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RESEARCH ARTICLE

Economic Determinants of Human–Elephant Conflict: Evidence from Lunugamwehera, Sri Lanka

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ABSTRACT

Human-elephant conflict (HEC) is a serious socioeconomic and environmental issue in rural Sri Lanka, particularly among smallholder farming communities. This study examines the factors influencing household economies resulting from wild elephant assaults in the Lunugamwehera Divisional Secretariat Division of the Hambantota District. A mixed-method research strategy was used, with both quantitative and qualitative methodologies. Purposive sampling was used to select 239 households for data collection, with key informant interviews and field observations supplementing the process. Correlation and multiple regression analyses were used to investigate the relationship between household economy and eight independent variables such as agricultural damage, property damage, adaptive measures, policy implementation, health measures, socioeconomic status, psychological stress, and habitat degradation. The findings demonstrated that agricultural damage, property damage, health measures, socioeconomic position, and psychological stress, habitat degradation all had significant exposure on the household economic loss. Adaptive measures and policy implementation were found to be statistically insignificant, demonstrating the limited effectiveness of current mitigation and institutional mechanisms. The findings highlight the complex relationship between human livelihoods, environmental deterioration, and wildlife behavior in influencing rural economic resilience. To reduce economic losses and promote sustainable coexistence between humans and elephants in conflict-prone areas of Sri Lanka, the study recommends strengthening community-based mitigation strategies, improving policy enforcement, diversifying livelihoods, and restoring elephant habitats.

***Keywords**: Agricultural damage, Habitat degradation, Household economy, Human–elephant conflict, Socioeconomic resilience*

INTRODUCTION

Human-elephant conflict (HEC) has become a significant environmental and socioeconomic problem in Sri Lanka, especially in rural agricultural settlements where people and elephants compete for resources and land. It is a serious social–ecological problem for the elephant range regions in Sri Lanka, as between 200 and 400 elephants have been killed annually over the last few years, and more than 1200 people have died as the consequences of elephant encounters within a decade (Köpke *et al.*, 2024). These frequent occurrences have harmed the financial security and general well-being of rural people. Gunawansa *et al.* (2023) noted that traditional and modern mitigation approaches have failed to manage

human-wildlife interactions effectively. The economic aspect of the conflict and its household-level drivers receive little attention in the many studies that already exist, which mostly concentrate on ecological or wildlife management viewpoints. Farmers frequently experience crop destruction and property damage in the Lunugamwehera Divisional Secretariat Division, but there are few systematic evaluations of how these issues affect their family economy as a whole. As a result, the objective of this research is to model and assess the causes of household economic losses caused by wild elephant attacks in the Lunugamwehera Divisional Secretariat Division of the Hambantota District, Sri Lanka.

Theoretical framework

The theoretical framework (Figure 1) uses principles from the Sustainable Livelihood Framework (Sapkota, 2021).

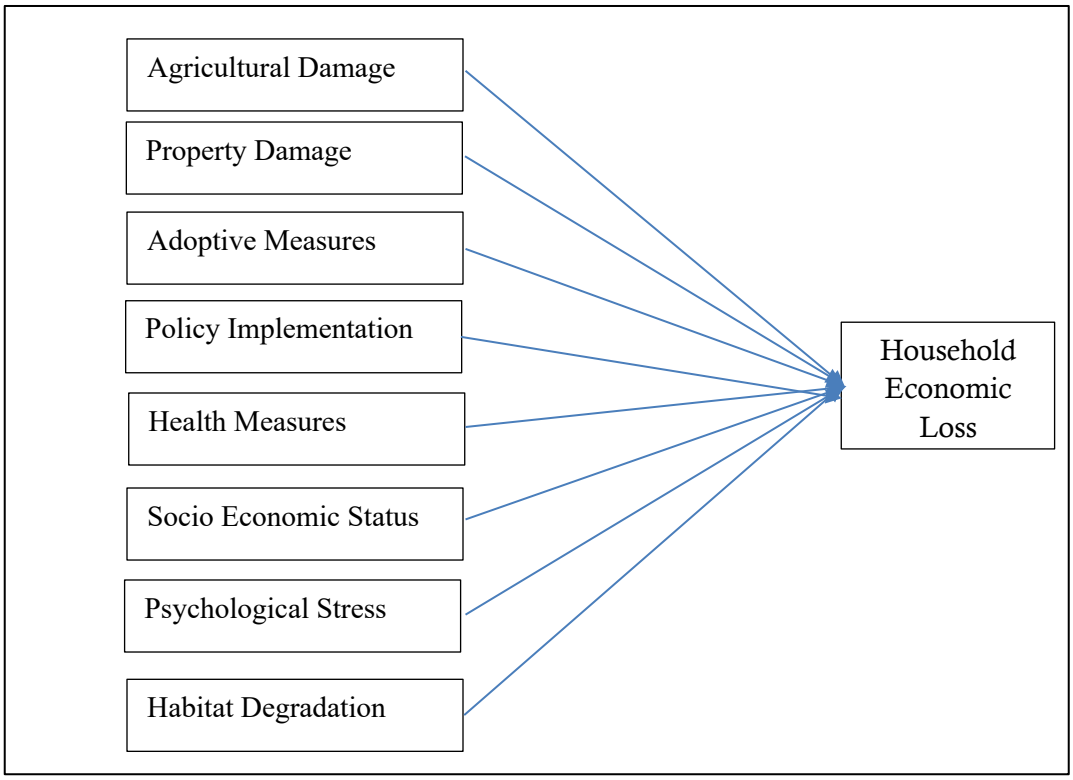

Figure 1: Conceptual framework of the study

Human-Wildlife Conflict concept (Madden, 2004), and the Economic Vulnerability concept (Briguglio *et al.*, 2009) explain about the household economic losses caused by wild elephant attacks.

Household economic loss

Wild elephant attacks affect household income and financial stability by causing crop loss, property damage, decreased productivity, and increased expenses. The household economy is measured using income fluctuations, economic losses, expenditures, and livelihood opportunities. Su *et al.* (2020) highlighted that economic loss needs to be considered in household economy loss in human-elephant conflict. Human-elephant conflict expenditures have a large impact on household economic loss due to agricultural destruction, property loss, animal depredation, and human mortality, all of which affect food security and livelihoods (Guru and Das, 2021).

Agricultural damage

Crop damage diminishes revenue, food security, and savings, increases dependency on loans or financial aid, and creates uncertainty in future farming investments. Guru and Das (2021) stated that such agricultural damage contributes significantly to household economic loss. Agricultural damage in human-elephant conflict was assessed using a variety of parameters to determine its influence on the household economy. Agricultural damage in human-elephant conflict is assessed through crop type vulnerability (Nair and Jayson, 2021), yield fluctuations (Negi *et al.*, 2022), damaged land area (Kim and Kwon, 2023), damage severity, and cultivation stage (Prins *et al.*, 2021). H1: Agricultural damages have a significant impact on the household economic loss.

Property damage

Elephant attacks destroy home infrastructure, resulting in costly repairs, degraded living conditions and financial pressures. Guru and Das (2021) emphasized that such property destruction adds significantly to household economic loss in human-elephant conflict zones. Property damage from human-elephant conflict is determined by elephant attraction, damage severity, and rebuilding expenses, resulting in household economic loss. These combined elements define the overall financial burden on households, emphasizing the importance of mitigating methods (Chen *et al.*, 2016; Gross *et al.*, 2020; Shamsuddoha and Aziz, 2021). H2: Property damages have a significant impact on the household economic loss.

Adoptive measures

Adoptive strategies like as fencing, guarding, crop diversification, and modifying cultivation practices lessen elephant-related losses, but they are generally expensive and labor-intensive, imposing an impacted on household resources. Nath *et al.* (2015) and Neupane *et al.* (2017) demonstrate that these adoption techniques can lessen economic loss while also serving as crucial measures of household resilience in human-elephant conflict. Household economic loss from

human-elephant conflict is determined by awareness, adoption willingness, and the practicality and durability of mitigating measures. Improving understanding, adoption, and viability of mitigation techniques lowers financial losses and increases household resilience (Gunaryadi *et al.*, 2017; Geleta and Mengesha, 2022; Majumder, 2022; Datta *et al.*, 2024). H3: Adoptive measures are having a significant impact on the household economic loss.

Policy implementation

Policy implementation in human-elephant conflict has an impact on the house economy, lowering losses and helping recovery when effective but increasing vulnerability and financial stress when poorly executed. Guru and Das (2021) observed that compensation policies change family views of economic impact, with adequacy determined by education and income. Continuous stakeholder feedback increases policy relevance, and long-term economic consequences are best reduced through sustainable, adaptive measures (Shaffer *et al.*, 2019; Majumder, 2022; Li *et al.*, 2023; Jarungrattanapong and Olewiler, 2024). H4: Policy implementations are having a significant impact on the household economic loss.

Health measures

Health consequences from human-elephant conflict, including as injuries, stress, and fatalities, increase household economic loss through medical bills, lower productivity, and income loss, particularly in areas with limited access to healthcare. Jadhav and Barua (2012) emphasized that both physical and mental health consequences lead to increased costs and greater household economic loss. These indicators reveal that, the major medical bills, income losses, and food insecurity, raising the overall household economic burden and undermining community resilience (Guru and Das, 2021; Majumder, 2022; Gunawansa *et al.*, 2023). H5: Health measures are having a significant impact on the household economic loss.

Socio-economic status

Socioeconomic status has an impact on the family economy in human-elephant conflict by determining income level, education, and resource access, all of which affect coping capability and loss recovery. Shahi *et al.* (2021) confirmed that socioeconomic position has a significant effect on household economic loss. Agriculture-dependent households and households with unstable or poor income sources, suffer larger losses and have fewer recovery alternatives, whereas households with diverse incomes are more resilient. This underlines that socioeconomic factors are important predictors of both short- and long-term economic outcomes (Yadav *et al.*, 2015; Thakur *et al.*, 2016; Van de Water and Matteson, 2018; Su *et al.*, 2020; Guru and Das, 2021). H6: Socio-economic status has a significant impact on the household economic loss.

Psychological stress

Psychological stress from frequent wild elephant assaults induces anxiety, worry, and exhaustion, which diminish productivity, impair decision-making, and discourage participation in agricultural and protective actions, resulting in economic loss. Fears and anxieties about crop loss generate strong negative emotional responses, showing the indirect economic impact of human-elephant conflict via mental stress. High stress levels in impacted populations contribute to health issues, greater medical costs, and decreased productivity in farming and employment (Jadhav and Barua, 2012; Mayberry *et al.*, 2017; Sampson *et al.*, 2021; De Silva *et al.*, 2023), ultimately increasing vulnerability and financial burden. H7: Psychological stresses have a significant impact on the household economic loss.

Habitat degradation

According to Guru and Das (2021), human-caused habitat degradation exacerbates human-elephant conflict and has an economic impact on households. Habitat degradation, such as deforestation, unauthorized construction, elephant corridor closures, and forest conversion to agriculture, draws elephants into human settlements, causing crop raiding, property destruction, and conflict-related mortality. These changes exacerbate economic losses for households, with the severity of the impact determined on the magnitude and kind of habitat loss (Chen *et al.*, 2016; Majumder, 2022; Gunawansa *et al.*, 2023; Li *et al.*, 2023; Baskaran *et al.*, 2024; Natarajan *et al.*, 2025). H8: Habitat degradation has a significant impact on the household economic loss.

MATERIALS AND METHODS

Research design

A mixed-methods strategy was used in this study, which combines quantitative and qualitative research methods in an explanatory cross-sectional design. Several independent variables, such as agricultural damage, property damage, adaptive measures, policy implementation, health measures, socioeconomic status, psychological stress, and habitat degradation, were used. These independent variables were tested for their hypothesized relationships with the dependent variable of household economy, using the quantitative component. By using this method, it was possible to determine the statistically important elements affecting household economic losses brought by conflict between humans and elephants. In order to provide more contextual information and explain the underlying mechanisms behind the quantitative results, the qualitative component of the study also included field observations and key informant interviews. Through the combination of quantifiable data, real-world viewpoints, and the lived experiences of impacted rural households, the

integration of both approaches allowed for a thorough understanding of the problem.

Study area

The research was carried out at the Lunugamwehera Divisional Secretariat Division in Hambantota District, Southern Province of Sri Lanka. This area was chosen because of the high frequency of HEC occurrences, which have a substantial impact on the livelihoods and economic stability of rural agricultural communities. The region is primarily made up of agriculture-dependent households, with paddy, maize, and other seasonal crops providing the majority of income. However, repeated elephant invasions have resulted in significant agricultural losses, property destruction, and increased socioeconomic vulnerability among inhabitants. Lunugamwehera is also close to key wildlife habitats, including the Lunugamwehera National Park, which acts as a natural corridor for elephants going between protected regions. The near proximity of settlements and farmlands to these wildlife zones worsens conflict situations, making the area an important location for researching the household economy caused by wild elephant attacks.

Population and sampling

The target population of the study comprised rural farming households living in seven (7) Grama Niladhari (GN) Divisions in the Lunugamwehera Divisional Secretariat Division in Beralihela area, which is situated in Hambantota District of Sri Lanka. These families were found to be directly impacted by assaults by wild elephants, which often result in harm to property, livelihoods, and agricultural land, affecting the financial stability of the household. There are 590 households in total in these seven GN divisions, based on local administrative records. A total of 239 households were selected to collect data. To make sure that the chosen participants had direct knowledge of the effects of battle, including wild elephants, the study used a purposive sampling technique. A greater percentage of the sample was assigned to GN divisions with a higher frequency of interactions with wild elephants.

Data collection

The study used both primary and secondary data sources. A pre-tested structured questionnaire was used to gather primary data from the 239 families that were chosen from among the seven GN divisions in the Beralihela area of the Lunugamwehera Divisional Secretariat Division. Agricultural damage, property damage, adaptation measures, policy execution, health measures, socioeconomic status, psychological stress, habitat degradation, and household economy were among the quantitative data that the questionnaire was intended to collect. These variables were included in the questionnaire on a Likert scale, which ranged from strongly disagreed (1) to strongly agreed (5). Prior to completing the whole

survey, a small sample of respondents pre-tested the questionnaire to make sure it was clear, relevant, and reliable. Secondary data were gathered from published sources and official records, such as reports from the Department of Wildlife Conservation in Colombo and the Lunugamwehera Divisional Secretariat of the Hambantota District, as well as appropriate reviews from earlier research, journals, and government documents. These secondary sources were utilized to support the primary data and give background information on the socioeconomic effects in the area, policy measures, and trends in human-elephant conflict.

Data analysis

The Statistical Package for the Social Sciences (SPSS) Version 26.0 was then used to evaluate the data. This software offers a dependable platform for doing both descriptive and inferential statistical analyses. In addition to describing the magnitude of damages and losses suffered by households, descriptive statistics such as frequencies, percentages, and tables were employed to summarize the demographic and socioeconomic features of respondents. Multiple linear regression (ordinary least squares) and correlation analysis were used to determine and quantify the elements affecting household economic loss. A number of criteria were used to quantify agricultural damage, including crop damage, impacted crop types, affected area, severity, affected stage of cultivation, and crop yield fluctuation. Property damage criteria included elephant attraction, property type, recovery cost, severity, property loss, and impaired property quality. Adoptive measures were evaluated based on knowledge of adaptive practices, mitigation strategies, willingness to adopt new methods, and practicability, whereas policy implementation was evaluated based on specific policies, implementation, feedback, alternative approaches, and long-term viability. Types of injuries and fatalities, healthcare expenditures, nutritional status and food security, and reported instances were used to assess health consequences, whereas family size, job status, and primary sources of income were used to assess socioeconomic status. Psychological stress was measured using anxiety levels, stress frequency, mental health status, and relaxation practices, while habitat degradation was measured using unauthorized constructions, deforestation, barriers to elephant movement, the extent of habitat loss, and the types of degradation. Finally, the dependent variable, household economic loss, was assessed using income changes, economic loss, spending patterns, and employment opportunities. The most significant causes of household economy among impacted farmers were identified by applying regression analysis to ascertain the direction and intensity of these associations.

RESULTS AND DISCUSSION

Socio economic background of the respondents

The survey included 239 farming households from the Beralihela area. As mentioned in Table 1, the majority were male (74.1%) and married (92.9%), primarily between the ages of 31 and 60. The majority of respondents (84.9%) had a basic education up to G.C.E. (O/L) and worked for themselves in agriculture. The majority earned 25,000-50,000 Rupees per month (60.7%), indicating a modest income level. Landholdings were typically small, with more than half (51%) cultivating less than half an acre. The primary crops grown are coconut, banana, and rice, indicating a mixed-crop agricultural system dominated by perennial and food crops.

Table 1: Socio-demographic and economic characteristics of respondents

Variable Catogory	Variable levels	Frequency	Percentage (%)
Gender	Male	177	74.1
	Female	62	25.9
Marital Status	Married	222	92.9
	Unmarried	17	7.1
Age Group	Under 15 years	0	0
	Between 16-30 years	11	4.6
	Between 31-45 years	91	38.1
	Between 46-60 years	87	36.4
	61 years or above	50	20.9
Education Level	No schooling	19	7.9
	Up to grade 8	91	38.1
	Up to G.C.E. (O/L)	103	43.1
	Up to G.C.E. (A/L)	23	9.6
	Diploma/Graduated	3	1.3
	Other	0	0
Status of Occupation	Public sector	16	6.7
	Private sector	15	6.3
	Self employed	203	84.9
	Retired	4	1.7
	Other	1	0.4
Monthly Income	Less than Rs.25000	57	23.8
	Between Rs.25000 to Rs.50000	145	60.7
	Between Rs.50000 to Rs.75000	37	15.5

	Between Rs.75000 to Rs.100000	0	0
	Between Rs.100000 to Rs.125000	0	0
Land Size	Half an acre	122	51.0
	Between 1 and 2 acres	94	39.4
	Between 2 and 5 acres	23	9.6
	More than 5 acres	0	0
Type of Crop Cultivated	Paddy	51	21.3
	Coconut	70	29.3
	Banana	66	27.6
	Mango	37	15.5
	Groundnut	14	5.9
	Onion	0	0
	Finger millet	1	0.4

Multivariate assumptions

According to Table 2, the collinearity data revealed that all tolerance values were above 0.1, ranging from 0.434 to 0.749. The Variance Inflation Factor (VIF) values were smaller than ten (10), ranging from 1.335 to 2.302. These findings demonstrate that there was no multicollinearity among the independent variables, supporting the statistical eligibility for regression analysis.

Table 2: Collinearity statistics

Model		**Collinearity Statistics**	
		Tolerance	**VIF**
1	Agriculture Damage	0.500	1.999
	Property Damage	0.542	1.846
	Adoptive Measures	0.508	1.969
	Policy Implementation	0.476	2.100
	Health Measures	0.434	2.302
	Socio Economic Status	0.698	1.433
	Psychological Stress	0.479	2.088
	Habitat Degradation	0.749	1.335

Cronbach's Alpha was used to determine the reliability of the measurement scales. Cronbach's Alpha was used to determine the reliability of the measurement scales. According to Table 3, the findings indicated that all constructs had adequate internal consistency, with Cronbach's Alpha values ranging from 0.620 to 0.840. According to Nawi *et al.* (2020), a score greater than 0.6 is considered appropriate for exploratory research.

Table 3: Reliability analysis

Variables	Cronbach's Alpha	N
Dependent Variable		
Household economic loss	0.721	239
Independent Variables		
Agricultural damage	0.689	
Property damage	0.647	
Adaptive measures	0.620	
Policy implementation	0.840	
Health measures	0.655	
Socio-economic status	0.749	
Psychological stress	0.834	
Habitat degradation	0.660	

All variables in this study were considered reliable for further investigation.

Descriptive analysis

As stated in Table 4, The Kaiser-Meyer-Olkin (KMO) index of sampling adequacy was 0.765, indicating that the sample was appropriate for factor analysis. The Bartlett's Test of Sphericity was statistically significant (χ^2=701.692, df=28, p<0.001), indicating that the variables were adequately linked. As a result, the dataset was considered eligible for further multivariate analysis, such as correlation and regression modeling.

Table 4: KMO (Kaiser–Meyer–Olkin) and Bartlett's test

Test	Value		
Test Value Interpretation			
Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy	0.765		
Bartlett's Test of Sphericity	**χ^2**	**df**	**Sig.**
	701.692	28	0.000

Correlation analysis

According to table 5, the Pearson correlation analysis revealed that agricultural damage (r=0.572, p<0.01), property damage (r=0.557, p<0.01), adaptive measures (r=0.311, p<0.01), policy implementation (r=0.258, p<0.01), health measures (r=0.627, p<0.01), socio-economic status (r=0.513, p<0.01), and

psychological stress (r=0.680, p<0.01) were all significantly and positively correlated with household economy.

Table 5: Correlation table of selected variables

		HE	**AD**	**PD**	**AM**	**PI**	**HM**	**SES**	**PS**	**HD**
HE	Pearson Correlation	1								
	Sig. (2-tailed)									
AD	Pearson Correlation	0.572**	1							
	Sig. (2-tailed)	0.000								
PD	Pearson Correlation	0.557**	0.610**	1						
	Sig. (2-tailed)	0.000	0.000							
AM	Pearson Correlation	0.311**	0.273**	0.241**	1					
	Sig. (2-tailed)	0.000	0.000	0.000						
PI	Pearson Correlation	0.258**	0.281**	0.205**	0.648**	1				
	Sig. (2-tailed)	0.000	0.000	0.001	0.000					
HM	Pearson Correlation	0.627**	0.567**	0.540**	0.320**	0.192**	1			
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.003				
SES	Pearson Correlation	0.513**	0.463**	0.436**	0.283**	0.231**	0.437**	1		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000			
PS	Pearson Correlation	0.680**	0.487**	0.488**	0.396**	0.264**	0.666**	0.422**	1	
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
HD	Pearson Correlation	0.003	0.187**	0.200**	-0.075	-0.315**	0.235**	0.048	0.037	1
	Sig. (2-tailed)	0.963	0.004	0.002	0.250	0.000	0.000	0.460	0.570	

***Correlation is significant at p=0.01 level (2-tailed)*

HE-Household Economic Loss; AD-Agricultural Damage; Property Damage (PD); Adaptive Measures (AM); Policy Implementation (PI); Health Measures (HM); Socio-Economic Status (SES); Psychological Stress (PS); Habitat Degradation (HD)

However, habitat degradation (r=0.003, p=0.963) did not demonstrate a meaningful association. These findings indicate that household economic loss from wild elephant assaults is primarily driven by physical damage, health consequences, socioeconomic factors, and psychological stress.

Regression analysis

According to Table 6, the regression model summary revealed a multiple correlation coefficient (R) of 0.778, indicating a strong positive association between the chosen independent variables and the household economy. The coefficient of determination (R^2) was 0.605, indicating that selected variables were explained 60.5% of the variation in household economy. The adjusted R^2 value of 0.591 demonstrates the model's excellent explanatory power, even after accounting for the number of factors. The standard error of the estimate (0.27371) indicates a minor difference between observed and expected values. The F-change (p=0.000) indicates that the entire regression model is statistically significant. Furthermore, the Durbin-Watson statistic of 1.973 is within the permissible range (1.5-2.5), showing the lack of autocorrelation in the residuals.

Table 6: Regression model summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Sig. F Change	Durbin-Watson
1	0.778[a]	0.605	0.591	0.27371	0.000	1.973

a. Predictors: (Constant), HD, PS, AM, SES, PD, AD, PI, HM
b. Dependent Variable: HE

AD-Agricultural Damage; Property Damage (PD); Adaptive Measures (AM); Policy Implementation (PI); Health Measures (HM); Socio-Economic Status (SES); Psychological Stress (PS); Habitat Degradation (HD); Household Economic Loss (HE)

Table 7: ANOVA table

ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	26.346	8	3.293	43.958	0.000[b]
Residual	17.231	230	0.075		
Total	43.577	238			

a. *Dependent Variable: Household Economic Loss (HE)*
b. *Predictors: (Constant), AD-Agricultural Damage, Property Damage (PD), Adaptive Measures (AM), Policy Implementation (PI), Health Measures (HM), Socio-Economic Status (SES), Psychological Stress (PS), Habitat Degradation (HD)*

As mentioned in Table 7, the ANOVA test confirmed the statistical significance (F=43.958, p<0.001) of the regression model. The regression sum of squares (26.346) was significantly greater than the residual sum of squares (17.231), indicating that the independent variables of agricultural damage, property damage, adaptive measures, policy implementation, health measures, socioeconomic status, psychological stress, and habitat degradation, explain a significant portion of the variation in household economy. The significance level (p=0.000) indicates that the regression model fits the data well and that the predictors have a significant impact on the dependent variable.

Table 8: Coefficient table

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	**Std. Error**	**Beta**		
1	(Constant)	1.259	0.274		4.591	0.000
	Agricultural Damage	0.183	0.066	0.163	2.774	0.006
	Property Damage	0.146	0.055	0.148	2.634	0.009
	Adaptive Measures	-0.012	0.051	-0.013	-0.228	0.820
	Policy Implementation	-0.009	0.037	-0.014	-0.236	0.814
	Health Measures	0.184	0.061	0.191	3.035	0.003
	Socio-Economic Status	0.121	0.039	0.154	3.111	0.002
	Psychological Stress	0.271	0.046	0.350	5.844	0.000
	Habitat Degradation	0.148	0.056	0.128	-2.666	0.008

a. Dependent Variable: Household Economic Loss (HE)

The regression coefficient results in Table 8 showed that various factors had significant effects on the household economy caused by human-elephant conflict in the Beralihela area. Predictors of household economy included agricultural damage (β=0.163, p=0.006), property damage (β=0.148, p=0.009), health measures (β=0.191, p=0.003), socio-economic status (β=0.154, p=0.002), psychological stress (β=0.350, p=0.000), and habitat degradation (β=-0.128, p=0.008). Psychological stress emerged as the most powerful predictor, demonstrating that the emotional load associated with frequent elephant encounters has a significant economic impact on afflicted households. In contrast, adaptive measures (p=0.820) and policy implementation (p=0.814) were not significant, implying that current coping strategies and institutional frameworks are insufficient for avoiding household economy. Overall, the model explained 59.1% of the variance in household economy, confirming its robustness and explanatory power.

Impact of habitat degradation on household economy loss due to human–elephant conflict

Human-elephant conflict causes significant agricultural damage, which has a positive direct influence on household economic loss (β=0.163, *p*-value<0.05). Crop destruction is the most apparent and immediate loss, since elephants destroy cultivated lands, resulting in the total or partial loss of yield. Su *et al.* (2020) found that crop loss represents over 95% of total elephant-related damage, with studies in India revealing substantial economic consequences. Dangol *et al.* (2020) confirmed crop damage as the most common type of elephant-induced harm, affecting agricultural communities consistently. The type of crops grown frequently determines how much of this loss occurs; cash crops like vegetables, paddy, or maize yield larger income losses than subsistence crops. Montero-Botey *et al.* (2020) found that sweet potatoes, bananas, peanuts, onions, pumpkins, and maize were the most preferred crops, with elephants damaging an average of 25.7% of cultivated farmland. Their analysis suggested that reducing preferred crops from 75% to 25% of farmland could decrease elephant crop damage by 64%. Recurrent elephant interventions cause crop yield fluctuation, which lowers trust in agricultural investment by farmers. Anoop *et al.* (2023) also highlighted that human-elephant conflicts lead to seasonal crop depredation, affecting rural food supply and economic well-being, which could lower trust in agricultural investment. The extent of the economic damage is frequently determined by the impacted area and the degree of destruction. Köpke *et al.* (2024) further identified specific conflict hotspots, indicating that economic impact is not uniform but depends on local landscape characteristics, human settlement patterns, and elephant habitat interactions. Households that cultivate larger or more valuable plots suffer major financial setbacks. Rani *et al.* (2024) also explained a similar idea, which is that households in high-risk areas, especially those with larger or more valuable plots in flat, agrarian areas, suffer major financial setbacks from human-elephant conflict due to crop damage. Elephant attacks during the flowering or ripening stages also cause farmers to lose months of work, fertilizer expenses, and potential revenue. This makes the cultivation stage at which the damage occurs crucial. Anoop *et al.* (2023) further revealed seasonal patterns, with peak crop depredation occurring during fruit seasons (May-September) and paddy seasons (September-December). As a result, ongoing losses in agriculture reduce the purchasing power of farmers, make them more dependent on debt, and make households less resilient financially overall. Therefore, agricultural damages have a significant positive impact on the household economy loss (H1 was accepted).

Impact of property damage on household economy loss due to human–elephant conflict

Property damage caused by human-elephant conflict has a considerable positive impact on the household economy loss (β=0.148, *p* value<0.05), imposing both direct and indirect financial obligations on the affected families. The degree of

influence is mostly determined by a number of crucial variables. Elephant attractions to homesteads are often caused by the storage of food, grains, or water, which increases the possibility of recurring damage to dwellings, fences, and storage facilities. Elephants are attracted to farms because of the desirable crops and proximity to waterbodies, and elephants are attracted to homesteads because of the stored food, resulting in severe property damage (Gross *et al.*, 2020; Montero-Botey *et al.*, 2024). The type of property damaged such as residences, wells, boundary walls, and grain stores determines the extent of economic loss, with more permanent buildings necessitating significant repair expenses. Gulati *et al.* (2021) emphasize that property losses, particularly those involving human casualties, can be economically devastating for rural households. The recovery cost associated with rebuilding or restoring these damaged assets can be a substantial amount of a household income, diverting funds from basic requirements such as food, health, or education. Human-elephant conflict imposes substantial economic burdens on households, significantly diverting resources from essential needs through crop damage and property destruction (Yadav *et al.*, 2015). Property loss varies in severity and extent, ranging from small fence damage to entire house destruction, resulting in temporary displacement or instability. According to Gross *et al.* (2020), studies in Asia and Africa have documented those elephants often damage property while searching for food, with incidents including the destruction of homes and storage facilities, sometimes causing higher mean financial losses than crop damage itself. Property loss varies in severity and extent, ranging from small fence damage to entire house destruction, resulting in temporary displacement or instability. While many incidents involve damage to fences, storage facilities, or outbuildings, more severe cases include the destruction of entire homes, which can force families into temporary displacement and create long-term instability for affected communities (Gross *et al.*, 2020; Shamsuddoha and Aziz, 2021). Collectively, these property damages lower household savings, raise debt dependency, and undermine long-term economic resilience among rural families living in elephant-prone areas. Therefore, property damages have a significant positive impact on the household economy loss (H2 was accepted).

Impact of adoptive measures on household economy loss due to human–elephant conflict

The regression results indicated that adaptive strategies have no meaningful impact on the household economies of farmers affected by the human-elephant conflict (p value>0.05). This means that, while adaptive methods exist, their application and effectiveness in decreasing household economic losses are limited. The regression results indicate that adaptive strategies have no meaningful impact on the household economies of farmers affected by the human-elephant conflict. This means that, while adaptive methods exist, their application and effectiveness in decreasing household economic losses are limited. Neupane *et al.* (2018) also explained that local people use basic mitigation measures like shouting and fire, but these are ineffective, indicating a

limited understanding of preventive techniques. Similarly, mitigating techniques like employing firecrackers, installing fences, and maintaining watch huts can give short-term fixes while failing to address the recurring nature of elephant invasions. Studies indicate that methods like making noise, using firecrackers, and building guard towers are commonly used and can be effective in immediately deterring elephants from crops or settlements, but their success rates vary and are often limited to specific incidents or locations (Purwanuriski *et al.*, 2022; Ardiansyah and Nugraheni, 2023). Cultural customs, cost, and trust in modern interventions all influence willingness to employ new approaches by people, therefore many households continue to use conventional ways that may not be economically efficient. Snyder and Rentsch (2020) also similarly explained that cultural customs and practical limitations influence the adoption of crop-damage-mitigation strategies, emphasizing the need for alignment with local attitudes and conditions. Furthermore, the viability of adaptive strategies is frequently restricted by insufficient financial resources, personnel shortages, and poor institutional support. Athulathmudali *et al.* (2024) found that high initial installation costs and inadequate institutional support hinder strategy implementation. As a result, these efforts did not significantly enhance household economic conditions or reduce elephant-related losses. Therefore, adoptive measures do not have a significant impact on household economy loss (H3 was rejected).

Impact of policy implementation on household economy loss due to human–elephant conflict

The regression analysis found that policy execution had no substantial impact on the household economic loss in communities affected by human-elephant conflict (p-value>0.05). This suggests that, while numerous policies and programs have been implemented to mitigate the effects of conflict, they have not resulted in significant economic recovery or stability for impacted households. One key difficulty is the specific rules created for conflict resolution, which are sometimes generic, fragmented, or misaligned with the local circumstances of agricultural communities. Failure and limited effectiveness of electric fencing in the Hambantota District reduce actual mitigation methods for decreasing household economic loss. Results were aligned with the findings from Sirikumara *et al.* (2025), who explained that the human-elephant conflict in Sri Lanka is aggravated by a lack of institutional coordination, political involvement, and inadequate regulatory enforcement, implying that present regulations are frequently generic, fragmented, or out of sync with local reality. Policy implementation is typically poor, with delays in compensation payments, minimal field monitoring, and a lack of coordination between government and wildlife agencies. The insufficient implementation of HEC mitigation measures, and a severe disconnect between the needs and anxieties of rural people and conservation policies, render the management of human-wildlife interactions ineffective (Köpke *et al.*, 2023). Furthermore, criticism on policies from affected groups is rarely considered, resulting in disappointment and limited participation

in official initiatives. Previous studies indicate a substantial gap between experiences, knowledge, and needs of rural people and the top-down conservation policies adopted by authorities, resulting in poor management and a lack of faith in official actions (Köpke *et al.*, 2023). The lack of other options, such as livelihood diversification and community-based conservation, reduces the scope of policy success. However, such alternative, community-driven initiatives remain neglected in national policy, with most efforts remaining focused on traditional mitigation measures rather than empowering locals or diversifying rural livelihoods (Dharmarathne *et al.*, 2020; Suresh *et al.*, 2024). Furthermore, most treatments lack long-term sustainability, as policymakers tend to prioritize reactionary measures over preventive or ecosystem-based approaches. According to research, these short-term measures frequently fail to address the underlying causes of conflict, such as land-use change and habitat loss, and require frequent maintenance, making them less successful over time. As a result, HEC events and injuries continue to increase, demonstrating that present measures are not producing long-term results (Perera *et al.*, 2022; Gunawansa *et al.*, 2023). As a result, these shortcomings limit the ability of policy interventions to promote household economic resilience, which explains their statistically insignificant association with the household economy in the research area. Therefore, policy implementations do not have a significant impact on household economy loss (H4 was rejected).

Impact of health measures on household economy loss due to human–elephant conflict

The regression analysis indicatesthat health measures have a considerable positive influence (β=0.191, p-value<0.05) on the household economic loss of people affected by the HEC. In addition to causing human suffering, the many injuries and fatalities brought on by elephant encounters also reduce the amount of labor available in households, particularly when important earners are impacted. Thennakoon *et al.* (2017) and Köpke *et al.* (2024) explained that when key earning members are injured or killed, households face a direct reduction in available labor, which can adversely affect agricultural productivity and overall livelihood stability. The cost of health difficulties, including medical treatments, hospital visits, and recovery-related fees, adds to the financial stress for rural households who already have restricted economic options. These health-related costs, along with the loss of labor when key earning members are impacted, can contribute to long-term economic hardship and lower resilience for rural households (Köpke *et al.*, 2021; Köpke *et al.*, 2024). Additionally, families sometimes use money intended for food and livelihood activities to pay for medical expenses, which has an indirect impact on nutritional status and food security. The financial burden of medical expenses and property damage further restricts the resources available for meals, frequently leading to lower meal quality and quantity for impacted households (Köpke *et al.*, 2021; Köpke *et al.*, 2024). The frequency and severity of these incidents, which together lead to economic instability, are also reflected in the number of cases reported to local

wildlife and health authorities. Human-Elephant Conflict is a major cause of long-term economic instability in many regions because many rural families lack sufficient resources to recover from repeated losses, which worsens the economic effects (Thennakoon *et al.*, 2017; Gunawansa *et al.*, 2023; Köpke *et al.*, 2024). Consequently, the study demonstrates that household economic loss are greatly positively impacted by the health-related effects of human-elephant conflict (H5 was accepted).

Impact of socio-economic status on household economy loss due to human–elephant conflict

The analysis indicates that the household economic loss of households impacted by human-elephant conflict was significantly positively influenced by their socioeconomic status (β=0.154, *p*-value<0.05). The size of the household is one of the most important factors. Larger households frequently face more financial strain since more members rely on scarce resources, and extra losses from property destruction or crop damage worsen the situation. According to research, socioeconomic circumstances and sensitivity to HEC are closely related, with larger households being especially vulnerable because of their higher reliance ratios and less ability to deal with repeated losses (Köpke *et al.*, 2024). Another important aspect affecting household resilience is the employment status of family members. In general, households with formal or steady work are better able to handle recovery expenses related to damage caused by conflicts and sustain revenue shocks. Research in Sri Lanka and other locations suggests that job status, together with income level and livelihood diversity, has a major influence on vulnerability and resilience of households to HEC impacts (Nguyen *et al.*, 2022; Köpke *et al.*, 2024; Zhang *et al.*, 2024). The primary source of income also influences how severely a household is affected. Families who rely heavily on agriculture are especially susceptible because human-elephant conflict immediately disrupts farming activities, damages crops, and diminishes harvest earnings. Montero-Botey *et al.* (2024) and Rani *et al.* (2024) emphasize that dependency on agriculture is a crucial indicator of how severely a household is affected by human-elephant conflict. Overall, the findings show that the socioeconomic status of households has a significant positive impact on their economic performance in conflict-prone regions (H6 was accepted).

Impact of psychological stress on household economy loss due to human–elephant conflict

The study found that psychological stress had a significant positive impact on the household economic loss of communities affected by human-elephant conflict (β=0.350, *p*-value<0.001). One important factor determining this outcome is the level of anxiety felt by household members. Frequent elephant incursions, crop raids, and threats to human safety instill anxiety and uncertainty. Research in Sri Lanka and other countries suggests that these psychological consequences are widespread and can be as severe as the direct economic costs. Fear of elephants

and worry about crop damage are strong negative effects on emotional wellness (Sampson *et al.*, 2021; De Silva *et al.*, 2023; Galley and Anthony, 2024). Economic losses are made even worse by the frequency of stress-related tasks, such as staying up late to preserve property or guarding fields at night. In some circumstances, the time and effort spent on guarding crops or property at night leaves less time for other income-generating activities or agricultural responsibilities, increasing the financial burden already caused by crop damage and property loss (Nyirenda *et al.*, 2018; Datta *et al.*, 2024). The emotional health of those afflicted is equally important. Continuous exposure to conflict circumstances might result in despair, trauma, or hopelessness, which can lead to unavailability at work or bad resource management decisions. Johnston *et al.* (2019) and Bryan *et al.* (2021) also find similarly, which explained constant exposure to stressful events may intensify these mental health concerns, resulting in behavioral symptoms that directly contribute to work inactivity and cognitive symptoms that disrupt decision-making, including resource management and coping techniques. Finally, the absence of possibilities for mental relaxation increases the situation. Because most afflicted families live in chronic stress and without access to counseling or community support systems, their recovery from traumatic experiences is slowed, resulting in long-term decreases in livelihood output and household economic stability. These mental health difficulties not only diminish individual resilience but also contribute to larger social and economic insecurity, as afflicted households struggle to recover and sustain income over time (Jadhav and Barua, 2012; Nyumba *et al.*, 2020; Galley and Anthony, 2024). Overall, the study demonstrates that psychological stress functions as an indirect yet powerful predictor of household economic performance in areas prone to human-elephant conflict (H7 was accepted).

Impact of habitat degradation on household economy loss due to human–elephant conflict

The findings indicates that habitat degradation has a considerable impact on the household economic loss in regions with human-elephant conflict (β=0.128, p value<0.05). The correlation study revealed no significant bivariate association between habitat degradation and household economy; however, in the multiple regression model, the influence of other connected variables was controlled. This enabled the distinctive effect of habitat degradation to emerge, demonstrating a strong link. The destruction of natural ecosystems immediately upsets the balance between human settlements and wildlife habitats, increasing conflicts and causing economic losses to local communities. One key factor contributing to this scenario is the increasing number of unauthorized structures within or near elephant pathways. The development of communities, roads, and other infrastructures into wildlife regions limits the natural migration of elephants, sending them to farmlands and residential areas in search of food and water. Research from India, Sri Lanka, and China demonstrates that land use and land cover changes, such as increased built-up areas, crop fields, and degraded forests, fragment elephant habitats and block traditional migration routes, resulting in

more frequent and severe encounters between elephants and humans (Li *et al.*, 2018; Nad *et al.*, 2021; Gunawansa *et al.*, 2023). By reducing the amount of natural food sources available to elephants, deforestation and land clearing for agriculture exacerbate this issue. Montero-Botey *et al.* (2024) highlighted that elephants are forced to adapt to diminishing and deteriorated settings when forests are converted to agricultural land, which disrupts elephant habitats, reduces acceptable foraging grounds, and increases the frequency and severity of crop raiding occurrences. Additionally, obstacles like concrete buildings or electric fences that are built along elephant pathways frequently obstruct migratory routes and make elephants more aggressive. According to research, these barriers limit the natural range of motion by elephants which leads them to "bunch up" against fences, change their feeding habits, and put more local pressure on vegetation. As a result, elephants may become more stressed and exhibit potentially aggressive behaviors as they try to get around or get past these obstacles (Loarie *et al.*, 2009; Vanak *et al.*, 2010; Huang *et al.*, 2019). The ecological capacity of these regions to support both humans and elephants has been further diminished by the degree of habitat loss and the various forms of degradation, such as soil erosion, wetland depletion, and fragmentation of forest patches. Elephants have less adequate habitat as a result of deforestation, land cover change, and fragmentation. This forces elephants into closer proximity to agricultural regions and human settlements, increasing the frequency and intensity of human-elephant conflict (Billah *et al.*, 2021; LaDue *et al.*, 2021; Gunawansa *et al.*, 2023). As a result, when habitat destruction increases it affects the household's economic loss (H8 was accepted).

CONCLUSION

The study indicated that HEC has a major impact on the household economic loss of the Lunugamwehera Divisional Secretariat Division. The findings indicate that agricultural and property damages have a positive and significant impact, indicating that these losses directly influence household income and asset recovery patterns. Meanwhile, habitat degradation has a considerable impact, highlighting how environmental deterioration and the loss of elephant corridors increase household vulnerability. Health measurements, socioeconomic status, and psychological stress all exhibit substantial positive associations, indicating that better health management, secure income sources, and adaptive psychological responses increase household resilience to conflict consequences. In contrast, adaptive measures and policy implementations have no significant impact, indicating the ineffectiveness of current mitigation efforts and institutional initiatives. Overall, the study emphasizes the complex relationship of social, economic, and environmental elements in determining household economic loss and supports integrated, long-term measures to mitigate the economic losses of human-elephant conflict.

RECOMMENDATION

The study suggests developing community-based mitigation techniques to prevent elephant-caused agricultural and property damage. Policy execution should be improved through effective collaboration between wildlife authorities and local people to ensure prompt compensation and preventive actions. Promoting livelihood diversification and improving socioeconomic conditions might help households become more resilient to economic shocks. Regular health monitoring and psychological support programs are critical for reducing stress and improving well-being in afflicted families. Furthermore, immediate effort is required to mitigate habitat degradation by reforestation, restoration of elephant corridors, and sustainable land-use planning. These coordinated initiatives will help to reduce conflict intensity and protect both rural livelihoods and elephant numbers in the long run.

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