

Research Article

Livelihood Transition of Vulnerable Tribal Groups (PVTGS) In Eastern India: Shift from Forest-Based Subsistence to Market-Orientation

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Abstract: The Particularly Vulnerable Tribal Groups (PVTGs) in Eastern India traditionally relied on forests for their subsistence, cultural identity and livelihood security. However, increasing market opportunities, infrastructure development and policy interventions are transforming traditional livelihood systems, giving rise to new economic opportunities as well as emerging vulnerabilities. However, the empirical evidence shows a changing spectrum of forest interaction and clear spatial variability of livelihood transformation among PVTGs, though they are unable to avoid their marginality in social position. This study examines the transition of PVTGs in Eastern India from forest-based subsistence to market-oriented livelihoods. It is based on a cross-sectional household survey of 157 households from 14 villages from the scattered locations of Jharkhand, Odisha and West Bengal. The livelihood transformation was evaluated by three integrated indicators, namely, Forest Dependency Index (FDI), Market Integration Index (MII) and Livelihood Diversification Index (LDI). The proposed analytical framework provides a robust basis for assessing livelihood transitions and informing evidence-based policy for forest-dependent indigenous communities. Index measures thus show a different form of livelihood transition among the PVTGS of Eastern India. The high FDI in Jharkhand (0.682) confirms that forests are still the main source of food, income and subsistence security. The relatively lower FDI in West Bengal (0.289) shows a greater shift towards agriculture and non-forest income sources. The middle location of Odisha indicates a transition phase where the dependence on forest resources still exists together with emerging options for livelihood.

Keywords: Particularly Vulnerable Tribal Groups (PVTG); Forest Dependency Index; Market Integration Index; Livelihood Diversification Index; Livelihood Transition.

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1. INTRODUCTION

Around the world, indigenous communities have depended on forests for their livelihoods, food security and cultural identity, as well as for crucial ecosystem services, income, nutrition and traditional medicines (FAO, 2022; Angelsen et al., 2014). These relationships are especially important to the Particularly Vulnerable Tribal Groups (PVTGs) in India, which are amongst the most socio-economically backward indigenous communities in the country. Small, declining populations, low literacy, pre-agricultural technologies, and high dependence on natural resources are the hallmarks of PVTGs. Traditionally, PVTGs have survived by hunting, gathering, shifting cultivation, collection of non-timber forest product (NTFP), and small-scale subsistence agriculture (Government of India, 2014; Ministry of Tribal Affairs, 2023). However, rapid infrastructure development, increasing market networks, digital financial inclusion, livelihood diversification programmes and forest governance reforms in the last two

decades have fundamentally changed the socio-economic landscape in which these communities live. Hence, a few PVTGs are undergoing gradual transition from forest-centred subsistence economies to market-oriented livelihood systems. The speed and result of this transition vary substantially across regions.

Available studies have separately focused on forest dependence (Angelsen et al., 2014; Behera et al., 2024), livelihood diversification (Ellis, 2000), and commercialisation among tribal and rural population. However, very few studies have integrated these three dimensions simultaneously using composite indicators across multiple states among the PVTG population. This is a critical methodological as well as empirical gap which the current study tries to address. Furthermore, earlier research has frequently viewed modernisation as a linear development, presuming that reduced reliance on forests is a sign of socioeconomic progress, without acknowledging that commercialisation can also result in greater livelihood specialisation, market vulnerability and inequality. This gap is especially stark in the eastern plateau and hill region of India where different degrees of infrastructure and divergent institutional contexts, along with ecological diversity, result in highly differentiated livelihood trajectories among PVTGs. Hence, there is a need for a more integrated understanding of the ways in which traditional forest-based livelihoods are being transformed by contemporary economic and policy changes.

In this context, the present study examines transition from forest-based subsistence to market-oriented livelihoods of PVTGs in Eastern India. It compares the extent of forest dependency, market integration and livelihood diversification across selected communities in Jharkhand, Odisha and West Bengal through the development of three complementary composite indicators namely Forest Dependency Index (FDI), Market Integration Index (MII) and Livelihood Diversification Index (LDI). By incorporating these dimensions into the Sustainable Livelihoods Framework, this study aims to provide a deeper understanding of livelihood transformation than that afforded by single-indicator assessments. Our study also provides an analytical approach that is transparent, replicable and relevant to other forest-dependent indigenous communities.

Study Area

The study was conducted in the Eastern Plateau and Hill Region (EPHR) of India consisting of the states of Jharkhand, Odisha, Bihar and West Bengal (Fig. 1). EPHR is one of the major physiographic regions of India, characterised by rugged plateaus, undulating hills, vast tropical deciduous forests and rich mineral resources. The region is socioeconomically marginalised despite its ecological importance and high biodiversity and is home to a large share of India's indigenous communities, including 25 out of the country's 75 officially recognised PVTGs (Government of India, 2014; Ministry of Tribal Affairs, 2023). These communities live in varied ecological settings from remote forest interiors and dissected uplands to transitional plateau landscapes and forest-agriculture interface areas where livelihoods are intrinsically linked to forest ecosystems and natural resources.

To capture the heterogeneity in ecological and socio-economic aspects of PVTGs, a purposive sampling framework was adopted based on six selection criteria, viz. geographical distribution, ecological setting, predominant livelihood practices, population size, cultural uniqueness and continuity of traditional socio-cultural institutions. Altogether, 157 households data were collected from 14 villages of 8 Community Development (CD) Blocks namely Bishunpur blocks of Gumla district, Bandu block of Ranchi district and Mahuadahr, Ghaghra of Latehar district of Jharkhand; Binpur-II block of Jhargram district and Baghmundi and Jhalda blocks of Purulia district in West Bengal and Khairpur block of Malkangiri districts of Odisha. The PVTGs

surveyed were Asur, Birhor, Birjia, Lodha Sabar and Bonda, which reflected distinct ecological adaptations and livelihood systems. These communities still live largely in rural forested landscapes where reliance on forest resources, subsistence agriculture, wage labour and developing market opportunities together constitute the contemporary livelihood strategies. Thus, the region depicts a suitable setting to study the ongoing transition from forest-based subsistence towards increasing tendency of market-based livelihood dependence among some of the most marginalised tribal population of India (MoEFCC, 2021; Census of India, 2011; Ministry of Tribal Affairs, 2023).

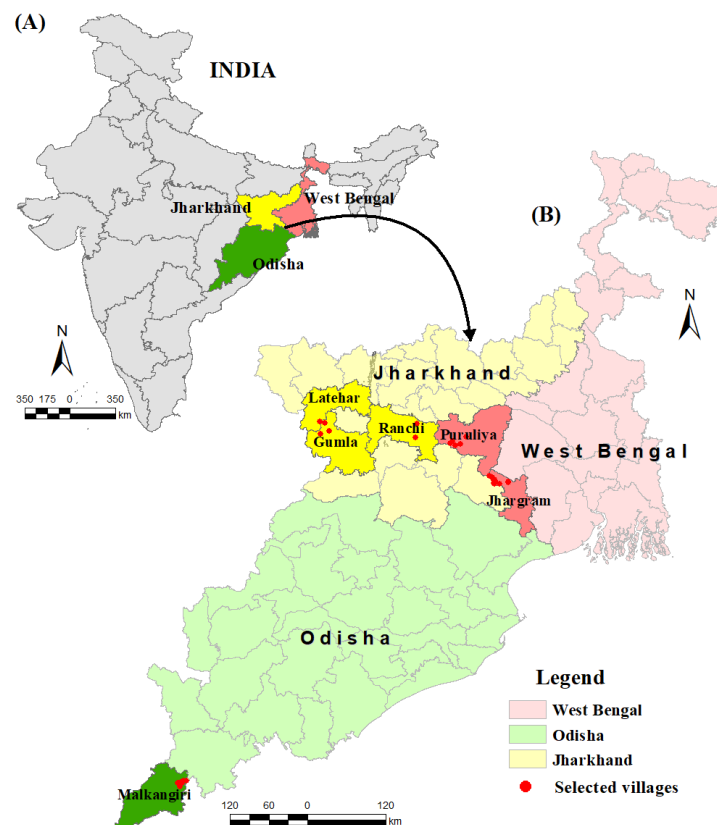


Fig. 1: Location Map of the study area.

Sampling Design, Data Collection and Ethical Considerations

A purposive sampling strategy was adopted to adequately reflect the ecological and socio-cultural heterogeneity of PVTGs inhabiting Eastern India. The selection of districts and CD Blocks itself was guided by purposive criteria, prioritising areas with a comparatively high concentration of PVTG population. Accordingly, eight CD Blocks spanning six districts were chosen from the states of Odisha, West Bengal and Jharkhand. The selection of study villages proceeded through a multi-stage process. Initially, an inventory of villages with documented PVTG habitation was compiled using records obtained from local administrative bodies and secondary literature sources. From this inventory, villages were subsequently shortlisted from the identified CD Blocks and districts, with due consideration given to variation in household size distribution, to ensure representation of both larger and smaller settlement clusters.

This spatial spread was deliberately designed to encompass diversity in physiographic settings, degree of forest dependence, and demographic profiles across the study region. At the household level, a total enumeration approach was employed within the selected villages, guided by pre-defined inclusion and exclusion criteria. This was preceded by a pilot survey, undertaken to validate the sampling framework and to

ensure adequate and proportional representation of the target population prior to full-scale data collection.

Therefore, structured interviews of 157 households were conducted to collect primary data. Household interviews typically were 15-20 min long, providing opportunity for a more thorough examination of livelihood transitions, forest dependence, and market participation.

Field investigations were conducted from December 2025 to March 2026 using a pretested semi-structured questionnaire designed to meet the objectives of the study (Fig. 2). The survey instrument was first developed in English, and then translated into Hindi, Bengali, Odia and back translated to ensure linguistic accuracy and conceptual equivalence as per internationally accepted cross-cultural survey protocols (Brislin, 1970; WHO, 2016). Content validity was established by expert review, and a pilot survey was conducted with 20 households to refine question wording, assess reliability and estimate time for interview.

The study was conducted in accordance with the internationally accepted ethical principles for research with human participants. Prior to the commencement of fieldwork, ethical clearance was granted by the Institutional Ethics Committee of The University of Burdwan, under approval certificate No. IEC/BU/2026/02, dated 24 February 2026. After a clear explanation of the study objectives, confidentiality provisions and voluntary nature of participation, all respondents were provided with written or verbal informed consent. Participants were free to refuse to participate or to withdraw from the study at any time without penalty. Throughout the entire research process, stringent measures were put in place to maintain anonymity, confidentiality and the responsible handling of research data, consistent with ethical guidelines for social science research (Israel & Hay, 2006).

2. METHODOLOGY

The present study is a quantitative cross-sectional household survey on the transition from forest-based subsistence to market-oriented livelihoods of the PVTGs of Eastern India. Main data were obtained through a household questionnaire on forest resource use, household income, market participation, livelihood activities and socio-economic characteristics. Three composite indicators have been constructed to fully understand the multidimensional character of livelihood transformation: the Forest Dependency Index (FDI), the Market Integration Index (MII) and the Livelihood Diversification Index (LDI). The indicators used to calculate the FDI, MII and LDI are presented in Table 1.

The selected indicators were chosen because they directly represent the key dimensions of livelihood transformation among PVTGs. Forest dependency indicators capture reliance on natural resources; market integration variables reflect engagement with emerging market systems and livelihood diversification measures assess shifts toward multiple income sources. Together, these indicators provide a comprehensive and context-specific framework for evaluating socio-economic transition across PVTG communities. The methodological framework is aligned with internationally accepted approaches for composite indicators' construction and livelihood assessment, ensuring analytical rigour and comparability across households.

Before the index construction, all the quantitative indicators were normalised using the Min-Max normalisation. This is an effort to eliminate the difference in the measurement scales and to transform the variables to a common scale between 0 and 1. The normalized value of each indicator was calculated as:

$$Z_i = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}} \quad (i)$$

where X_i denotes the observed value of the indicator, while $X_{\min}$ and $X_{\max}$ represent its minimum and maximum observed values, respectively. This normalization approach is recommended by the OECD for developing robust composite indicators because it preserves the relative variation among observations while ensuring comparability across variables (OECD, 2008).

The Forest Dependency Index (FDI) was designed to measure the extent to which households depend on forest resources for their livelihoods. After normalisation, the indicator weights were estimated using Principal Component Analysis (PCA), a multivariate technique that is objective and reduces subjectivity by deriving weights from the underlying covariance structure of the data. Where there was no theoretical basis for differential weighting, equal weighting was taken as an alternative. The composite FDI was calculated as:

$$FDI = \sum_{i=1}^n W_i Z_i \quad (ii)$$

where W_i represents the weight assigned to the i th indicator, Z_i is its normalized value, and the weights sum to one ($\sum W_i = 1$). Higher FDI values indicate greater household dependence on forest-derived products and ecosystem services, reflecting stronger reliance on forest-based subsistence livelihoods (Angelsen et al., 2014; Byron & Arnold, 1999; Vedeld et al., 2007; OECD, 2008).

To evaluate the integration of households in the market economy, the **Market Integration Index (MII)** was developed according to a similar framework of composite indicator. All variables were normalised using Min–Max scaling. The distance to market indicator was reverse-coded, because the shorter the travel distance, the higher the market accessibility. Indicator weights were estimated through PCA, and the composite MII was computed using the weighted linear aggregation method:

$$MII = \sum_{i=1}^n W_i Z_i \quad (iii)$$

where W_i denotes the PCA-derived weight and Z_i the standardized indicator value. Higher MII scores represent stronger market participation, improved accessibility to commercial networks, and greater integration into market-oriented livelihood systems (Barrett, 2008; Carletto et al., 2017; von Braun & Kennedy, 1994; OECD, 2008).

Livelihood diversification was assessed using the **Livelihood Diversification Index (LDI)** based on the Simpson Index of Diversity (SID), which simultaneously accounts for both the number of income sources and the distribution of household income among them. The index was calculated as:

$$LDI = 1 - \sum_{i=1}^n P_i^2 \quad (iv)$$

where P_i is the proportion of household income derived from the i th livelihood source relative to total household income. The LDI is a measure ranging from 0 to 1, where higher values indicate more livelihood diversification and less dependence on a single source of income. This has been widely used in livelihood studies due to its effectiveness in capturing the complexity and resilience of rural household livelihood portfolios (Simpson, 1949; Ellis, 2000; Joshi et al., 2004).

The combined use of FDI, MII and LDI together provides a holistic analytical framework to evaluate the livelihood transformation of PVTGs through the joint analysis of forest dependence, market participation and income diversification. Standardised indicators, PCA-based weighting and internationally accepted diversity measures are combined to improve methodological robustness, transparency and reproducibility of the analysis, enabling meaningful comparisons between households and informing evidence-based policies to support sustainable livelihood transitions in forest-dependent communities.

Table 1: Outline of the indicators used for the assessment of the FDI, MII, and LDI.

Indicator	Symbol	Measurement	Scale/Unit
Forest Dependency Index (FDI)			
Income from forest products	FI	Total annual income earned by the household from the sale and self-consumption (monetary value) of forest products, including timber, fuelwood, bamboo, honey, medicinal plants, and non-timber forest products (NTFPs).	Indian Rupees per year (INR/year)
Fuelwood collection	FW	Total quantity of fuelwood collected by the household from forests during the previous 12 months for domestic use and/or sale.	Kilograms per year (kg/year)
NTFP collection frequency	NF	Total number of days in the previous 12 months during which household members collected non-timber forest products (e.g., sal leaves, mushrooms, fruits, honey, medicinal plants, bamboo, tendu leaves).	Days per year (days/year)
Household labour in forest activities	FL	Total labour contributed by all household members to forest-based livelihood activities (collection, processing, hunting, fishing, fuelwood gathering, NTFP harvesting) during the previous 12 months.	Person-days per year (person-days/year)
Share of forest income in total household income	FS	Percentage of total annual household income derived from forest-based activities. Calculated as: $(\text{Annual Forest income} \div \text{Total annual household income}) \times 100$.	Percentage (%)
Food collected from forest	FF	Percentage of the household's annual food consumption obtained directly from forests (e.g., wild fruits, vegetables, mushrooms, fish, game, edible tubers, honey). Calculated as: $(\text{Value or quantity of forest-derived food} \div \text{Total annual household food consumption}) \times 100$.	Percentage (%)
Market Integration Index (MII)			
Percentage of production sold	PS	Proportion of total agricultural and forest produce sold in the market during the last 12 months. $PS = \frac{\text{Value of produce sold}}{\text{Total value of produce}} \times 100$	Percentage (%)
Market visit frequency	MV	Average number of visits made by any household member to the nearest market for buying or selling goods during the last month.	Number of visits/months
Distance to market (Reverse coded)	DM	Road distance from the household or village to the nearest permanent market. Since shorter	Kilometres (km)

		distances indicate greater market integration, the variable will be reverse normalized before index construction.	
Mobile banking use	MB	Whether the household uses mobile banking services (e.g., UPI, mobile wallet, bank app) for financial transactions.	Binary (0 = No, 1 = Yes)
Digital payment	DP	Whether the household uses digital payment methods (UPI, QR code, debit card, etc.) for purchasing inputs or selling products.	Binary (0 = No, 1 = Yes)
Cooperative membership	CM	Membership in any agricultural cooperative, Forest Producer Organization (FPO), Self-Help Group (SHG), Tribal Cooperative, or producer collective involved in marketing activities.	Binary (0 = No, 1 = Yes)
Commercial crop cultivation	CC	Share of cultivated land devoted to market-oriented or commercial crops. $CC = \frac{\text{Area under commercial crops}}{\text{Total cultivated area}} \times 100$	Percentage (%)
Market information access	MI	Household's level of access to market information (prices, demand, buyers, weather, transport, etc.) measured using a 5-point Likert scale.	1 = Very Poor, 2 = Poor, 3 = Moderate, 4 = Good, 5 = Very Good
Livelihood Diversification Index (LDI)			
Income from Forest	IF	Income generated from all forest-based livelihood activities.	Income (₹)/Year
Income from Agriculture	IA	Income obtained from all farming and agriculture-related livelihood activities.	Income (₹)/Year
Income from Livestock	IL	Income generated through livestock production and related livelihood activities.	Income (₹)/Year
Income from Business	IB	Income obtained from all self-employment and business activities.	Income (₹)/Year

Respondent Profile

The profile of the respondents throws upvaried demographic and socio-economic characteristics of the Particularly Vulnerable Tribal Groups (PVTGs) surveyed across Jharkhand, Odisha and West Bengal and offers important information about their capacity to negotiate the ongoing transition from forest-based subsistence to market-oriented livelihoods.



Fig. 2: Field photographs taken during the household survey

The household survey population profiles indicated that the population was predominantly young with children (0-14 years) accounting for 33.1% of the population in West Bengal, 39.0% in Odisha and 41.9% in Jharkhand, suggesting relatively high dependency burdens across all the study areas. The age group of 15-60 years, which is economically productive, constituted 60.9%, 58.8% and 52.2% of the population in West Bengal, Odisha and Jharkhand, respectively implying varying levels of demographic dividend and availability of labour for diversification of livelihood. Conversely, the elderly population (>60 years) was relatively low, ranging from 2.2% in Odisha to 6.0% in West Bengal.

The occupational characteristics indicate a gradual transition from traditional forest-based livelihoods to informal wage employment. Casual day labour was the main occupation of the 149 economically active respondents in the study region, comprising 41.6%. Forest-based jobs, work in factories, driving and formal service were much smaller components. Differences at the state level provide evidence of the heterogeneity of

livelihood transitions. In Odisha, collection of forest-products (29.7 %) and agriculture (27.0 %) indicated relatively higher dependence, while casual labour was the most concentrated (55.6 %) in Jharkhand. Labour force participation in wage employment was higher in West Bengal, but most of the jobs were informal and insecure. In all three states, over three quarters of respondents depended on the informal economy for their livelihoods, reflecting limited access to stable employment and formal labour markets.

The income profile further shows that the household of PVTGs are still in an economically vulnerable condition. A majority of the surveyed households (47.8 per cent) had a monthly per capita income in the range of Rs 1,001 and Rs 2,000 while 22.7 per cent of the respondents had an income below Rs 1,001. So, despite increased participation in market-oriented activities, income levels are still low everywhere. Income distributions varied among the states. Odisha had relatively higher income heterogeneity, Jharkhand was clustered in the lower income categories associated with forest-based and casual labour activities and West Bengal had relatively better market access but also higher income inequality. These respondent attributes together suggest demographic pressure, occupational informalities and persistent income insecurity as drivers of livelihood transformation among PVTGs, which highlight the need for inclusive livelihood policies, improved human capital development and equitable market integration (Ellis, 2000; Scoones, 1998; FAO, 2018).

Forest Dependency Index (FDI)

The inter-state variation in the extent to which PVTG households still depend on forest resources for their livelihoods is considerable as reflected in the Forest Dependency Index (FDI) presented in Table 2. Among the surveyed communities, Jharkhand had the highest composite FDI (0.682) showing forest-based subsistence as the main livelihood base (Fig. 3). This high dependence is reflected in consistently high standardised scores across all six indicators, especially for annual income from forest products (0.83), the proportion of food obtained from forests (0.79) and fuelwood collection (0.71). Odisha exhibited a moderate forest dependence (FDI=0.413), although forest resources continue to contribute significantly in supporting household livelihood, a proportion of this contribution is offset by other income-generating activities. Among the states, West Bengal recorded the lowest FDI (0.289) with relatively lower values in all the indicators indicating a sharp decline in direct dependence on forest resources. The uniform indicator weights (0.162–0.169) suggest that each dimension contributed almost equally to the composite index, confirming that differences among states mainly reflect differences in household dependence rather than methodological bias. The findings together indicate a marked gradient of livelihood transition across Eastern India.

The PVTGs of Jharkhand are still mostly forest dependent communities but those of Odisha are in the intermediate phase of transformation. By contrast, West Bengal shows stronger evidence of a shift from traditional forest-based subsistence towards diversified and increasingly market-oriented livelihoods. These spatial variations reflect the differential pace of socio-economic transition among the PVTGs and highlight the continuing role of forests as a livelihood safety net in areas with still limited access to other economic opportunities.

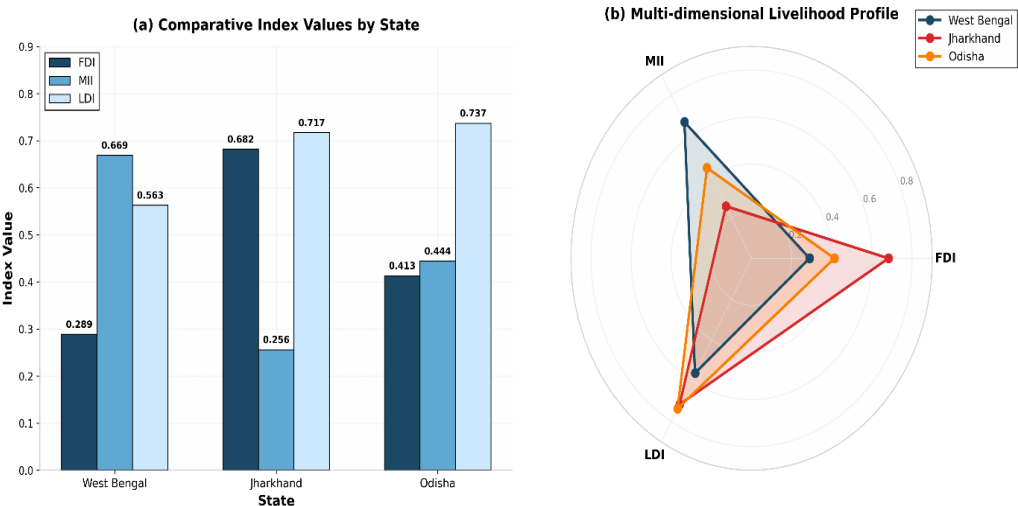


Fig. 3: FDI, MII & LDI: (a) Comparative values by state.(b) Multi-dimensional livelihood profile.

Table 2:Detailsof Results of Forest Dependency Index (FDI) of selected state.

Indicator	Symbol	WB		Jharkhand		Odisha	
		Standardized Value	Weight	Standardized Value	Weight	Standardized Value	Weight
Annual income from forest products	FI	0.42	0.168	0.83	0.168	0.59	0.168
Quantity of fuelwood collected	FW	0.34	0.167	0.71	0.167	0.42	0.167
NTFP collection frequency	NF	0.26	0.169	0.64	0.169	0.37	0.169
Household labour devoted to forest activities	FL	0.23	0.162	0.61	0.162	0.45	0.162
Percentage of food obtained from forest	FF	0.29	0.166	0.79	0.166	0.37	0.166
Medicinal plant dependence	MP	0.19	0.168	0.51	0.168	0.28	0.168

Market Integration Index (MII)

The Market Integration Index (MII) shows considerable variations in the way PVTG households are linked to market-based economic systems across states (Table 3). West Bengal recorded the highest composite MII (0.669), suggesting relatively high level of market participation and commercialisation among the communities surveyed (Fig. 3). The strong integration is reflected in high standardised scores for access to market information (0.86), adoption of digital payments (0.83), frequency of market visits (0.75) and proportion of production sold (0.72), indicating that households are increasingly

integrated into formal markets, digital financial services, and commercial exchange networks.

Odisha recorded a moderate MII (0.444) indicating a transitional phase with increased market participation, but still limited by restricted accessibility, low digital inclusion and limited commercialisation of agricultural production. In contrast, Jharkhand had the lowest MII (0.256) and relatively low values for most indicators e.g. market visits (0.31), use of mobile banking (0.29), cooperative membership (0.29) and commercial crop cultivation (0.32).

Table 3: Detailsof Results of Market Integration Index (MII) of selected state.

Indicator	Symbol	WB		Jharkhand		Odisha	
		Standardized Value	Weight	Standardized Value	Weight	Standardized Value	Weight
Percentage of production sold	PS	0.72	0.127	0.39	0.127	0.32	0.127
Market visit frequency	MV	0.75	0.128	0.31	0.128	0.19	0.128
Distance to market (reverse coded)	DM	0.66	0.125	0.37	0.125	0.16	0.125
Mobile banking use	MB	0.64	0.128	0.29	0.128	0.20	0.128
Digital payment	DP	0.83	0.126	0.58	0.126	0.43	0.126
Cooperative membership	CM	0.48	0.113	0.29	0.113	0.34	0.113
Commercial crop cultivation	CC	0.43	0.126	0.32	0.126	0.25	0.126
Market information access	MI	0.86	0.128	0.45	0.128	0.33	0.128

These findings suggest that market engagement for PVTGs in Jharkhand is still limited and livelihoods are largely dependent on subsistence-oriented production and local resource use. The weights of the indicators are nearly uniform (0.113–0.128), which confirms that each of the variables contributed proportionally to the composite index. This also guarantees that differences at the state level are mainly due to real differences in market integration rather than weighting effects.

Overall, the results reveal a clear spatial gradient in economic transformation in Eastern India. While West Bengal seems to be in a more advanced stage of transition from forest-based subsistence to market orientated livelihoods, Odisha in an intermediate phase of integration and Jharkhand is still relatively low in market connectivity. These patterns highlight the need for better market access, digital financial inclusion, transport infrastructure and institutional support to facilitate sustainable livelihood diversification for PVTGs.



Livelihood Diversification Index (LDI)

The Livelihood Diversification Index (LDI) reveals a significant difference in the composition and diversity of PVTG livelihood portfolios across Eastern India (Fig. 4). Odisha has registered the highest LDI (0.737) representing the most diversified livelihood structure where the household income is relatively well distributed across forest resources, agriculture, livestock and business activities (Fig. 3).

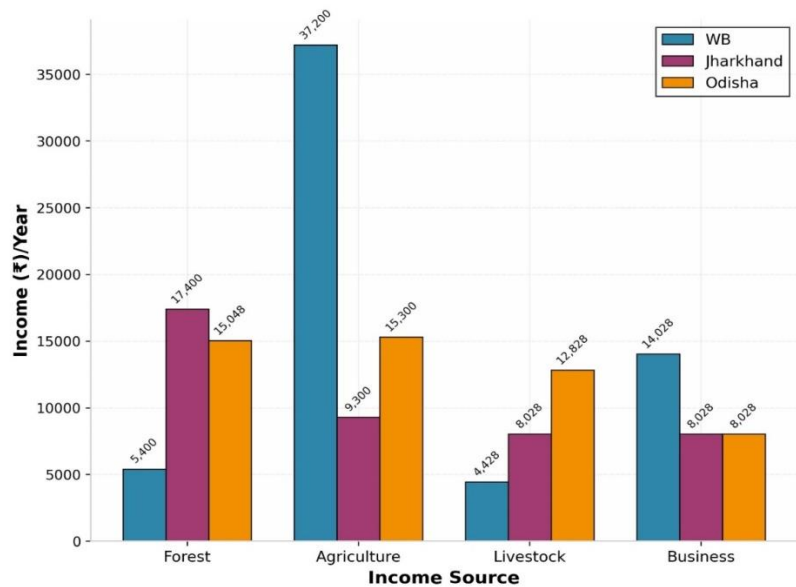


Fig. 4: Details results of Livelihood Diversification Index (LDI) of selected states

Agriculture (₹15,300) and forest-based income (₹15,048) were almost equally important for household earnings, with livestock (₹12,828) and business (₹8,028) contributing significantly to supplementary income, suggesting a balanced and resilient livelihood system. Jharkhand was second on the list with LDI of 0.717, but livelihood composition was still dominated by forest resources. Income from forests (₹17,400) was considerably higher than from agriculture (₹9,300), livestock (₹8,028) and business (₹8,028) indicating diversification has occurred but is limited by continued dependence on forest-based subsistence. In contrast, West Bengal had the least LDI (0.563), despite having the highest agricultural income (₹37,200) and relatively higher business income (₹14,028). The small contribution of forest products (₹5,400) and livestock (₹4,428) indicates a livelihood structure that is more specialised and less dispersed across multiple sources of income. So, although West Bengal has seen a major turn to agriculture and market-oriented activities, a lower index value means a less diverse livelihood composition, and not lower economic development.

Overall, the findings indicate that the livelihood transformation of PVTGs is not homogeneous across the region. Odisha has the most balanced and diversified livelihood system; Jharkhand is undergoing diversification but has a strong forest dependence and West Bengal has moved to a more agriculture and market-based economy with relatively lower livelihood diversity. Such state-to-state variations highlight the need for not only a reduction in reliance on forests to achieve successful livelihood transformation but also the development of diverse income sources that are mutually reinforcing to strengthen household resilience and long-term socioeconomic sustainability.

3. DISCUSSION

The findings reveal a conspicuous, but spatially uneven transition from forest-based subsistence to market-oriented livelihoods among PVTGs in Eastern India. This

demonstrates that the transformation of livelihoods is not linear or homogeneous across states. The high FDI in Jharkhand (0.682) confirms that forests are still the main source of food, income and subsistence security. The relatively lower FDI in West Bengal (0.289) shows a greater shift towards agriculture and non-forest income sources. The middle location of Odisha indicates a transition phase where the dependence on forest resources still exists together with emerging options for livelihood. These patterns are consistent with the argument that forests are an important safety net for vulnerable tribal households with limited access to markets and infrastructure, and with the global evidence that environmental income still plays a fundamental role in sustaining rural livelihoods in the midst of increasing economic modernisation (Angelsen et al., 2014; Vedeld et al., 2007). The observed inter-state variation further supports the Sustainable Livelihood Framework proposed by Scoones (1998) that livelihood strategies are determined by differential access to natural, financial, physical, social and human capital. The MII also shows that the transformation of livelihoods is strongly correlated with improvements in access to markets, digital financial inclusion, transport networks and institutional participation. West Bengal had the highest MII (0.669) depicting stronger commercialisation, greater adoption of digital payment and better access to market information, while Jharkhand had the lowest market integration (0.256) indicating that subsistence orientated production still prevails. These findings are in line with other studies that demonstrate that improved market access enhances commercialisation, income generation and livelihood resilience of smallholders, albeit benefits are uneven where physical infrastructure and institutional support are lacking (Barrett, 2008; Carletto et al., 2017). The findings also suggest that PVTG modernisation is not only due to occupational change but increasingly due to formal financial and value chain inclusion, which however is hampered by geographical isolation and institutional capacity constraints. These interpretations are consistent with the empirical patterns reported in the manuscript, where differences in digital payment adoption, market visits and market information explain a large part of the observed variation in market integration.

One of the main contributions of this study is to show that lower forest dependence does not necessarily imply higher livelihood resilience. Odisha had the highest Livelihood Diversification Index (LDI = 0.737), suggesting a relatively balanced income portfolio across forests, agriculture, livestock and business activities, while West Bengal had the lowest diversification (0.563) despite the strongest market integration and agricultural income. This finding underscores that the livelihood specialisation associated with commercialisation could increase dependence on fewer income sources and potentially expose households to market shocks, climatic variability or price fluctuations. Similar observations have been made by Ellis (2000) who argued that diversification improves household resilience by spreading livelihood risks over multiple economic activities. Thus, the shift away from forest-based livelihoods should not be seen as just a reduction in dependence on forest resources but as the creation of complementary and diversified livelihood opportunities that can contribute to improved long-term socioeconomic security.

The pronounced forest dependence observed in Jharkhand reflects the persistence of remote forest settlements, limited market connectivity, inadequate infrastructure, and continued reliance on non-timber forest products (NTFPs) as primary sources of food and income, consistent with previous studies (Government of India, 2014; Angelsen et al., 2014; Behera et al., 2024). In contrast, Odisha exhibits greater livelihood diversification because households combine forest collection with agriculture, livestock, wage labour, and small businesses, supported by community-based livelihood programmes and stronger resource complementarities. West Bengal demonstrates higher commercialisation owing to better transport networks, digital financial inclusion, and

market accessibility; however, households increasingly specialize in agriculture and market-oriented activities, reducing the diversity of income sources despite stronger market integration (Ellis, 2000; Carletto et al., 2017; Ministry of Tribal Affairs, 2023). These findings reinforce that market integration and livelihood diversification do not necessarily progress simultaneously.

The results have significant policy implications for sustainable tribal development. Development interventions should not promote complete substitution of forest-based livelihoods but should promote a balanced approach of sustainable forest management and better market connectivity, value addition of non-timber forest products, digital financial inclusion, producer cooperatives and skill development. Such an approach would enhance economic opportunities while maintaining the ecological knowledge and cultural identity that are still central to PVTG communities. These recommendations are particularly salient with the increasing challenges and opportunities identified in the previous works on PVTG where infrastructure development has often outpaced community participation and institutional effectiveness.

Several limitations should be acknowledged as well. First, the analysis uses cross-sectional comparisons of three states and cannot fully capture the temporal dynamics of livelihood transition. Second, composite indices tend to oversimplify complex livelihood processes and may not be comprehensive in terms of the social capital, cultural values and informal economic exchanges included. Third, the study focuses primarily on household economic indicators and does not explicitly address gendered livelihood roles, climate change adaptation, or intergenerational knowledge transmission. Fourth, reliance on self-reported income and expenditure data introduces the possibility of recall error and reporting inaccuracies, which may affect the precision of the constructed indices. Fifth, the potential influence of social desirability bias cannot be ruled out, particularly in responses concerning income sources, resource use, and market behaviour. Finally, data collection at a single time point does not account for seasonal variation in forest dependency, agricultural income, and market engagement, all of which are known to fluctuate considerably across the annual cycle in tribal-dominated landscapes.

Future research should therefore adopt longitudinal panel survey designs capable of tracking livelihood trajectories over time, complemented by geospatial monitoring of forest cover change linked with household-level socio-economic data. Particular attention should be given to gendered livelihood pathways, which remain underexplored in existing PVTG research, alongside the long-term impacts of key policy and institutional interventions, including the Forest Rights Act, the PM-JANMAN scheme, NTFP processing centres, tribal cooperatives, and local procurement systems, on livelihood resilience and market integration across diverse PVTG communities. Multidisciplinary investigations of this nature would offer a more holistic understanding of how processes of modernisation can be harmonised with ecological sustainability, while ensuring that development pathways remain culturally appropriate and responsive to the lived realities of forest-dependent indigenous populations.

4. CONCLUSION

The present study attempts to explore the transition of PVTGs in the Eastern Plateau and Hill Region from forest-based subsistence to more market-oriented livelihoods, and the evidences presented here are far from uniform. Jharkhand's households show appreciably high dependency on the forest economy, relying for their food, income and labour on the surrounding forests. Odisha is somewhere in the middle, with a balance between continued forest use and a genuinely diversified income base; and West Bengal has moved furthest towards commercial agriculture and participation in digitally enabled

markets, though at the cost of a narrower and less resilient livelihood portfolio. The three composite indices developed for this study the FDI, MII and LDI are not only descriptive of three separate states, but also trace a coherent, if uneven, gradient of socio-economic change across the region. In so doing they lend empirical weight to the Sustainable Livelihood Framework's central premise that access to different forms of capital, rather than any single driver, shapes how households adapt.

The theoretical contribution of this work is precisely to bring these three dimensions-forest reliance, market embeddedness, and income diversity in a comparative frame that allows a nuance that single-indicator studies tend to miss that stepping away from the forest does not automatically translate into a more secure livelihood. West Bengal's case drives the point starkly in the sense that against any policy instinct, forest disengagement is increasing day by day due to increasing scope for non-forest income and easy market access. What is proposed instead is an argument for layered interventions that would strengthen sustainable NTFP value chains, expand digital and financial inclusion, support producer cooperatives and invest in skills that would enable households to build market linkages without abandoning the ecological safety net that forests continue to provide. The findings also highlight how much the speed of transition depends on institutional delivery, not just policy design, given the persistent gaps in translating instruments such as the Forest Rights Act and PM-JANMAN into change on the ground. Of course, these threestates, cross-sectional comparison does not permit us to see how these trajectories will play out over time, nor does it fully address attitudinal outlook of the PVTGs across the three states. It is inarguably true that due to successful land reform programmes in West Bengal, forest dependency has shifted to agricultural dependency and in many pockets of Jangle mahal of West Bengal, Lodhas has transformed into agriculturist. Moreover, the increasing involvement in livestock and business across the three states. Livelihood diversity indices of the three states are very close to each other signifying that PVTGs in this region is not vehemently dependent on forest which signals that they are gradually stepping towards mainstream, especially the younger generation. Hopefully therefore, younger generation will decide the destiny of their close to forest or mainstreaming with distancing forest relation.

Collective and Specific Contributions by the Authors

Sanat Kumar Guchhait conceived and designed the study, supervised the research, and contributed to writing, reviewing, and editing the final manuscript.

Ananda Mohan Kar performed the methodology, conducted data analysis, and assisted in drafting the original manuscript.

Kumari Vibhuti Nayak has scrutinized the paper and provided suggestion.

Birendra Suna has added some dimensions of this work.

Shimul Roy was involved in reviewing the paper with important suggestions regarding methodology, policy decisions etc.

Md Hasanuzzaman (RA of the project) contributed to resources, visualization, and critically reviewed the manuscript for important intellectual content.

All authors read and approved the final version of the manuscript.

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