



Forest Resource Degradation and Its Impact on Rural Livelihood in North Bengal

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ABSTRACT

North Bengal, encompassing the sub-Himalayan foothills and the Terai-Dooars ecological zone, harbours some of India's richest forest biodiversity. However, sustained anthropogenic pressure, compounded by policy shortfalls and climate variability, has led to progressive forest degradation over the past five decades. This study examines the multidimensional relationship between forest resource degradation and the livelihood vulnerability of rural communities across eight districts of North Bengal, West Bengal, India. Employing a mixed-methods research design, primary data were collected from 500 purposively sampled households across 25 villages using structured questionnaires, focus group discussions (FGDs), and key informant interviews (KIIs). Secondary data were sourced from the Forest Survey of India (FSI), State Forest Department records, Census of India, and NSSO reports. The findings reveal that approximately 68% of rural households remain directly dependent on forest resources for fuel, fodder, food, and supplementary income. Forest cover in the study area has declined by an estimated 24.3% over the last three decades, substantially reducing the availability of non-timber forest products (NTFPs) and increasing household income vulnerability. Forest-dependent households record annual incomes 43% lower than non-forest-dependent counterparts, with higher rates of poverty, food insecurity, child malnutrition, and lower school enrolment. The study identifies illegal felling, agricultural encroachment, and over-extraction of fuelwood as the primary drivers of degradation. Community-based forest governance, alternative livelihood promotion, and sustainable NTFP enterprise development are recommended as priority interventions for restoring forest-livelihood linkages in North Bengal.

Keywords: Forest Degradation, Rural Livelihood, North Bengal, Non-Timber Forest Products, Community Forest Management, Livelihood Vulnerability, Terai-Dooars

1. Introduction

Forests constitute one of the most vital natural capital assets for rural communities across the developing world, providing a complex web of provisioning, regulating, and cultural ecosystem services. In South Asia, forests serve as the primary safety net for hundreds of millions of rural poor who depend on them for food, fuel, fodder, fibre, and income (World Bank, 2008; Angelsen & Wunder, 2003). The interdependence between forests and rural livelihoods is especially pronounced in the sub-Himalayan biodiversity corridors of northern West Bengal, a region historically



characterised by rich floral diversity, dense forest cover, and high levels of agrarian and forest dependency among its predominantly tribal and marginal communities.

North Bengal, comprising the districts of Darjeeling, Kalimpong, Jalpaiguri, Alipurduar, Cooch Behar, North Dinajpur, South Dinajpur, and Malda, encompasses the Terai-Dooars ecological belt — one of the globally recognised biodiversity hotspots. The forests of this region, including the Buxa Tiger Reserve, Gorumara National Park, Jaldapara National Park, Neora Valley National Park, and numerous reserve and protected forests, support not only extraordinary wildlife but also sustain the livelihoods of over 2.5 million forest-dependent individuals (West Bengal Forest Department, 2021). These communities include the Scheduled Tribes (Oraon, Munda, Santhali, Rajbanshi, Lepcha, Bhutia), ex-tea garden workers, and other marginal cultivators for whom forests are not peripheral but central to their daily survival strategies.

However, the last five decades have witnessed accelerating degradation of forest resources in North Bengal driven by a confluence of demographic, economic, and policy factors. The Forest Survey of India (FSI, 2021) reports a significant net decline in dense forest cover across the sub-Himalayan districts, with concurrent expansion of degraded and open scrubland. Rapid population growth, agricultural expansion, unregulated timber extraction, fuelwood dependency, infrastructure development, and tea estate closures have collectively intensified pressure on forest ecosystems. This degradation has far-reaching consequences for the rural poor who depend on forest goods and services as both a primary source of subsistence and a crucial livelihood buffer during periods of agricultural stress. Despite growing recognition of the forest-livelihood nexus at the national policy level — evidenced by the Forest Rights Act (2006), Joint Forest Management (JFM) programmes, and CAMPA (Compensatory Afforestation Fund Management and Planning Authority) — ground-level implementation in North Bengal has been uneven, contested, and inadequate in reversing the trajectory of degradation. Academic scholarship on this interface in North Bengal remains limited relative to the region's ecological and socio-economic significance, creating a critical knowledge gap that this study seeks to address. This paper presents a comprehensive empirical investigation of the patterns, drivers, and livelihood consequences of forest resource degradation in North Bengal. Drawing on mixed-methods primary research across eight districts, supplemented by secondary data analysis, it aims to generate evidence that can inform both academic discourse and policy action on sustainable forest governance and rural livelihood security in this ecologically sensitive region.

2. Statement of the Problem

The progressive degradation of forest resources in North Bengal represents a compound crisis that simultaneously threatens ecological integrity and the socio-economic well-being of millions of rural households. At the core of this crisis lies a fundamental paradox: communities whose livelihoods are most dependent on forests are often the least equipped — in terms of legal rights, institutional access, and financial capital — to manage or resist the processes of degradation that undermine their survival. The problem is multi-layered. First, the physical dimensions of forest degradation — loss of canopy cover, decline in species diversity, soil erosion, and watershed disruption — are well-documented but poorly translated into assessments of their socio-economic consequences at the household level. Second, while aggregate statistics on forest loss exist, granular, community-level data on how



degradation reshapes income portfolios, food security, gender roles, and seasonal migration patterns among forest-dependent communities are largely absent. Third, existing policies and programmes aimed at forest conservation in the region have inadequately addressed the livelihood dimensions of community forest dependency, often prioritising ecological targets over human development outcomes.

Key questions that motivate this study include:

- What is the nature and extent of forest resource degradation across the districts of North Bengal, and what are its primary drivers?
- How do rural communities depend on forest resources for their livelihoods, and how has this dependency been affected by degradation?
- What are the differential impacts of forest loss on income, food security, gender, and tribal communities in the study region?
- What coping strategies have households adopted in response to declining forest access, and how sustainable are these strategies?
- What policy and institutional interventions can effectively address the dual challenge of forest conservation and livelihood security in North Bengal?

Answering these questions is essential not only for academic understanding but for designing interventions that can break the vicious cycle of poverty-driven forest degradation and degradation-driven poverty in North Bengal's rural communities.

3. Objectives of the Study

The study is guided by the following specific objectives:

1. To assess the spatial and temporal patterns of forest cover change in North Bengal over the period 1990–2023 using secondary data from the Forest Survey of India and related sources.
2. To identify and rank the primary anthropogenic and institutional drivers of forest resource degradation in the study region.
3. To evaluate the socio-economic impacts of forest degradation on rural household welfare, including income, poverty, food security, health, and educational outcomes.
4. To document and assess the coping strategies adopted by forest-dependent households in response to resource depletion.

4. Review of Literature

4.1 Forest Dependency and Rural Livelihoods

The relationship between forest ecosystems and rural livelihoods has been extensively studied across the global South. Angelsen and Wunder (2003) established that forest income contributes between 20% and 35% of total household income for rural communities in tropical developing countries, a figure that rises substantially for the rural poor. The Sustainable Livelihoods Framework (DFID, 1999; Scoones, 1998) provides a foundational theoretical lens for understanding how natural capital — including forests — interacts with human, social, financial, and physical capitals to produce diverse livelihood outcomes. Shackleton et al. (2007) further demonstrated that non-timber forest product (NTFP) harvesting constitutes a critical income safety net, particularly for women-headed and landless households.



In the Indian context, Gupta and Sharma (2014) documented that forest-dependent communities in central and eastern India derive 30–60% of their caloric intake during lean seasons from forest foods, underscoring the irreplaceable nutritional role of forests. Studies by Pattnaik and Dutta (2019) in the Himalayan foothills found that JFM participation improved household income by 18–24% when accompanied by alternative livelihood components.

4.2 Forest Degradation: Drivers and Dynamics

Forest degradation — distinguished from deforestation by the loss of quality rather than complete removal of forest cover — is increasingly recognised as a major and often underestimated dimension of global forest loss (FAO, 2020; Sasaki & Putz, 2009). In sub-Himalayan India, drivers of degradation include population pressure, fuelwood extraction, livestock grazing, fire, and agricultural encroachment (Chaudhary et al., 2016). Roy and Tomar (2000) using satellite imagery demonstrated a decline of 18–22% in dense forest cover across northern West Bengal between 1972 and 2000. More recently, Biswas and Sen (2018) mapped forest fragmentation in the Dooars region, correlating it with increased edge effects, biodiversity loss, and reduced NTFP yields. The role of institutional factors — including unclear tenure, inadequate law enforcement, and JFM implementation gaps — has been highlighted by Lele et al. (2010) and Sarin et al. (2003), who argued that institutional failure is as significant a driver of degradation as direct resource extraction. The political ecology of forests in West Bengal is complicated by a historical legacy of colonial forest policy, subsequent nationalisation, and more recent decentralisation initiatives that have produced contested and often contradictory resource access regimes (Bhattacharya, 2009).

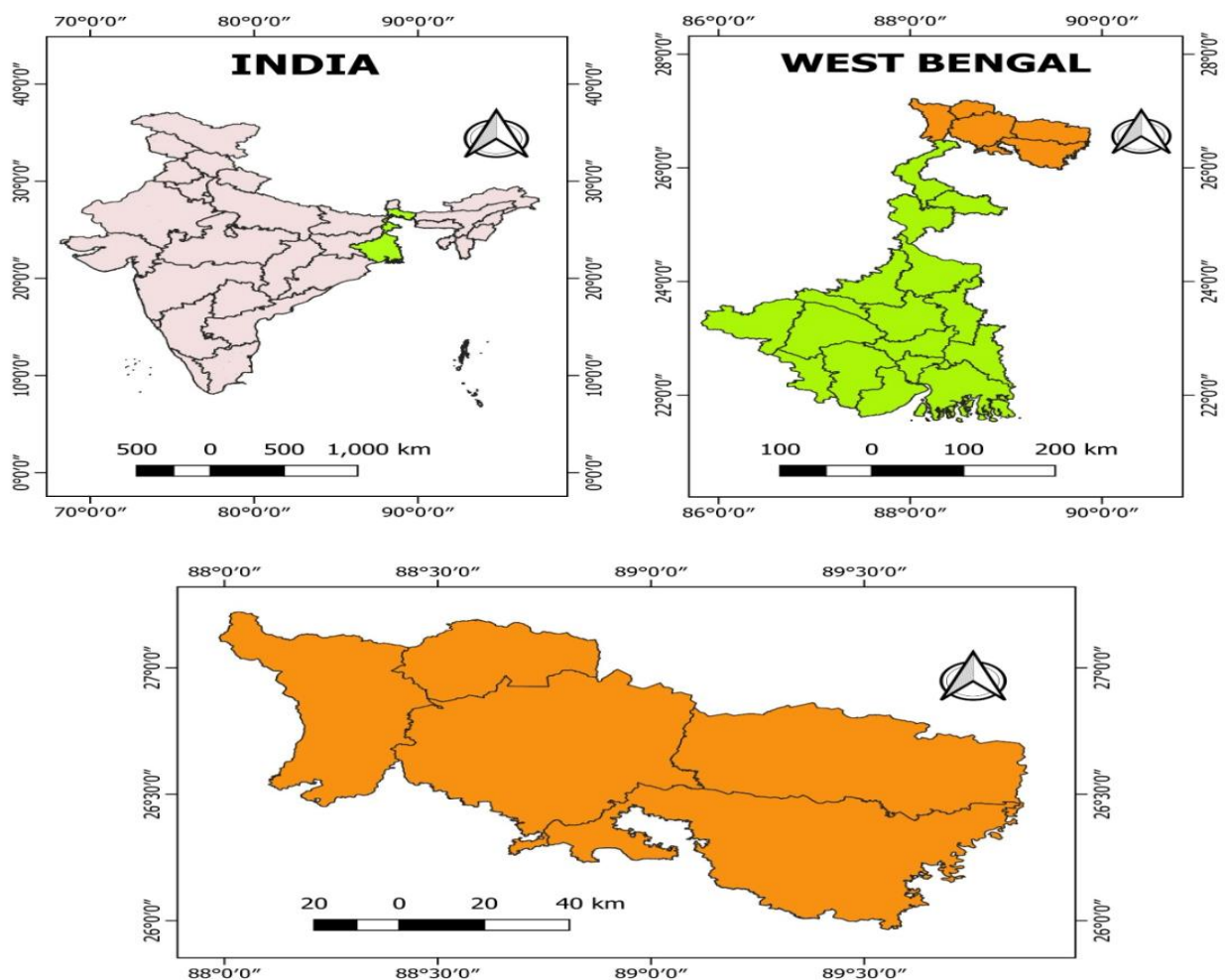
4.3 Tribal Communities and Forest Rights

Tribal communities in North Bengal, including the Oraon, Munda, Santhali, Rajbanshi, and Garo, have historically maintained intricate relationships with forest ecosystems embodying customary use rights, ecological knowledge, and cultural identity. The enactment of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA) represented a landmark attempt to correct the historical dispossession of forest-dependent communities. However, implementation in West Bengal has been severely constrained: as of 2023, fewer than 30% of eligible claims under FRA have been settled in the state (Ministry of Tribal Affairs, 2023). Sengupta and Roy (2020) documented that unrecognised tenure rights in North Bengal continue to expose tribal households to eviction risk, limiting both investment in forest stewardship and access to institutional credit.

5. Study Area

The study encompasses all eight districts of North Bengal division in West Bengal, India, situated between latitudes 25 degrees 32 minutes N and 27 degrees 13 minutes N, and longitudes 87 degrees 46 minutes E and 89 degrees 53 minutes E. The region is bounded by Nepal and Bhutan to the north, Assam and Bangladesh to the east, Bihar and Jharkhand to the west, and the remaining districts of West Bengal to the south. Physiographically, the study area can be divided into three distinct zones: (i) the High Himalayan and Sub-Himalayan hill zone (Darjeeling and Kalimpong districts), (ii) the Terai-Dooars alluvial foothill zone (Jalpaiguri and Alipurduar districts), and (iii) the North Bengal plains zone (Cooch Behar, North Dinajpur, South Dinajpur, and Malda districts).

The hill and foothill zones contain the bulk of the region's forest wealth, comprising sal (*Shorea robusta*) dominant forests, mixed tropical moist deciduous forests, subtropical broad-leaved hill



forests, and Himalayan wet temperate forests. These forests host critically important biodiversity corridors connecting the Eastern Himalayas to the Indo-Burma biodiversity hotspot. The Terai-Dooars belt encompasses some of Asia's most productive grassland-forest mosaics, supporting Bengal tigers, Indian elephants, one-horned rhinoceroses, and an extraordinary assemblage of flora and fauna.

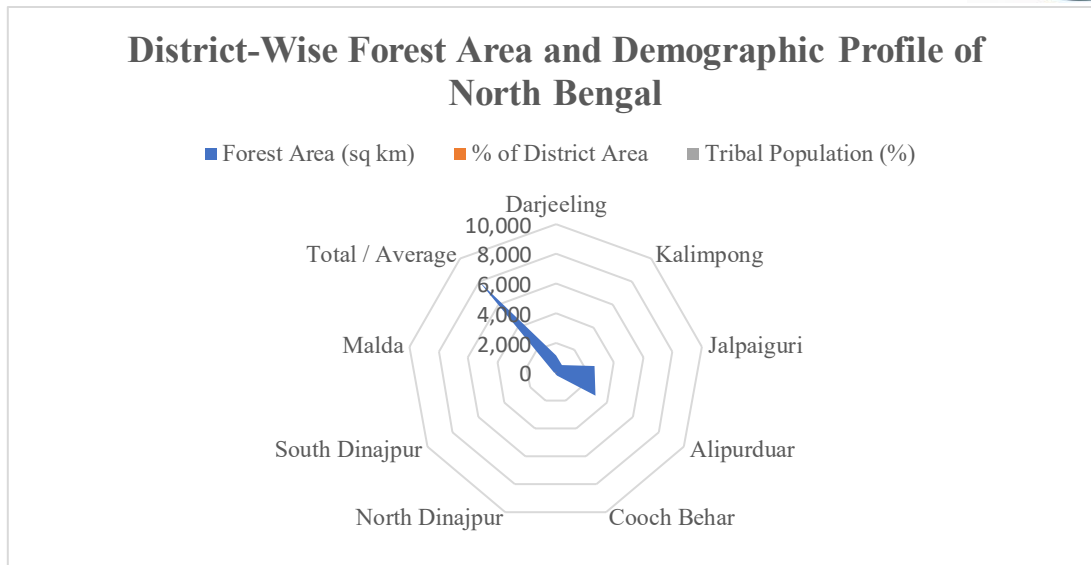


The total forest area of the region is approximately 8,029 square kilometres, constituting about 34.8% of the geographical area of North Bengal. The population of the study region is approximately 17.6 million (Census of India, 2011), characterised by high levels of rural poverty, significant tribal and indigenous populations, low levels of formal employment, and heavy reliance on agriculture and forest-based livelihoods.

Table 1: District-Wise Forest Area and Demographic Profile of North Bengal

District	Forest Area (sq km)	% of District Area	Tribal Population (%)
Darjeeling	1,188	38.4	14.6
Kalimpong	642	43.2	12.8
Jalpaiguri	2,643	52.7	22.4
Alipurduar	3,096	62.3	29.7
Cooch Behar	187	8.9	6.1
North Dinajpur	93	4.2	10.3
South Dinajpur	68	3.5	7.8
Malda	112	5.1	5.6
Total / Average	8,029	34.8	13.7

Source: Forest Survey of India (2021); Census of India (2011); West Bengal Forest Department (2023)



6. Methodology

6.1 Research Design

This study adopts an explanatory mixed-methods research design, integrating quantitative household survey data with qualitative information gathered through focus group discussions (FGDs) and key informant interviews (KIIs). The mixed-methods approach is particularly appropriate for investigating complex socio-ecological phenomena where both the magnitude of impacts (requiring quantification) and the lived experiences of affected communities (requiring contextual interpretation) are essential to a comprehensive understanding (Creswell & Plano Clark, 2018).

6.2 Sampling Strategy

A multi-stage stratified purposive sampling technique was employed. In the first stage, three districts were selected to represent each physiographic zone — one hill district (Darjeeling), two foothill districts (Jalpaiguri and Alipurduar), and two plains districts (Cooch Behar and North Dinajpur). Within each selected district, five villages with documented high forest dependency were identified in consultation with forest range officers and village panchayat leaders. From each village, twenty households were selected through systematic random sampling from the village household register, yielding a total sample of 500 households across 25 villages. The sample was stratified to ensure adequate representation of tribal households (minimum 40%), women-headed households (minimum 20%), and NTFP-dependent households (minimum 30%).

6.3 Data Collection Instruments

Primary data were collected through: (i) a structured household questionnaire covering demographic characteristics, land and asset ownership, income sources and amounts, forest resource use patterns, food security status, health and education indicators, forest access and perception, and coping strategies; (ii) five FGDs conducted in each district, disaggregated by gender and age, to explore community perceptions of forest change, historical trends, and institutional dynamics; (iii) twenty-five KIIs with forest officers, panchayat functionaries, NTFP traders, NGO practitioners, and community



leaders. Secondary data were compiled from FSI Biennial Reports (1987–2021), West Bengal Statistical Handbook, Census of India, NSSO Household Consumer Expenditure Surveys, and published satellite imagery analyses.

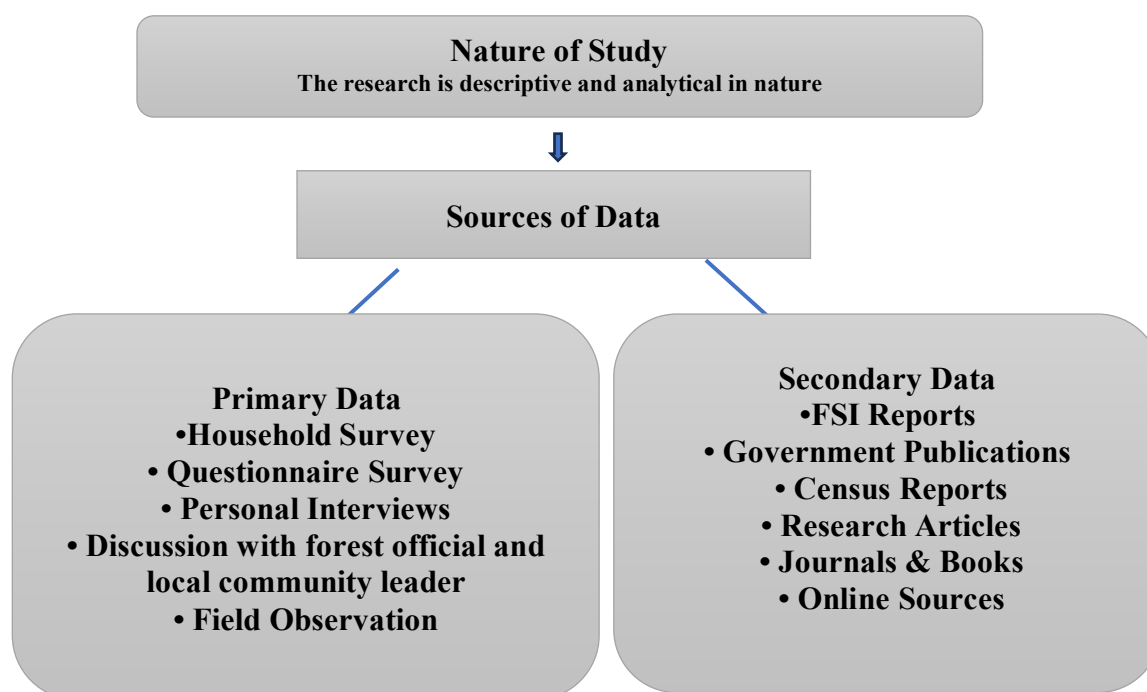
6.4 Analytical Methods

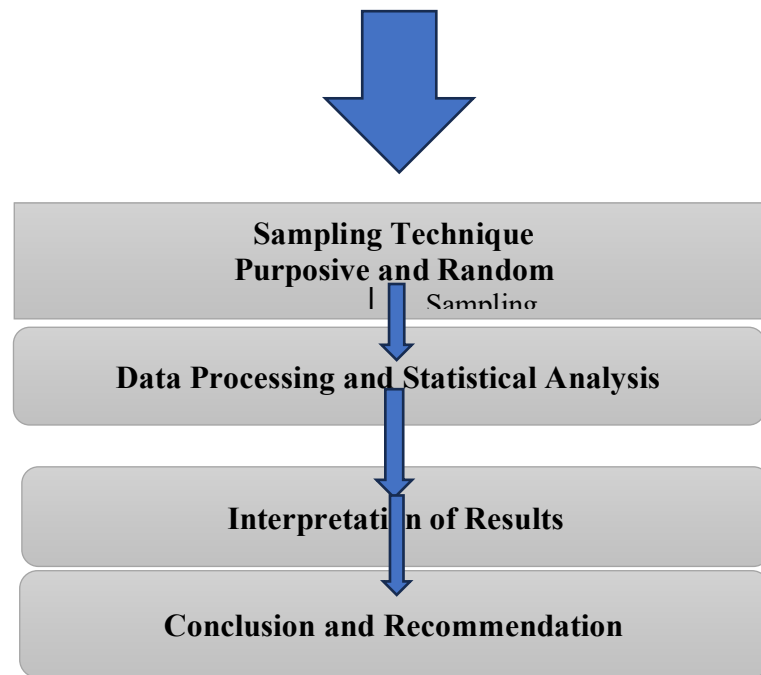
Quantitative data were analysed using SPSS 26.0 and Microsoft Excel. Descriptive statistics (frequency distributions, means, standard deviations) were computed for all socio-economic indicators. Chi-square tests and independent samples t-tests were used to assess significant differences between forest-dependent and non-forest-dependent households. A Forest Dependency Index (FDI) was constructed using principal component analysis (PCA) to composite household-level indicators of forest reliance. Forest Household Livelihood Security scores were computed following the Chambers and Conway (1991) framework adapted for forest contexts. Qualitative data from FGDs and KIIs were analysed using thematic content analysis, with themes identified inductively from the data and validated through member-checking with community participants. Triangulation between primary quantitative data, qualitative data, and secondary sources was employed throughout the analysis.

6.5 Ethical Considerations

Informed consent was obtained from all research participants prior to data collection. Participants were assured of confidentiality and anonymity. The research protocol was reviewed and approved by the Institutional Ethics Committee of the University of North Bengal (Ref. No.: NBU/IEC/2023/047). Community-level feedback sessions were conducted in each study village to share preliminary findings and validate interpretations.

Framework of the research paper:





7. Data Analysis and Results

7.1 Forest Cover Change in North Bengal (1990–2023)

Analysis of FSI biennial report data reveals a consistent and significant decline in dense forest cover across the North Bengal region over the study period. The total forest cover (including very dense, moderately dense, and open forest categories) declined from approximately 10,608 sq km in 1990 to 8,029 sq km in 2021, representing a net loss of 2,579 sq km or 24.3% of the 1990 baseline. The rate of loss was highest during the decade 1995–2005, averaging 87 sq km per year, corresponding to a period of rapid tea estate closures, increased refugee settlements along the Nepal and Bangladesh borders, and weak forest governance institutions.

The Terai-Dooars districts of Jalpaiguri and Alipurduar have experienced the most severe absolute losses, with dense forest cover declining by 31.6% and 28.4% respectively between 1990 and 2023. Darjeeling and Kalimpong hill districts show relatively lower rates of dense cover loss (14–18%), partially offset by plantation activities and natural regeneration at higher elevations. However, FGD participants consistently noted that the quality of remaining forests has declined sharply even where canopy cover statistics suggest relative stability, with increasing prevalence of invasive species (particularly *Mikania micrantha* and *Eupatorium adenophorum*) and loss of understory diversity. The plains districts show negligible forest cover but significant loss of riverine vegetation and bamboo stands, which constitute important livelihood resources for local communities.

7.2 Forest Resource Dependency Pattern

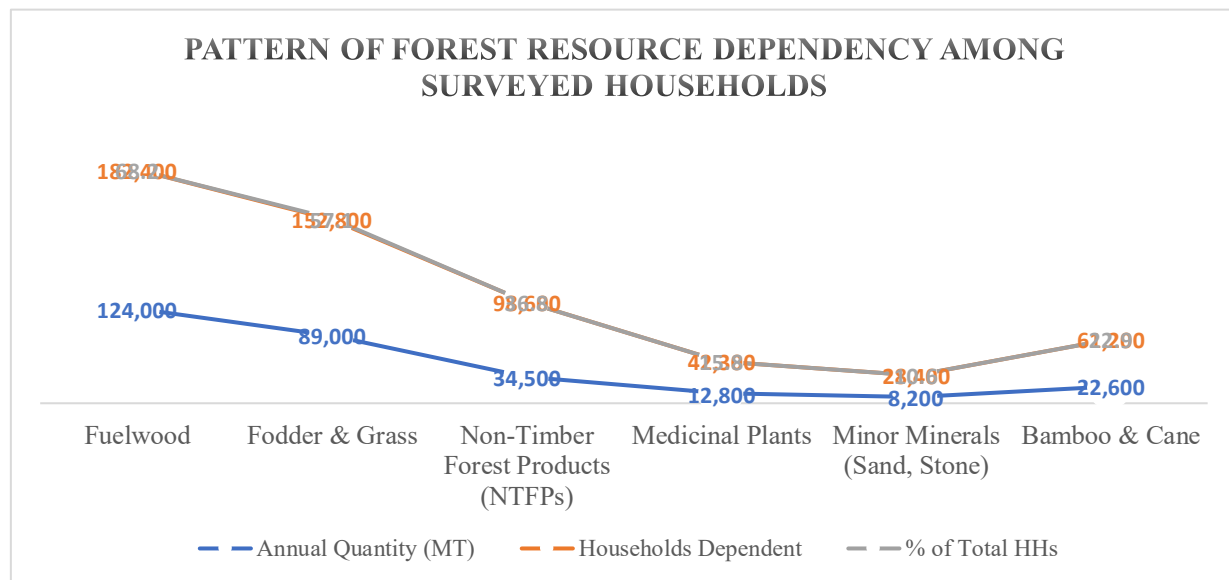
The household survey data confirms a high and pervasive dependence of rural communities on forest resources across all study sites. Overall, 68.2% of sampled households reported regular collection of fuelwoods from forests, 57.1% relied on forest fodder for livestock, and 36.8% engaged in NTFP

collection for consumption and sale. The following table presents the pattern of forest resource use among surveyed households:

Table 2: Pattern of Forest Resource Dependency Among Surveyed Households

Forest Produce	Annual Quantity (MT)	Households Dependent	% of Total HHs
Fuelwood	1,24,000	1,82,400	68.2
Fodder & Grass	89,000	1,52,800	57.1
Non-Timber Forest Products (NTFPs)	34,500	98,600	36.8
Medicinal Plants	12,800	42,300	15.8
Minor Minerals (Sand, Stone)	8,200	28,400	10.6
Bamboo & Cane	22,600	61,200	22.9

Source: Primary Survey Data (2023); N = 500 Households



NTFP collection encompasses a wide range of forest produce including sal seeds (*Shorea robusta*), mahua flowers (*Madhuca longifolia*), wild tubers, mushrooms, honey, lac, and various medicinal plants. Qualitative data reveal that NTFP collection serves multiple functions: direct food consumption (particularly during lean months), income generation through sale to local traders and weekly markets, and traditional medicinal practice. Women respondents reported disproportionate roles in fuelwood and NTFP collection, spending an average of 3.8 hours per day on forest-related activities — time that

displaces schooling for adolescent girls and limits women's participation in income-generating activities outside the household.

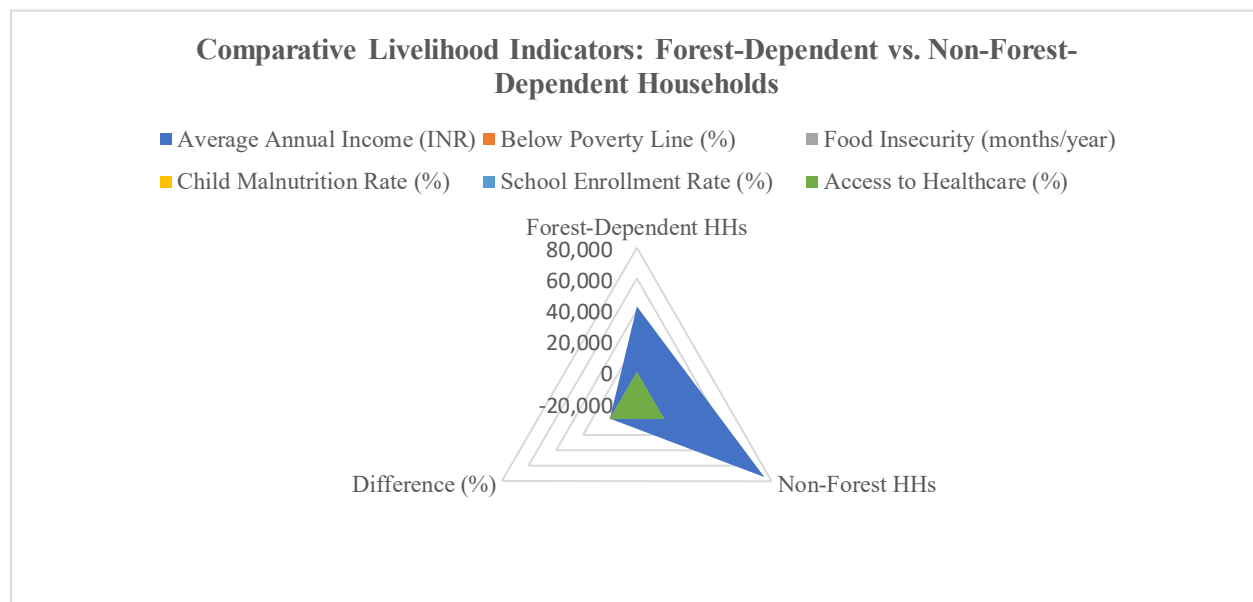
7.3 Livelihood Impacts of Forest Degradation

The socio-economic consequences of declining forest access are reflected starkly in household welfare indicators. Comparative analysis between households classified as highly forest-dependent (Forest Dependency Index score > 0.6) and those with low forest dependency reveals substantial and statistically significant differences across all welfare indicators ($p < 0.01$ for all comparisons).

Table 3: Comparative Livelihood Indicators: Forest-Dependent vs. Non-Forest-Dependent Households

Livelihood Indicator	Forest-Dependent HHs	Non-Forest HHs	Difference (%)
Average Annual Income (INR)	42,300	74,600	-43.3
Below Poverty Line (%)	58.4	27.6	+111.6
Food Insecurity (months/year)	4.2	1.8	+133.3
Child Malnutrition Rate (%)	38.7	18.4	+110.3
School Enrollment Rate (%)	61.2	82.4	-25.7
Access to Healthcare (%)	44.8	71.3	-37.2

Source: Primary Survey Data (2023); Statistical significance tested at $p < 0.01$ level (t -test)



The income differential between forest-dependent and non-forest-dependent households is particularly striking, with the former earning on average INR 42,300 annually compared to INR 74,600 for the



latter — a gap of 43.3%. This income gap has widened over the past decade as forest degradation has reduced the availability and quality of NTFPs, simultaneously increasing collection time and effort while reducing yields and market value. Over 58% of forest-dependent households fall below the State poverty line, compared to 27.6% of non-forest-dependent households. Food insecurity — measured by the number of months per year in which households report insufficient food access — averages 4.2 months for forest-dependent families, more than double the 1.8 months reported by non-forest-dependent households.

The health and education dimensions of forest degradation are equally concerning. Child malnutrition rates (weight-for-age below -2 standard deviations from WHO median) stand at 38.7% among forest-dependent households, substantially above the already alarming West Bengal state average of 32.4% (NFHS-5, 2021). School enrolment rates among children aged 6–14 from forest-dependent households are 61.2%, compared to 82.4% for non-forest-dependent peers, with girl children showing the largest gap due to their involvement in forest collection activities. KII data from health workers corroborate the survey findings, noting higher incidences of respiratory disease (from indoor biomass combustion), musculoskeletal injuries (from load carrying), and reproductive health complications among forest-dependent women.

7.4 Drivers of Forest Resource Degradation

Community members were asked to identify and rank the factors they perceived as most responsible for forest degradation in their localities over the past two decades. The following table presents the aggregated response frequencies and ranks from all 500 household respondents.

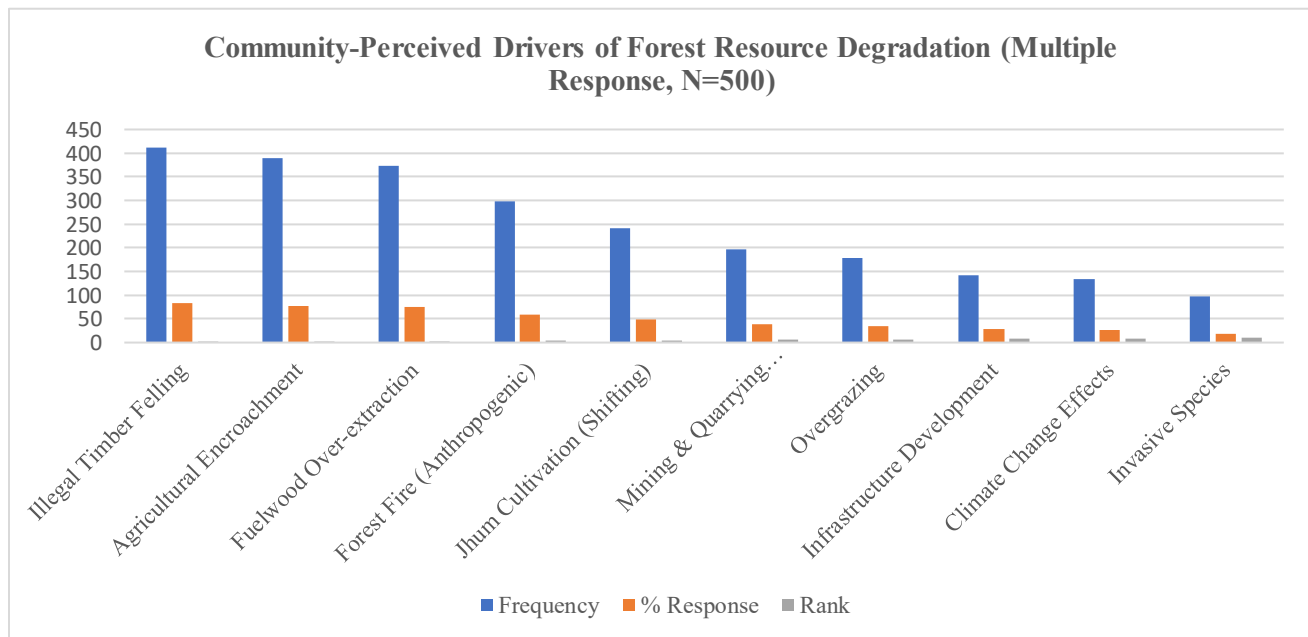
Table 4: Community-Perceived Drivers of Forest Resource Degradation (Multiple Response, N=500)

Cause of Degradation	Frequency	% Response	Rank
Illegal Timber Felling	412	82.4	1
Agricultural Encroachment	389	77.8	2
Fuelwood Over-extraction	374	74.8	3
Forest Fire (Anthropogenic)	298	59.6	4
Jhum Cultivation (Shifting)	241	48.2	5
Mining & Quarrying Activities	196	39.2	6
Overgrazing	178	35.6	7



Cause of Degradation	Frequency	% Response	Rank
Infrastructure Development	143	28.6	8
Climate Change Effects	134	26.8	9
Invasive Species	97	19.4	10

Source: Primary Survey Data (2023); Multiple responses permitted; percentages exceed 100%



Illegal timber felling emerged as the most widely perceived driver of degradation, cited by 82.4% of respondents. FGDs across all sites consistently described networks of organised timber trade involving local contractors, forest fringe communities providing labour, and external traders, often operating with the complicity of corrupt low-level forest officials. Agricultural encroachment was the second most cited factor, driven by landlessness among growing populations and the absence of secure legal land rights in degraded forest margins. Over-extraction of fuelwood ranked third, reflecting both the intensity of household energy dependency and the inadequacy of alternative fuel supply. Forest fire was identified as the fourth most significant driver, with FGD data emphasising that fires are predominantly human-caused — set intentionally to facilitate NTFP collection, clear grazing land, or enable encroachment. Key informants from the Forest Department acknowledged that effective patrolling of the vast forest area is severely constrained by inadequate staffing (estimated at 60% below sanctioned strength), insufficient mobility resources, and technological limitations. Several informants also highlighted the role of tourism infrastructure development — including roads, resort construction, and trekking routes — in facilitating forest access for illegal extraction and accelerating edge degradation around protected areas.

7.5 Differential Vulnerability of Tribal and Women-Headed Households

Analysis disaggregated by social category reveals that tribal households and women-headed households face compounded vulnerability in the context of forest degradation. Tribal households,



which constitute 47.2% of the study sample, score significantly higher on the Forest Dependency Index (mean FDI = 0.74 vs. 0.52 for non-tribal households; $p < 0.001$), reflecting deeper structural dependence rooted in cultural practice, customary rights, and limited access to alternative income opportunities. Despite the provisions of the Forest Rights Act (2006), only 31.4% of tribal households in the sample had received any form of formal recognition of their forest rights, exposing the majority to continuing insecurity of access. Women-headed households (18.4% of the sample) face acute time poverty associated with forest access constraints: as forest depletion requires travelling greater distances for collection, time burdens on women increase disproportionately, with qualitative data indicating that collection distances have increased by an average of 2.8 km over the past decade in the hill and foothill zones. This results in reduced time for child care, agricultural work, and participation in community governance structures including JFM committees, where women's formal representation averages only 27.3% despite policy mandates of 33% reservation.

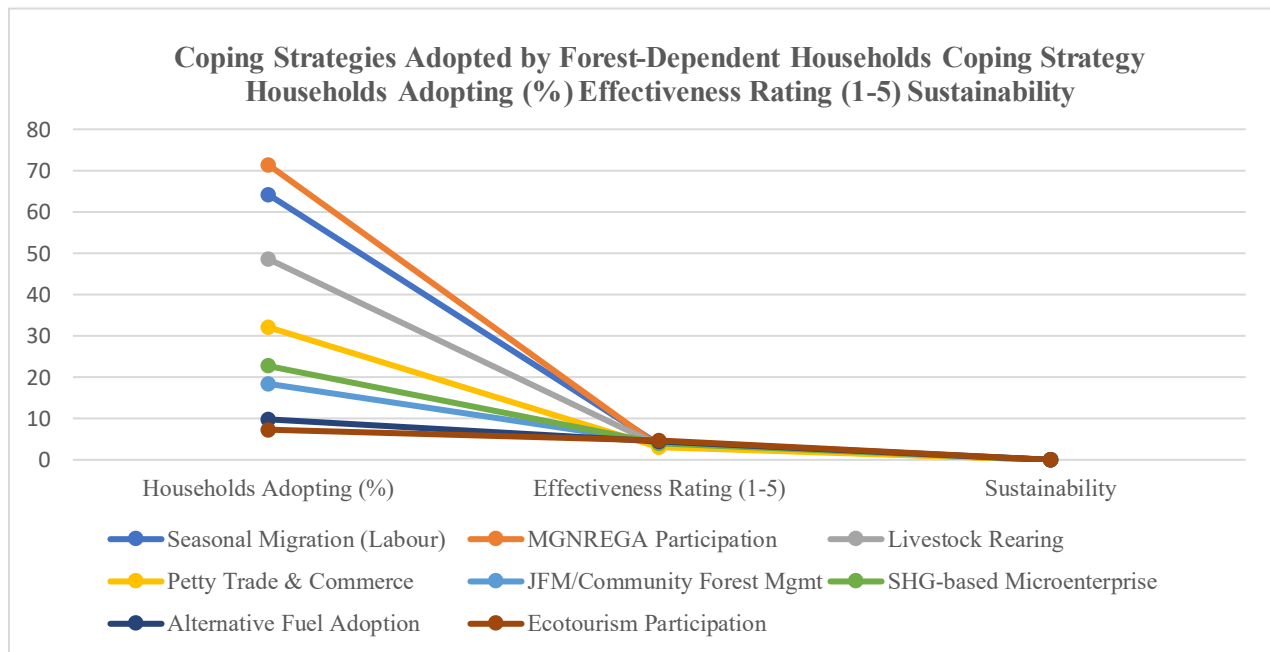
7.6 Coping Strategies of Forest-Dependent Households

In response to declining forest resource availability, rural households have adopted a range of coping strategies with varying degrees of effectiveness and sustainability, as presented in the following table.

Table 5: Coping Strategies Adopted by Forest-Dependent Households

Coping Strategy	Households Adopting (%)	Effectiveness Rating (1-5)	Sustainability
Seasonal Migration (Labour)	64.2	3.8	Low
MGNREGA Participation	71.4	3.2	Moderate
Livestock Rearing	48.6	3.5	Moderate
Petty Trade & Commerce	32.1	3.0	Moderate
JFM/Community Forest Mgmt	18.4	4.2	High
SHG-based Microenterprise	22.7	4.0	High
Alternative Fuel Adoption	9.8	4.5	High
Ecotourism Participation	7.3	4.6	High

Source: Primary Survey Data (2023); Effectiveness rated by respondents on a 1–5 Likert scale



Seasonal migration for wage labour, particularly to Siliguri, Kolkata, Delhi, and Kerala, is the most widespread coping response, adopted by 64.2% of forest-dependent households. While it provides cash income, migration is associated with family separation, high transaction costs, vulnerability to labour exploitation, loss of traditional forest knowledge, and long-term weakening of community forest governance capacity. MGNREGA participation is widespread but respondents consistently rate its effectiveness as moderate (3.2/5), citing irregularity of work provision, delayed wage payments, and insufficient employment days relative to household needs.

Community Forest Management (CFM) and JFM participation, though adopted by only 18.4% of households, receives among the highest effectiveness ratings (4.2/5), with participants reporting improved forest quality, reduced collection time, and supplementary income from NTFP enterprises. SHG-based microenterprise and alternative fuel adoption (biogas, improved cookstoves, solar) are similarly rated highly but remain marginal in coverage, highlighting the critical gap between the demonstrated effectiveness of sustainable interventions and their actual scale.

8. Discussion

The findings of this study confirm and extend the existing literature on forest-livelihood linkages in sub-Himalayan India. The scale of forest resource dependency documented here — with more than two-thirds of rural households relying on forests for essential provisioning services — underscores the continued centrality of natural capital in rural livelihood portfolios, even as urbanisation and labour market integration gradually transform the economic landscape of North Bengal. This high dependency coexists with rapid forest degradation, creating a self-reinforcing spiral: reduced forest availability intensifies extraction pressure per unit area, accelerating degradation and further reducing resource availability.



The income gap between forest-dependent and non-forest-dependent households (43.3%) is larger than comparable figures reported from central India (Gupta & Sharma, 2014) or the Western Ghats (Ghate & Nagendra, 2005), suggesting that North Bengal's forest-dependent communities face particularly acute livelihood insecurity relative to national patterns. This may reflect the region's limited industrial base, the legacy of tea estate closure-induced unemployment, and restricted formal sector employment opportunities that constrain the ability of forest-dependent households to diversify into non-forest income sources.

The finding that only 31.4% of eligible tribal households have received formal recognition of forest rights under the FRA underscores a critical policy implementation failure that perpetuates tenure insecurity and disincentivises community investment in forest stewardship. Without secure rights, communities lack both the legal authority and the economic incentive to protect and sustainably manage forest resources — a dynamic well-established in the common pool resource governance literature (Ostrom, 1990; Agrawal, 2001). The state government's commitment to expediting FRA implementation must be viewed as a prerequisite for effective community-based forest conservation in North Bengal. The differential vulnerability of women and tribal communities documented in this study aligns with the broader feminist political ecology literature (Rocheleau et al., 1996; Agarwal, 1992), which argues that forest resource access and control are fundamentally gendered and caste-differentiated social phenomena. Women's disproportionate forest collection burdens, combined with their underrepresentation in JFM governance structures, mean that conservation and livelihood interventions that do not explicitly prioritise gender equity will systematically fail to reach the most vulnerable segments of forest-dependent communities. The high effectiveness ratings assigned to community forest management and sustainable NTFP enterprise development by the small proportion of households engaged in these activities are particularly instructive. They suggest that the fundamental barrier to scaling these interventions is not their technical viability but institutional and financial constraints — inadequate extension support, weak market linkages, limited access to credit, and insufficient government investment in community-level implementation infrastructure.

9. Suggestions and Policy Recommendations

9.1 Institutional and Governance Reforms

Forest governance in North Bengal requires fundamental institutional restructuring to align ecological and livelihood objectives. Specifically:

- Accelerated implementation of the Forest Rights Act (2006) is urgently needed. The state government should establish fast-track FRA claim settlement mechanisms with dedicated district-level task forces, reducing processing time from the current average of 4–6 years to a maximum of 12 months. Priority should be given to tribal households in the Terai-Dooars belt where tenure insecurity is most acute and forest dependency highest.
- Joint Forest Management (JFM) committees must be reformed to ensure genuine community ownership and gender equity. At minimum, 50% women's representation in executive positions should be mandated and enforced, with dedicated capacity building support. JFM benefit-sharing mechanisms must be reviewed to ensure that 70% of forest produce revenues are retained by local communities.



- Strengthening of forest law enforcement through increased staffing, improved mobility infrastructure, technology-enabled monitoring (including drone surveillance and geofencing of protected area boundaries), and rigorous anti-corruption measures within the Forest Department is essential to reduce illegal extraction.

9.2 Sustainable Livelihood Promotion

Addressing the livelihood dimensions of forest degradation requires targeted investment in sustainable alternative income opportunities:

- A North Bengal Forest Livelihood Mission should be established with dedicated funding to support NTFP value chain development, including processing, grading, certification (organic, FairWild), and market linkage facilitation. Community NTFP processing enterprises, particularly those controlled by women's SHGs, should receive priority support.
- Ecological enterprises such as community ecotourism, butterfly parks, forest homestays, and birding tourism — sectors with strong market demand given North Bengal's extraordinary biodiversity — should be scaled through public-private-community partnerships, with revenue sharing mechanisms ensuring that a minimum of 60% of tourism revenues benefit forest-adjacent communities.
- Medicinal plant cultivation on degraded forest lands and homestead plots should be promoted through technical support from the Indian Council for Medical Research (ICMR) regional centres and Ayush Mission funding, creating both income and incentives for forest conservation.

9.3 Energy Transition to Reduce Forest Pressure

Fuelwood extraction, the third-largest driver of degradation identified in this study, can be substantially reduced through targeted clean energy interventions. A district-level programme for universal distribution of improved biomass cookstoves (reducing fuelwood consumption by 40–60%), coupled with biogas plant installation in livestock-owning households and subsidised LPG under PM Ujjwala Yojana, should be prioritised. Community biogas plants fed by forest biomass waste and agricultural residue offer an additional avenue for clean energy supply without increasing pressure on standing forest resources.

9.4 Strengthening Social Protection

Given the high and chronic poverty of forest-dependent households, strengthened social protection is a non-negotiable complement to livelihood and conservation interventions. MGNREGA implementation in forest-fringe areas should be streamlined to ensure at least 150 employment days per household per year, with work programmes explicitly designed to support forest regeneration activities (nursery preparation, plantation, firebreak maintenance, check dam construction). Convergence of MGNREGA with CAMPA-funded afforestation activities can simultaneously expand employment and accelerate forest restoration.

9.5 Research, Monitoring, and Adaptive Management



A permanent Forest-Livelihood Observatory should be established in North Bengal, housed at the University of North Bengal in collaboration with the West Bengal Forest Department and civil society partners, to conduct annual monitoring of forest cover change, NTFP yield trends, and community livelihood indicators. This observatory would provide the evidence base for adaptive management of conservation and livelihood programmes and generate the longitudinal data necessary to evaluate the effectiveness of policy interventions over time.

10. Conclusion

This study provides comprehensive empirical evidence of the profound and multidimensional consequences of forest resource degradation for rural livelihoods in North Bengal. The findings reveal a region at a critical inflection point: decades of forest loss have substantially eroded the natural capital base upon which millions of rural poor depend for their daily survival, while insufficient progress in forest governance reform, rights recognition, and alternative livelihood development has left communities with inadequate means to adapt. The convergence of high forest dependency, rapid degradation, institutional failure, and structural poverty creates a complex crisis that demands an equally complex, multi-pronged, and sustained policy response.

The evidence generated by this study makes clear that conservation and livelihood objectives in North Bengal are not fundamentally in conflict — communities that hold secure tenure rights and participate meaningfully in forest governance are demonstrably more effective stewards of forest resources and simultaneously achieve better livelihood outcomes. The challenge is therefore not conceptual but political and institutional: mobilising the will and capacity to implement the legal frameworks (Forest Rights Act), participatory governance models (reformed JFM), and livelihood investments (NTFP enterprise, ecotourism, clean energy) that the evidence consistently supports.

North Bengal's forests are not merely a regional asset. They are a component of one of the world's most important biodiversity corridors, a critical watershed for millions in the Brahmaputra-Ganga plain, and an irreplaceable repository of ecological, cultural, and spiritual heritage for the communities that have co-evolved with them over generations. Their protection and restoration is therefore a matter of both local livelihood justice and global ecological responsibility. This study contributes to the evidence base required to pursue that dual imperative with the urgency and rigour it demands. Future research should employ longitudinal designs to track changes in forest-livelihood linkages over time, incorporate remote sensing-based quantification of biomass and biodiversity loss alongside socio-economic data, and conduct more granular analyses of intra-community differentiation in forest access and benefit distribution. Comparative studies across similar sub-Himalayan regions in northeastern India, Nepal, and Bhutan would further strengthen the theoretical and policy relevance of the findings presented here.

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