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Technological Diffusion And Sustainable Livelihoods In Scheduled Areas Of Telangana: Empirical Insights From Itda Bhadrachalam And Eturnagaram

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Abstract
This study examines the role of technological diffusion in promoting sustainable livelihoods in the Scheduled Areas of Telangana, with empirical insights from ITDA Bhadrachalam and ITDA Eturnagaram. Using primary data collected in 2024 from 368 forest-dependent households through a structured questionnaire and Likert-scale analysis, this study analyzed adoption patterns and livelihood, employment, and sustainability outcomes associated with digital and eco-friendly technologies. The analytical framework integrates the Diffusion of Innovations (DOI) theory and the Technology Acceptance Model (TAM) to capture both community-level diffusion dynamics and individual adoption behaviour. The findings indicate that technological diffusion has strengthened the legitimacy of forest-based livelihoods, improved income from Minor Forest Produce (MFP), expanded employment opportunities, and encouraged environmentally responsible consumption practices. However, marked regional disparities persist. ITDA Bhadrachalam records higher levels of technology adoption and livelihood benefits owing to better digital connectivity, market access, and institutional support. In contrast, ITDA Eturnagaram continues to face infrastructural limitations, low digital literacy, and weak governance. By providing empirical evidence from an under-examined tribal and forest-based context, the study contributes to the literature on the technology–sustainability nexus in India. The policy implications underscore the need for localized digital capacity-building, the integration of traditional ecological knowledge with modern technologies, strengthened participatory governance, and targeted infrastructure investments to achieve inclusive and sustainable livelihood transformation in the Scheduled Areas of Telangana.

Keywords: Technological diffusion, Sustainable livelihoods, Digital innovation, Scheduled Areas, Minor Forest Produce (MFP), Telangana.

1. Introduction:
Sustainable development has emerged as a central policy and research priority, particularly for marginalized communities living in ecologically sensitive and resource-rich regions. The Scheduled Areas of Telangana, predominantly inhabited by indigenous and forest-dependent communities, present a complex development context marked by livelihood vulnerability, ecological dependence, and persistent institutional constraints. In recent years, technological diffusion has increasingly been viewed as a potential mechanism for addressing these challenges by enhancing livelihood opportunities, strengthening environmental conservation, and improving socio-economic well-being.

Technological diffusion refers to the process through which new technologies are introduced, adopted, and integrated into social and economic systems. In the Scheduled Areas, the diffusion of digital tools, innovative production practices, and sustainable resource management

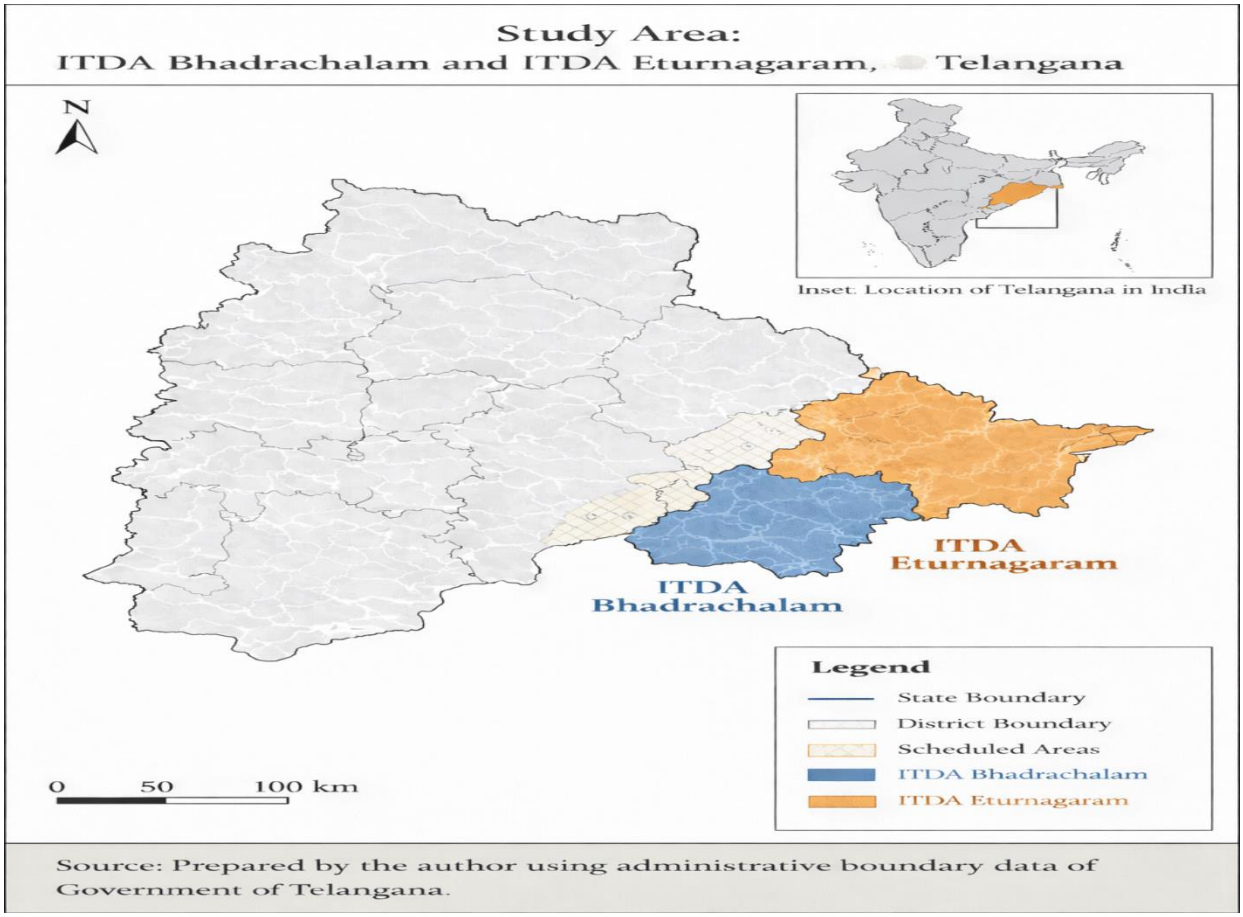
technologies has begun to influence traditional livelihood systems. Technologies such as Geographic Information Systems (GIS), remote sensing, mobile-based market platforms, and eco-friendly production methods have improved efficiency, transparency, and sustainability in forest-based economies. In addition, digital interventions have facilitated participatory governance by enabling local communities to engage more effectively in decision-making related to forest conservation and resource management.

The relevance of technological diffusion is particularly pronounced among forest-dependent communities that have historically faced limited market access, exploitative trading practices, and environmental degradation. Technology-driven initiatives have improved market connectivity, increased income from Minor Forest Produce, and promoted sustainable agricultural and forestry practices. Digital financial services and improved information flows have further contributed to livelihood stability and economic resilience. However, technology adoption in such contexts is shaped not only by access and availability but also by social diffusion processes and individual behavioural responses. While the Diffusion of Innovations (DOI) theory explains how technologies spread through social networks, institutional structures, and demonstration effects, the Technology Acceptance Model (TAM) focuses on individual perceptions of usefulness, ease of use, and behavioural intention that influence adoption decisions. Together, these frameworks provide a comprehensive lens for understanding uneven adoption outcomes across regions.

Despite increasing policy emphasis on digital inclusion and sustainable development, empirical evidence on how technological diffusion reshapes livelihoods in India's Scheduled Areas remains limited. Existing studies largely focus on agriculture-centric or generalized rural contexts, offering insufficient insights into forest-based tribal economies operating under similar policy frameworks but divergent infrastructural conditions. In particular, comparative evidence on how technology adoption varies across Integrated Tribal Development Agency (ITDA) regions is scarce. Addressing this gap, the present study examines the impact of technological diffusion on sustainable livelihoods in the Scheduled Areas of Telangana, with a comparative focus on ITDA Bhadrachalam and ITDA Eturnagaram. By integrating the Diffusion of Innovations (DOI) theory and the Technology Acceptance Model (TAM), the study provides a nuanced understanding of both community-level diffusion dynamics and individual adoption behaviour in forest-dependent contexts.

Figure 1. Study Area Map showing ITDA Bhadrachalam and ITDA Eturnagaram in the Scheduled Areas of Telangana

Source: Census of India and Government of Telangana



Understanding Technological Diffusion in the Scheduled Areas of Telangana:

Technological advancements play a critical role in achieving sustainable development, particularly in remote and forest-dependent communities. The Scheduled Areas of Telangana, home to indigenous and marginalized populations, face significant socio-economic and environmental challenges. The introduction of new technologies, such as digital trade platforms, precision agriculture, renewable energy solutions, and forest resource management tools, has the potential to enhance livelihoods, promote sustainability, and empower local communities. However, the success of such interventions depends on the acceptance and diffusion of technology in these communities. To analyze the factors influencing technological adoption, this study integrates two well-established theoretical models:

1) Diffusion of Innovations (DOI) Theory: This model explains how technology spreads within a society and the role of social networks in the adoption process.

2) Technology Acceptance Model (TAM): This model examines why individuals choose to adopt (or reject) technology, based on their perceptions of usefulness and ease of use.
By combining these two frameworks, this study provides a comprehensive understanding of the technological transformation occurring in Telangana's Scheduled Areas, identifying barriers, facilitators, and policy interventions needed for sustainable development.

1. Diffusion of Innovations (DOI) Theory

Everett Rogers' Diffusion of Innovations (DOI) Theory (1962) provides a foundational framework for analyzing how new ideas, technologies, and practices spread through a population. The DOI model is particularly relevant for understanding the social and cultural dynamics that shape technology adoption in rural, forest-dependent communities.

1.1 Key Elements of DOI in the Context of Scheduled Areas

1.1.a) Characteristics of Innovation

The rate of technology adoption depends on five key attributes:

1. Relative Advantage: If technology is perceived as significantly better than existing practices, it is more likely to be adopted. For instance, digital trading platforms for minor forest produce (MFP) offer better market access and fairer pricing than traditional middleman-driven markets.
2. Compatibility: Technologies that align with existing cultural values, livelihood patterns, and local knowledge are more easily embraced. For example, solar-powered irrigation systems are more acceptable than grid-based electricity due to irregular power supply in forested regions.
3. Complexity: If a technology is too difficult to use, adoption is slower. Digital tools that require literacy, internet connectivity, or complex training may face resistance from forest-dependent communities.
4. Trialability: Communities are more likely to adopt a new technology if they can experiment with it on a small scale before full commitment. Pilot programs for bamboo-based entrepreneurship or biofuel production can help build confidence.
5. Observability: If the benefits of a technology are visible and tangible, adoption accelerates. For example, when communities see neighboring villages benefitting from agroforestry techniques, they are more likely to follow.

1.1.b) The Role of Social Systems and Networks

Technology adoption is not just an individual decision; it is heavily influenced by peer networks, community leaders, and institutional support. In Telangana's Scheduled Areas, key social actors include:

1) Community-Based Organizations (CBOs): Facilitating knowledge-sharing and cooperative action.
2) Self-Help Groups (SHGs): Empowering women and marginalized groups through training and credit access.

3) Forest Protection Committees (FPCs): Promoting sustainable resource management and conservation technologies.
4) NGOs and Government Programs: Acting as intermediaries between technology providers and local communities.

1.1.c) Adoption Categories

People adopt new technologies at different rates, classified into five categories:
1. Innovators (2.5%)**:** The first to try new technology, usually tech-savvy youth or educated farmers experimenting with new techniques.
2. Early Adopters (13.5%)**:** Influential community leaders, progressive farmers, and local entrepreneurs who validate new ideas.
3. Early Majority (34%)**:** More cautious but willing to adopt once they see successful case studies.
4. Late Majority (34%)**:** Skeptical adopters who require strong evidence of benefits.
5. Laggards (16%)**:** Resistant to change, often relying on traditional practices until the new technology becomes unavoidable.
6. Understanding these adoption patterns helps policymakers design targeted interventions to accelerate and broaden technological diffusion.

2. Technology Acceptance Model (TAM)
While DOI explains the social and systemic spread of technology, the Technology Acceptance Model (TAM) (Davis, 1989) focuses on individual behavioral factors influencing adoption. In Telangana's Scheduled Areas, many technologies fail not because they are ineffective, but because local users find them impractical or difficult to use.

2.1 Core Components of TAM in the Study Context
2.1.A) Perceived Usefulness (PU)

The extent to which an individual believes that using a particular technology will enhance their productivity or quality of life in the Scheduled Areas, examples include:
1) Mobile applications for selling forest products, ensuring better market prices.
2) Remote sensing and GIS-based forest monitoring, preventing illegal logging and land encroachment.
3) Renewable energy solutions (e.g., biogas plants, solar cookers) reduce dependence on firewood and improve health outcomes.
If communities see clear, immediate benefits, they are more likely to embrace new technologies.

2.1.B) Perceived Ease of Use (PEU)
Even if a technology is useful, it will not be adopted if people find it too difficult to operate. In Telangana's Scheduled Areas, barriers to ease of use include:
1) Low literacy and digital skills: Many community members are not familiar with smartphones or digital transactions.

2) Language barriers: Most technological interfaces are in English or Telugu, excluding smaller tribal languages.
3) Infrastructure limitations: Poor internet connectivity and a lack of repair services make the technology unreliable.
Designing user-friendly solutions, such as voice-based interfaces in local dialects and offline mobile apps, can improve adoption rates.

2.1.C) External Factors Affecting Adoption
TAM also considers external influences that shape attitudes toward technology, such as:
1. Training programs**:** Government and NGO-led capacity-building workshops.
2. Peer influence**:** Adoption increases when influential villagers endorse new technologies.
3. Technical support**:** Availability of local guidance and troubleshooting services.

3. Integrating DOI and TAM for a Holistic Understanding
. The combined DOI-TAM approach provides a more comprehensive analysis of technological diffusion in Scheduled Areas.
1) DOI explains systemic barriers, such as lack of awareness, resistance to change, and absence of role models.
2) TAM explains personal barriers, such as low perceived usefulness, difficulty of use, and lack of confidence.
By addressing both community-level and individual-level factors, sustainable technological interventions can be more effective and widely accepted.

2. Review of Literature:

This section reviews key academic and empirical studies on technological diffusion, sustainable development, and livelihoods in the scheduled areas, with particular emphasis on forest-dependent and marginalized communities. The review situates the present study within broader development and innovation debates and highlights the relevance of applying the Diffusion of Innovations (DOI) and Technology Acceptance Model (TAM) frameworks to Scheduled Areas.

Early scholarship emphasizes the role of institutions in shaping technological outcomes. Ruttan (1996) argued that institutional support is as critical as technological innovation in promoting rural development, noting that weak governance structures can limit or reverse development gains in marginalized regions. Building on this institutional perspective, Rogers (2003) developed the Diffusion of Innovations (DOI) theory, demonstrating how social systems, communication channels, and perceived attributes of innovation influence adoption rates. The DOI framework has since been widely applied to understand technology diffusion in rural and community-based settings.

Several studies have examined the relationship between forests, poverty, and livelihoods. Angelsen and Wunder (2003) highlighted the forest–poverty nexus, arguing that forest-based economies can contribute to poverty reduction when combined with market access and technological support. Similarly, Sunderlin et al. (2005) identified strong spatial overlaps between poverty and forest dependence, emphasizing the need for targeted interventions that

simultaneously address livelihood vulnerability and ecological sustainability. Hall and Khan (2003) further noted that access to education, communication, and markets is essential for effective technology adoption. conditions often lacking in the Scheduled Areas.

At the individual level, Davis (1989) introduced the Technology Acceptance Model (TAM), which explains technology adoption in terms of perceptions of usefulness and ease of use. Subsequent extensions, particularly TAM 3 by Venkatesh and Bala (2008), incorporated additional individual and organizational factors influencing adoption behaviour. Empirical evidence supports the relevance of TAM in rural and marginalized contexts. Jensen (2007) demonstrated how mobile phones transformed price efficiency and incomes in South Indian fisheries, offering parallels to Minor Forest Produce (MFP) trade in tribal regions. Mishra, Patnaik, and Dash (2017) similarly found that perceived usefulness, local demonstrations, and tailored training significantly influence technology adoption in Indian villages.

The literature also underscores the role of digital and spatial technologies in sustainable forest governance. Agarwal (2010) emphasized the importance of GIS and remote sensing in community-based forest management, while FAO (2018) advocated for integrating drone and GIS technologies into participatory forest monitoring systems. Donner and Escobari (2010) highlighted how mobile technologies improved market participation among rural entrepreneurs, offering lessons for tribal enterprises. Pretty et al. (2011) introduced the concept of sustainable intensification, advocating eco-friendly technologies that enhance productivity without degrading natural resources, while Berdegué and Escobar (2012) emphasized territorial development through context-specific innovation systems.

Recent Indian studies highlight persistent digital exclusion in tribal regions. Yadav and Sahni (2015) identified barriers to digital governance in tribal areas, including language constraints, infrastructural deficits, and a lack of trust in institutions. Policy-oriented research, including the Government of Telangana (2022), emphasizes community-driven approaches to digital inclusion, MFP trade, and forest governance. The India Inequality Report (2022) and SPRF (2023) document enduring digital divides linked to connectivity and literacy gaps, while Thomas and George (2023) note particularly low levels of digital empowerment among tribal women. Kumar et al. (2024) similarly report infrastructural constraints limiting technology adoption among tribal communities in eastern India.

Overall, the reviewed literature indicates that technology can support sustainable livelihoods when supported by strong institutions and inclusive governance. However, existing studies are largely agriculture-centric or situated in generalized rural contexts, offering limited insight into forest-based economies. Moreover, technology adoption is frequently analysed as a technical process, with inadequate attention to the combined roles of social diffusion mechanisms and individual behavioural perceptions, while comparative micro-level evidence from Scheduled Areas remains scarce. Addressing these gaps, the present study integrates the Diffusion of Innovations (DOI) and Technology Acceptance Model (TAM) frameworks and provides comparative empirical evidence from ITDA Bhadrachalam and ITDA Eturnagaram.

3. Objective of the Study

This study aims to analyse the impact of technological diffusion on sustainable livelihoods and development outcomes in the Scheduled Areas of Telangana, with a comparative focus on ITDA Bhadrachalam and ITDA Eturnagaram.

4. Research Questions

1. How has technological diffusion influenced livelihood security, employment opportunities, income diversification, and sustainability outcomes in forest-dependent communities in the Scheduled Areas of Telangana?
2. What are the differences in technology adoption patterns and livelihood outcomes between ITDA Bhadrachalam and ITDA Eturnagaram?
3. How do institutional support, digital infrastructure, and individual perceptions shape the diffusion and adoption of digital and eco-friendly technologies in the Scheduled Areas?
4. How do the Diffusion of Innovations (DOI) and Technology Acceptance Model (TAM) frameworks explain observed patterns of technological adoption and partial diffusion in forest-based regions?

5. Methodology

The study is based on both primary and secondary data sources. Primary data were collected in 2024 from respondents in the Scheduled Areas under ITDA Bhadrachalam and ITDA Eturnagaram in the state of Telangana. A total of 368 respondents were selected using stratified random sampling, with economic status as the key stratification criterion to ensure representativeness across income groups. Economic status was chosen as the stratification variable because income levels significantly influence access to technology, adoption capacity, and livelihood outcomes among forest-dependent communities. Of the total sample, 57.1 per cent of respondents were drawn from ITDA Bhadrachalam and 42.9 per cent from ITDA Eturnagaram.

Data were collected using a pre-designed, structured questionnaire and interview schedule that focused on technology adoption, livelihood patterns, and perceptions of sustainable development. The collected data were processed and analysed using simple percentages, frequency distributions, and a five-point Likert scale to assess respondents' attitudes toward technological diffusion and its socio-economic impacts. Likert-scale items were grouped into composite outcome domains, and internal consistency was assessed using Cronbach's alpha, yielding acceptable values ($\alpha > 0.70$). Descriptive statistical techniques were employed to capture dominant trends, while comparative interpretation was used to examine regional variations between ITDA Bhadrachalam and ITDA Eturnagaram. Informed consent was obtained from all respondents, and the study adhered to ethical research standards, ensuring confidentiality and voluntary participation.

6. Results and Analysis

To enhance analytical clarity, the results are presented across three composite outcome domains: Livelihood Security, Employment and Income Outcomes, and Sustainability and Consumption Outcomes. Responses from the five-point Likert scale were aggregated into three categories Positive (Agree + Strongly Agree), Neutral, and Negative (Disagree + Strongly Disagree) to highlight dominant trends and comparative patterns.

Table 6.1. Livelihood Security Outcomes of Technological Diffusion (%)

Indicator	Positive (Agree + Strongly Agree)	Neutral	Negative (Disagree + Strongly Disagree)
Forests recognised as a legitimate livelihood source	61.7	19.8	18.5
Assured forest-based livelihood within time & resources	48.1	32.6	19.3
Minor Forest Produce as a sustainable income source	70.6	20.9	8.4
Improved access to forest resources	51.9	33.7	14.4

Source: Field Survey (2024)

Table 6.1 shows that technological diffusion has significantly strengthened livelihood security among forest-dependent households. A clear majority of respondents recognise forests (61.7 per cent) and Minor Forest Produce (70.6 per cent) as reliable and sustainable livelihood sources, indicating that technology-enabled interventions have enhanced the legitimacy and economic viability of forest-based activities. However, perceptions regarding assured livelihoods and improved access to forest resources remain moderate, with nearly one-third of respondents expressing neutral views. This pattern reflects uneven diffusion and partial integration of technology, particularly in areas constrained by infrastructural limitations and weaker institutional support.

Table 6.2. Employment and Income Outcomes of Technological Diffusion (%)

Indicator	Positive (Agree + Strongly Agree)	Neutral	Negative (Disagree + Strongly Disagree)
Increase in employment opportunities	66.3	19.6	14.1
Decline in poverty levels	60.0	22.0	17.9
Growth of off-farm income activities	55.5	25.3	19.3
Expansion of forest-based enterprises / MFP trade	56.8	28.8	14.4

Source: Field Survey (2024)

Table 6.2 reveals a strong positive association between technological diffusion and employment and income outcomes. More than two-thirds of respondents reported increased employment opportunities, while 60 per cent perceived a decline in poverty levels, indicating that technology has expanded livelihood options beyond subsistence activities. Although income diversification through off-farm activities and forest-based enterprises shows positive trends, relatively higher neutral responses suggest that economic gains are not uniformly experienced across households. These findings imply that while technology has opened new income avenues, the stability and depth of benefits depend on market access, skill levels, and institutional support.

Table 6.3. Sustainability and Consumption Outcomes of Technological Diffusion (%)

Indicator	Positive (Agree + Strongly Agree)	Neutral	Negative (Disagree + Strongly Disagree)
Perceived long-term forest sustainability	57.3	24.2	18.5
Afforestation providing employment & health benefits	62.8	22.8	14.4
Adoption of eco-friendly consumption patterns	57.1	24.5	18.5
Availability of healthy food at affordable prices	53.0	27.2	19.8

Source: Field Survey (2024)

Table 6.3 indicates moderate but encouraging progress in sustainability and consumption outcomes. Most respondents associate technological diffusion with afforestation programmes that generate both employment and health benefits, reflecting convergence between ecological restoration and livelihood generation. Adoption of eco-friendly consumption patterns and improved access to healthy food are also evident; however, the relatively high proportion of neutral responses suggests that these changes are not yet fully embedded. This indicates that behavioural and consumption transitions remain gradual and require sustained institutional engagement, continuous awareness-building, and active community participation.

6.4 Regional Comparison: ITDA Bhadrachalam and ITDA Eturnagaram

A clear regional contrast emerges when livelihood, employment, and sustainability outcomes are compared between ITDA Bhadrachalam and ITDA Eturnagaram. Overall, respondents from ITDA Bhadrachalam report higher positive outcomes across all domains, particularly in livelihood security, income from Minor Forest Produce, and employment generation. These patterns reflect relatively better digital connectivity, stronger institutional outreach, and improved market access, which have facilitated wider exposure to and more effective adoption of technological interventions. In contrast, ITDA Eturnagaram exhibits a higher proportion of neutral responses across indicators, suggesting partial diffusion and cautious adoption of technology. Persistent infrastructural constraints, limited digital literacy, and weaker institutional support continue to moderate the translation of technological access into tangible livelihood gains. Despite operating under similar policy frameworks, the divergence in outcomes across the two regions highlights the critical role of local infrastructural, institutional, and behavioural conditions in shaping the effectiveness of technological diffusion.

Overall, the consolidated results demonstrate that technological diffusion positively influences livelihood security, employment generation, income diversification, and the adoption of eco-friendly practices in the Scheduled Areas of Telangana. However, the consistently high proportion of neutral responses across outcome domains indicates partial adoption and uneven diffusion. Comparative patterns between ITDA Bhadrachalam and ITDA Eturnagaram highlight the critical roles of infrastructure, institutional support, and digital capacity in shaping adoption outcomes. These findings suggest that access to technology alone does not automatically translate into sustained livelihood improvements, underscoring the importance of supportive infrastructure, digital literacy, and institutional facilitation. The observed patterns provide the basis for the

following discussion, which interprets the results using the Diffusion of Innovations and Technology Acceptance Model frameworks.

7. Discussion

The findings of this study provide clear empirical evidence on how technological diffusion influences sustainable livelihoods in the Scheduled Areas of Telangana, while also revealing important regional disparities between ITDA Bhadrachalam and ITDA Eturnagaram. Overall, the results demonstrate that digital and eco-friendly technologies have contributed positively to livelihood security, employment generation, income diversification, and environmentally responsible practices among forest-dependent communities. However, the uneven distribution of benefits and the persistence of neutral responses across outcome domains indicate partial adoption and incomplete diffusion, underscoring the importance of examining both social diffusion processes and individual adoption behaviour.

7.1 Livelihood Security and Diffusion Dynamics: Insights from DOI

From the perspective of the Diffusion of Innovations (DOI) theory, the observed improvements in livelihood security reflect the role of social networks, institutional facilitation, and demonstration effects in accelerating the spread of technological practices. The strong recognition of forests and Minor Forest Produce as legitimate and sustainable livelihood sources suggests that technologies supporting forest management, market access, and value addition are increasingly evident and socially validated within communities. In ITDA Bhadrachalam, where institutional presence and communication channels are relatively stronger, innovations appear to have progressed beyond early adoption stages, reinforcing livelihood legitimacy and stability. Conversely, the moderate perceptions regarding assured livelihoods and access to forest resources indicate that diffusion remains uneven, particularly in areas with weaker infrastructure and limited institutional outreach.

7.2 Employment and Income Outcomes: Evidence from TAM

The positive employment and income outcomes observed in the study are consistent with the Technology Acceptance Model (TAM), particularly the role of perceived usefulness in shaping adoption behaviour. Respondents reporting increased employment opportunities, declining poverty, and expansion of forest-based enterprises indicate that technologies are viewed as economically beneficial and relevant to everyday livelihood needs. These perceived gains strengthen behavioural intention to adopt and continue using technology. However, the relatively high proportion of neutral responses suggests that perceived usefulness alone is insufficient when adoption is constrained by skill deficits, market volatility, or unreliable digital infrastructure. This finding reinforces TAM's emphasis on the interaction between usefulness, ease of use, and external facilitating conditions.

7.3 Sustainability and Consumption Outcomes: Behavioural Transitions and TAM

Sustainability and consumption outcomes further illustrate the relevance of TAM in explaining gradual behavioural change. The association between technological diffusion, afforestation-based employment, eco-friendly consumption patterns, and access to healthy food suggests that technology can influence long-term environmental and health behaviours. However, the

persistence of neutral responses reflects uncertainty and incomplete internalisation of these practices. From a TAM perspective, this suggests that while communities may recognise the usefulness of sustainable technologies, limited ease of use, insufficient awareness, and weak local support systems continue to slow behavioural transitions. Sustained engagement and user-centred design, therefore, remain critical for deepening adoption.

7.4 Explaining Regional Disparities through DOI and TAM

The comparative analysis between ITDA Bhadrachalam and ITDA Eturnagaram provides strong support for combining DOI and TAM frameworks. In Bhadrachalam, stronger social networks, better digital connectivity, and greater institutional engagement have enhanced observability and peer learning, accelerating diffusion in line with DOI predictions. Simultaneously, higher perceived usefulness of digital tools for market access and livelihood improvement has strengthened behavioural intention, as explained by TAM. In contrast, ITDA Eturnagaram exhibits slower diffusion and cautious adoption, characterised by higher neutral responses across outcome domains. Here, DOI explains diffusion constraints arising from weak communication channels and limited role models, while TAM highlights low perceived ease of use, limited digital skills, and infrastructural barriers that weaken sustained adoption despite policy availability.

7.5 Integrating DOI and TAM for Sustainable Livelihood Transformation

Taken together, the findings demonstrate that technological diffusion in Scheduled Areas cannot be understood through a single theoretical lens. DOI explains how innovations spread unevenly across communities, depending on institutional support, social systems, and the visibility of benefits, while TAM explains how individual-level decisions are shaped by perceived usefulness, ease of use, and facilitating conditions. The persistence of partial adoption and neutral perceptions indicates that access to technology alone does not guarantee sustainable livelihood transformation. Instead, successful outcomes depend on the alignment of social diffusion processes with individual acceptance and capability.

Overall, this study advances the technology sustainability literature by empirically demonstrating that technological interventions in forest-based Scheduled Areas must be both socially embedded and behaviourally accessible to generate durable and inclusive development outcomes. Strengthening local institutions, enhancing digital literacy, and designing user-centric technologies are therefore essential for translating innovation into sustained livelihood improvements in tribal and forest-dependent regions.

8. Conclusion

This study provides empirical insights into the role of technological diffusion in promoting sustainable livelihoods in the Scheduled Areas of Telangana, with specific reference to ITDA Bhadrachalam and ITDA Eturnagaram. The findings demonstrate that the adoption of digital and eco-friendly technologies has contributed to improved livelihood security, enhanced income from Minor Forest Produce, increased employment opportunities, and the adoption of environmentally responsible practices among forest-dependent communities. However, these benefits remain uneven, with ITDA Bhadrachalam showing stronger outcomes than ITDA Eturnagaram due to differences in infrastructure, institutional support, and digital capacity. By integrating the

Diffusion of Innovations and Technology Acceptance Model frameworks, the study empirically demonstrates that sustainable livelihood transformation in the Scheduled Areas of India depends not only on access to technology but also on its social embedding, perceived usefulness, ease of use, and supportive institutional conditions. The persistence of partial adoption and neutral perceptions highlights the limitations of technology-centric policy approaches that overlook structural and behavioural constraints.

The study is subject to certain limitations, including its cross-sectional design and reliance on self-reported perceptions, which may not fully capture long-term behavioural changes. Nevertheless, it provides valuable empirical insights into the dynamics of technology adoption in forest-based Scheduled Areas. Policy implications highlight the need to strengthen digital infrastructure, enhance local capacity building, integrate traditional ecological knowledge with modern technologies, and promote participatory governance mechanisms to achieve inclusive and sustainable development outcomes. Future research should adopt longitudinal designs to examine the long-term impacts of technological diffusion on livelihood resilience, ecological sustainability, and governance effectiveness across different Scheduled Areas. Overall, the study advances the development literature beyond agriculture-centric, purely descriptive analyses by demonstrating that technology-led development in forest-based Scheduled Areas must be institutionally supported and behaviorally inclusive to achieve long-term sustainability.

9. Policy Implications

The findings of this study underscore the need for context-specific policy interventions to ensure that technological diffusion in the Scheduled Areas of Telangana is inclusive, sustainable, and responsive to local livelihood realities. Given the ecological sensitivity of forest regions and the socio-economic vulnerability of tribal communities, policy approaches must move beyond mere technology provision and focus on adoption, usability, and long-term integration into livelihood systems.

First, strengthening localized digital capacity-building is critical to enhancing digital literacy, operational skills, and entrepreneurship among tribal and forest-dependent households. Integrated Tribal Development Agencies (ITDAs), in coordination with the Tribal Welfare Department, should institutionalize training programmes focused on mobile-based market platforms, digital payments, and forest resource management tools. Delivering these programmes in local languages and adapting them to community learning levels can significantly improve perceived ease of use, reduce adoption resistance, and promote sustained technology use.

Second, policies should promote the integration of traditional ecological knowledge (TEK) with modern digital tools, such as GIS-based forest monitoring systems, mobile applications, and online marketplaces. Combining indigenous knowledge systems with technology can strengthen sustainable forest management, enhance value addition in Minor Forest Produce, and preserve cultural practices. Such integration also increases community ownership of technological interventions, improving their relevance and long-term acceptance.

Third, non-governmental organizations (NGOs) and Forest Protection Committees should be formally integrated as implementation partners to address last-mile adoption challenges. NGOs can play a crucial role in providing continuous hand-holding support, facilitating value-chain development for Minor Forest Produce, and strengthening participatory governance and community data ownership. Enhanced coordination among ITDAs, the Tribal Welfare Department, NGOs, and grassroots institutions is essential to translate technological interventions into durable livelihood gains and environmentally sustainable outcomes in the Scheduled Areas of Telangana. These policy recommendations align with DOI and TAM perspectives, emphasizing that sustainable technological diffusion requires both supportive social systems and user-centric adoption conditions.

References:

1. Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.
2. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
3. Angelsen, A., & Wunder, S. (2003). Exploring the forest-poverty link: Key concepts, issues, and research implications. *CIFOR Occasional Paper No. 40*. Center for International Forestry Research.
4. Hall, B. H., & Khan, B. (2003). *Adoption of new technology*. National Bureau of Economic Research. https://doi.org/10.3386/w9730
5. Sunderlin, W. D., Dewi, S., & Puntodewo, A. (2005). Forests, poverty, and livelihoods: A multi-country analysis of spatial association. *World Development, 33*(3), 495–510. https://doi.org/10.1016/j.worlddev.2004.07.001
6. Jensen, R. (2007). The digital divide: Information (technology), market performance, and welfare in the South Indian fisheries sector. *Quarterly Journal of Economics, 122*(3), 879–924. https://doi.org/10.1162/qjec.122.3.879
7. Venkatesh, V., & Bala, H. (2008). Technology Acceptance Model 3 and a research agenda on interventions. *Decision Sciences, 39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x
8. Agarwal, C. (2010). *GIS and remote sensing for effective community-based forest management and sustainability*. Environmental Research Journal, **15**(4), 233-248.
9. Aker, J. C., & Mbiti, I. M. (2010). Mobile phones and economic development in Africa. *Journal of Economic Perspectives, 24*(3), 207–232. https://doi.org/10.1257/jep.24.3.207
10. Pretty, J., Toulmin, C., & Williams, S. (2011). Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability, 9*(1), 5–24. https://doi.org/10.3763/ijas.2010.0583
11. Donner, J., & Escobari, M. X. (2010). A review of evidence on mobile use by micro and small enterprises in developing countries. *Journal of International Development, 22*(5), 641–658. https://doi.org/10.1002/jid.1717
12. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008
13. Mishra, A., Patnaik, S., & Dash, M. (2017). Understanding rural technology adoption: A study using the Technology Acceptance Model (TAM). *Journal of Rural Studies, 55*, 151–165. https://doi.org/10.1016/j.jrurstud.2017.07.004

14. Food and Agriculture Organization (FAO). (2018). *Using GIS and drones for sustainable forest monitoring and deforestation prevention*. FAO Forestry Paper.
15. United Nations Development Programme (UNDP). (2019). *Digital inclusion and sustainable development: Bridging the technology divide in marginalized areas*. UNDP Report.
16. Indian Council of Forestry Research and Education (ICFRE). (2020). *Afforestation and rural employment: Technology-driven approaches for ecosystem restoration*.
17. World Bank. (2021). *The role of digital infrastructure in rural development: Transforming education, market access, and financial services*. World Bank Publications.
18. Government of Telangana. (2022). *Sustainable Development Initiatives in Telangana's Scheduled Areas: Policy Review and Technological Interventions*. Department of Tribal Welfare, Telangana.