The second highlighted enhancements in quality of life, food security, and sustainable resource use, indicating socio-environmental gains (Shukla et al., 2024). The third emphasized empowerment particularly women's decision-making roles, reduced dependency on moneylenders, and adoption of resource-efficient practices showcasing social equity and inclusiveness (Rashid & Gani, 2025). The fourth was directly linked to poverty reduction, evidencing tangible economic upliftment (Ayoo 2022). These findings were statistically validated by a Kaiser-Meyer-Olkin (KMO) value of 0.751 and a highly significant Bartlett's test ($p < 0.001$) (Mustafa et al., 2025). Qualitative insights from respondents further supported the statistical outcomes, consistently affirming that green microfinance initiatives drive transformative change by enhancing livelihoods, empowering marginalized groups, and promoting environmental sustainability in rural communities (Haroon, 2025).

The research concludes that Green Microfinance serves as a critical driver in alleviating poverty while simultaneously advancing environmental sustainability and social inclusion within rural Uttar Pradesh. The factor analysis results underscore the multi-dimensional impact of such initiatives, revealing benefits that extend well beyond financial assistance. These include enhanced income generation, asset creation, improved food security, resource-efficient practices, and women's empowerment each contributing to a more resilient and equitable rural economy. The robust factor structure derived from the analysis validates that these benefits are interconnected and mutually reinforcing, creating a cumulative effect on the overall socio-economic well-being of the target population. The reliability of these conclusions is further strengthened by the alignment between statistical evidence such as the KMO value of 0.751 and the significant results of Bartlett's test and qualitative insights gathered from field interactions. Respondents consistently highlighted how access to green microfinance transformed their livelihoods, reduced reliance on exploitative moneylenders, and encouraged environmentally responsible behaviour. This confluence of quantitative and qualitative evidence demonstrates that targeted green finance initiatives are not merely financial interventions but also act as catalysts for holistic rural development. By addressing economic, social, and ecological dimensions in tandem, Green Microfinance emerges as a sustainable pathway for poverty eradication, fostering community empowerment, and ensuring long-term rural resilience.

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Ethical Approval:

This study, "Assessing the Role of Green Microfinance in Poverty Alleviation and Sustainable Livelihood Development: An Empirical Study of Rural Households," was approved by the Ethics Committee of Integral University, Lucknow, ensuring compliance with ethical research standards. Approval number: IU/R&D/2025-MCN0003903

Informed Consent:

Participation in the study was voluntary, and all participants provided written informed consent. Participants were fully informed about the study objectives, their roles, and their rights to withdraw at any stage.

Conflict of interest:

There is no such conflict of interest with any party.

Data availability statement:

The used data will be provided on proper request.

Authors' contributions:

All authors have contributed equally to all aspects of the research. All authors read and approved the final manuscript.