

Assessing the Socio-Economic Impacts of the Forest Rights Act on Tribal Communities in Odisha: An Empirical Study of the Juang Tribe

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Abstract - Tribal communities in India have inhabited forests since ancient times, depending on forest resources for their livelihoods while also managing and protecting these ecosystems. However, several policy and institutional interventions have restricted many of their customary rights, leading to livelihood challenges and socio-economic stress. Although the Forest Rights Act, 2006 (FRA), was enacted to restore the forest land and resources rights of tribal and forest dwelling communities, ensuring livelihood securities and conservation of forests, its implementation has remained inconsistent across different regions. This study aims to assess the relationship between FRA implementation and the socio-economic conditions of the Juang tribe in Keonjhar district of Odisha, employing composite socio-economic and vegetation cover indices. A primary survey was conducted across five villages in the Banspal block, covering 150 tribal households. The findings indicate variations in both indices across villages, with relatively higher and lower values observed in different locations. These results suggest that the overall impact of the FRA in improving livelihood security and socio-economic conditions remains constrained due to gaps in its effective implementation. The prime constraints include limited access to land rights, restricted livelihood opportunities, lower educational attainment, and continued reliance on low-productivity activities. The findings highlight the need to strengthen FRA implementation to ensure equitable livelihood enhancement, sustainable forest management, and improved socio-economic outcomes for tribal communities.

Keywords: Forest Rights Act, Tribal Livelihoods, Socio-Economic Conditions, Composite Index, Forest-dependent Communities

I. INTRODUCTION

The Forest Rights Act (FRA) of 2006 was designed to correct historical injustices faced by forest-dwelling communities in India, specifically focusing on recognizing their land and

resource rights. Although the Act was introduced to promote the socio-economic upliftment of forest dwellers by restoring their individual land rights over traditionally cultivated or occupied areas, its implementation has remained uneven across different regions. The available literature has identified a few challenges which prevent the successful implementation of the FRA, especially in tribal territories of Odisha. The basic groundwork on the necessity of a wholesome land rights reform was laid by Nandwani, (2022), who determined that the failure to legalize the issue of customary land rights has been one of the reasons why these communities remain in poverty.

Nevertheless, more researchers have diverted the focus to the real implementation of the FRA. Gupta et al., (2022) and Swain et al., (2025) studied the implementation gaps in the work of FRA, and their research revealed that it is marked with the presence of bureaucratic inefficiencies and institutional constraints that hamper its mission. Such studies highlight that though the FRA has legal acknowledgment, its efficacy in elevating the lives of forest communities is not much as a result of the hurdles in the procedures and lack of uniformity in implementation on a cross-regional basis. This perspective is also echoed by Leonard et al., (2020) and Mishra & Tripathi (2022), who stated that, although FRA has a potential to enhance the socio-economic conditions, the actual effects are limited because of poor enforcement systems and insufficient thorough engagement with the communities.

While much of the literature related to these studies is concerned with legal and institutional factors, an increasing body of literature acknowledges the necessity of investigating socio-economic outcomes of FRA through a

multidimensional lens. Gupta et al. (2022) empirically assessed the direct influence of FRA on socio-economic and environmental outcomes. However, the absence of unified frameworks of assessing these dimensions is one of the main gaps. In that respect, a combination of socio-economic data and environmental indicators like vegetation cover has been limited as noted by Das, (2022) and Swain et al., (2025).

The proposed study aims to fill this gap through the use of composite indices that combine socio-economic variables (e.g., income, education, land ownership) with environmental variables (e.g., vegetation cover, forest management) to evaluate the overall effect of FRA on the Juang tribe in Keonjhar district, Odisha. This method is also consistent with increasing awareness of multidimensional assessment frameworks (Chang, 2011; Datta et al., 2010; El Gibari et al.,

2019), thereby providing a more comprehensive understanding of the impact of the FRA through an integrated evaluation of both social and environmental outcomes.

The study extends the work of Swain et al. (2025) who examined the effect of the FRA in a broader context but did not incorporate environmental sustainability and socio-economic development in an integrated manner. Composite indices provide a more systematic analysis of the interaction between these dimensions, which contributes to the growing body of literature that recognizes the relationship between legal and policy deliverables and real-life changes in the socio-economic and environmental conditions of tribal populations. Table I summarizes the key provisions, status of implementation and research gaps related to FRA implementation.

TABLE I KEY PROVISIONS, AND RESEARCH GAPS OF THE FOREST RIGHTS ACT (FRA), 2006

Theme	Key Provisions and Outcomes	Research Gaps	Reference
Legal recognition of forest rights	FRA restores individual and community rights over forest land and resources, including rights to cultivation, habitation, and access to forest produce.	Limited empirical evaluation of the effectiveness of rights recognition in improving long-term socio-economic outcomes.	Das, (2022)
Livelihood security and socio-economic development	FRA aims to enhance livelihood opportunities through secure land tenure, access to forest resources, and livelihood diversification.	Lack of systematic assessments linking FRA implementation with measurable livelihood and income improvements across regions.	Swain et al., (2025)
Community forest management and conservation	FRA empowers communities to participate in forest governance, conservation, and sustainable resource management.	Insufficient empirical evidence on the relationship between FRA implementation and environmental outcomes such as vegetation cover and forest sustainability.	Gupta et al., (2022)
Institutional implementation and governance	Government programmes and institutional mechanisms support FRA implementation and land development.	Persistent institutional and procedural barriers affecting effective implementation, particularly at local levels.	Aggarwal, (2011); Gupta et al., (2022); Vaidya, (2022)
Assessment and monitoring frameworks	FRA implementation varies across regions depending on governance, institutional capacity, and socio-economic conditions.	Absence of standardized, multidimensional assessment frameworks integrating socio-economic and environmental indicators.	Das et al., (2025); Swain et al., (2025)
Regional and local-level empirical studies	FRA implementation varies across states and tribal communities depending on local socio-economic and ecological contexts.	Limited region-specific empirical studies assessing FRA impacts on forest-dependent tribal communities, particularly in Odisha.	Das et al., (2025)

In this context, an important methodological approach for determining the socio-economic status of tribal communities is the use of composite indices, which play a valuable role in multidimensional evaluation (Datta et al., 2010). Composite indices have the advantage of multidimensionality, as they aggregate multiple indicators into a single measure representing complex phenomena of development (El Gibari et al., 2019; Ravallion, 2012). This makes composite indices an effective framework for the systematic evaluation of livelihood conditions and policy impacts.

The purpose of the study is to assess the impact of Forest Rights Act, 2006 on socio-economic parameters, livelihood outcomes and environmental indices among the forest dependent tribal communities using a composite index framework in Banspal block, Keonjhar district, Odisha,

India. The study aligns with key Sustainable Development Goals, especially SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 10 (Reduced Inequalities) and SDG 15 (Life on Land).

Key Contributions

1. This research offers detailed empirical assessment on the socio-economic effects of Forest Rights Act (FRA) on the Juang tribe in the Keonjhar district in Odisha.
2. The study utilizes composite socio-economic and vegetation cover indices to provide a multidimensional analysis of the effectiveness of FRA in enhancing livelihood security and environmental sustainability.

- It combines both the socio-economic (family size, education, income) and the environmental (vegetation cover) data to evaluate the combined effect of the FRA on tribal communities.

This paper is organized as follows: Section II, Materials and Methods presents the methodological approach used with emphasis on the development of composite indices to assess socio-economic conditions and vegetation cover in the study area. Section III, Results and Discussion, presents the findings of the study, highlighting variations in the socio-economic conditions and vegetation cover across different villages and discussing their relationship with the implementation of the FRA. Section IV, Conclusion, summarizes the major findings and suggests recommendations for improvement of the implementation of the FRA, along with directions for future research related to tribal welfare and sustainable forest management.

II. MATERIALS AND METHODS

The composite index approach was used in this study for the evaluation framework (Datta et al., 2010; Dean, 2022). However, its application within the context of evaluating the FRA was relatively novel. Results may vary across different states due to differences in its implementation, institutional mechanisms, and policies adopted to enforce it. Keonjhar District was selected as the study area to examine the relationship between social and economic variables, vegetation cover, and their association with the implementation of the individual Forest Rights Act.

Study Area

Keonjhar is located in the northern state of Odisha, India (Fig. 1), with forest cover representing 37.30% of the total area. The district covers a geographical area of 8,303 sq. km. and lies between latitudes 21°01' N to 22°10' N and longitudes 85°11' E to 86°22' E. Based on the 2011 census, the district has a higher proportion of tribal population compared to the state average, 11.62% belongs to the Scheduled Caste, while 45.45% belongs to the Scheduled Tribe. Among the prominent and marginalized indigenous communities includes Juang tribe who traditionally live in the forested areas of the district, mainly dependent on agriculture and forest resources (El Gibari et al., 2019; Jena et al., 2025).

Banspal block, a major tribal-dominated area within Keonjhar district, has a total geographical area of 1,200.79 sq. km. With almost 62% area under forest cover, the region is a reflection of high level of forest dependence for livelihood, and socio-cultural practices amongst local tribal communities.

The implementation of the FRA is monitored by four departments of the region, i.e. Forest and Environment Department, Panchayati Raj Department, Tribal and Scheduled Caste Development Department, and Revenue and Disaster Management Department. Their responsibilities include reporting on the act, explaining implementation procedures, and executing the law through their staff.

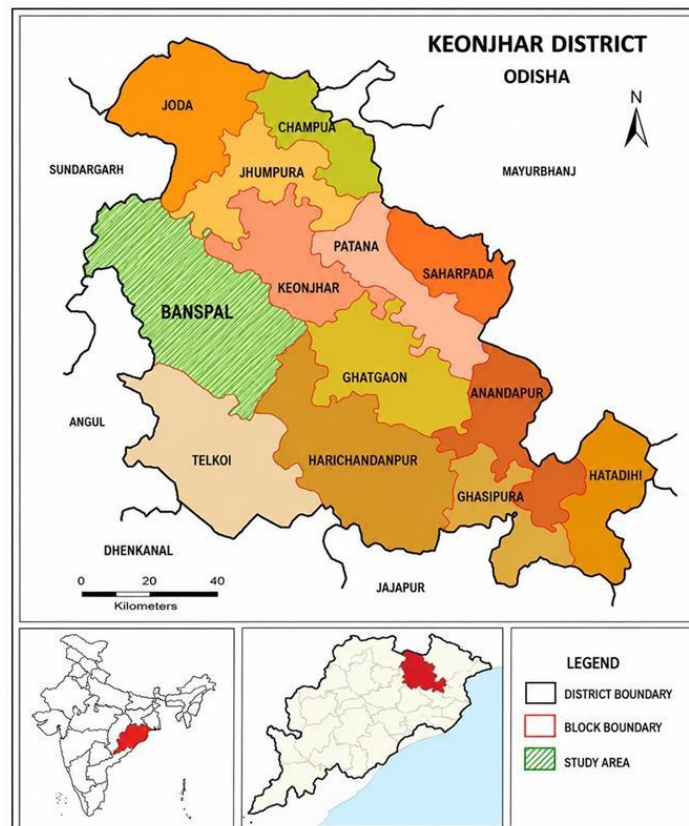


Fig. 1 Location Map of the Study Area

Composite Index

The composite index was developed based on Organization for Economic Co-operation and Development (OECD) study in 2008 and was adapted to fit the study area and the community under investigation, which are forest-dwelling tribal communities (Joint Research Centre, 2008). The composite index is made up of a set of economic and social indicators. Firstly, data was collected from a small sample of 15 households to validate the developed composite index. Subsequently, a random sample of 5 villages was taken, with an average of 30 households per village. Prior to household interviews, their free consent to participate in this study was obtained.

To assess the impact of vegetation cover, a geographic area was identified to determine the prevailing primary uses of forest resources. The interview method and focused group discussions were used, and a methodology for the vegetation cover index was adopted from Chandra et al. (2016). Plant samples were collected within the designated geographic area in each of the 5 villages.

The relationship between household economic and social indicators and vegetation cover conditions was examined using linear regression and correlation models. This relationship helped determine the extent to which the conditions of tribal households, after recognition of their rights, affected vegetation cover and land owned by them.

Research Design

This study adopted a mix-methods research design, combining both quantitative and qualitative approaches to provide a comprehensive analysis of the socio-economic and environmental impacts of FRA on the Juang tribe in Keonjhar district, Odisha. The quantitative component included the use of composite indices based on socio-economic and vegetation cover elements to assess the effectiveness of the implementation of FRA across multiple dimensions such as livelihood security, education and forest sustainability. This approach is consistent with studies in Information Systems, which emphasize multidimensional assessments for evaluating policy effectiveness (Swain et al., 2025). The qualitative component included field-based interviews and focused group discussions, which helped to capture the nuanced and contextual factors influencing the implementation of the FRA in the tribal areas, such as the community participation and local governance.

Data Sources

The primary data for this study were collected from five tribal villages of the Banspal block. These villages labelled as V1, V2, V3, V4 and V5 were chosen on the basis of their degree of implementation of FRA, thus providing a wide range of socio-economic and environmental conditions. Primary data were collected from 150 tribal households and at least 30

houses were surveyed in each village. The dataset was prepared through a combination of field surveys, interviews and focused group discussion with tribal households, village leaders and local government officials.

Secondary data sources included government records related to the implementation of the FRA, including land rights allocation, information on local forest resources, such as vegetation cover. The period of the data collection ranged from 2018 to 2023, to ensure that the study reflected recent developments in the implementation of FRA and its impact on tribal communities.

Dataset Characteristics

The data set comprised of 150 households from five villages (V1-V5) with a total of nine socio-economic and three environmental variables recorded. The socio-economic variables included family size, educational level, income, land ownership, family living standard and community activities participation, while the environmental variables comprised vegetation cover, number of tree species, and age of trees in the designated areas. The data collection period which provided a snapshot of the evolution of the implementation of FRA over time, and its implications for the communities.

The data collection attributes had high relevance to Information Science because they provided insights into information access, service efficiency, and community behavior concerning the implementation of forest rights. The study employed composite indices to relate socio-economic conditions to environmental outcomes and thus it is relevant to understanding the broader impacts of information and resource management systems in indigenous communities.

Sampling Strategy

A stratified random sampling method was applied to select households from each village to ensure representation across different socio-economic categories. The villages V1 to V5 were selected to represent different stages of implementation of the FRA, ranging from villages with weak implementation (V1, V2, and V5) to those with relatively better implementation (V3, and V4). Within each village, households were randomly based on the following criteria:

1. **Household size** (to ensure diversity in family size).
2. **Access to land rights** (both recognized and unrecognized FRA land).
3. **Occupation** (to capture a broad spectrum of livelihoods).

The sample was stratified in order to ensure that these variables were adequately represented across the five villages, thereby enabling a comprehensive analysis of the socio-economic impacts of the implementation of FRA.

Variables and Constructs

The study included the following key variables for analysis:

1. **Socio-economic conditions:** Family size, educational level, income level, family living standard, and involvement in community activities.
2. **Environmental sustainability:** Vegetation cover, number of tree species, and age of trees within designated areas.

These variables were measured and scaled using a Likert scale (from 0 to 3), where 0 indicated no or low performance (e.g. poor access to education, no land rights) and 3 indicated high performance (e.g. high education level, secure land rights, diversified income sources). Composite indices were then calculated by aggregating these values, thereby providing a comprehensive picture of the socio-economic and environmental conditions of each village.

Tools and Software Used for Analysis

The study employed following statistical and analytical tools:

1. SPSS was used for statistical analysis like descriptive statistics, correlation analysis and Principal Component Analysis (PCA) for deriving the composite socio-economic index.
2. R was used for regression modeling to understand the relationship between socio-economic conditions and environmental outcomes, particularly vegetation cover.

Analytical Workflow

1. **Data Collection:** Primary data included household surveys, interviews and focus group discussions with communities. Secondary information was acquired from government reports on FRA and local vegetation information.
2. **Data Cleaning and Preparation:** The data collected were cleansed from inconsistency (e.g. missing data) and standardized for analysis so that all variables were comparable across the sample.
3. **Composite Index Development:** Using the principal component analysis (PCA), we developed the composite indices for the socio-economic conditions and vegetation cover were developed based on the relative importance of the variables.
4. **Statistical Analysis:** Descriptive statistics, correlation and regression analyses were performed to examine the relationship between socio-economic variables and environmental outcomes

The methodological approach of the study to its objectives is the use of composite indices to measure complex socio-economic and environmental outcomes. This mixed-methods approach enabled a comprehensive examination of both short- and long-term impact of the FRA on tribal communities.

Methodological Alignment with Research Objectives

This methodology aligns with the objectives of this study by providing a clear multi-dimensional assessment of the implementation of Forest Rights Act. By integrating both quantitative and qualitative data, the study offers a more holistic view of the effects of the FRA. The findings will contribute to the existing body of knowledge on how legal recognition of community rights can affect broader socio-economic and environmental outcomes, particularly in forest inhabited tribal areas.

Development of the Composite Index of Socio-Economic Indicators

Based on the nature of the study and its relation to the FRA, social and economic indicators were selected according to several criteria, including: 1) their relation to the Forest Rights Act, 2006; and 2) their correlation within the study framework (Shek & Wu, (2018)). Consequently, a series of meetings were held with both researchers and members of the village community to identify the most important indicators related to the FRA, including indicators related to economic nature, those related to social development, and the descriptive indicators related to both social and economic aspects (Kosov et al., 2016). A list of 9 indicators was created. The reliability of the indicators was tested using Cronbach’s alpha by collecting data from 15 randomly selected households. The answers to the questions were evaluated, their correlation was checked. The questionnaire was designed to contain four possible options, with the respondent having the option to choose only one. Each answer was assigned a code (given that the scale used was ordinal), ranging from 0 to 3, where 0 represented the lowest performance and 3 represents the best performance achieved.

Principal Component Analysis (PCA) was applied, to reduce differences among indicators and assign standardized values for uniformity. For example, a variable ranging from 0-100 would dominate over a variable ranging from 0-1, resulting in biased results. Therefore, the value was calculated using the following equation:

$$z = \frac{\text{Value} - \text{Mean}}{\text{Standard deviation}}$$

Once the values of the variables x1, x2, x3,...n were unified, the sum of these values was calculated to obtain the value of the main index xi, composed of a number of sub-variables n.

$$\text{Composite index}_i = \sum_{i=1}^{i=n} X1 + X2 \dots \dots Xn$$

The villages where the FRA had been implemented were classified and ranked based on the average value and standard deviation of the composite index. As a result, three categories were identified: weak, good, and very good. Table II illustrates the socio-economic indicators as well as the method used for their calculation.

TABLE II SOCIO-ECONOMIC VARIABLES

Symbol	Variable name	Description
X1	Family size	Refers to the number of individuals living in the same household who share the same dwelling, food, and drink.
X2	Educational level	Represents the highest level of education attained by any member of the family.
X3	Family living standard	The level of infrastructure of the family's residence, including access to clean drinking water, electricity, and sanitation facilities.
X4	Annual income	The level of the family's welfare, which is determined by the annual income.
X5	Land ownership	Represents the size of land owned by the family in hectares.
X6	Ownership of agricultural animals	Refers to the number of agricultural animals owned by the family.
X7	Income diversity	Refers to the number of sources of income for the family.
X8	Active participation in community activities	Represents the number of activities in which the family participates with the local community during the year.
X9	Primary source of household income	Represents the source of highest family income: 1) Agricultural and livestock labor 2) Farm labor 3 Activities related to forest product collection 4) Any other (specify)

Development of the Vegetation Cover Index

Vegetation Cover Index is a composite index consisting of a set of criteria, including:

- Number of trees within a specific area of land (X10).
- Age of these trees, commonly measured by cutting the tree and counting the rings inside the tree's stump (X11).
- Number of tree species present (X12).

The area was classified according to the development of its vegetation cover, based on a numbered classification from 0 to 3, where the highest degree represents the best development or best performance of the vegetation cover. Therefore, the values of the criteria for the composite vegetation cover index were given equal weights, so as not to affect the different calculations.

III.RESULTS AND DISCUSSION

Table III presents the results of the data analysis of 150 households in the Banspal bock, Keonjhar district. The table

provides the social and economic indicators for five villages; V1 to V5 (names are kept anonymous on ethical ground). The weighted value of each indicator in the composite index, derived through PCA analysis is shown. The final results of the socio-economic indicators revealed three villages with poor performance and two villages with good performance.

The poor performance of the villages V1, V2, and V5 is associated with lower values of educational level (X2), the standard of living (X3), and the type of occupation (X9). The relatively better performance of villages V3 and V4, is attributed to the high values of family size (X1), educational level X2, standard of living (X3), annual income level (X4), and type of occupation (X9).

Households in the poor performing villages V1, V2, and V5, primarily rely on agricultural work and animal husbandry, where the study revealed that the type of work plays a major role in lowering the standard of living for households. The findings further indicate that the size of agricultural land holdings plays a significant role in reducing the value of the composite index, with the average agricultural land holding within the sample being 1.4 hectares.

The size of agricultural land holdings granted to tribes living in the forest remains a major concern, as land ownership forms a central component of the Forest Rights Act framework. Agricultural land allocations differ between individual households and community groups. The higher the value of the agricultural land holding, the greater the support received by the individual or group, and therefore improving their social and economic conditions, which contributed to a higher standard of living.

The low values for the composite index in the villages clearly indicate a lack of proper implementation of the FRA. As a result, individuals and communities have not been granted their rights and have not been able to contribute to improving their household economies.

The relationship between the composite index and its low value can also be explained by the level of education. When individuals have a higher level of education, the implementation of the FRA becomes easier, as it enables officials responsible for enforcing the act to communicate effectively with community members. However, if the government fails to take measures to increase knowledge and develop skills among indigenous populations, this becomes a critical factor in the low value of the index. Consequently, households lack the necessary knowledge to effectively engage in modern and profitable agricultural practices. If villagers are excluded from any participation in effective community activities and are not given a role in forest management and governance, this tends to lead to a decrease in household awareness, and therefore a decrease in the value of the composite index. On the other hand, the presence of community members in social events and activities can lead to better dissemination of information and higher performance in implementing the act.

TABLE III RESULTS OF THE ASSESSMENT OF SOCIO-ECONOMIC INDICATORS IN COMPOSITE INDEX

Village name	Score of X1	Score of X2	Score of X3	Score of X4	Score of X5	Score of X6	Score of X7	Score of X8	Score of X9	Composite score	Socio- economic condition (X)
Village 5 (V5)	0.34	0.03	-0.12	0.04	-0.23	-0.23	-0.08	-0.05	0.13	-0.16	Poor
Village 4 (V4)	-0.33	0.41	0.32	0.33	-0.09	-0.13	0.16	-0.05	0.26	0.27	Good
Village 3 (V3)	0.14	0.30	0.42	-0.54	0.24	0.11	0.17	-0.05	0.09	0.39	Good
Village 2 (V2)	-0.06	-0.41	-0.08	-0.16	-0.15	0.04	0.06	-0.07	-0.13	-0.09	Poor
Village 1 (V1)	0.05	-0.14	-0.74	0.01	0.06	0.38	-0.08	-0.07	-0.34	-0.08	Poor

Evaluating the Impact on Vegetation Cover

The results of intensive discussions with tribal communities indicate a loss of around 150 sq.km. of forests due to industrial activities and shifting cultivation (a form of agriculture in which a portion of the vegetation is burned to restore soil fertility after several years). The residents believe that the FRA has a significant impact on their ability to preserve the land, as owning land increases their ability to take better care of it.

The implementation of the FRA prevents a significant deterioration of forests and leads to an increase in agriculture and farming, which works towards improving the economic and social conditions of the population, thus enhancing their well-being. In this study, the composite Vegetation Cover Index used by Chandra et al., (2016) was evaluated and further developed.

The value of the composite Vegetation Cover Index (VCI) was calculated for each village in the five study villages and the results showed that two villages had very good vegetation conditions, while three villages had poor vegetation conditions. V1, V2, and V5 have the lower composite VCI scores due to land degradation and the presence of several factories in these villages. Additionally, the cultivation of economically unviable plants contributed to this degradation. On the other hand, the villages with high composite VCI values (V3 and V4) were supported by the government through afforestation projects and tree planting activities carried out at different intervals.

The areas that relied on forest products experienced a decrease in productivity, unlike the forests or villages where an increase in productivity was observed (V3 and V4). Table IV shows an increase in all values of the composite VCI, including the number, types, and ages of trees in both villages, indicating that their environmental degradation is lower compared to other villages in the sample.

TABLE IV RESULTS OF THE ASSESSMENT OF VEGETATION COVER INDICATORS IN COMPOSITE INDEX

Village	Score of X10	Score of X11	Score of X12	Composite VCI	Socio- economic condition (X)
V1	-0.17	-0.19	-0.15	-0.51	Poor
V2	0.22	0.08	-0.35	-0.06	Poor
V3	0.39	0.52	0.38	0.49	Good
V4	0.25	0.39	0.37	0.35	Good
V5	-0.38	-0.59	0.25	-0.72	Poor

Relationship Between Socio-Economic Indicators and Vegetation Cover Indicators

The Indian government has enacted the FRA to promote the development of tribal communities and improve their living conditions, whether economic or social, or both, with the ultimate goal of reducing poverty. While short-term economic growth may seem to occur, this growth will affect the forests and lead to further environmental degradation in long run.

The correlation between the composite socio-economic index and the composite VCI was examined using correlation analysis. A significant positive correlation ($r = 0.893$) was noted, indicating that an improvement in socio-economic conditions is associated with an improvement in vegetation cover. This positive relationship may be attributed to the increased ability of households with secure tenure and better socio-economic ability to manage forest resources in a more sustainable way (Dikshit & Dikshit, 2014; Shek & Wu, 2018).

Accordingly, strengthening the implementation mechanisms of FRA, promoting livelihood diversification and economic empowerment, building awareness and capacity, strengthening community participation and local governance and integrating conservation with livelihood planning are critical towards improving the socio-economic status of forest-dependent communities. These measures can enhance livelihood security, encourage sustainable resource management, and contribute to long-term environmental stability and poverty reduction.

Limitations

While this study gives important insights into the socio-economic and environmental impacts of the FRA on the Juang tribe of Keonjhar district, few limitations need to be taken into consideration namely:

1. **Regional Focus:** The study is limited to five villages in Banspal block, Keonjhar district, Odisha. As such, the results may not necessarily be directly applicable to other tribal communities in other regions with potentially different socio-economic conditions, cultural practices and implementation of the FRA. The generalisability of the results is limited because of this regional focus.

2. **Sample Size and Data Collection Method:** The research is based on a sample of 150 households which, whilst representative of the five villages, is certainly not representative of the full range of socio-economic conditions possessed by the broader tribal population. Additionally, the use of self-reported information via surveys and interviews may be subject to some biases such as social desirability bias or misreporting, which may affect the accuracy of the results.
3. **Temporal Constraints:** The data was gathered over a relatively short period (2018-2023) and this limits the possibility to assess the long-term impacts of the implementation of FRA on socio-economic conditions and environmental sustainability. Long-term studies are required to capture the full range of effects and provide a more complete understanding of the impact of the FRA.

IV. CONCLUSION

The study showed significant spatial variations in the socio-economic conditions and vegetation cover across villages in the Banspal block of Keonjhar district following the implementation of Forest Rights Act, 2006. The impact of FRA implementation on livelihood security and environmental sustainability was assessed through a systematic and multidimensional assessment using composite index of socio-economic conditions and vegetation cover. This enabled to identify key socio-economic factors and classify the villages on the basis of development level and implementation of FRA. This classification highlights areas with weak FRA implementation that need policy intervention, and at the same time identifies better performing villages that can serve as models for other areas. It further provides insights on the linkages between forest rights recognition, socio-economic development, and environmental sustainability. The findings indicate that villages that had better recognition and implementation of the forest rights exhibited improved socio-economic status, higher livelihood diversification, and better vegetation cover. In contrast, villages with weaker FRA implementation showed lower composite index scores, indicating lack of access to land rights, restricted livelihood opportunities, lower educational attainment and continued dependence on low productivity activities. Livelihood insecurity and low-income levels often contribute to unsustainable resource use, including improper management of forest products, inefficient agricultural practices and land degradation. A significant positive relationship was found between socio-economic conditions and vegetation cover, suggesting that households with better livelihood security, land ownership and diversified sources of income tend to adopt sustainable land-use practices. These findings confirm that secure tenure and improved socio-economic conditions improve environmental stewardship through a higher level of incentives for sustainable forest management and conservation. The composite index approach was found to be useful in assessing disparities in the implementation of the FRA and evaluating the socio-economic and environmental

outcomes of this flagship program. While the FRA has considerable potential to enhance livelihood security and foster ecological sustainability, its impact remains dependent on inclusive and consistent implementation. Strengthening institutional mechanisms, raising awareness and building community and administrative capacity are key to ensure the full benefits of the FRA being achieved and sustainable development being realized amongst forest-dependent tribal communities.

For future studies, it is possible to focus on the long-term impacts of the FRA and examine the sustained impact of the act on socio-economic conditions and environmental sustainability through longitudinal studies. Additionally, cross-regional comparative studies would give insight into region-specific issues of challenges and successes as well as broader environmental assessments of biodiversity and soil health would give a more comprehensive understanding of the ecological outcomes of the FRA. Strengthening institutional mechanisms, enhancing awareness, and building community and administrative capacities are essential to realizing the full benefits of the FRA and ensuring sustainable development among forest-dependent tribal communities.

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