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Fading Echoes of Tradition: The Transformation of Intergenerational Farming Knowledge in Toto Tribal Communities

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HIGHLIGHTS

- Toto tribal community in West Bengal witnessed a gradual shift from traditional knowledge systems to modern techniques, particularly among younger generations.
- Knowledge erosion is attributed to reduced social participation and changing family aspirations.
- Among tribal communities promoting elder-youth knowledge exchange is crucial for preserving traditional knowledge and enhancing climate resilience.
- Socio-economic factors like family educational status and material possessions positively influenced agricultural livelihood.

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ABSTRACT

Indigenous knowledge systems have traditionally played an important role in supporting agricultural livelihoods, particularly in tribal populations. The Toto tribe, an endangered indigenous population in West Bengal, India, has relied on intergenerational knowledge transmission to ensure sustainable farming practices but their traditional wisdom is at risk due to socio-economic changes and modernization. The study examines the various socio-economic factors influencing the transmission of agricultural knowledge within Toto family farms, analyzing the impact of intergenerational exchange on agricultural sustainability. A mixed-methods approach was employed, integrating qualitative participatory research with quantitative data analysis. Data were collected through Focus Group Discussions, personal interviews, participant observation and structured household surveys among 120 Toto family farms in Totopara village. Pearson's Correlation Analysis assessed socio-economic factors influencing livelihood choices, while thematic coding in ATLAS.ti identified patterns of knowledge retention and transformation. The study reveals a generational gap in farming knowledge due to shifts in aspirations, formal education, and reduced reliance on traditional farming techniques. Modernization has improved efficiency but displaced indigenous methods like seed preservation and water conservation. Integrating traditional knowledge with modern advancements is crucial for climate-resilient and sustainable farming. Policy interventions, community-led conservation efforts and indigenous education programs are critical for preserving agricultural heritage.

INTRODUCTION

Indigenous communities worldwide have long depended on intergenerational knowledge systems to sustain their livelihoods, particularly in agriculture (Singh et al., 2022). These knowledge systems, deeply embedded in cultural traditions, play a crucial role in shaping farming practices, resource management, and resilience to environmental changes (Jakes, 2024; Talwar & Singh, 2024).

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Among such communities, the Toto an aboriginal Indo-Bhutanese tribe of West Bengal, India, represents a small and endangered indigenous group whose agricultural practices have been guided by traditional wisdom for generations (Hossain, 2022). Intergenerational knowledge transmission in agriculture involves the passing down of farming skills, ecological understandings, and resource management techniques from elders to younger generations (Wójcik et al., 2019; Akhmar et al., 2023). Within the Toto community, this exchange of wisdom is not a simple transfer of information but a dynamic and adaptive process shaped by changing climatic conditions, market integration, and socio-political shifts (Priyadarshini et al., 2020). Traditionally, knowledge transmission occurred through oral traditions, hands-on demonstrations, and ritualistic practices, ensuring that younger generations acquired practical farming skills and a deep ecological understanding of their environment (Rayis et al., 2023). This indigenous farming knowledge, accumulated over centuries, enabled the Toto people to maintain sustainable agricultural practices through diverse cropping patterns, soil conservation techniques, and locally adapted water management systems (Priyadarshini & Abhilash, 2019). Shifts in aspirations, urban migration and formal education systems that do not integrate indigenous knowledge have led to the gradual erosion of these traditional learning pathways.

Studies have indicated that indigenous knowledge systems are increasingly vulnerable to rapid socio-economic changes, technological advancements, and declining youth participation in traditional livelihoods (Kom et al., 2024; Macusi et al., 2023). While modern agricultural interventions have introduced efficiency and higher yields, they have also contributed to the displacement of time-tested indigenous farming techniques, including traditional seed preservation, organic pest management, and community-based water conservation practices (Sharma et al., 2020). The diminishing role of elders in guiding agricultural decisions further exacerbates this knowledge loss, creating a generational disconnect in farming wisdom (Aswani et al., 2018). Despite these challenges, traditional farming knowledge preservation is crucial for agricultural sustainability and climate resilience, as it has historically enabled tribal communities to adapt to environmental changes through climate-responsive farming strategies (Kumar, 2015). Therefore, striking a balance between preserving traditional farming practices and integrating contemporary innovations is essential for sustaining Toto tribal agriculture in the face of modernization.

This study aims to examine the transmission of traditional agricultural knowledge within Toto family farms, assess the roles of elders and youth in preserving and adapting indigenous farming techniques, and analyse the impact of intergenerational knowledge exchange on the sustainability and resilience of the Toto tribal farming system. By focusing on these aspects, the research contributes to the broader discourse on indigenous knowledge retention, agricultural adaptation and climate resilience in tribal communities.

METHODOLOGY

This study adopted a mixed-methods approach, integrating qualitative participatory research techniques with quantitative data analysis to examine the decline of traditional farming knowledge among the Toto tribe. The study was conducted in Totopara Village, Madarihat Block, Alipurduar District, West Bengal, in the year 2024-2025, where the Toto community primarily resides. A purposive sampling technique was employed to select 120 family farms, ensuring representation across different age groups (elders, middle-aged farmers, and youth) to capture generational differences in knowledge retention and transmission. A combination of qualitative and quantitative data collection methods was employed to ensure triangulation and reliability. Focus Group Discussions (FGDs) were conducted separately with elders, youth, and women to understand patterns of knowledge transfer, perceptions of modernization, and emerging challenges. Oral history interviews were used to document traditional farming practices and their transformation over time. Participant observation was undertaken to directly examine farming activities and validate the insights obtained from interviews and FGDs. Additionally, structured household surveys were administered to gather demographic data, farming practices, and the extent of knowledge transmission within families. For quantitative analysis, descriptive statistics (mean, standard deviation, and coefficient of variation) were used to summarize the data, while Pearson's Correlation Analysis examined relationships between socio-economic variables with agricultural and non-agricultural livelihoods. SPSS is used for quantitative data analysis. Qualitative data were analyzed using thematic coding in ATLAS.ti. Transcribed FGDs, oral histories, and observational notes were systematically coded to identify key themes. An open coding process was used to develop initial codes, followed by categorization to group related concepts. The final themes were refined through code co-occurrence analysis, which helped establish connections between factors influencing knowledge loss. Network visualization in ATLAS.ti provided insights into how socio-economic changes and modernization contributed to shifts in indigenous agricultural practices.

RESULTS

Correlation analysis

The correlation table provides insight into the relationship between independent and dependent variables (Y_1: Livelihood in Agriculture and Allied Sectors, Y_2: Livelihood Activities Other than Agriculture and Allied Sectors). Data from Table 1 shows that family education status (r = 0.282) is positively significant with Y_1 at 5% level of significance (p = < 0.05) whereas, primary occupation (r = 0.454), land holding (r = 0.649), material possession (r = 0.529) and attitude towards adoption of innovation (0.479) were positively significant with dependent variable Y_1 at 1 % level of significance (p = < 0.01). Mass media exposure (r = -0.200) was negatively significant at 5% level of significance (p< 0.05) and innovativeness (r = -0.417) was negatively significant with Y_1 at 1% level of significance (p < 0.01). Other independent variables such as age, education, family size, house type, social participation and cosmopoliteness were non-significant with Y_1.

Accordingly, education (r = 0.287) and family education status (r = 0.289) were positively significant with Y_2 at 5% level of significance (p< 0.05) while family size (r = 0.367) was positively correlated with Y_2 at1 % level of significance (p = < 0.01).

Table 1. Correlation analysis of selected independent variables with dependent variables (n=120)

Variable	r (Y_1)	"p" value	r (Y_2)	"p" value
Age	-0.155	0.091	-0.124	0.177
Education	0.139	0.130	0.287*	< 0.05
Family Size	0.013	0.888	0.367**	< 0.01
Family Education Status	0.282*	< 0.05	0.289*	< 0.05
Primary Occupation	0.454**	< 0.01	0.036	0.696
Land Holding	0.649**	< 0.01	0.067	0.480
Material Possession	0.529**	< 0.01	0.044	0.631
House Type	-0.010	0.910	-0.129	0.161
Social Participation	-0.079	0.395	-0.181	0.050
Cosmopoliteness	0.164	0.070	0.032	0.730
Mass Media Exposure	-0.200*	< 0.05	-0.031	0.737
Innovativeness	-0.417**	< 0.01	-0.327*	< 0.05
Attitude Towards Adoption of Innovation	0.479**	< 0.01	-0.010	0.910

Significance: *p < 0.05, **p < 0.01

Y_1: Livelihood in Agriculture and Allied Sectors; Y_2: Livelihood Activities Other than Agriculture and Allied Sectors

Innovativeness (r = -0.327) was negatively significant with Y_2 at 1% level of significance (p = < 0.01). Other variables such as age, occupation, land holding, material possession, house type, social participation, cosmopoliteness, mass media exposure and attitude towards adoption of innovation were non-significant with Y_2.

Thematic analysis

A graphical representation of thematic analysis is shown in Figure 1 through a network diagram.In the diagram, different categories of themes were denoted by different colours: Light Blue No des: Main Themes (Knowledge Erosion, Adaptation to Modern Techniques, Youth Perspectives on Traditional Farming), Light Green Nodes: Sub-categories (Factors influencing each theme), Light Coral Nodes: Key Variables with Correlation Values.

Theme 1: Knowledge Erosion

Knowledge erosion was the main theme, analysed by the thematic analysis of FGDs that was recorded at the time of data collection. Knowledge erosion was connected with three green nodes i.e. education and knowledge loss, material possession impact and social participation decline. These green nodes were further connected by independent variables (red node) such as education, material possession and social participation.

The analysis identified education as a key factor influencing knowledge retention, with a moderate positive correlation between education and agricultural livelihood (r = 0.139) and non-agricultural livelihood (r = 0.287). Material possession and economic stability were significantly associated with traditional agricultural practices. Material possession showed a strong correlation with agricultural livelihood (r = 0.529) and a weaker correlation with non-agricultural livelihood (r = 0.044). Social participation and oral knowledge transfer were linked to community interaction. Social participation exhibited a weak negative correlation with agricultural livelihood (r = -0.079) and non-agricultural livelihood (r = -0.181).

Theme 2: Adaptation to Modern Techniques

Adaptation to modern techniques emerged as a key theme, represented by the light blue node in the network diagram. This theme was linked to three sub-themes: landholding and occupational shifts, attitude towards innovation, and innovativeness and traditional practices, denoted by green nodes. These sub-themes were further associated with independent variables, represented by red nodes, including landholding, attitude towards innovation, and innovativeness.

Landholding showed a highly significant correlation with agricultural livelihood (r = 0.649) and a less significant correlation with non-agricultural livelihood (r = 0.067), indicating its influence on the adoption of modern techniques. Attitude towards innovation had a positive correlation with agricultural livelihood (r = 0.479) and a slightly negative correlation with non-agricultural livelihood (r = -0.010), reflecting generational differences in the perception of innovation. Innovativeness was identified as a divisive factor, with a negative correlation with agricultural livelihood (r = -0.417) and non-agricultural livelihood (r = -0.327), suggesting that higher innovativeness was associated with a shift away from traditional farming practices.

Theme 3: Youth Perspectives on Traditional Farming

Youth's perspective on traditional farming emerged as a central theme, influenced by cosmopoliteness & urban influence, mass media & changing aspirations, and family size & generational trends, represented by green nodes in the network diagram. These factors were connected to independent variables such as cosmopoliteness, mass media exposure, and family size, denoted by red nodes.

Cosmopoliteness and exposure to urban influences play a crucial role in shaping livelihood choices. Cosmopoliteness demonstrated a positive correlation with both agricultural livelihood (r = 0.164) and non-agricultural livelihood (r = 0.032). Similarly, mass media exposure and evolving aspirations are key factors influenced by the level of media engagement. Mass media exposure showed a negative correlation with agricultural livelihood (r = -0.200) and non-agricultural livelihood (r = -0.031). Family size and generational farming trends significantly impact livelihood patterns. Family size exhibited a weak correlation with agricultural livelihood (r = 0.013) but showed a moderate correlation with non-agricultural livelihood (r = 0.367).

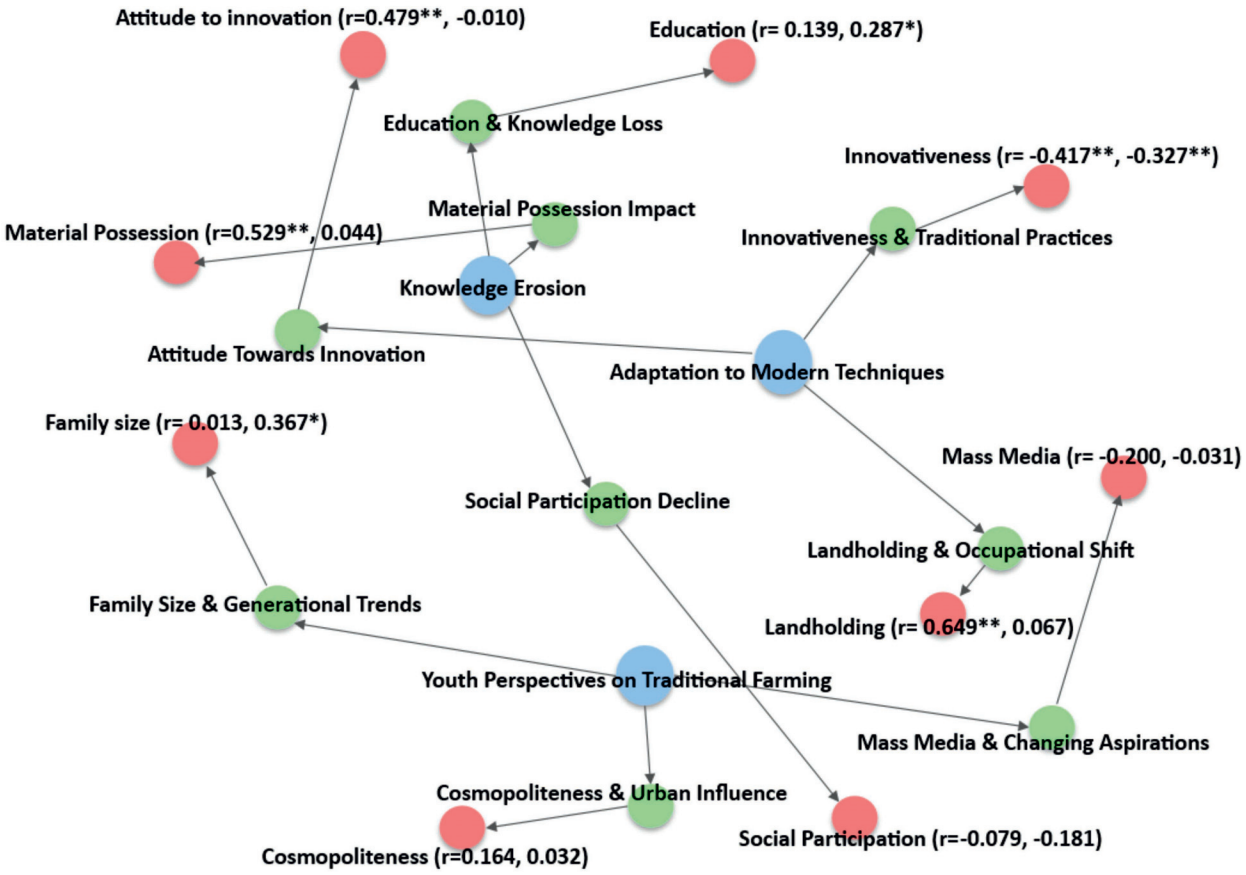

Figure 1. Graphical representation of thematic analysis using a hierarchical network diagram

DISCUSSION

The correlation analysis provides valuable insights into the factors influencing livelihood choices in both agricultural and non-agricultural sectors. The findings highlight the significance of various socio-economic attributes in determining an individual's inclination toward these livelihood options.

Education was significantly correlated with non-agricultural livelihood, while family education status showed a significant positive correlation with both agricultural and non-agricultural sectors. indicating that households with higher educational attainment tend to pursue diversified livelihoods. This suggests that education enhances decision-making and adaptability, enabling households to simultaneously engage in agriculture using improved practices and explore non-farm employment opportunities, supporting the findings of Gautam & Andersen (2016), who found that education strengthens livelihood diversification in rural settings. Family size showed a non-significant relationship with agricultural livelihood and a positive significant relationship with non-agricultural livelihood, which indicates that a larger family size might necessitate diversification of income sources, thereby pushing individuals toward non-agricultural ventures. Similarly, primary occupation was significantly associated with agricultural livelihood, suggesting that individuals whose main occupation is agriculture are more likely to continue their livelihoods in the sector, a finding consistent with Pal et al., (2017) & Pradhan et al., (2021), who observed occupational commitment as a key factor in agricultural engagement. Landholding and material possession had a strong and highly significant association with agricultural livelihood due to which landholding emerged as a critical determinant of agricultural livelihood, as access to larger land enables greater productivity and income stability. Material possession also played a supportive role, emphasizing that asset-rich households are better equipped to sustain agriculture. Whereas, mass media exposure showed a negative and significant correlation with agricultural-based livelihood, indicating that higher media access may encourage livelihood diversification away from agriculture. Similar findings were reported by Baird & Hartter (2017) & Ghosh et al., (2017), who observed that increased exposure to television, internet, and mobile platforms led rural youth to explore non-farm employment opportunities, reducing reliance on traditional farming. Attitude towards adoption of innovation was positively correlated with agricultural livelihood, implying that receptiveness to new technologies enhances agricultural participation. Conversely, innovativeness showed a negative and significant correlation with both agricultural and non-agricultural sectors. This suggests that individuals with higher tendency to innovate may prefer to disengage from both traditional farming and conventional non-agricultural livelihoods, possibly opting for novel or entrepreneurial pathways. A similar pattern was observed by Sekhar et al., (2024), who noted that rising innovativeness among rural youth coincided with a decline in traditional engagement in both farming and wage-based work. Other

independent variables, such as age, education, family size, house type, social participation and cosmopoliteness, were found to be non-significant with respect to agricultural livelihood, suggesting their limited direct influence on agricultural engagement. The results are similar with the findings of Pradhan et al., (2021) who reported that socio-demographic factors alone are insufficient to determine agricultural participation in rural settings. Similarly, variables such as age, occupation, landholding, material possession, house type, social participation, cosmopoliteness, mass media exposure, and attitude towards adoption of innovation, were found to be non-significant with non-agricultural livelihood, indicating that these factors do not strongly determine engagement in non-agricultural activities. The findings of the study are in line with the work of Munawar et al., (2022) who highlighted that non-agricultural livelihood choices are often influenced more by external factors like infrastructure access, skill availability, and market connectivity than by household socio-economic characteristics.

The thematic analysis using a hierarchical network diagram reveals the complex interplay of socio-economic, cultural, and technological factors in shaping indigenous agricultural knowledge transformation. The first major theme, knowledge erosion, highlights the role of formal education, economic stability, and social participation in diminishing traditional farming knowledge. Education exhibits a weak correlation with agricultural livelihood (r = 0.139) but a stronger positive correlation with non-agriculture livelihood (r = 0.287), reflecting a shift away from farming among the educated youth. Economic stability, marked by material possession (r = 0.529), increases reliance on modern tools, further eroding indigenous techniques. The declining role of social participation (r = -0.079 with agriculture livelihood and r = -0.181 with non-agriculture livelihood) weakens oral knowledge transfer and collective farming traditions. A similar conclusion was also drawn by Rao (2024) in his work related to the erosion of indigenous knowledge. The second theme, adaptation to modern techniques, underscores how landholding patterns, attitudes toward modernization, and innovation adoption influence traditional farming. Larger landowners, highly correlated with agriculture livelihood (r = 0.649), integrate hybrid farming, while smallholders, constrained by resources, retain traditional methods. A significant generational divide is evident in the attitude toward innovation (r = 0.479 with agriculture livelihood), where youth embrace modern techniques while elders resist, leading to a shift from organic to chemical-based inputs. Innovativeness, negatively correlated with agriculture livelihood (r = -0.417) and non-agriculture livelihood (r = -0.327), further widens the rift as modern experimentation discourages traditional practices. A similar finding was also given by Sekhar et al., (2024). The third theme, youth perspectives on traditional farming, is shaped by urban exposure, mass media influence, and family structures. Higher cosmopoliteness correlates with agriculture livelihood (r = 0.164), indicating migration-induced detachment from farming, while mass media exposure negatively correlates with agriculture livelihood (r = -0.200), showcasing its role in diverting youth aspirations toward non-agricultural careers. Family size (r = 0.367 with non-agriculture livelihood) plays a critical role, where larger families retain farming knowledge, whereas nuclear families lean towards wage-based employment. The findings of the study are aligned with the study of Girdziute et al., (2022) who reported that household size significantly influences labor allocation decisions, with larger households tending to diversify livelihoods to ensure financial stability. The analytical approach employs text queries and matrix coding to visualize thematic analysis, demonstrating that declining community interactions, economic pressures, and technological advancements collectively contribute to the gradual erosion of traditional agricultural knowledge (Kumari et al., 2024). This study suggests that while innovation and market-driven adaptations are inevitable, integrating indigenous wisdom with sustainable modern techniques through education, policy interventions, and intergenerational collaboration could mitigate the loss of traditional knowledge and promote resilient agricultural practices.

CONCLUSION

The study highlights the intricate relationship between socio-economic factors and livelihood choices in both agricultural and non-agricultural sectors. Findings suggest that family education status, primary occupation, landholding size, material possession, and openness to innovation significantly influence agricultural engagement, while education, family size, and family education status drive non-agricultural livelihoods. Innovativeness negatively correlates with both sectors, indicating a shift toward diversified income opportunities. The thematic analysis underscores the ongoing transformation of indigenous agricultural knowledge, driven by education, economic stability, and modernization. The generational divide in knowledge adoption and mass media influence further accelerates this shift. To sustain traditional farming wisdom, integrating indigenous practices with modern techniques through education, policy support, and intergenerational collaboration is essential. By fostering adaptive strategies and knowledge-sharing mechanisms, agricultural resilience can be enhanced, ensuring a balanced approach to modernization and heritage conservation.

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