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Livelihood Enhancement Through Sustainable Harvesting of Sal leaf in Gonpur Forest of Eastern Lateritic Part of India - An Operational Economic Appraisal.

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ABSTRACT

The *Shorea robusta* (*Sal*) forest landscape of eastern lateritic part of India, supports a substantial tribal population, predominantly (Santal), whose livelihoods depend heavily on non-timber forest products (NTFPs). This study assesses the ecological and economic importance of forest floristic resources, with particular emphasis on *Sal* leaves used in traditional plate-making, and proposes a community-based strategy for forest conservation, restoration, and livelihood enhancement. The study covered 18 forest-fringe tribal villages surrounding the Gonpur forest using participatory rural appraisal, structured and semi-structured interviews, direct harvest estimation, and market chain analysis. Total annual *Sal* leaf collection was estimated at 3,336.8 tonnes, with an average of yearly 2,517.40 kg per family. Economic analysis revealed that the *Sal*-leaf plate value chain is highly inequitable: collectors earned an average gross return of Rs.8,391.33 per family annually against labour and processing costs of Rs.15,648.56, resulting in a net loss of Rs.7,257.23. In contrast, first and second intermediaries gained substantial profits, indicating that most value accrues away from primary producers. The study highlights the economic significance of *Sal* leaf enterprises while demonstrating the need for community-led producer groups, direct market linkages, local value addition, and restoration of key NTFP species to support conservation and improve tribal livelihoods.

Keywords: Economic valuation, Forest management, Livelihood generation, NTFP, Santal community, *Sal* leaf plates.

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INTRODUCTION

Forest-dependent indigenous communities have historically developed close and adaptive relationships with surrounding landscapes through subsistence gathering, seasonal harvesting, and the transmission of traditional ecological knowledge across generations. In tropical and subtropical forest regions, non-timber forest products (NTFPs) play a critical role in supporting food security, household subsistence, medicine, fuel supply, and supplementary income, particularly among tribal and forest-fringe communities [1,2]. In India, especially in the dry deciduous and lateritic forest belts of eastern India, NTFPs remain a major component of rural and tribal livelihood systems and often provide crucial economic support during agricultural lean periods [3,2,4].

The Mahammad Bazar Block of Birbhum district, West Bengal, represents a distinctive lateritic socio-ecological landscape characterized by unclassed state forest patches, agricultural land, and forest-fringe tribal settlements. Within this landscape, the Gonpur forest forms one of the most important forest tracts in the district and plays a vital role in sustaining the livelihoods of local tribal communities, particularly the Santal community, who have long depended on forest floristic resources for both subsistence and income generation. The vegetation is dominated by *Shorea robusta* (Sal)-based dry deciduous forest, associated with several economically and ethnobotanically important species such as *Buchanania lanzan*, *Madhuca longifolia*, *Semecarpus anacardium*, *Gardenia latifolia*, *Asparagus racemosus*, *Tinospora cordifolia*, *Tinospora sinensis*, and several *Dioscorea* species. Sal-dominated dry deciduous forests are widely recognized as ecologically important and as key sources of livelihood-linked NTFPs in eastern India [5,2].

The forest and its fringes also support rich seasonal wild food diversity. Local communities collect about 21 species of wild edible mushrooms and nearly 30 species of minor wild fruits and vegetables following well-defined seasonal patterns [4,6]. Traditional ecological knowledge plays an important role in the sustainable use of these resources. For example, while harvesting tuberous *Dioscorea* species, collectors often leave part of the tuber or avoid disturbing the bulbils to facilitate regeneration, while similar culturally informed practices are followed during mushroom collection and handling. Such practices reflect a long-standing conservation-oriented use ethic, consistent with broader observations that indigenous knowledge systems often contribute significantly to biodiversity conservation and sustainable resource management [7,8].

Previous field-based observations from the region have documented nearly 40 economically important wild floristic resources contributing substantially to tribal household economies in the Mahammad Bazar landscape. Among these, *Shorea robusta* is the most economically significant species because of its multiple uses: fresh leaves are stitched into disposable plates, dry leaves are used as fuel, twigs are used as traditional toothbrushes (*dantan*), and resin is occasionally collected for local use. Sal leaf has long been recognized as an important NTFP in eastern and central India, supporting a seasonal cottage industry based on leaf-plate production and sale [3,2]. However, despite high utility and market demand, the *Sal*-leaf trade is often dominated by local intermediaries, and primary collectors typically receive only a small share of the final market value, creating a persistent imbalance between labour contribution and economic return [1,9].

This creates a significant conservation development paradox. Although the forest resource remains productive and commercially valuable, the tribal households who perform the labour-intensive work of leaf collection and plate-making remain economically marginalized. Such inequitable value distribution may weaken incentives for local stewardship and can ultimately undermine both livelihood security and biodiversity conservation. Against this background, the present study was undertaken to examine the extraction pattern, economic valuation, and value-chain structure of *Shorea robusta* leaf-based livelihoods across 18 forest-fringe villages of Mahammad Bazar Block, Birbhum district, West Bengal. The study also seeks to provide a scientific basis for a community-participatory model integrating biodiversity restoration, sustainable harvesting, local value addition, and direct market linkage under the institutional framework of the Biodiversity Management Committee (BMC).

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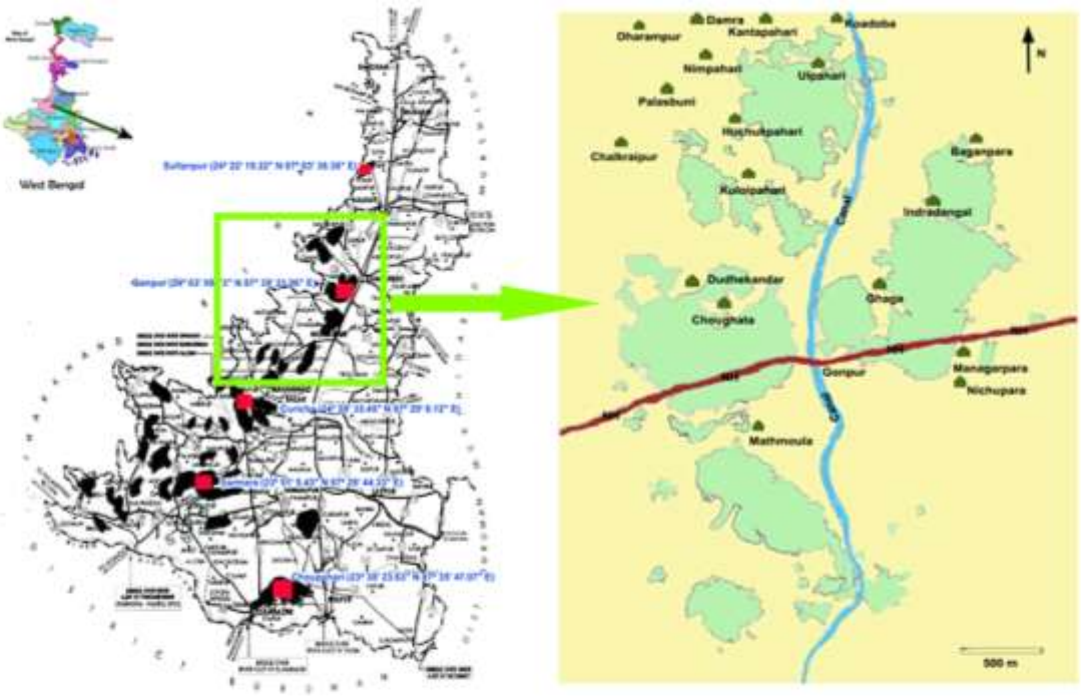
Study area

The present study was conducted in Mahammad Bazar Block of Birbhum district, West Bengal, India, with particular emphasis on the Gonpur forest and its surrounding tribal forest-fringe villages. The Gonpur forest is situated approximately between 24°06′25.09″ N to 24°03′02.83″ N latitude and 87°38′41.09″ E to 87°41′18.59″ E longitude, covering an area of about 11.58 km^2, and is recognized as the second largest forest tract in Birbhum district (Figure 1). Geographically, the study area forms part of the northwestern extension of the Chota Nagpur Plateau and is characterized by lateritic red soil, undulating topography, and dry deciduous *Sal*-dominated vegetation. The overall landscape is ecologically diverse and supports a mixed land-use pattern comprising unclassed state forest, agricultural land, and gradually expanding human settlements. The forest is presently managed under the Joint Forest Management (JFM) system. The northwestern part of the forest is particularly undulating and ecologically heterogeneous, while the northern tract near the canal, especially in the vicinity of Ulpahari village, is distinguished by dense climber and liana cover along with thick ground vegetation, reflecting high structural complexity of the vegetation. The present investigation covered 18 forest-fringe villages located around the Gonpur forest, namely Managarpara, Baganpara, Indradangal, Ghaga, Kantapahari, Choughata, Kuloipahari, Dudakandar, Ulpahari, Huchukpahari, Palasboni, Nimpahari, Chackraipur, Koadoba, Mathmoula, Dharampur, Sibpahari, and Shibpur, all of which are closely linked to the forest for livelihood and resource extraction (Figure 1). These villages are predominantly inhabited by the Santal tribal community, whose livelihoods are closely tied to forest resources including edible mushrooms, wild fruits, tubers, medicinal plants, fuelwood, and *Sal* leaves.

Figure 1: Study area showing the fragmented unclassed state forest (Gonpur forest) and the tribal villages at its fringe area



MATERIALS AND METHODS

Research Design and Data Collection

The present study was undertaken as a community-participatory socio-economic and ecological assessment in the Biodiversity Management Committee (BMC) area of Mahammad Bazar Block, Birbhum district, West Bengal, with special emphasis on *Shorea robusta* leaf harvesting and the *Sal*-leaf plate value chain. The study adopted an integrated field-based approach combining participatory rural appraisal (PRA), household-level socio-economic survey, direct resource-use estimation, and market-chain analysis to evaluate the ecological and economic significance of *Sal* leaf extraction from the Gonpur forest landscape [10,11,8].

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Primary data were collected using a combination of field quantification of production, Participatory Rural Appraisal (PRA) techniques, structured interviews, semi-structured interviews, direct harvest measurement, participatory observation, and questionnaire-based market surveys (huts, big markets at Bolpur, Durgapur and other nearby cities).

During the month of December to February, 2018 and 2019 total leaf production in form of dry leaves in the forest floor was measured through random sampling and sweeping method every four days interval. A 20 X 20 sq. ft. area (quadrat) were plotted randomly in different part of the forest and total dry leaves on the forest floor were weighed by using spring balance. Percentage of *Shorea* leaf out of the total leaves was measured through sampling method in each quadrat.

PRA tools were employed to understand local resource use patterns, seasonal calendars, labour participation, and community perceptions regarding forest dependence and species availability [10]. Structured and semi-structured interviews were conducted with *Sal* leaf collectors, household members, plate-makers, local traders, and intermediaries involved in the collection, processing, transport, and marketing of *Sal*-leaf plates. Direct field measurements of harvested leaves were undertaken to estimate family-level and village-level extraction, while market surveys were used to document price structures, processing costs, and profit margins at different levels of the value chain. Participatory observation was also used to verify the sequence of collection, drying, bundling, stitching, and local trading practices, following standard ethnobiological and non-timber forest product (NTFP) field methods [11,8].

A total of 18 forest-fringe villages surrounding the Gonpur forest were included in the socio-economic survey. Collectively, these villages comprised 1,300 households with a total population of 6,758 individuals. For detailed assessment of *Sal* leaf harvesting, eight villages were randomly selected from the 18 study villages and monitored during the active collection season from March to June 2018 and 2019. From each of these eight villages, ten *Sal* leaf collector households were selected for direct harvest estimation, resulting in a total sample of 80 collector families. Random village selection and purposive inclusion of active collector households were considered appropriate for capturing seasonal variation in extraction intensity and household-level dependence on the resource.

Variables Recorded

The study recorded both socio-economic and ecological variables related to *Sal* leaf collection and value-chain performance. The principal socio-economic and collection variables included: number of households (NH), average family members per household (AFM/H), population per village (PV), mean collectors per family per day (MC/F/D), mean collection days per year per family (MCD/Yr/F), and mean collection time per day (MCT/D). These variables were used to assess household labour contribution, village-level dependence, and intensity of forest resource use.

The principal economic and production variables included: collection amount per year per village (CA/Y/V; kg), collection amount per year per family (CA/Y/F; kg), number of plates produced per family, number of *Gonda* (where 80 plates = 1 *Gonda*), gross economic revenue per family per year (GER/F/Y), labour and collection cost (LC), net collector return, first intermediary cost and profit, second intermediary cost and profit, and estimated annual bio-resource value. These variables were used to quantify the distribution of economic returns across the *Sal*-leaf plate value chain and to identify the relative benefits accruing to primary collectors and intermediaries.

Conversion Factors and Rational Economic Assumptions

Economic calculations were performed using the conversion factors and rational assumptions available in the project dataset and validated during the field-based market survey. The wet weight of one *Sal*-leaf plate was taken as 0.045 kg, and 80 plates were considered equivalent to one *Gonda*, which is the standard local trade unit. The producer selling price was recorded as Rs.12 per *Gonda* (equivalent to Rs.0.15 per plate), the first intermediary selling price was Rs.35 per 80 plates (equivalent to Rs.0.44 per plate), and the final consumer-level selling price was 58 per 80 plates (equivalent to Rs.0.73 per plate). Based on these data, the total annual value of the bio-resource was estimated by accounting for the costs, margins, and value addition across the collector, first intermediary, and second intermediary levels. This type of value-chain approach is commonly used in NTFP livelihood studies to reveal inequities in benefit sharing and market access [12,13].

Data Processing and Statistical Analysis

As the available dataset consisted primarily of village-level aggregated values, statistical analysis was conducted at the village scale (n = 18). The data were organized and analysed using standard descriptive and inferential statistical methods appropriate for summarised socio-economic datasets where raw household-level observations are not uniformly available. Comparative ranking of villages was also carried out based on annual harvest volume and key economic indicators, to identify high-dependence and high-extraction settlements. Pearson's correlation analysis was also performed using PAST 4.03 statistical software to examine relationships among major variables, such as annual village harvest versus population, number of households and collectors per family. To study the family level harvest, annual family harvest versus collection days and collection time was also taken for the same statistical procedure. Pearson's correlation coefficient was used to determine the strength and direction of linear association among variables. The use of village-level correlation analysis is appropriate in this context because the dataset represents aggregated community-scale estimates rather than continuous household-level raw observations. This analytical framework allows for identification of broad patterns of extraction intensity, labour participation, and economic return within a community-based forest resource system.

Methodological Scope and Rationale

The methodological framework adopted in this study is particularly suitable for assessing forest-dependent tribal livelihoods, because it integrates ecological estimation, local participation, and market-chain evaluation within a single analytical structure. By combining PRA, household survey, direct biomass estimation, and value-chain analysis, the study captures both the material extraction of a key NTFP and the distribution of benefits across market actors, thereby linking biodiversity use with livelihood outcomes and conservation planning [10,8,13].

RESULTS

Demographic and Collection Profile of Forest-Fringe Villages

The 18 surveyed forest-fringe villages together comprised 1,300 households with a total population of 6,758 persons, indicating a substantial level of human dependence on surrounding forest resources. The average household size across villages ranged from 4.0 to 6.0 members, with a mean of 5.28 ± 0.67 persons per household (Table 1), while village population varied considerably from 180 individuals in Shibpur to 750 individuals in Dharampur. The average number of active *Sal*-leaf collectors per family per day ranged from 1.0 to 2.0, with an overall mean of 1.27 ± 0.28 collectors (Table 1), suggesting that *Sal*-leaf collection is typically undertaken by one or occasionally two family members. Households remained engaged in *Sal*-leaf collection for an average of 103.0 ± 17.18 days per year (Table 1), with village-level values ranging from 75 to 140 days, reflecting the seasonal but recurrent importance of this activity. Similarly, the average time spent on collection was 199.17 ± 25.80 minutes per day (approximately 3.32 hours), ranging from 140 to 250 minutes per day (Table 1). Descriptive statistics further showed that the mean number of households per village was 72.22 ± 27.91, with values ranging from 30 to 150, and the average village population was 375.44 ± 140.15 persons (Table 1). These findings indicate that *Sal*-leaf collection constitutes a major seasonal labour activity that is deeply embedded within household livelihood systems across the study landscape.

Table 1: Demographic and *Shorea robusta* Leaf Harvest Profile of Forest-Fringe Villages.

Variable	Mean ± SD
Number of households (NH)	72.22 ± 27.91
Average family members/household (AFM/H)	5.28 ± 0.67
Population per village (PV)	375.44 ± 140.15
Mean collectors/family/day (MC/F/D)	1.27 ± 0.28
Mean collection days/year/family (MCD/Yr/F)	103.00 ± 17.18
Mean collection time/day (MCT/D, minutes)	199.17 ± 25.80

Statistical Relationships in Harvest Pattern

To understand the factors influencing variation in annual harvest, Pearson's correlation analysis was performed among selected demographic and collection variables (Table 2). The results revealed a strong positive correlation between population per village (PV) and annual village harvest (CA/Y/V) (r = 0.894), indicating that villages with larger populations tended to extract substantially greater quantities of *Sal* leaves annually. Similarly, the number of households (NH) showed a comparably strong positive relationship with annual village harvest (r = 0.897), further confirming that settlement size is a major determinant of total extraction pressure (Table 2). At the household level, the mean number of collectors per family per day (MC/F/D) exhibited a strong positive correlation with annual family harvest (CA/Y/F) (r = 0.738), suggesting that labour availability within the family is a key driver of collection output. In contrast, collection days per year per family showed only a weak to moderate positive relationship with annual family harvest (r = 0.314), while collection time per day displayed a very weak positive relationship (r = 0.089) (Table 2). These findings indicate that although collection frequency contributes to annual yield, the strongest household-level determinant of higher annual harvest is the number of active collectors rather than time spent per day. The weak relationship between collection time and output further suggests that productivity is not determined by labour time alone, but is likely shaped by factors such as forest accessibility, leaf density, collector experience, patch quality, and the spatial distribution of productive *Sal* stand.

Table 2: Pearson's Correlation analysis between quantum of extraction and different variables associated with harvest of *Shorea robusta* Leaf.

Relationship	Correlation coefficient (r)	Interpretation
Population per village (PV) vs annual village harvest (CA/Y/V)	0.894	Strong positive
Number of households (NH) vs annual village harvest (CA/Y/V)	0.897	Strong positive
Collectors/family/day (MC/F/D) vs annual family harvest (CA/Y/F)	0.738	Strong positive
Collection days/year/family vs annual family harvest	0.314	Moderate positive
Collection time/day vs annual family harvest	0.089	Very weak positive

Annual *Shorea robusta* Leaf Harvest

The total annual fresh leaf harvest of *Shorea robusta* across the 18 villages was estimated at 3,336,800.46 kg (approximately 3,336.8 tonnes), demonstrating the large-scale magnitude of this non-timber forest product (NTFP)-based livelihood activity. At the household level, the mean annual collection per family was 2,517.40 ± 610.43 kg, with values ranging from 1,534.00 kg to 4,026.75 kg (Table 3). Village-wise annual harvest varied widely, from a minimum of 56,640.00 kg in Shibpur to a maximum of 454,300.00 kg in Dharampur (Table 3), highlighting pronounced inter-village variation in extraction intensity. The three highest-harvesting villages were Dharampur (454,300.00 kg), Chackraipur (324,370.20 kg), and Nimpahari (306,033.00 kg), whereas the lowest harvesting villages were Shibpur (56,640.00 kg), Koadoba (90,860.00 kg), and Kuloipahari (113,516.00 kg) (Table 3). This substantial variation suggests that village-level harvest is strongly influenced by socio-demographic characteristics such as population size and labour availability, as well as ecological and spatial factors including access to productive forest patches and the density of *Sal* stands.

Plate Production and Gross Economic Return

Based on the conversion rate of 0.045 kg of fresh *Sal* leaf per plate, annual plate production per family varied substantially across villages. Estimated production ranged from 34,088.89 plates per family per year in Kuloipahari to 89,483.33 plates per family per year in Nimpahari, indicating considerable differences in household-level output (Table 3). When converted into the local commercial unit of *Gonda* (80 plates = 1 *Gonda*), annual family production ranged from 426.11 *Gonda* to 1,118.54 *Gonda* (Table 3). The corresponding gross economic return to collectors, based on *Sal*e to the first intermediary at the prevailing producer price, ranged from Rs.5,113.33 per family per year in Kuloipahari to Rs.13,422.50 per family per year in Nimpahari (Table 3). Across all villages, the mean gross return was estimated at Rs.8,391.33 ± 2,034.77 per family per year (Table 3). Because the producer price remained effectively fixed across villages, annual family harvest and gross return showed an almost perfectly linear relationship, indicating that higher returns were achieved only through greater extraction volume rather than through improved price realization or value addition at the collector level.

Labour Cost and Net Return to Collectors

Table 3: Production, harvest, gross and net economic revenue from *Shorea robusta* Leaf to the collector level.

VI LL	CA/Y/V (KG)	CA/Y/F (KG)	Total no. of plate produced/ Fam (W/plate-ww 0.045 kg.)	No. of *Gonda* (G.) (80 pcs plate = 1 *Gonda* @12/- per G. from producer (1 pc plate = Rs 0.15/-	GER/F/Y (selling price to the 1st INTERM.	LC= (leaf Collection from forest+ collection of stick + making of plate + drying)	Net profit of collector - plate maker of (Rs/F/Y)
Managarpara	229875.80	2498.65	55525.56	694.07	8328.83	15532.01	-7203.18
Baganpara	203550.00	2714.00	60311.11	753.89	9046.67	16870.66	-7823.99
Indradangal	126873.60	1982.40	44053.33	550.67	6608.00	12322.92	-5714.92
Ghaga	141255.83	2173.17	48292.59	603.66	7243.89	13508.75	-6264.86
Kantapahari	115524.36	2750.58	61124.00	764.05	9168.60	17098.05	-7929.45
Choughata	222331.67	2615.67	58125.93	726.57	8718.89	16259.40	-7540.52
Kuloipahari	113516.00	1534.00	34088.89	426.11	5113.33	9535.59	-4422.26
Dudakandar	181720.00	2271.50	50477.78	630.97	7571.67	14120.01	-6548.34
Ulpahari	203550.00	2212.50	49166.67	614.58	7375.00	13753.26	-6378.26
Huchukpahari	147972.00	2690.40	59786.67	747.33	8968.00	16723.96	-7755.96
Palasboni	128502.00	1947.00	43266.67	540.83	6490.00	12102.86	-5612.86
Nimpahari	306033.00	4026.75	89483.33	1118.54	13422.50	25030.92	-11608.42
Chackraipur	324370.20	3180.10	70668.89	883.36	10600.33	19768.01	-9167.68
Koadoba	90860.00	2596.00	57688.89	721.11	8653.33	16137.15	-7483.82
Mathmoula	148680.00	2065.00	45888.89	573.61	6883.33	12836.37	-5953.04
Dharampur	454300.00	3028.67	67303.70	841.30	10095.56	18826.68	-8731.12
Sibpahari	141246.00	3138.80	69751.11	871.89	10462.67	19511.28	-9048.62
Shibpur	56640.00	1888.00	41955.56	524.44	6293.33	11736.11	-5442.78
Total	3336800.4		111226.68	12586.99	151043.93	15648.56	-130630.0

VILL- Village, CA/Y/V-Collection amount per year per village, CA/Y/F- collection amount per year per family, GER/F/Y-Gross economic revenue per family per year, INTERM- Intermediator, Rs. / F/Y- Rupees per family per year, LC-labour cost.

When labour and processing costs were incorporated, the economic condition of collectors became markedly unfavourable. The total annual labour and processing cost per family—including leaf collection, gathering of stitching materials, plate-making, drying, and handling—ranged from Rs.9,535.59 in Kuloipahari to Rs.25,030.92 in Nimpahari, with an average of Rs.15,648.56 ± 3,796.79 per family per year (Table 3). In comparison, the average annual gross return of Rs.8,391.33 was substantially lower than the corresponding labour investment, resulting in negative net returns in all 18 villages. The least negative net return was recorded in Kuloipahari (–Rs.4,422.26 per family per year), whereas the most severe loss occurred in Nimpahari (–Rs.11,608.42 per family per year) (Table 3). Overall, the mean net return to collectors was estimated at –Rs.7,257.23 ± 1,761.98 per family per year (Table 3). These findings clearly demonstrate that under the current production and marketing system, *Sal*-leaf plate making is economically non-remunerative for the primary tribal producer, as the activity fails to recover the full value of household labour and associated processing costs.

Value Chain Analysis: Intermediary-Level Profits

Table 4: Economic Appraisal at Intermediate-Level.

VILL	TC + LC of 1st INTERM (Rs 8/- per 100 kg. / Km, avg. dist of transport 8 km SD 3)	Selling price to the 2nd INTERM = @Rs 35/- per 80 pcs. (@ Rs. 0.44/-per Pc) (Gross revenue)	Net profit of 1st INTERM	TC+LC+VAS of 2nd INTEM (Rs. 50/-/Q/130 to 150 km) (LC+VAS=Rs . 30/Q	Selling price to the consumer level (Rs. 58/80 pcs = 0.73/pc)	Net profit of 2nd INTERM	Value of bio-resource
Managarpara	7995.68	24292.43	7967.92	1998.92	40256.03	13964.68	14729.42
Baganpara	8684.80	26386.11	8654.64	2171.20	43725.56	15168.24	15998.90
Indradangal	6343.68	19273.33	6321.65	1585.92	31938.67	11079.41	11686.15
Ghaga	6954.13	21128.01	6929.99	1738.53	35012.13	12145.59	12810.71
Kantapahari	8801.86	26741.75	8771.29	2200.46	44314.90	15372.69	16214.53
Choughata	8370.13	25430.09	8341.07	2092.53	42141.30	14618.67	15419.23
Kuloipahari	4908.80	14913.89	4891.76	1227.20	24714.44	8573.36	9042.85
Dudakandar	7268.80	22084.03	7243.56	1817.20	36596.39	12695.16	13390.38
Ulpahari	7080.00	21510.42	7055.42	1770.00	35645.83	12365.42	13042.58
Huchukpahari	8609.28	26156.67	8579.39	2152.32	43345.33	15036.35	15859.78
Palasboni	6230.40	18929.17	6208.77	1557.60	31368.33	10881.57	11477.47
Nimpahari	12885.60	39148.96	12840.86	3221.40	64875.42	22505.06	23737.49
Chackraipur	10176.32	30917.64	10140.99	2544.08	51234.94	17773.23	18746.53
Koadoba	8307.20	25238.89	8278.36	2076.80	41824.44	14508.76	15303.29
Mathmoula	6608.00	20076.39	6585.06	1652.00	33269.44	11541.06	12173.07
Dharampur	9691.73	29445.37	9658.08	2422.93	48795.19	16926.88	17853.84
Sibpahari	10044.16	30516.11	10009.28	2511.04	50569.56	17542.40	18503.07
Shibpur	6041.60	18355.56	6020.62	1510.40	30417.78	10551.82	11129.67
Total	145002.18	440544.81	144498.70		730045.68	253250.33	267118.96

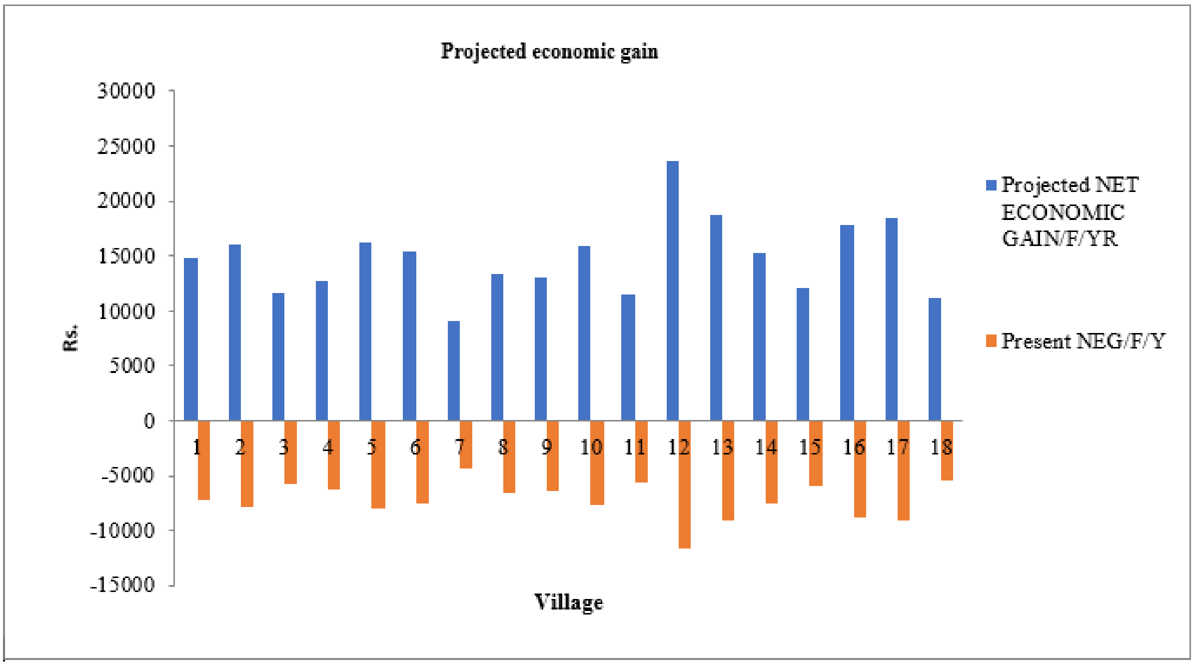
TC-Transport Cost, LC-Labour Cost, VAS- Value Added Services, INTERM- Intermediator, R- value of bio-resource, Pc-Profit of collector.

In contrast to the negative returns experienced by collectors, the downstream intermediaries in the *Sal*-leaf value chain were found to earn substantial profits. At the level of the first intermediary, the total annual operational cost, including transport and labour, was estimated at Rs.145,002.17, while the total annual gross revenue reached Rs.440,544.82, resulting in a net annual profit of Rs.144,498.71 (Table 4). The second intermediary, operating closer to the consumer market, generated even higher returns, with total annual consumer-level *Sal*es of Rs.730,045.68 and an estimated net annual profit of Rs.253,250.35 (Table 4). In addition, the annual estimated bio-resource value of *Shorea robusta* leaf was calculated at Rs.267,118.96 (Table 4), reflecting the underlying ecological and material worth of the harvested forest resource. At the aggregate level, the total gross return to collectors, based on the summed village-level estimates, was approximately Rs.151,043.93 (Table 3), yet net returns remained negative across all villages after accounting for labour and processing costs. These results reveal a strongly asymmetric value-chain structure in which the highest share of economic benefit is captured by actors located farther from the forest and closer to the final market, while the tribal households who invest the primary labour and directly interface with the forest resource receive the least benefit.

Scope for Improvement Under Community-Led Market Reform

The present analysis indicates significant scope for improving the economic position of collectors under a community-led market reform model. Under the existing system, collectors recover only 53.62% of their total labour and operational cost (Figure 2), demonstrating that even basic labour valuation is not achieved. However, under a proposed community-based or Biodiversity Management Committee (BMC)-led restructuring model, the recovery level could potentially increase to 157.70%, which would not only ensure full recovery of labour and operational costs but also provide an additional 57.70% net economic benefit to collector households (Figure 2). The analysis further suggests that through improved local value addition, direct market linkage, and reduction in intermediary dependency, gross economic return to collectors could increase by as much as five-fold compared with the present system. These findings provide strong economic justification for community-based institutional intervention and support the need for a more equitable and locally controlled *Sal*-leaf value chain.

Figure 2: Present economic contribution and projected potentiality of economic contribution of *Shorea robusta*.



DISCUSSIONS

The findings of the present study reveal that the forest-based economy of Mahammad Bazar Block is both ecologically significant and structurally inequitable. The Santal community remains deeply dependent on the Gonpur forest and associated lateritic woodland systems for food, fuel, household materials, and income-generating non-timber forest products (NTFPs). Among these resources, *Shorea robusta* leaf collection and Sal-leaf plate making constitute one of the most important livelihood-linked forest enterprises, combining subsistence use, seasonal cash flow, and culturally embedded household labour. This pattern is consistent with broader studies from India and other tropical regions, where NTFPs often function as critical livelihood buffers for forest-fringe communities, particularly during periods of agricultural uncertainty and limited wage employment [1,2].

Forest Dependency and Traditional Ecological Knowledge

The recorded use of diverse forest floristic resources including wild mushrooms, fruits, tubers, medicinal plants, and leaf products demonstrates that the local livelihood system is not merely market-oriented, but instead operates as a mixed subsistence-plus-cash economy. Such livelihood diversification is typical of indigenous and forest-dependent communities, where forest resources support both direct household consumption and periodic cash needs [2]. The observed practices of partial tuber harvesting, non-destructive extraction, and selective seasonal collection further indicate the continued relevance of traditional ecological knowledge in regulating resource use. These practices reflect a conservation-oriented use ethic in which extraction is shaped not only by immediate need but also by intergenerational knowledge of regeneration and seasonality. Similar relationships between indigenous knowledge systems and biodiversity conservation have been widely documented, especially in resource-constrained ecological settings where local communities rely on long-term landscape familiarity for sustainable use [7,8]. In lateritic dry deciduous landscapes such as Mahammad Bazar, where ecological productivity is highly seasonal, such knowledge assumes particular significance because forest resources act as livelihood safety nets during periods of agrarian stress.

Scale of Extraction and Socio-Demographic Drivers

The estimated annual *Shorea robusta* leaf harvest of 3,336.8 tonnes indicates that Sal-leaf collection is not a marginal activity but a major seasonal bio-resource economy in the study area. The strong positive correlations between village population, number of households, and annual harvest suggest that extraction pressure increases with settlement size and demographic concentration. Likewise, the strong association between the number of active collectors per household and annual harvest confirms that labour availability is a major determinant of extraction intensity. This aligns with established observations that NTFP extraction in rural economies is often labour-driven rather than capital-driven, especially where entry barriers are low and household labour substitutes for financial investment [2,3]. However, the weak relationship between collection time and annual harvest suggests that productivity is not simply a function of labour hours, but also depends on resource density, accessibility, distance to collection sites, collector experience, and the ecological condition of collection patches. This indicates that extraction outcomes are shaped by both social and ecological variables, and therefore any management strategy must account for spatial heterogeneity in resource availability rather than relying solely on labour-based assumptions.

The Hidden Poverty of NTFP Labour

One of the most significant findings of the present study is that all surveyed villages recorded negative net returns at the collector level when labour costs were fully accounted for, indicating that Sal-leaf plate production fails to generate adequate economic compensation under formal cost–benefit valuation. Yet the activity continues across the study landscape, revealing a classic paradox of informal forest economies. In many forest-dependent rural systems, family labour is unpaid, undercounted, or socially normalized, meaning that even low or economically irrational returns may still be accepted if they provide immediate cash in the absence of alternatives [1]. Sal-leaf collection persists because it is seasonally compatible with agricultural lean periods, requires minimal capital input, involves relatively low mobility compared with wage migration, and is embedded in a familiar socio-cultural labour structure. Thus, its persistence is not necessarily evidence of profitability, but rather of livelihood compulsion and constrained choice. This pattern is widely recognized in NTFP-based livelihood systems, where participation often reflects vulnerability rather than economic advantage [14,15]. The present findings therefore reinforce the argument that NTFP dependence should not automatically be interpreted as an indicator of livelihood security; in many cases, it instead signals structural poverty and limited access to better-remunerated economic opportunities.

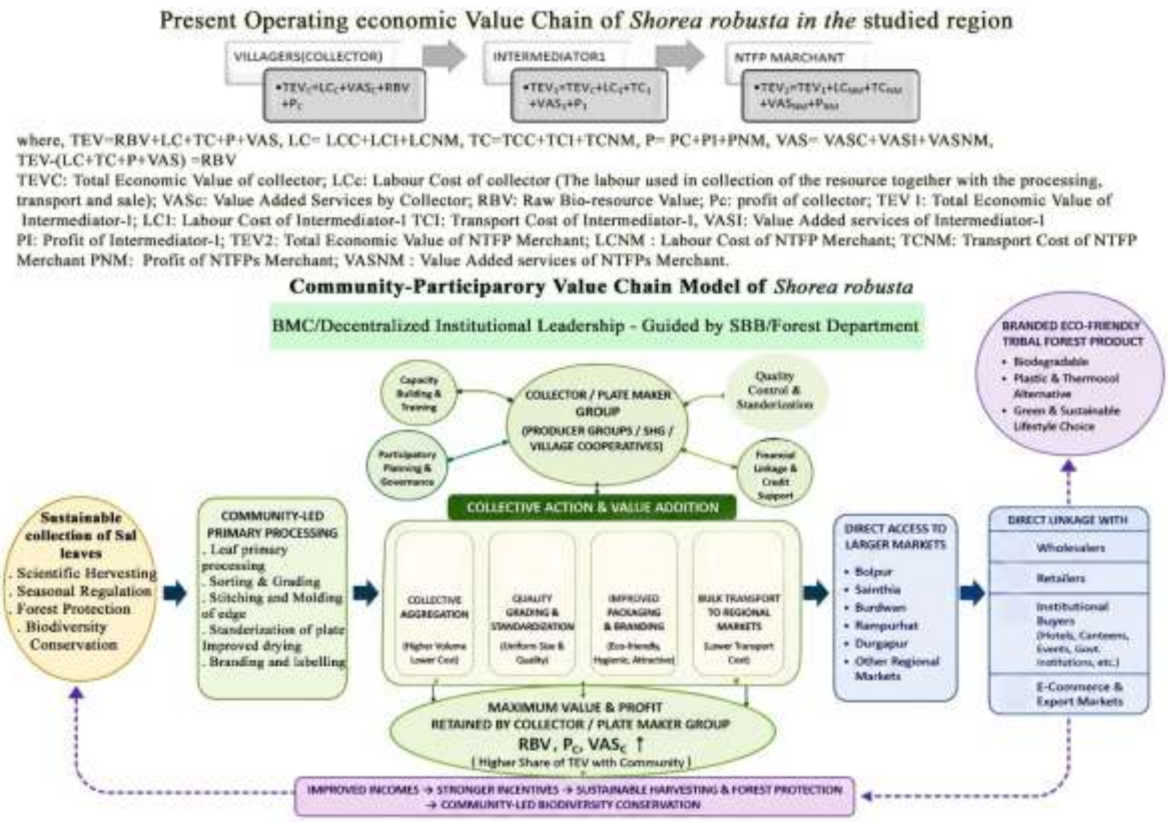
Market Inequity and Conservation Risk

A major developmental implication of this study is the highly unequal distribution of value across the Sal-leaf supply chain. The primary collector, who undertakes the labour-intensive work of collection, carrying, sorting, stitching, and initial processing, receives the smallest share of the final market value, whereas the first and second intermediaries capture a disproportionately large share of profit. Such asymmetry is common in informal NTFP markets, where collectors often lack bargaining power, market information, transport access, storage capacity, and direct linkages with higher-order buyers [3,15]. This inequitable structure has important long-term conservation consequences. When local communities are not fairly rewarded, incentives for forest stewardship may weaken, reducing willingness to support conservation or regeneration initiatives. At the same time, low unit returns may encourage households to increase extraction volume in order to maintain cash income, thereby increasing the risk of localized overharvesting. In addition, stagnating returns from Sal leaves may push households toward greater dependence on other vulnerable or high-value species, potentially redistributing pressure across the forest ecosystem. Therefore, biodiversity conservation in the Mahammad Bazar landscape cannot be achieved through plantation, restoration, or regulatory measures alone; it must be integrated with livelihood justice, fair pricing, and equitable value distribution. This supports the broader view that successful forest conservation in inhabited landscapes depends not only on ecological restoration but also on correcting the socio-economic structures that shape extraction behaviour [9].

Need for a Community-Participatory Value-Chain Model

The evidence generated by this study strongly supports the need for a community-participatory value-chain model under the leadership of the Biodiversity Management Committee (BMC) or similar decentralized institutions. If collectors are organized into producer groups, self-help clusters, or village-level cooperatives, several practical improvements become possible, including collective leaf aggregation, quality grading, standardization of plate size, improved drying and hygienic packaging, and bulk transport to larger regional markets such as Bolpur, Sainthia, Burdwan, Rampurhat, and Durgapur (Figure 3). Such institutional organization could reduce dependence on local intermediaries, improve price transparency, and strengthen direct negotiation with wholesalers, retailers, or institutional buyers. Similar participatory approaches in NTFP systems have been recommended as a means of enhancing local value retention while promoting more sustainable extraction behaviour [15,9]. In the present context, a locally governed Sal-leaf enterprise could also support the development of a branded eco-friendly tribal forest product, especially in the growing market for biodegradable alternatives to plastic and thermocol. By retaining a greater share of value within the community, such reforms could improve household incomes while simultaneously reinforcing incentives for sustainable harvesting, forest protection, and community-led biodiversity conservation (Figure 3). Thus, the future of Sal-based livelihoods in Mahammad Bazar depends not only on ecological sustainability, but equally on institutional innovation, market democratization, and community ownership of the value chain.

Figure 3: Operating and proposed economic value chain model of *Shorea robusta*



CONCLUSION

The Mahammad Bazar Block BMC area of Birbhum district represents an important socio-ecological landscape where biodiversity conservation and tribal livelihoods are closely interconnected. The Santal communities of the 18 forest-fringe villages remain highly dependent on the Gonpur forest for diverse non-timber forest products, among which *Shorea robusta* leaf collection and *Sal*-leaf plate making constitute a major seasonal livelihood activity. The study reveals that *Sal*-leaf harvesting occurs at a substantial scale, with more than 3,336 tonnes of fresh leaves collected annually, and that village-level harvest is strongly shaped by population size, household number, and labour participation. However, despite high labour input and significant production, the existing market system remains highly inequitable, as collectors and primary plate-makers incur net losses in all villages while first and second intermediaries capture considerable profits. This clearly indicates that the *Sal*-leaf value chain is economically viable overall, but structurally exploitative at the producer level. The findings therefore strongly support the need for a community-based participatory intervention model emphasizing direct market linkage, local value addition, producer group formation, transparent price information, BMC-led enterprise development, and restoration of commercially important but declining NTFP species. If effectively implemented, such an approach can transform the present exploitative extraction economy into a conservation-linked livelihood system in which improved household income becomes an incentive for sustainable harvesting and long-term biodiversity stewardship. Thus, the study has strong ecological, socio-economic, and policy relevance, and offers a replicable model for similar lateritic forest-fringe tribal landscapes of eastern India.

Based on the present findings, it is recommended that tribal producer groups, self-help groups, or BMC-linked forest product cooperatives be formed to strengthen collective bargaining and local enterprise development. Direct market linkages with urban and peri-urban centres should be established to reduce dependence on multi-tier intermediaries and improve price realization for collectors. Village-level training should be provided on improved plate finishing, drying, packaging, and quality control, alongside pilot branding of eco-friendly *Sal*-leaf products to enhance market value. Seasonal market intelligence on price trends, demand, and buyer networks should also be regularly disseminated among collector households. In parallel, community nursery development, enrichment planting of priority NTFP species, and species-specific sustainable harvest protocols should be introduced to ensure long-term resource availability. Finally, annual participatory monitoring of extraction volume and regeneration status should be integrated with People's Biodiversity Registers and BMC planning so that livelihood enhancement and biodiversity conservation can be pursued together through a locally governed and ecologically sustainable framework.

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