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Assessment of Knowledge of Microplastic Pollution and its Environmental Effects among Rural Dwellers in the Idanre Forest Zones, Ondo State, Nigeria

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Abstract. This study assessed the knowledge of microplastic pollution and its environmental effects among rural dwellers in the Idanre forest zones of Ondo State, Nigeria. A multistage sampling technique was used to select 180 respondents from three forest-fringe communities: Omifunfun, Ofusu, and Modaredele. Primary data were collected using structured questionnaires and analyzed using descriptive statistics and inferential models including logit regression, probit regression, and linear regression. The descriptive analysis revealed that the mean age of respondents was 2.20, indicating that most respondents fell within the 21–26 year age category. The mean value for gender was 1.34, suggesting that the majority of respondents were male. Educational attainment recorded a mean value of 2.50, showing that most respondents had at least secondary education. Household size had a mean value of 1.89, indicating that most households consisted of four to six members. The mean value for occupation was 1.86, suggesting that trading was the dominant occupation, while the mean income value of 1.89 indicated that most respondents earned between ₦1 and ₦30,000 monthly. The logit regression results showed that age ($\beta = 0.031$, $p < 0.05$), gender ($\beta = 0.462$, $p < 0.05$), education ($\beta = 0.518$, $p < 0.01$), income ($\beta = 0.417$, $p < 0.05$), and farming experience ($\beta = 0.028$, $p < 0.05$) significantly influenced awareness of microplastic pollution. Similarly, the probit regression results revealed that education ($\beta = 0.492$, $p < 0.01$), age ($\beta = 0.024$, $p < 0.05$), gender ($\beta = 0.381$, $p < 0.05$), and farming experience ($\beta = 0.022$, $p < 0.05$) significantly influenced respondents' knowledge of microplastic pollution. The linear regression results further indicated that education, income, household size, age, and farming experience significantly influenced respondents' perception of the environmental effects of microplastic pollution. The study concluded that socio-economic characteristics significantly influenced rural dwellers' awareness, knowledge, and perception of microplastic pollution in the study area.

Keywords: Microplastic pollution, Environmental awareness, Rural communities, Forest ecosystems, Environmental education.

1. Introduction

Microplastic pollution had increasingly emerged as a critical environmental challenge across the globe due to its persistence, mobility, and potential ecological and human health implications. Microplastics are generally defined as plastic particles smaller than 5 mm in diameter that originate either from the fragmentation of larger plastic materials or from primary micro-sized plastics intentionally produced for industrial and domestic uses such as cosmetics, synthetic textiles, and cleaning products (Thompson *et al.,* 2004; GESAMP, 2015). Over the past several decades, global plastic production had expanded rapidly following industrial growth and increasing consumer demand, leading to significant accumulation of plastic waste in both terrestrial and aquatic environments. Consequently, microplastic contamination had become an emerging environmental concern affecting soil ecosystems, freshwater systems, marine environments, wildlife, and human populations (Andrady, 2017; Barnes *et al.,* 2009). Globally, the magnitude of plastic pollution had reached alarming levels. Reports indicated that approximately 11 million metric tons of plastic waste entered aquatic environments each year, and projections suggested that this figure could increase significantly if effective waste management strategies were not implemented (Jambeck *et al.,* 2015; UNEP, 2021). As plastics degrade through exposure to

ultraviolet radiation, mechanical abrasion, and environmental weathering, they break down into smaller particles that persist in the environment for extended periods. These microplastic particles can easily be transported by wind, water, and soil processes, thereby contaminating diverse ecosystems far from their original sources (Cole *et al.,* 2011). In recognition of the growing environmental threat posed by plastic pollution, the United Nations Environment Assembly adopted a global resolution aimed at addressing plastic waste and promoting sustainable production and consumption patterns (UNEA, 2022).

While earlier research focused predominantly on marine pollution, more recent studies had demonstrated that terrestrial ecosystems, including forest landscapes, were also important sinks and pathways for microplastic contamination. Forest zones often serve as ecological buffers that regulate climate, protect biodiversity, and support local livelihoods; however, they had increasingly been exposed to anthropogenic pollution pressures, including plastic waste accumulation (Rillig, 2012). Plastics discarded within forest environments can undergo physical and chemical degradation, producing microplastic particles that accumulate in forest soils, streams, and vegetation. These particles may interfere with soil microbial communities, nutrient cycling, and plant growth, thereby altering ecosystem functioning (de Souza Machado *et al*., 2018; Horton *et al.,* 2017). Forest ecosystems located near human settlements are particularly vulnerable to plastic contamination because of increased tourism, agricultural activities, fuelwood collection, and domestic waste disposal practices. In many developing countries, waste management infrastructure remains inadequate, resulting in open dumping and uncontrolled disposal of plastic materials in natural environments (Lebreton and Andrady, 2019). Such practices often lead to the gradual fragmentation of plastic debris into microplastics that can be transported through soil erosion, rainfall runoff, and wind movement into surrounding ecological systems.

The Idanre forest zones in Ondo State represent one of the ecologically important forest regions in southwestern Nigeria. These forest landscapes support rich biodiversity and provide multiple ecosystem services such as climate regulation, watershed protection, and livelihood resources for surrounding rural communities. Rural dwellers within these forest zones depend heavily on forest resources for agriculture, hunting, fuelwood collection, and other subsistence activities. However, increasing human population pressure and expanding rural settlements around the forest had intensified environmental challenges, including improper waste disposal and plastic pollution. Plastics used for food packaging, agricultural inputs, and household goods were frequently discarded in open spaces or forest margins where they gradually degraded into smaller fragments and microplastic particles. Understanding the level of knowledge among rural dwellers regarding microplastic pollution was therefore crucial for effective environmental management and conservation. Environmental knowledge has long been recognized as a key determinant of community attitudes and behaviors toward pollution control and natural resource management. According to Ajzen (1991), individuals' environmental behavior is strongly influenced by their knowledge, perceptions, and attitudes toward environmental problems. Similarly, Schultz (2002) emphasized that awareness of environmental issues plays a fundamental role in shaping responsible environmental practices among communities.

Despite the growing global concern regarding microplastic contamination, studies investigating community knowledge and awareness of microplastic pollution remained limited, particularly within rural communities in developing countries. Most existing research had focused primarily on marine ecosystems, urban waste management systems, or scientific monitoring of environmental contamination, leaving a significant knowledge gap regarding rural populations' understanding of microplastic pollution (Horton *et al.,* 2017; Rillig and Lehmann, 2020). Given that rural communities living around forest zones often interact closely with the natural environment through farming, hunting, and forest resource harvesting, their knowledge and perceptions of environmental pollution could significantly influence waste disposal behaviors and conservation practices.

Therefore, assessing the knowledge of rural dwellers regarding the environmental effects of microplastic pollution within the Idanre forest zones of Ondo State was considered important. Such an assessment provided insights into the level of environmental awareness among communities that depend directly on forest ecosystems for their livelihoods. Furthermore, identifying knowledge gaps could assist policymakers, environmental managers, and extension agencies in designing targeted environmental education programs and community-based waste management strategies aimed at reducing plastic pollution and protecting forest ecosystems. Ultimately, improving community awareness and promoting sustainable waste management practices would contribute to safeguarding biodiversity, enhancing environmental

quality, and ensuring the long-term sustainability of forest landscapes in southwestern Nigeria.

2. Research Methodology

2.1 The Study Area

The Idanre Forest Reserve was a significant protected woodland area situated in the Idanre Local Government Area of Ondo State in southwestern Nigeria. It was mapped at approximately latitude 6°51′28″ N and longitude 5°06′20″ E (decimals ~6.8577° N, 5.1056° E), resting at an elevation of about 148 meters above sea level. Protected Planet (2011). The forest reserve itself had covered several hundred square kilometers of dense vegetation, interspersed with rivers, ridges, and patches of primary and secondary forest that supported a range of wildlife and timber species. It was bounded by natural features such as the river Ofusu to one side and sat near historic landmarks like the famed Idanre Hills that rose dramatically beyond its western fringe. (Oguntimehin and Onyekwelu, 2019). Around this forest, there were a number of small settlements and villages where people lived and farmed, the major occupation of the people is farming, many of them within just a few kilometers of the reserve boundary.

2.3 Target Population

The target population of the study was household head or representative around the communities in Idanre forest reserves

2.4 Sampling Procedures and Sampling size

A reconnaissance survey was initially conducted to identify settlement surrounding the Idanre Forest Reserve. Five settlements were identified within an 15 km radius. Of these, three settlements Omifunfun to the East, Modaredele to the north, and Ofusu to the south were systematically selected for the study. The remaining communities, including Owobamibo and Onipako are located along the same southern axis as Ofusu, were not considered. The selected settlements purposively chosen based on presence of mircoplastic and their substantial population within the study area. Base line survey and household counting was carried out to obtain a population in each selected community using Participatory rural appraisal (PRA) techniques. 1550 household were identified in Omifunfun, in Ofusu 1100 and 1000 in Modaredele through. 5 percent of the household heads or representatives who were participating in homegrown farming were selected. In Omifunfun, 75 heads were selected Ofusu, 55 heads and 50 from Modaredele. The total respondents for the study were 180.

2.5 Data Analysis

Data were analyzed with both descriptive statistics such as frequency count and percentages and inferential analysis (logit regression, probit regression and linear regression).

2.6 Measurement of Variables

2.61 Socio-Economic Variables and their Measurement

To understand the relationship between the surrounding communities and the forest reserve, several socio-economic variables were typically measured in research studies. These included:

Age of Respondents: measured in years, often categorized into age groups (e.g., 18–30, 31–45, 46–60, and above 60).

Gender: measured as a categorical variable (male or female).
Household Size: measured as the number of persons living in a household.
Educational Level: measured according to the highest level of formal education attained (no formal education, primary, secondary, tertiary).

Primary Occupation – measured as a categorical variable (farming, trading, civil service, artisan work, etc.).
Farm Size – measured in hectares (ha) to indicate the scale of agricultural production.
Annual Income – measured in Nigerian Naira (₦) per year, often grouped into income ranges.

2.7 Regression Measurements

Several socio-economic variables were converted into dummy variables in order to capture category-specific effects. Gender was coded as a dummy variable where male respondents were assigned a value of 1 while female respondents were coded as 0. Marital status was also represented as a dummy variable where married respondents were coded as 1 and unmarried respondents were coded as 0. Furthermore, household size was categorized into four groups: 1–3 persons, 4–6 persons, 7–10 persons, and 11–13 persons. The smallest household size group (1–3 persons) served as the reference category, while three dummy variables represented the remaining categories. Estimated monthly income was categorized into ₦1–30,000,

₦30,001–60,000, and ₦60,001–90,000. The lowest income group served as the reference category, while two dummy variables represented the other income groups. Also, primary occupation was categorized into trading, farming, and artisan activities. Trading was used as the reference category, while dummy variables represented farming and artisan occupations. Lastly, age and farming experience were retained as continuous variables measured in years.

2.8 Model Specification

The logit model used to estimate awareness of microplastic pollution was specified as:

Logit $(\mathrm{Pi}) = \beta 0 + \beta 1\mathrm{age} + \beta 2\mathrm{gender} + \beta 3\mathrm{educ} + \beta 4\mathrm{marital} + \beta 5\mathrm{hh4\_6} + \beta 6\mathrm{hh7\_10}$

Where:

Pi= probability that respondent iii was aware of microplastic pollution.

The probit model estimating knowledge of microplastic pollution was expressed as:

$P(Y=1)=\varphi(\beta 0+\beta 1age+\beta 2gender+\beta 3educ+\beta 4 marital+\beta 5hh4\_6+\beta 6hh7\_10+\beta 7hh11\_13+\beta 8 inc30\_60+\beta 9inc60\_90+\beta 10farm+\beta 11artisan+\beta 12 exp+\varepsilon)$

Where:

Φ represents the cumulative normal distribution function.

Linear Regression Model (Perceived Effects)

The model estimating perceived environmental effects was specified as:

$Yi=\beta 0+\beta 1age+\beta 2gender+\beta 3educ+\beta 4marital+\beta 5 hh4\_6+\beta 6hh7\_10+\beta 7hh11\_13+\beta 8inc30\_60+\beta 9 inc60\_90+\beta 10farm+\beta 11artisan+\beta 12exp+\varepsilon$

Yi= perceived effect index of microplastic pollution.

3. Result and Discussion

Table 1 presented the socio-economic characteristics of the respondents in the study area, with emphasis on the mean values of the variables to explain the dominant patterns among respondents. The mean age of the respondents was 2.20, which indicated that the majority of respondents fell within the 21–26 years age category. This result suggested that most of the respondents were relatively young adults who were likely to be within their active and productive years. Individuals within this age group often possess higher cognitive capacity and exposure to educational activities that enhance environmental awareness and understanding of emerging environmental problems such as microplastic pollution. This finding supported the observation of Adeogun *et al.* (2022), who reported that individuals within this age range tend to demonstrate greater environmental awareness and responsiveness to sustainability education. The gender distribution of respondents produced a mean value of 1.34, indicating that the study population was predominantly male. This result suggested that male respondents constituted a larger proportion of participants involved in environmental and agricultural activities within the study area. The dominance of male respondents could be attributed to socio-cultural and occupational structures in rural communities where men are often more involved in activities such as farming, forest resource extraction, and environmental decision-making. Similar gender patterns have been reported in previous studies, where male participation in agriculture and environmental resource management was found to be higher than female participation due to socio-economic and cultural factors (Okorie *et al.,* 2022). The mean value for religious affiliation was 1.56, indicating that the respondents were largely distributed between Islam and Christianity. This finding suggested a relatively balanced representation of the two major religions within the study area. Religion plays an important role in shaping individuals' ethical values and environmental attitudes in many African societies. Both religious traditions emphasize stewardship and responsible management of natural resources, which may influence community perceptions of environmental protection and sustainability. Previous research has shown that religious teachings can positively influence pro-environmental behavior and strengthen community commitment toward environmental conservation (Adeyemi and Ojo, 2021).The analysis of marital status yielded a mean value of 1.07, indicating that most respondents were single. This result reflected the demographic structure of the respondents, where the majority were likely to be young adults with limited family responsibilities. The predominance of single individuals suggested that respondents might have greater flexibility to participate in educational activities and environmental awareness programs. This observation was consistent with the findings of Ogunbanjo and Adeola (2022), who reported that single individuals, particularly young adults, often demonstrated higher engagement in environmental awareness and sustainability-related activities. Educational attainment recorded a mean value of 2.50, which indicated that the majority of respondents had at least secondary education. This result suggested that the respondents possessed a moderate level of literacy and educational exposure that could facilitate understanding of environmental issues such as plastic pollution and environmental degradation. Higher levels of education are generally associated with improved environmental literacy, better access to environmental information, and stronger adoption of environmentally responsible

behaviors. Household size recorded a mean value of 1.89, suggesting that most respondents belonged to households consisting of approximately 4–6 members. This moderate household size indicated relatively stable family structures within the study area. Household size may influence consumption patterns, waste generation, and domestic resource management practices. Larger households may generate more plastic waste through daily consumption activities, thereby contributing to environmental pollution if waste management practices are inadequate. The distribution of respondents by occupation showed a mean value of 1.86, indicating that trading was the dominant livelihood activity among the respondents. Trading activities are common within rural communities and often involve the use of packaging materials such as plastic bags, bottles, and containers. The predominance of trading suggested that respondents were frequently exposed to plastic materials through market activities, which may contribute to the accumulation of plastic waste within local environments. Finally, the estimated monthly income of respondents recorded a mean value of 1.89, indicating that the majority of respondents earned between ₦1 and ₦30,000 per month. This result suggested that most households in the study area belonged to the low-income category, which is typical of rural communities in developing countries. Income level can significantly influence access to environmental information, educational opportunities, and the adoption of environmentally sustainable practices. Households with limited income may prioritize basic livelihood needs over environmental management practices.

Table 1: Socio-Economic Characteristics of the Respondents in the study area

Variables	Categories	Mean	Interpretation
Age	10–20, 21–26, 27–30	2.20	Majority of respondents were between 21–26 years, indicating a relatively young and active population.
Gender	Male, Female	1.34	Respondents were predominantly male.
Religion	Christianity, Islam, Traditional	1.56	Majority of respondents practiced either Islam or Christianity.
Marital Status	Single, Married	1.07	Most respondents were single.
Educational Level	No formal education, Primary, Secondary, Tertiary	2.50	Majority had at least secondary education.
Household Size	1–3, 4–6, 7–10, 11–13 persons	1.89	Most households consisted of about 4–6 members.
Occupation	Trading, Farming, Artisan	1.86	Trading was the dominant occupation among respondents.
Monthly Income (₦)	1–30,000; 30,001–60,000; 60,001–90,000	1.89	Majority of respondents belonged to the low-income category (₦1–30,000).

The logit regression results in Table 2 examined the socio-economic determinants of awareness of microplastic pollution among rural dwellers in the Idanre forest zones. The findings indicated that age had a positive and statistically significant influence on awareness ($\beta = 0.031$, $p < 0.05$), suggesting that older respondents were more likely to be aware of microplastic pollution than younger individuals. Education also exhibited a strong positive and highly significant effect on awareness ($\beta = 0.518$, $p < 0.01$), indicating that respondents with higher levels of education demonstrated greater awareness of microplastic pollution. Gender showed a positive and significant relationship with awareness ($\beta = 0.462$, $p < 0.05$), implying that male respondents were slightly more likely to be aware of microplastic pollution compared to female respondents. Income level within the highest category also had a positive and significant effect ($\beta = 0.417$, $p < 0.05$), suggesting that respondents with higher income were more likely to be aware of environmental pollution issues. Additionally, farming experience showed a positive and significant influence on awareness ($\beta = 0.028$, $p < 0.05$), indicating that respondents with longer experience in farming activities were more likely to recognize environmental pollution problems. These findings suggested that education, age, income, gender, and farming experience were the major determinants of awareness of microplastic pollution in the study area. Similar findings have been reported by Kollmuss and Agyeman (2002), who noted that socio-economic factors such as education and experience significantly influence environmental awareness.

Table 2: Logit Regression Estimates for Awareness of Microplastic Pollution (n = 180)

Variable	Coefficient	Std. Error	z-value	p-value
Age	0.031	0.014	2.21	0.027
Gender	0.462	0.211	2.19	0.028
Education	0.518	0.132	3.92	0.000
Marital status	0.207	0.188	1.10	0.271
HH (4–6)	0.331	0.174	1.90	0.058

Variable	Coefficient	Std. Error	z-value	p-value
HH (7–10)	0.289	0.183	1.58	0.114
HH (11–13)	−0.142	0.221	−0.64	0.523
Income (30–60k)	0.296	0.168	1.76	0.079
Income (60–90k)	0.417	0.194	2.15	0.031
Farming	−0.118	0.182	−0.65	0.516
Artisan	−0.236	0.205	−1.15	0.249
Experience	0.028	0.013	2.15	0.032

Significant at 5%

Table 3 presented the probit regression results examining the determinants of respondents' knowledge of microplastic pollution and its environmental implications. The findings revealed that age had a positive and statistically significant effect on knowledge (β = 0.024, $p = 0.042$), indicating that older respondents were more likely to possess knowledge about microplastic pollution. This may be attributed to accumulated environmental experience and longer exposure to environmental changes over time. Education again emerged as a strong determinant of knowledge (β = 0.492, $p < 0.001$), demonstrating that respondents with higher levels of education possessed greater knowledge of microplastic pollution and its environmental effects. Education improves individuals' environmental literacy and capacity to understand complex environmental issues (Stern, 2000). Gender also showed a positive and significant relationship with knowledge (β = 0.381, $p = 0.049$), suggesting that male respondents had slightly higher knowledge levels compared with female respondents. Income level displayed a positive influence on knowledge, particularly among respondents earning between ₦60,001 and ₦90,000 (β = 0.348, $p = 0.054$), although the significance level was marginal. Higher income groups may have better access to information sources such as media, educational programs, and environmental campaigns. Farming experience also had a positive and statistically significant influence on knowledge (β = 0.022, $p = 0.046$), indicating that individuals with longer engagement in farming activities were more likely to understand environmental pollution issues affecting agricultural ecosystems. Overall, the results suggested that education, age, gender, and farming experience were important determinants of respondents' knowledge of microplastic pollution in the study area.

Table 3: Probit Regression Estimates for Knowledge of Microplastic Pollution

Variable	**Coefficient**	**Std Error**	**z-value**	**p-value**
Age	0.024	0.012	2.03	0.042
Gender	0.381	0.194	1.96	0.049
Education	0.492	0.121	4.06	0.000
Marital	0.176	0.167	1.05	0.294
HH (4–6)	0.298	0.160	1.86	0.063
HH (7–10)	0.221	0.172	1.28	0.201
HH (11–13)	−0.163	0.207	−0.79	0.431
Income (30–60k)	0.262	0.152	1.72	0.086
Income (60–90k)	0.348	0.181	1.92	0.054
Farming	−0.094	0.165	−0.57	0.567
Artisan	−0.203	0.187	−1.09	0.276
Experience	0.022	0.011	2.00	0.046

Significant at 5%

The multiple linear regression results presented in Table 4 examined the socio-economic factors influencing respondents' perception of the environmental effects of microplastic pollution. The results indicated that age had a positive and statistically significant effect on perceived environmental effects (β = 0.043, $p = 0.018$), suggesting that older respondents were more likely to perceive microplastic pollution as a serious environmental issue. Increased environmental exposure over time may enable individuals to better recognize environmental degradation. Education showed the strongest positive and highly significant effect on perception of environmental effects (β = 0.561, $p < 0.001$), indicating that respondents with higher levels of education demonstrated stronger perceptions of the environmental consequences of microplastic pollution. Education improves environmental awareness and risk perception, enabling individuals to better understand environmental threats (Kollmuss & Agyeman, 2002).

Gender also had a positive and statistically significant influence on perceived environmental effects (β = 0.316, p = 0.028), indicating that male respondents were more likely to perceive microplastic pollution as a serious environmental concern. Household size within the 4–6 member category also showed a positive and significant effect (β = 0.284, p = 0.020), suggesting that households of moderate size may experience greater exposure to plastic waste generation and environmental pollution. Income level further demonstrated a positive and significant influence on perception of environmental effects, particularly among respondents earning between ₦60,001 and ₦90,000 (β = 0.341, p = 0.009). Higher income levels may enhance access to environmental information and awareness programs. Farming experience also showed a positive and statistically significant effect (β = 0.036, p = 0.017), indicating that respondents with longer agricultural experience were more likely to recognize the environmental impacts of microplastic pollution. Overall, the findings revealed that education, income, age, household size, and farming experience significantly influenced respondents' perception of the environmental effects of microplastic pollution.

Table 4: OLS Regression Estimates for Perceived Effects of Microplastic Pollution

Variable	Coefficient	Std Error	t-value	p-value
Age	0.043	0.018	2.39	0.018
Gender	0.316	0.142	2.22	0.028
Education	0.561	0.117	4.79	0.000
Marital	0.151	0.136	1.11	0.269
HH (4–6)	0.284	0.121	2.35	0.020
HH (7–10)	0.217	0.134	1.62	0.106
HH (11–13)	−0.192	0.166	−1.16	0.247
Income (30–60k)	0.271	0.118	2.29	0.023
Income (60–90k)	0.341	0.129	2.64	0.009
Farming	−0.142	0.126	−1.13	0.261
Artisan	−0.213	0.139	−1.53	0.128
Experience	0.036	0.015	2.40	0.017

Significant at 5%

4. Conclusion

The study assessed the knowledge of microplastic pollution and its environmental effects among rural dwellers in the Idanre forest zones of Ondo State, Nigeria. The findings showed that respondents possessed varying levels of awareness and knowledge regarding microplastic pollution, which were significantly influenced by their socio-economic characteristics. Education emerged as the most consistent determinant across the regression models, indicating that individuals with higher educational attainment demonstrated greater awareness, knowledge, and perception of the environmental impacts of microplastic pollution. Age, gender, household size, income level, and farming experience also played significant roles in shaping respondents' understanding of microplastic pollution. The study therefore highlighted the importance of socio-economic factors in determining environmental awareness within rural communities that depend heavily on forest ecosystems.

5. Recommendations

Based on the findings of the study, the following recommendations were proposed:

- Environmental education programs should be intensified in rural communities surrounding forest reserves in order to improve awareness and knowledge of microplastic pollution and its environmental consequences.
- Government agencies and environmental organizations should implement community-based waste management programs that promote proper disposal and recycling of plastic materials.
- Agricultural extension services should incorporate environmental pollution awareness, particularly microplastic contamination, into their training programs for farmers and rural households.
- Public awareness campaigns using local media, community meetings, and educational workshops should be organized to educate rural dwellers on the environmental risks associated with plastic waste.
- Policy interventions aimed at reducing single-use plastics and promoting environmentally friendly alternatives should be strengthened to minimize plastic waste generation in rural communities.

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