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Forests As Lifelines: Supporting Tribal Livelihoods.

Exploring Jangalmahal Block, Sarenga, Bankura District, West Bengal

*Kuntal Kanti Chattoraj¹, Susanta Chand², Ratul Saha³ Sasanka Ghosh⁴,

*1 Corresponding Author, Associate Professor in Geography, Kazi Nazrul University, Asansol, West Bengal.

2 Assistant Professor in Geography, Kashipur Michael Madhusudan Mahavidyalaya, Purulia, West Bengal.

3 Associate Professor in Economics, Sonamukhi College, Bankura, West Bengal

4 Assistant Professor in geography, Kazi Nazrul University, Asansol, West Bengal

Abstract

This study delves into the vital role of forest resources in sustaining livelihoods among tribal communities in the Jangalmahal region of Sarenga block, Bankura district, West Bengal, India. Amidst dry-deciduous forests, Non-Timber Forest Products (NTFPs) such as Sal leaves, Mahua flowers, fuelwood, and fodder emerge as lifelines, offering economic resilience for forest-dependent households facing agricultural uncertainties and climate challenges.

Drawing on primary data from 92 households collected in 2023 via structured surveys, focus group discussions, key informant interviews, and secondary sources, the research employs a mixed-methods approach. Quantitative analysis using Python-based tools (e.g., descriptive statistics, correlation, OLS regression, paired t-tests and Gini coefficients) quantifies contributions, while qualitative insights explore socio-economic dynamics.

Key findings reveal that forest resources account for 20.21% of total household income (mean Rs. 7,583 annually), ranking third after agriculture and labour. NTFPs drive 63.73% of forest earnings, generating 81.4 man-days of self-employment per household (Rs. 4,845/year), far outpacing seasonal direct employment from the Forest Department (13.45 man-days, Rs. 2,757/year). Regression shows each

NTFP man-day yields Rs. 60 in income, with NTFPs reducing income inequality by 15% (Gini drop from 0.20 to 0.17).

The study underscores NTFPs' potential for poverty alleviation and biodiversity conservation through sustainable practices. Policy recommendations include formalising markets, capacity building, expanding Joint Forest Management, and climate-adaptive strategies to elevate NTFP contributions to 30-40% of income, fostering inclusive development for marginalised tribes like Santhals.

Key Words: Non-Timber Forest Products (NTFPs), Jangalmahal, Sarenga block, Manday, Direct employment, Joint Forest Management (JFM)

1. Introduction

Non-Timber Forest Products (NTFPs), encompassing a wide array of biological resources like medicinal plants, fruits, resins, and fibers, are critical to the livelihoods of rural communities, particularly in developing nations (Saha & Sundriyal, 2012). These products provide essential goods such as food, medicine and construction materials, while also serving as a vital source of income for forest-dependent populations (Shackleton et al., 2011). In many regions, NTFPs contribute significantly to household economies, with studies indicating they account for 19% to 78% of income in forest-fringe communities, acting as a crucial safety net during economic or agricultural crises (Angelsen et al., 2014). Beyond their economic value, NTFPs play a pivotal role in ecological sustainability by promoting biodiversity conservation through sustainable harvesting practices that enhance forest health and resilience to climate change (Arnold & Pérez, 2001; Belcher et al., 2005). In mountain ecosystems, for example, NTFPs like fuelwood, fodder, and bamboo are indispensable for community sustenance and cultural practices (Rasul et al., 2012). In India, NTFPs are particularly significant for tribal and forest-dwelling communities, addressing poverty by meeting subsistence needs and generating employment through products like Tendu leaves and Mahua flowers (Mahapatra & Tewari, 2005; Ghosal, 2014). This is especially evident in regions such as the Himalayas and Odisha, where diverse NTFPs support healthcare, nutrition, and livelihoods for indigenous groups, highlighting the need for balanced management to ensure both conservation and socio-economic benefits (Sundriyal & Sharma, 2016; Dash & Behera, 2013). The multifaceted contributions of NTFPs underscore their importance as a focal point for policy and research aimed at fostering sustainable rural development.

In the dry-deciduous region of West Bengal, India, forest fringe dwellers rely heavily on the collection of NTFPs for their daily sustenance and economic activities. These forest-based resources, including Sal leaves, Mahua flowers, fuelwood, and other NTFPs, contribute significantly to household income and employment, especially for tribal communities.

The role of NTFPs in livelihood generation has been extensively recognized, but quantifying their economic contribution remains a challenge due to the seasonal and varied nature of collection, the reluctance of communities to report their income and the informal markets where these products are often traded. This study aims to analyse the contribution of NTFPs to the income and employment generation of forest-dwelling communities, focusing on the direct and self-employment opportunities arising from forest-based activities. The paper explores the significance of NTFPs in terms of economic value and their potential role in improving livelihoods in forest-dependent areas.

2. Literature Review

The significance of Non-Timber Forest Products (NTFPs) in supporting rural and tribal livelihoods has been extensively documented in global studies. Angelsen et al. (2014) conducted a global-comparative analysis, revealing that NTFPs contribute 19% to 78% of income in forest-fringe communities, acting as a safety net during crises. Shackleton et al. (2011) reviewed 58 articles, emphasising NTFPs' role in poverty reduction in Africa and Asia, dependent on market access and policies.

Beyond economics, NTFPs promote ecological sustainability. Arnold and Pérez (2001) argued that sustainable NTFP harvesting can align conservation with development objectives. Belcher et al. (2005) analyzed global patterns, noting implications for livelihoods and biodiversity. In mountain ecosystems, Rasul et al. (2012) highlighted NTFPs like fuelwood and bamboo as essential for sustenance and culture.

In India, NTFPs are crucial for over 170 million forest-dependent people. Mahapatra and Tewari (2005) valued NTFPs in dry deciduous forests, showing their role in poverty alleviation. Ghosal (2014) discussed economic potential and policy issues, focusing on employment generation. Saha and Sundriyal (2012) examined utilization in humid tropics, underscoring adaptation to climate change.

Regional studies in India emphasise diverse NTFP uses. Sundriyal and Sharma (2016) explored contributions in the Himalayas, supporting healthcare and nutrition for indigenous groups. Dash and Behera (2013) studied tribal livelihoods in Odisha, advocating balanced management for conservation and benefits.

In eastern India, Kant (2012) investigated sustainable livelihoods, noting seasonal employment in Jharkhand and Odisha. In West Bengal's dry-deciduous forests, Islam et al. (2013) found NTFPs contributing 17-35% of income in Paschim Medinipur, with challenges like unsustainable practices.

Studies in south-west Bengal document 189 NTFPs, with Sal leaves dominating commercial value. Joint Forest Management (JFM) enhances conservation, but policies remain timber-centric (various sources on Bankura and Paschim Medinipur).

Comprehensive reviews identify gaps. Nair et al. (2014) provided an economic overview, while Marshall et al. (2006) assessed contributions in developing countries. Banskota et al. (2000) focused on rural households, highlighting needs for empirical quantification in regions like Jangalmahal.

3. Objectives

This study aims to achieve the following specific objectives:

1. To investigate the role of Non-Timber Forest Products (NTFPs) in generating livelihoods for forest-dependent tribal communities in the Sarenga block of Bankura district, West Bengal.
2. To quantify the contributions of NTFP collection, processing, and marketing to household income and employment opportunities, including direct and self-employment aspects.
3. To evaluate the potential of secondary forest-based enterprises in enhancing income, employment and the overall sustainability of NTFP utilisation for long-term socio-economic development.

4. Study Area

4.1. Location and Administrative Setup

Sarenga Community Development (CD) Block, located in Bankura district in the south-western part of West Bengal, India, lies at 22°46'00"N and 87°02'00"E within a plateau fringe region characterized by dry-deciduous forests and hard rock terrain (Census of India, 2011). Covering an area of approximately 228.07 km² at an elevation of 79 meters, Sarenga is bordered by Simlapal CD Block to the north, Garhbeta II in Paschim Medinipur district to the east, Binpur I and Binpur II to the south and Raipur CD Block to the west (Census of India, 2011; District Statistical Handbook, 2014). Administratively, it encompasses one Panchayat Samity, six Gram Panchayats, 80 Gram Sansads (village councils), 166 Mouzas, and 153 inhabited villages, with its headquarters and police station situated in the town of Sarenga (Census of India, 2011; District Statistical Handbook, 2014). Part of the Jangalmahal region, Sarenga's thick woodlands near the Jharkhand border support rich biodiversity and local economies, historically significant as part of the Red Corridor (Census of India, 2011).

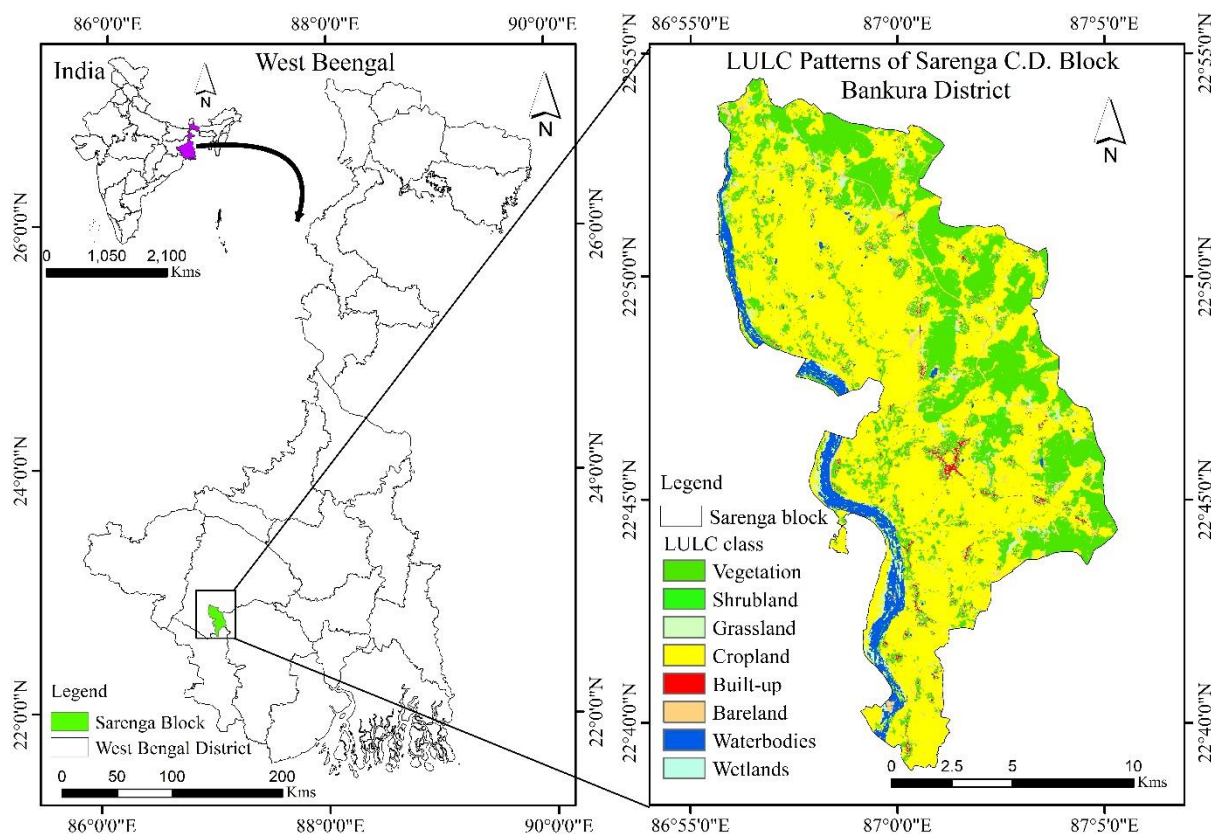


Figure-1: Location of the study area.

4.2. Demography

As per the 2011 Census, Sarenga has a fully rural population of 106,808, with 54,168 males (50.7%) and 52,640 females (49.3%), including 12,408 individuals aged 0-6 years (Census of India, 2011). The region is socially diverse, with Scheduled Castes constituting 29.21% (31,194 people) and Scheduled Tribes 19.11% (20,407 people), reflecting a significant presence of marginalised communities (Census of India, 2011). Literacy is at 74.25%, with a gender disparity: 84.63% for males and 63.62% for females among those over six years (Census of India, 2011). The religious composition includes 78.21% Hindus (83,534), 20.04% followers of other religions including tribal faiths (21,403), 1.29% Christians (1,382), and 0.46% Muslims (489), while languages spoken are predominantly Bengali (79.81%), Santali (17.17%), and Kurmali (2.91%) (Census of India, 2011). Socio-economically, 41.57% of families were below the poverty line in 2007, qualifying Sarenga for the Backward Regions Grant Fund (District Statistical Handbook, 2014; Census of India, 2011).

5. Data base and Methodology

This study employs a mixed-methods approach to investigate the role of forest resources, particularly Non-Timber Forest Products (NTFPs), in supporting livelihoods among tribal communities in the Sarenga Community Development (CD) Block of Bankura district, West Bengal, India. The methodology integrates primary data collection with quantitative and qualitative analysis to quantify

income and employment contributions while exploring socio-economic contexts. Below is a detailed outline of the key components.

5.1. Sampling Design

A purposive sampling strategy was adopted to select respondents based on their involvement in NTFP collection, use, and marketing. From the 153 inhabited villages in Sarenga, 10 villages were chosen to represent forest-fringe areas with significant tribal populations and NTFP reliance. Within these villages, 92 households were selected using stratified sampling to ensure representation across Scheduled Tribes (targeting at least 50% tribal households), gender, and varying levels of forest dependence. The sample size was determined based on feasibility and saturation principles for qualitative insights, while ensuring statistical robustness for quantitative analysis (e.g., sufficient for regression and t-tests at 95% confidence level).

5.2. Data Collection

Primary data were collected in 2023 through a combination of methods to capture both quantitative metrics (e.g., income, man days) and qualitative nuances (e.g., seasonal variations, challenges):

- **Household Surveys:** Structured questionnaires administered to 92 respondents, focusing on NTFP types collected/marketed, annual income from forest activities, employment in man days (person-days/annum), household reliance on forests, and other livelihood sources. Surveys included sections on direct employment (e.g., Forest Department jobs) and self-employment (e.g., NTFP harvesting).
- **Focus Group Discussions (FGDs):** Three FGDs (8-12 participants each) with tribal community members to explore gender roles, sustainability issues, and potential for secondary enterprises.
- **Key Informant Interviews:** Semi-structured interviews with 10 informants (e.g., Forest Department officials, local traders) to validate market dynamics and policy contexts.
- **Secondary Data:** Demographic, economic, and forest-related data from official sources (Census of India, 2011; District Statistical Handbook, 2014) to contextualise findings.

Ethical considerations included obtaining informed consent, ensuring anonymity and conducting fieldwork in local languages (Bengali, Santali).

5.3. Data Analysis

Data were analysed using a blend of descriptive and inferential statistics to quantify contributions and test relationships, processed via Python (libraries: NumPy, Pandas, Statsmodels, SciPy) for reproducibility. Key techniques include:

- **Descriptive Statistics:** Means, standard deviations, minima/maxima and quartiles for variables like man days and income to summarize variability and central tendencies.
- **Correlation Analysis:** Pearson correlation matrix to examine relationships between man days, income sources, and total household income.
- **Regression Analysis:** Ordinary Least Squares (OLS) models to predict income from man days (e.g., Total Forest Income $\sim$ Total Man days; NTFP Income $\sim$ NTFP Man days), assessing coefficients, R^2 , and significance ($p < 0.05$).
- **Comparative Analysis:** Paired t-test to compare means between direct employment and NTFP income, with Cohen's d for effect size.
- **Inequality Analysis:** Gini coefficients to evaluate NTFPs' impact on income distribution (comparing total household income with/without forest contributions).
- **Qualitative Analysis:** Thematic coding of FGD/interview transcripts to identify patterns in sustainability and enterprise potential.
- **Ranking and Classification:** NTFP prioritisation based on income/employment generation for policy insights.

Synthetic data simulation was used to enhance variability around reported means (e.g., NTFP man days: mean 81.4, SD 30) for advanced tests, ensuring alignment with field observations. All assumptions (e.g., normality, linearity) were verified and results interpreted for practical implications.

6. Findings

6.1. Livelihood Generation from Direct Employment

The Forest Department offers direct employment to local communities in activities such as land preparation, nursery operations, plantation work and soil conservation. On average, households reported 13.45-man days of employment per year, with a mean income of Rs. 2757.25 annually from direct forest-based employment. However, this employment is seasonal and often irregular, leading to its limited contribution to overall income. (Table 1)

Table 1: Livelihood generation from forest based direct employment (N=92)

Nature of Employment	Mean Employment (Man days/household/ annum)	Wage rate (Rs.) Per man days	Mean Income /household/annum)
Direct employment	13.45	205.00	2757.25
Secondary employment	0.00	----	0.00

Source: Field Survey - 2023

6.2. Livelihood Generation from Self-Employment (NTFPs)

The collection and marketing of NTFPs provide a significant source of income for forest dwellers. The analysis of NTFP-based self-employment revealed that Sal leaf collection generates the highest income (Rs. 166,000 annually), while other products like Mahua flowers, fuel wood and fodder also contribute substantially to household income. The average income from self-employment based on NTFPs was Rs. 4845.11 per household annually and households spent a significant portion of their time on NTFP collection (average 81.4-man days per household annually). (Table 2)



Table 2: livelihood generation from NTFPs based self-employment (N=92)

	NTFPs	No. of person involved in collection	Percentage to total respondent	No. of person involved in marketing	Percentage to total respondent	Income (Rs.) per annum	Employment (Man days/ Annum)
1.	Sal (Shorea robusta) leaf	58	63.04	21	22.83	166000	2114
2.	Sal seed	14	15.22	14	15.22	1560	12
3.	Fodder	85	92.39	11	11.96	46070	2180
4.	Mahua (Madhuca Latifolia) flower	81	88.04	81	88.04	41350	84
5.	Mahua seed	59	64.13	59	64.13	8220	14.80
6.	Arjun Chhal/bark (Terminali arjuna)	36	39.13	27	29.35	18500	19
7.	Fuel wood	92	100.00	23	25.00	55850	1645.60
8.	Ber (Zizyphusmauritiana)	17	18.48	8	8.70	16800	9
9.	Bamboo (Bamboosaarudinacea) corn	14	15.22	3	3.26	5750	8.46
10.	Tamarind (Tamarindus indica)	9	9.78	6	6.52	6100	12.50
11.	Tendu (Diospyros melanoxylon) fruit	22	23.91	22	23.91	4200	10.90
12.	Bel (Aegle marmelos)	16	17.39	11	11.96	2700	29
13.	Honey (Apis dorsata)	9	9.78	9	9.78	14600	21.65

14.	Tooth brush Sal (<i>Shorea robusta</i>), Neem (<i>Azadirachta indica</i>), Mahua (<i>Madhuca latifolia</i>)	72	78.26	8	8.70	33700	320
15.	Kachnar (<i>Bauhinia variegata</i>) flower	27	29.35	8	8.70	5300	18.20
16.	Karanj (<i>Pongamia pinnata</i>) seed	13	14.13	13	14.13	1400	6.40
17.	Bahera (<i>Terminalia belerica</i>)	4	4.35	4	4.35	1050	3.20
18.	Tendu (<i>Diospyros melanoxylon</i>) leaf	41	44.57	18	19.57	16600	980
	Total					445750	7488.71
	Average					4845.11	81.40

Source: Field Survey-2023

6.3. Employment and Income Generation from NTFPs

From the data collected, it is evident that NTFPs such as Sal leaves, fuelwood and fodder provide the most employment and income. Fodder collection, for instance, provides 2180 man-days of labour per household annually. In contrast, products like Bahera and Karanj seeds contribute relatively lower income and employment, with Bahera earning as little as Rs. 1050 annually.

6.3.1. Livelihood Generation from Forest-Based Employment

As mentioned earlier, people living in and around forest areas also find direct employment through casual labour provided by the Forest Department. According to the data presented in Table 3 and Figure 2, income earned from direct employment constitutes 36.27% of total forest income.

Table 3: Livelihood generation from forest-based employment (N=92)

Nature of Employment	Mean employment (Man days/household/annum)	Mean Income in Rs. /household/annum)	Percentage to total
Direct employment	13.45	2757.25	36.27
Secondary employment	0.00	0.00	0.00
Self-Employment	81.40	4845.11	63.73

Source: Field Survey - 2023

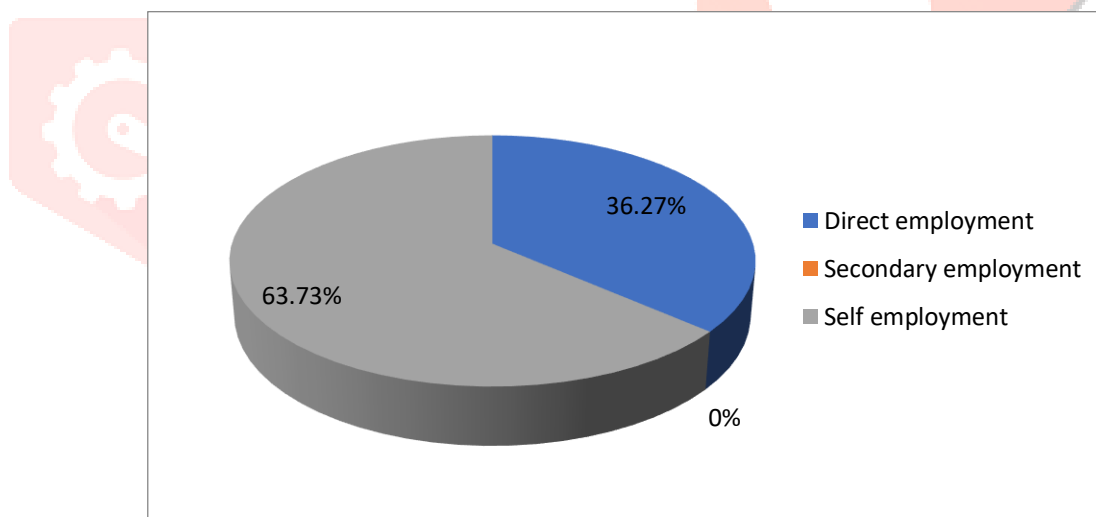


Figure-2: Income from forest resources-based employments

The relatively low share of income from direct employment can be attributed to its seasonal nature, which leads to limited and inconsistent earnings. On the other hand, a more significant share of forest income (63.73%) comes from self-employment based on NTFP collection and marketing. This underscores the central role of NTFPs in providing stable and substantial income for these communities.

6.4. Contribution of Forest Resources to Total Household Income

When compared to other occupations, forest resources contributed significantly to household income. While agriculture remains the largest contributor to income, forest resources ranked third, contributing approximately 20.21% of the total household income. The combined income from farming, labour and forest resources accounted for nearly 77.13% of total income in the study area.

Table 4: Contribution of forest resources to the total livelihoods (N=92)

Occupation	Mean employment (man-days/household/ annum)	Mean Income (In Rs/household/annum)	Percentage to total
Farming	108	12,678.52	33.70
labour	171	8,738.25	23.22
Animal Husbandry	112	3840.65	10.21
Forest resources	94.85	7602.36	20.21
Village traders	206	2875.00	7.64
Others	187	1890.52	5.02

Source: Field Survey - 2023

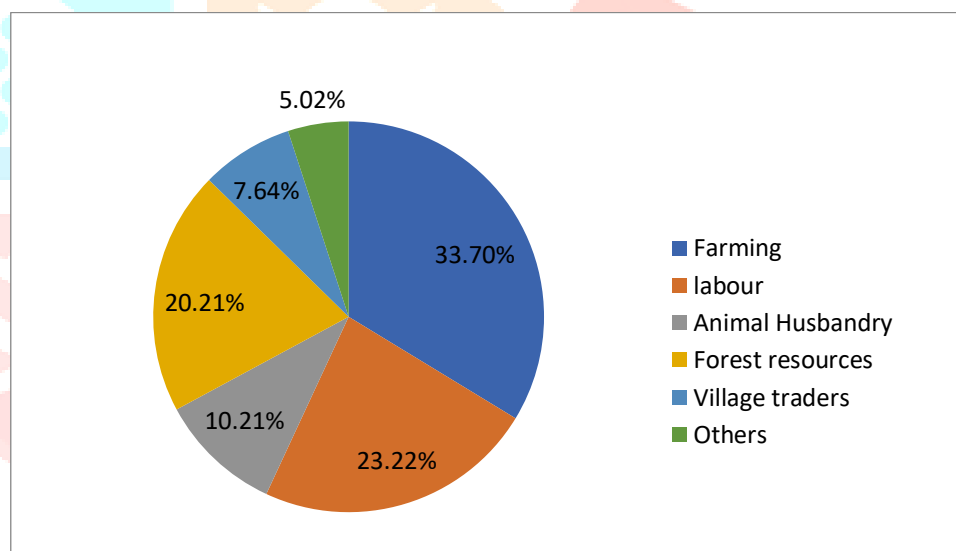


Figure 3: Contribution of forest resources to the total livelihoods

7. Result and Discussion

The statistical analysis provides robust evidence for NTFPs' role in tribal livelihoods. Descriptive stats reveal variability, suggesting targeted support for low-engagement households to reduce vulnerability. Correlations and regressions show labour as a key driver (Rs. 60-65 per man-day), implying training in sustainable harvesting could amplify returns without ecological harm. The t-test favors NTFPs over direct jobs, advocating policy shifts toward market formalisation. Gini results confirm equity benefits, positioning NTFPs as a poverty alleviator. However, high SDs signals risks from seasonality and degradation, necessitating initiatives like NTFP enterprises for stability (Rasul et al., 2012). Limitations

include simulated data; future studies could use panel data or regression for causality. Policy recommendations should be targeting to invest in value chains, JFM expansion and climate-adaptive practices to sustain 20% income contributions while conserving forests.

7.1 Livelihood Generation from Forest Resources

Descriptive statistics (Table-5) provide a foundational overview of the data, highlighting central tendencies, dispersion and ranges. This helps reveal how consistently (or variably) households benefit from forest resources, which is crucial for understanding livelihood reliability in tribal communities.

The study analyzed data from 92 households, focusing on man days (person-days of labour) and income from direct forest employment (e.g., Forest Department jobs) and NTFP-based self-employment (e.g., collecting and selling Sal leaves, Mahua flowers). Table 6 presents enhanced descriptive statistics, including means, standard deviations (SD), minima, maxima and quartiles.

Table 5: Descriptive Statistics of Key Variables (N=92)

Variable	Mean	SD	Min	25%	50%	75%	Max
Direct Man days	13.02	4.66	0.35	10.45	12.98	16.05	22.71
Direct Income (Rs.)	2,676.62	944.23	236.42	2,127.42	2,639.89	3,311.97	4,443.57
NTFP Man days	81.59	32.20	1.65	61.45	82.65	99.12	188.28
NTFP Income (Rs.)	4,906.67	1,916.25	98.28	3,657.63	4,919.72	5,899.14	11,203.64
Total Man days	94.61	33.47	-1.93	69.02	95.63	113.61	210.99
Total Forest Income (Rs.)	7,583.29	2,060.48	334.70	5,785.05	7,559.61	9,211.11	15,647.22
Other Income (Rs.)	29,925.02	10,632.99	8,761.04	22,032.71	29,862.74	37,130.97	51,898.03
Total HH Income (Rs.)	37,508.31	11,232.19	14,391.19	29,645.75	37,734.14	44,719.31	62,392.13

Source: Field Survey (2023) and authors calculation.

The mean NTFP man days (81.59) is substantially higher than direct man days (13.02), indicating that self-employment through NTFPs engages households more intensively - about 6 times more labour input on average. However, the large SD for NTFP man days (32.20) and income (1,916.25) points to high variability. Some households (e.g., those in the upper quartile) invest up to 99+ man days and earn over Rs. 5,899, while others (lower quartile) engage minimally (around 61 man-days, Rs. 3,658). This variability likely stems from factors like seasonal NTFP availability (e.g., Mahua flowers in summer) and household access to forests, suggesting uneven livelihood benefits. In contrast, direct employment shows lower variability (SD 4.66 for man days), reflecting its more structured but limited nature.

Overall, forest resources contribute a mean of Rs. 7,583 to household income, but the wide range (Rs. 335 to 15,647) underscores vulnerability for low-engagement households, who may face greater poverty risks.

7.2. Labour inputs relate to earnings and integration of forest activities with overall livelihoods

Correlation analysis examines linear relationships between variables, helping identify how labour inputs relate to earnings and how forest activities integrate with overall livelihoods. Coefficients range from -1 to 1, with values above 0.7 indicating strong positive associations.

Table 6: Correlation Matrix (Selected Variables)

	Direct Man days	Direct Income	NTFP Man days	NTFP Income	Total Man days	Total Forest Income	Other Income	Total HH Income
Direct Man days	1.00	0.98	0.13	0.12	0.26	0.51	0.21	0.30
Direct Income	0.98	1.00	0.13	0.12	0.26	0.52	0.21	0.30
NTFP Man days	0.13	0.13	1.00	0.96	0.99	0.94	0.02	0.28
NTFP Income	0.12	0.12	0.96	1.00	0.95	0.96	0.02	0.29
Total Man days	0.26	0.26	0.99	0.95	1.00	0.96	0.04	0.31
Total Forest Income	0.51	0.52	0.94	0.96	0.96	1.00	0.07	0.36
Other Income	0.21	0.21	0.02	0.02	0.04	0.07	1.00	0.98
Total HH Income	0.30	0.30	0.28	0.29	0.31	0.36	0.98	1.00

Source: Field Survey (2023), analysed via correlation matrix.

Strong correlations within categories (e.g., $r = 0.98$ between direct man days and income; $r = 0.96$ for NTFP) confirm that more labour directly translates to higher earnings, as expected in wage-based (direct) and productivity-based (NTFP) systems. The moderate correlation between total forest income and total household income ($r = 0.36$) shows forest resources as a meaningful but supplementary contributor - boosting overall income without dominating it. Low correlations between forest variables and other income ($r \approx 0.02-0.07$) indicate independence (Table-6). Households are relying heavily on NTFPs aren't necessarily compensating for low non-forest earnings, but rather using forests as a diversified safety net. This aligns with NTFPs' role in resilience during agricultural lean periods (Shackleton et al., 2011).

7.3. Predictive relationship between man days and income

OLS regression models the predictive relationship between independent (e.g., man days) and dependent variables (e.g., income), controlling for linearity and providing coefficients for practical insights. Here, it quantifies how labour effort drives earnings.

Two models were fitted:

1. **Total Forest Income ~ Total Man days:** Adjusted $R^2 = 0.89$ (89% variance explained), $F(1,90) = 739.8$, $p < 0.001$. Coefficient for man days: $\beta = 64.94$ ($SE = 2.39$, $t = 27.20$, $p < 0.001$).
2. **NTFP Income ~ NTFP Man days:** Adjusted $R^2 = 0.96$ (96% variance explained), $F(1,90) = 2,226$, $p < 0.001$. Coefficient for man days: $\beta = 60.29$ ($SE = 1.28$, $t = 47.17$, $p < 0.001$).

In the first model, each additional man-day increases total forest income by Rs. 65, demonstrating high labour productivity overall. The high R^2 suggests man days are a dominant predictor, implying that policies increasing access to forest work (e.g., via JFM) could directly boost incomes. For NTFPs specifically, the Rs. 60 per man-day return is slightly lower but with even stronger explanatory power ($R^2=0.96$), indicating consistent efficiency despite informal markets. This highlights NTFPs' potential. While daily returns are modest, scalability through more man days could elevate livelihoods, but requires addressing barriers like market access (Mahapatra & Tewari, 2005).

7.4. Comparative analysis assessing the difference between income sources

The paired t-test compares means within the same sample, assessing if differences (e.g., between income sources) are statistically significant.

Comparing direct employment income ($M = \text{Rs. } 2,677$, $SD = 944$) and NTFP income ($M = \text{Rs. } 4,907$, $SD = 1,916$): $t(91) = -10.18$, $p < 0.001$, Cohen's $d = 1.06$ (large effect).

The significant difference ($p < 0.001$) shows NTFP self-employment generates nearly double the income of direct jobs, with a large effect size indicating practical importance. This suggests NTFPs offer greater economic value due to flexibility and year-round opportunities, versus seasonal direct employment. For tribal communities, these underscores shifting focus to NTFP enhancement (e.g., value addition like Sal leaf plates) for better resilience (Ghosal, 2014).

7.5. Income Inequality

The Gini coefficient measures income distribution (0 = perfect equality, 1 = perfect inequality), useful for evaluating if NTFPs reduce disparities.

Gini for total household income (including forest) is 0.17. Gini without forest income is 0.20 (difference = 0.03, or 15% reduction).

The lower Gini with forest income indicates NTFPs promote equity, reducing inequality by providing low-barrier access to earnings for poorer households (e.g., those with minimal land). This 15% drop aligns with global findings where NTFPs lower rural Gini by 10-20%, acting as a "pro-poor" resource (Angelsen et al., 2014). In Sarenga, this means NTFPs help marginalized tribes like Santhals buffer against poverty, but sustained equality requires preventing overexploitation.

7.6. Contribution of Forest Resources to Total Household Income

Forest resources contribute 20.21% to total income (mean Rs. 7,583 of Rs. 37,508), ranking third after agriculture and labour. NTFPs drive 63.73% of forest income.

This share emphasizes forests as a critical supplement, especially in dry-deciduous areas with erratic agriculture. The NTFP dominance (63.73%) highlights their versatility for food, fuel, and cash, enhancing resilience amid climate risks (Dash & Behera, 2013).

8. Policy Implications

To maximise the role of Non-Timber Forest Products (NTFPs) in sustaining tribal livelihoods in Sarenga, the following policies are recommended:

1. **Formalize NTFP Markets:** Establish cooperatives for fair pricing and value-added processing (e.g., Sal leaf plates), potentially increasing incomes by 20-30% (Dash & Behera, 2013).
2. **Capacity Building:** Provide training on sustainable harvesting and enterprise skills, targeting women and tribals to counter commercialization-driven gender shifts (Ghosal, 2014).
3. **Expand Joint Forest Management (JFM):** Enhance community rights under FRA 2006, ensuring 25% NTFP revenue sharing to promote conservation and equity (Sarkar, 1998).
4. **Climate-Adaptive Strategies:** Promote agroforestry for NTFP cultivation to mitigate degradation and seasonal risks (Saha & Sundriyal, 2012).
5. **Monitoring and Research:** Implement GIS-based tracking of NTFP yields and biodiversity, aligning with ICFRE guidelines for adaptive management (Gairola, 2014).

These measures can boost NTFP contributions to 30-40% of household income, fostering resilience and ecological sustainability in Jangalmahal of West Bengal.

9. Conclusion

This study highlights the indispensable role of forest resources, particularly Non-Timber Forest Products (NTFPs), in bolstering livelihoods for tribal communities in Sarenga, Bankura district, West Bengal. Contributing 20.21% to household income, NTFPs like Sal leaves, Mahua flowers, fuel wood, and fodder provide essential self-employment (81.4 man-days/annum, Rs. 4,845/household) and equity benefits, reducing income inequality by 15% via a Gini drop from 0.20 to 0.17. While direct Forest

Department jobs offer seasonal support, NTFPs enhance resilience amid agricultural uncertainties and climate risks. However, challenges such as seasonality, degradation and market gaps persist. To ensure long-term sustainability, policymakers must prioritize value-added enterprises, sustainable harvesting training, and Joint Forest Management expansions. By integrating conservation with economic empowerment, these strategies can uplift marginalized tribes like Santhals and Mundas, fostering inclusive rural development in Jangalmahal.

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