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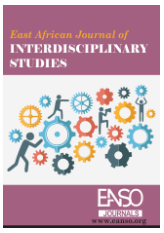

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Original Article

Willingness to Pay and Factors Influencing the Amount of Forestry Insurance by Tree Growers in Mufindi, Tanzania

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Forest Insurance, Private Tree Growers, Willingness to Pay.

ABSTRACT

Forests influence the economic development of emerging economies by providing ecological and social services to human beings and natural systems. With increasing demand for wood products, private tree growers reduce pressure in natural forests by providing services similar to those in natural forests. Private tree growers faced substantial risks due to climatic change. Forest catastrophes were increasing and causing economic losses to the tree growers, while no efforts were being made to address the situation. This study will analyze willingness to pay, perceptions, and factors influencing the amount to pay for fire, disease, and pest insurance. A multistage sampling technique was employed to sample 120 tree growers in four villages which include Ifwagi, Nundwe, Mwitikilwa and Ilasa. The Tobit model was used to analyze factors influencing the amount of forest insurance. Results indicate that 84.2% of the tree growers were willing to pay for forest insurance, age, Income, previous fire, tree species planted, land ownership, and farm location are significant influences on the amount of forest insurance for tree stand protection. This study recommended that insurance providers develop affordable, flexible policies and collaborate with local authorities to create awareness campaigns. Policymakers should also explore subsidies or incentives to reduce barriers to entry for tree growers.

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INTRODUCTION

Forest is among those that influence the economic development of society. It provides aesthetic value but also contributes significantly to economic growth, supports ecological balance, and offers vital social services that benefit both human communities and the stability of the natural system (Temu et al., 2024). Due to increased demand for wood products, natural forests are under pressure to disappear due to over-exploitation (Race et al., 2022). Private tree growers play an important role by increasing wood production and forest landscape restoration efforts; hence reducing pressure on the natural forest (Arvola et al., 2019). Globally, 1.5 billion smallholders depend on forest and farm landscapes for their livelihoods (Gupta et al., 2020; Nambiar, 2021; Race et al., 2022; Temu et al., 2024). Climatic change problems are reported to increase natural hazards in the forests (Hartmann et al., 2022); Esperon-Rodriguez et al., 2022). Forest catastrophes such as forest fire, wind, flood, pests, and disease cause economic losses for private tree growers, with limited mechanisms to mitigate these risks (Romagnoli et al., 2022; Siddik & Islam, 2024). Climatic change causes natural hazards to continuously increase, which causes the loss of forest stands if unmanaged properly. The increase in natural hazards affects the production of forestland in the world (Zhang & Stenger, 2014). It estimated that between the years 2001 to 2019, fire cleared on average 67 million hectares of forest per year, insects affected 85 million hectares of forests while 12.5 million forests were affected by various diseases (Tyukavina et al., 2022) and climatic change was identified as main factors for the natural hazard to increase.

Forest insurance has existed for over a century in many countries worldwide, currently, it is put forward as a recommended tool to finance resilience and adaptation towards climatic change (Bose, 2022; Brunette & Couture, 2023). It protects investments in forest businesses and ensures financial security in the face of natural disasters or unforeseen events that could impact forest resources. Forest insurance is widely adopted in developed countries and remains underutilized in many developing nations (Afriyie-Kraft et al., 2020; He & Ren, 2022). Tanzania has been reported to have a rapid global expansion of private forest investments in the form of plantations (Degnet et al., 2018).

Economically, the expansion of forest plantations is reported to contribute to national and local economies through the supply of raw materials and the provision of employment opportunities to the areas where plantations are based (Temu et al., 2022; Ali et al., 2024). It has been reported that Tanzania's population increases by 3.1% annually (Byaro et al., 2023). With increasing population and urbanization, demand for wood from these plantations will exceed supply by about 2,200,000 m^3 by the year 2030 (Mhando et al., 2022). This exotic tree species has demonstrated high susceptibility to forest catastrophes such as fire, pests and disease (Harrington & Wingfield, 2000). This results in reduced forest yields, lower income for the tree growers, and forest degradation. Besides, there are no adequate existence efforts to enable tree growers to cope with such situations, yet information to introduce relevant practices such as insurance schemes to address such forest problems is scant. Objectively this study will analyze willingness to pay (WTP) for insurance, as well as

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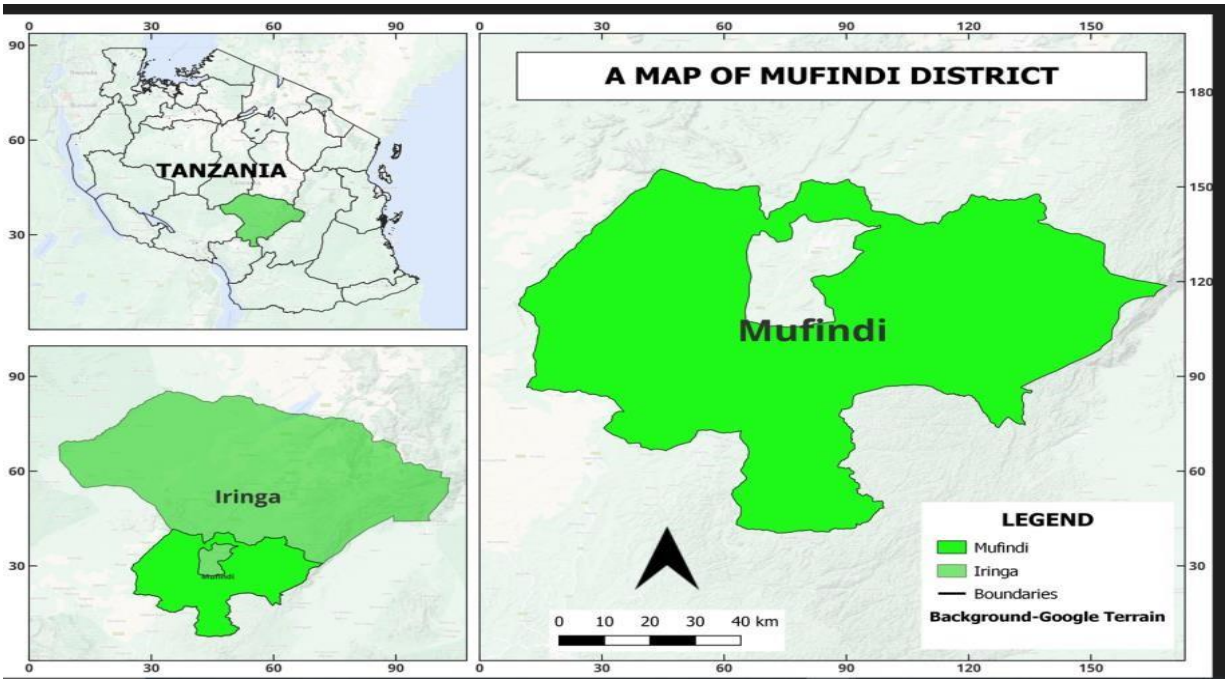
tree grower perceptions and factors influencing the amount of forest insurance is key to promoting adoption. This study aims to generate insights that could inform policies to influence the uptake of forest insurance helping tree growers manage risks more effectively and ensuring the sustainability of developing countries forest sector.

METHODOLOGY

Description of the study area

The study was conducted in the Mufindi district one of seven districts in the Iringa region of Tanzania (8°-9°S; 30°-36°E). The district lies at an altitude of 800 to 2200 meters above sea level (m.a.s.l) with an average annual temperature of 17.1℃. It experiences a well-distributed rainfall ranging from 950 to 1,600 mm yr, 263 kha of tree cover and the main commercial crops are tea and forest plantations (Mwambusi et al., 2021). Mufindi district has a total area of 712,200 ha divided into 5 Divisions, 30 Wards, 125 Villages, and 608 Hamlets (Mwambusi et al., 2021). Mufindi population is 288,996, with 41.66/km² Population Density and 1.6% Annual Population Change from 2012 - 2022 (Laurent & Mushi, 2024) Nowadays, Mufindi district is a centre of forests and different tree planting programs (Nkwera, 2010). For instance, the largest state forest plantation Sao Hill Forest Plantation- SHFP occupies a large part of this district (Singunda, 2009). Mufindi district experiences the problem of forest fires, especially during the dry season (Mgina & Wawa, 2021), as well as the problem of various diseases especially pine species (Petro & Madoffe, 2011). Some of the tree growers try to minimize this effect by effective silvicultural management but the problem continues to occur reducing the economic well-being of the tree growers and environmental distraction. The main tree species which are planted in Mufundi district are exotic; mostly *Pines patula* and *Eucalyptus species*.

Figure 1: Map of the study area



Research Design

The study was cross-sectional, and both qualitative and quantitative methods were used. It's a cross-sectional design because data collection was done once in the fields (Bryman, 2012). An experimental

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design was used to assess the WTP for forest insurance.

A Discrete Choice Experiment (DCE) was used in the data collection because is a quantitative method that bused to elicit preferences from participants without directly asking them to state their preferred options. In a DCE, participants are presented with a series of alternative hypothetical scenarios, each containing several variables or "attributes" with different levels of variation. Participants are asked to state their preferred choice each consisting of a combination of these attributes/levels.

Table 1: Alternatives, scenarios and attributes of the DCE decision situation

		Levels				
S/N	**Attributes**	**1**	**2**	**3**	**4**	**Choice**
1	Type of tree species	Pines	Eucalyptus	Cypress	Others	☐
2	WTP for Forest Insurance	Yes	NO	……	……..	☐
3	Insurance time premium	quarter	Semi-annual	Annual	Others	☐
4	Type of Insurance	Fire	Disease	Combined	No insurance	☐
5	Maximum to pay Acre/year in (TZS)	……	…….	……..	……	

Sampling procedure and sample size determination

The multistage sampling technique was used to sample the population in the study area due to its large geographical area. In the first stage, the purposive sampling approach was used to select the area of study, thus Mufindi District in Southern Highlands of Tanzania objectively due to the large number of tree growers. In the second stage, the purposive sampling technique was applied to select 4 Villages which are Mwitikilwa, Ifwagi, Ilasa, and Nundwe. In the third stage, proportional random sampling was used to select the number of tree growers per village to be included. A list of tree growers was obtained from the village officer in the registered book and those registered and unregistered to Tanzania Tree Growers Association Union (TTGAU). The study population was 2728 tree growers, according to the sensor of 2022 and the study employed the Yamane formula in sample size determination (Yamane, 1973).

$n = \frac{N}{1+Ne^2} = \frac{2728}{1+2728(0.1^2)} n$ =97 Where by

$n = sample\ size,$

$N = Total\ popultion\ size\ and\ e = Margin\ of\ error\ or\ allawable\ error(10\%).$

The formula minimizes sampling error and bias as it draws a representative sample from the target population (Suleiman et al., 2017). The generated sample size from the formula was 97 households. The sample size generated aligns with the central limit theorem that states a sample size ≥ 30 is enough for a standard deviation and can provide enough results, however for this study, 120 households were sampled. Therefore, the sample size selected is appropriate because it is greater than 97 which was the minimum sample required for the statistical analysis. A list of all households (tree growers) was acquired from the village's office in the registered book.

Data Collection

Primary data: A structured interview was conducted to gather data from the tree growers by the use of a questionnaire. The questionnaire was designed to contain both closed and open-ended questions to provide room for more data collection from the study population. Also, the questionnaire was

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translated into Swahili, a primary language that could easily be understood for the data collection process. The questions were developed to capture the following study contents: willingness to pay for forest insurance, knowledge, perceptions and attitudes of tree growers towards forest insurance. Clearly, understanding social economic characteristics, threats affecting forest investment, knowledge of forest insurance, experience in tree planting and challenges they face. The questionnaire was pre-tested by taking 5% of the total household and giving a total of 6 households. The household respondents that were part of the pre-test were not part of the respondents during the interview onset. This exercise helps to assess the effectiveness and the structure of the questionnaire (Karupu et al., 2021). The pre-test results were used to adjust the questionnaire accordingly.

Method of Data Analysis

Analysis for assessment of the perceptions towards forest insurance.

To assess the perception of tree growers toward forest insurance Likert-type scale questions were employed Likert scale and rated using 5 = Very confident, 4= somewhat confident, 3 = Not very confident, 2 = not confident at all, and 1= Neutral. Larger values reflected positive perception towards forest insurance and low values reflected negative attitudes towards forest insurance. The raw data was presented in descriptive statistics and summarized in tabular form. Cross tabulations were used to estimate perceptions of tree growers toward forest insurance.

Determinant's choice of the amount of forest insurance for stand protection

The Tobit model, also known as the censored data regression model, is commonly used in econometrics to model situations where the dependent variable is censored, meaning they are not observed (Pertiwi & Wulandari, 2016). The Tobit model uses the maximum likelihood (ML), the combination of the ordered least square (OLS), and the probit model. In the Probit model, we estimate the probability that a tree grower pays forestry insurance which will depend on the relevant social-economic and forest variables. The OLS regression model determines the amount of payment. The advantage of the Tobit model it combines these two models by developing the appropriate likelihood functions and then estimating them by the method of ML. The combined likelihood functions are complicated and estimated by iterative methods. The ML estimators are consistent and asymptotically distributed, provided the model is correctly specified and the error term is normally distributed.

Tobit model is expressed as follows:

$$Yi^* = \beta_0 + \sum_{i=1}^{n} \beta_j X_j + \varepsilon_i$$

$$Y_i = Yi^* \; if \; Yi^* \geq 0, Y_i = 0 \; if \; Yi^* \leq 0$$

Where by $Y_i = observed\ dependent\ variable, Yi^* = latent$ variable, $X_j = regressor\ and\ \varepsilon_i = residuals\ that\ are\ independent\ and\ distributed\ normally\ with\ mean\ zero\ and\ a\ commn\ varaiance\ \sigma$

The empirical specification of the Tobit model is expressed as follows;

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_{12} X_{12}$$

RESULTS

The social demographic of the respondents

Table 2 provides demographic and socioeconomic characteristics of individuals with a mean age of 47 years. Out of 120 participants, the majority were

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male 75.8%, while females made up (24.2%). Most respondents are married (80.8%), followed by singles 10%, widows 8.3%, and those divorced (0.8%). In terms of education, the largest group has completed primary education (54.2%), while 21.7% have secondary education, 12.4% have a college or university education, and 11.7% have no formal education. The total income for tree growers was $2028.48 (TZS 5,343,333) per year at an exchange rate of USD= (TZS 2,634.16)

Table 2: Social characteristics of the respondents

Variable	Mean	Frequency	Percentage (%)
Age	47years		
Sex			
Male		91	75.8
Female		29	24.2
Marital status			
Divorce		1	0.8
Married		97	80.8
Widow		10	8.3
single		12	10
Education			
Non-formal		14	11.7
Primary		65	54.2
Secondary		26	21.7
colleges/university		15	12.4
Total income	TZS5,343,333		
Size of the forest	4Ha		
Experience in tree planting	19years		

Tree growers are willing to pay

Results in Table 3 show respondents' willingness to pay for forest insurance per hectare (Ha). The mean willingness to pay for fire, pest and disease for tree stand protection was 88,500 with a standard deviation of 16121.91

Table 3: willingness to pay amount

Variable	Mean	Std. Deviation
Amount tree grower willing to pay for fire, disease and pest	88500	16121.91

Source: Nyange *et al.*, (2024)

Perceptions of the tree growers toward forest insurance based on education

The Likert scale analysis in (Figure 2) was subjected to Pearson's chi-square test ($\chi^2 = 22.245$, $p = 0.035$), demonstrating a statistically significant association between education level and perceived value, directly affecting forest insurance adoption. Higher education levels, such as college or university, are valued as "extremely valuable by 4.2% of respondents and moderately valuable by 8.3%, suggesting that individuals with advanced education may better understand and appreciate the benefits of complex financial products like forest insurance. In contrast, primary school education is deemed moderately valuable by 42.5% and somewhat valuable by 2.5% indicating that simplified and accessible information on forest insurance could resonate better with communities at this level. The findings highlight the need for targeted educational campaigns to raise awareness and improve

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understanding of forest insurance, tailoring communication strategies to the literacy levels of specific groups. Effective engagement could leverage the higher appreciation of education to enhance the adoption of risk mitigation practices in forest management.

Figure 2: Perceptions of forest insurance based on education

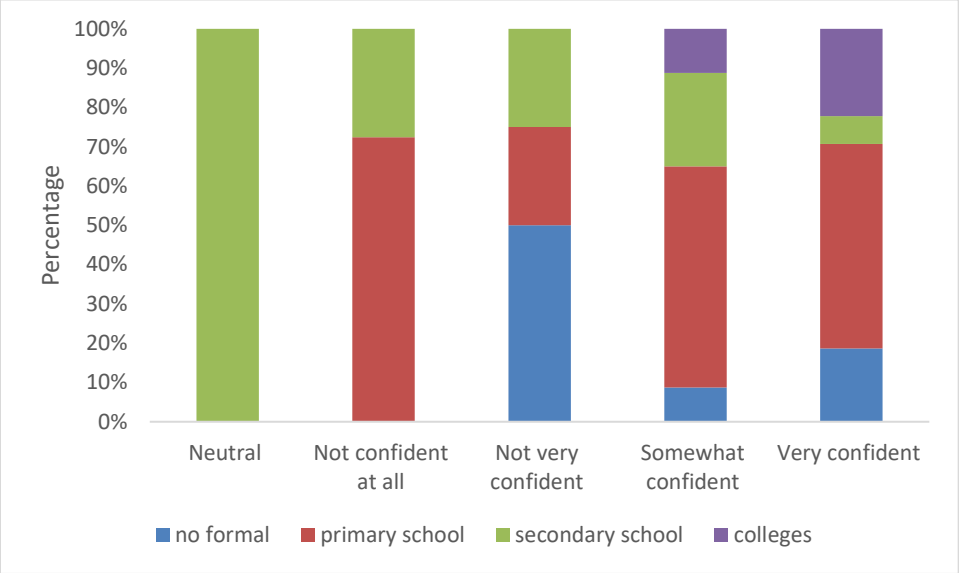

Table 4: Preference for forest insurance

Variables	Frequency	Percentage (%)
willingness to pay		
Yes	101	84.2
No	19	15.8
Forest insurance type		
Fire insurance	76	63.3
Pest and disease	9	7.5
Combined insurance	35	29.2
Insurance premium		
Per Annually	98	81.7
Quarter	5	4.2
Semi-Annually	17	14.2
Mix tree species planted.		
Eucalyptus	13	10.8
Pines	9	7.5
Pines and Cypress	11	9.2
Pines and Eucalyptus	87	72.5

Source: Nyange *et al.*, (2024)

Determinants influencing the amount of forest insurance.

Results in Table 5 show that out of twelve variables entered in the model, six variables significantly influence the amount of forest insurance, including age, income, previous fire, tree species planted, land ownership and locations of the tree farm. Pseud r square (0.0181), long-likelihood (-1383.2125) and Prob>χ2 (0.000) show the model has the correct fit.

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Table 5: Determinant influencing the amount of forest insurance

Variable	Coefficient	Std. err	p-value
Age	-591.724	297.764	0.049**
Sex	1250.164	5375.744	0.817
Years spent in school	448.234	748.471	0.551
Total income	0.003	0.001	0.003***
Forest size	1134.758	812.847	0.166
Experience in tree planting	-161.645	213.161	0.45
previous fire	11067.875	5654.337	0.053*
Disease and pest	4476.228	5781.499	0.44
Tree species planted	-11169.613	5678.813	0.052*
Land ownership	18384.102	6197.089	0.004***
Stand age	3967.639	5638.64	0.483
Location of farm	-14301.902	5917.719	0.017**
Constant	76938.341	19144.354	0.000***
Number of observations	120		
Pseud R^2	0.0181		
Prob>χ^2	0.000		
Log-likelihood	-1383.2125		
LR $\chi^2(12)$	51.01		

DISCUSSIONS

Table 2 shows the mean age of the respondents was 47 years which indicates tree growers were of reproductive age and could diversify their income into different investments for the future. This was not far from Mensah *et al.* (2021) who reported the mean age of the reproductive group was 52 years which is an active age in production. Most of the forest plantation owners were male which indicates males invest more than females in forest plantation this was similar to Bleyer *et al.* (2016) who found women prefer to invest in short-term business. Based on the findings the majority of woodlot owners had primary education, this implies that these woodlot owners have entrepreneurial skills and business education. This suggests low level of education might affect the growth of income of woodlot owners in the study area due to the over-dependence on forest products for livelihood due to limited capacity to seek employment opportunities in the formal sectors. This was similar to Dessie *et al.* (2019) who say higher education levels are associated with low dependence on forests for livelihoods due to employment opportunities in other sectors of the economy. The total income of the tree growers per year shows that the respondents can afford to pay for forest insurance and a large percentage of the income was obtained from agricultural activities which include crop cultivation. The mean size of the forest size was 4Ha which was characterized by the small-scale tree growers. This appears similar to (Hingi, 2018) who found most of the respondent's forest sizes ranged from 1-4Ha.

From (figure 2) the highly educated tree growers were willing to purchase forest insurance. This conforms with the study conducted by (Falola et al., 2013) which found that tree growers and farmers with high education are more willing to purchase forest insurance than those with low education. The statistical analysis confirms that education level significantly affects perceptions of forest insurance's value in protecting forests**.**

Table 5 shows, age significantly influenced the amount of forest insurance with a negative coefficient. This indicates that as the age of tree growers increases, the amount of forest insurance decreases. This finding aligns with the results reported by Mensah *et al.* (2021) and Nambiar

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(2021) who found age significantly impacts the decision to insure timber. Due to different methodological uses, the result differs from the findings of Dai *et al.* (2015) and Qin *et al.* (2016) Qin *et al.*, (2016) who reported age has a positive significant influence amount of forest insurance.

The income of the tree growers was found to positively influence the amount of forest insurance, other factors remain constant increasing the income of the tree growers and its direct impact amount of forest insurance. This appears similar to Mensah *et al.* (2021) who reported as the income of the tree growers increased the probability of tree growers participating in forest insurance will also increase.

The previous occurrence of fire was statistically significant with a positive coefficient, as the increased occurrence of fire also amount of forest insurance increased and the participation of the tree growers also increased. This validated study conducted by Mensah *et al.* (2021) found that the added occurrence of fire will increase the amount of forest insurance and participation in forest insurance**.**

The species of trees planted had a significant negative influence on the amount of forest insurance. This means that certain types of trees planted in a forest can strongly and measurably reduce the cost or availability of forest insurance. Similarly, Brunette *et al.* (2020) found the choice of tree species planted affects the financial aspects of forest insurance due to their perceived vulnerability to various hazards.

Land ownership had a statistically significant positive effect on the amount of forest insurance, this indicates that if private land ownership increases, the amount of forest insurance also increases. This finding aligns with the study by Brunette *et al.* (2020) and Zhi *et al.* (2020) who reported that land ownership positively influenced tree growers' participation in forest insurance as most tree growers' private land ownership tends to increase the involvement in forest insurance.

Farm location has a statistically significant negative impact on the amount of forest insurance. This may be due to lower environmental risks, better access to emergency services, or regional economic and cultural differences in risk perception. This was similar to Mensah et al. (2021) and Wodaju *et al.* (2023) which reported location of the farm negatively influences forest insurance costs.

CONCLUSIONS AND RECOMMENDATIONS

This study aimed to assess the willingness to pay for forestry insurance among tree growers in Mufindi, Tanzania, and identify the key factors influencing their decisions regarding the amount of insurance they would commit to pay. The findings revealed that factors such as age, income, previous occurrence of fire, tree species planted, land ownership and location of the farm significantly influenced tree growers' Willingness to pay for forest insurance. These insights emphasize the importance of designing custom-made insurance products that consider the financial capacities and risk perceptions of tree growers. For policymakers, the study highlights the need to enhance education and awareness programs to improve the uptake of forestry insurance in the region. This study recommended that insurance providers develop affordable, flexible policies and collaborate with local authorities to create awareness campaigns. Policymakers should also explore subsidies or incentives to reduce barriers to entry for small-scale tree growers.

This study provides a foundation for further exploration of insurance models that address the unique needs of tree growers in developing countries. Enhancing access to forestry insurance could not only mitigate risks but also promote sustainable forest management and economic resilience among rural communities.

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