CROP AND PROPERTY DAMAGE BY ASIAN ELEPHANT IN DHANUSHA DISTRICT, NEPAL

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May, 2023

DECLARATION

I hereby declare that the work presented in this thesis entitled **"Crop and property damage by Asian Elephant in Dhanusha District, Nepal"** is the result of genuine work and research, except as cited in references. The thesis work has not been submitted, or accepted elsewhere for other degree done by myself, and has not been submitted elsewhere for the award of any degree.

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RECOMMENDATION

This is to recommend that the thesis entitled **"Crop and property damage by Asian Elephant in Dhanusha District, Nepal"** has been carried out by Mrs. Pabitra Dawadi for the partial fulfillment of the requirements for the Degree of Master of Science in Zoology with a special paper 'Ecology and Environment'. This is her original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institution.

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On the recommendation of the supervisor Assistant Professor Dr. Bishnu Prasad Bhattarai, this thesis submitted by Mrs. Pabitra Dawadi entitled **"Crop and property damage by Asian-elephant in Dhanusha District, Nepal"** is approved for the examination in partial fulfillment of the requirement for the Master's Degree of Science in Zoology with special paper "Ecology and Environment".

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CERTIFICATE OF ACCEPTANCE

This thesis entitled **"Crop and property damage by Asian-elephant in Dhanusha District, Nepal"** submitted by Mrs. Pabitra Dawadi has been accepted for partial fulfillment of the requirement of Master's Degree of Science in Zoology with Special paper Ecology and Environment.

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ABBREVIATION AND ACRONYMS

GIS	Geographical Information System
GPS	Global Positioning System
HEC	Human-Elephant Conflict
IUCN	International Union for Conservation of Nature

ABSTRACT

Most of the damage incidents caused by elephants occur when humans and elephants compete for the same resources in overlapping areas. This issue is prevalent in Asia and Africa. The objective of this study was to examine the crop and property damage caused by elephants and to study the preventive measures applied by the local people to prevent such damage in two interconnected community forests in the Dhanusha district. The study employed various methods, including a household questionnaire survey, focus group discussion and GPS data collection. Data analysis was conducted using Microsoft Excel, QGIS and R-software and present in the table, chart and in graph. A total of 91 incidents of damage were documented, resulting an estimated economic loss of approximately NRs. 1,049,250 (US$ 8198) in which crop damage was found to be Rs. 914,250 and property damage was found to be Rs. 135,000 within a span of one year. Damage incidents were most prevalent during November-December and March-April, with occasional occurrences in June. Most of the people use traditional methods like shouting, firing etc as preventive measures. To mitigate the damage caused by elephants most of the people suggested constructing electric fences around the forest area.

1. INTRODUCTION

1.1 Background

Nepal is an elephant range country with having a population of >200 elephants in a highly disintegrated landscapes (Ram & Acharya 2020). Elephants from Assam, India, migrate to eastern Nepal, passing through the plains of the Darjeeling district of West Bengal, India, in search of food and shelter. During migration, these elephants cause much damage to property and life because the migration corridors are fragmented and used for human settlements and agricultural purposes (Baidya 2010). Elephants have a tendency to favour habitats that are frequently found within landscapes controlled by humans rather than outside protected area networks (Fernando et al. 2022). In shared landscapes, elephants often exploit anthropogenic food sources such as crops, leading to negative human-elephant interaction (Sitati et al. 2003). Due to human impingement on forest resources, animals find themselves more frequently in competition with humans for their survival (Pimm et al. 1995). Crop raiding mostly takes place at night and raiding elephants present real dangers to small holders protecting crops. Although elephants are attracted to well-grown or ripe crops (Chiyo et al. 2005). This decreases the availability of natural food resources for elephants and increases their need to enter human-dominated landscapes. Expanding agricultural areas also provide a diversity of cultivated crops (Koirala et al. 2015).

Elephants adapt to consume cultivated food crops that are more nutritious compared to the natural vegetation they typically consumed in the wild (Thapa & Dhakal 2014), when food supplies in natural areas are insufficient or more difficult to access (Cook et al. 2015). For farmers residing in regions affected by elephants damaging their crops, homes, and families safeguarding against such harm is an integral part of their everyday existence (Saif et al. 2020). The risk of damage is higher in close proximity to a protected area than further away from it, and people living near protected areas have less capacity to deal with damage caused by elephants (Wilson et al. 2015). Concomitantly, damage to crops and houses was more frequent nearer the wilderness–agriculture boundary than further away from it (Prins et al. 2022). Forest cover is a primary determinant of elephant distribution, thus, understanding impact of forest loss and fragmentation is crucial for elephant conservation (Padalia et al. 2019).

Several mitigation measures have been implemented to reduce damage incidents caused by elephants but none of them is effective in long-term (Fernando et al. 2011). Hence, the various problem caused by elephants and conflict with people has become the foremost, widely debatable conservation issue and challenge for governments, policymakers, conservationists and local people of Asia and Africa including Nepal (Sukumar 2006).

1.2 Objectives

1.2.1 General objectives

The main aim of this study was to examine the crop damage and property damage caused in the Bhatighari Community Forest and Murgiya Hariyali Community Forest area in Dhanusha District.

1.2.2 Specific objectives

- To investigate the crop damage and property damage caused by elephants in the study area.
- To analyze various preventive measures applied by the local people.

1.3 Rationale of the study

Damage caused by elephant is a major issue in elephant-range countries. In the case of Nepal, elephant is the major problematic animal in the Terai region and annually cause so many damage incidents. People living near protected areas and community forests face most of the problems. So this study is useful to mainly focus on crops damage and property damage, and mitigation measures done by the local people and their effectiveness. This study is essential to find out the major crops and property damage caused by elephants in the study area. Also, it is important to investigate the preventive measures used by local people and their effectiveness.

2. LITERATURE REVIEW

2.1 Crop damage and property damage by elephants

Crop raiding was a serious effect caused by Asian Elephants and most of the conflicts was caused by young and old bull elephants (Santiapillai et al. 2010). The peak season for crop-raiding by wild elephants is September-November for paddy, January-March for wheat, and May-June for maize (Neupane et al. 2017). During August-November the conflict frequencies were highest when there was precipitation and crops like millet, paddy and maize were ripening in villages with higher protected area frontage and unirrigated land were key variables of conflict frequency (Koziarski et al. 2016). Similarly more than 90% of human casualties occurred within 1 Km from the protected area including 21 death and 4 serious injury during 2010-2012 in central Nepal (Pant et al. 2015). Elephants prefer crops that contain a higher amount of sodium and minerals, so at the timing of finger millet to inflorescence and harvesting stage during (August-November) conflict incidents was higher (Bal et al. 2011). In eastern Nepal, study reported that 66% people face the damage caused by wild animal where rice was the major crop. Annually, 320 kg of rice per household was damaged, which is equivalent to one-third of the annual consumption for each household where wild elephants were the key contributors (62%) to the damage from (Dahal et al. 2021).

In Kenya Asian Elephants are responsible for raiding various crops which happens mostly at night. About 1-40 elephants were engaged in crop raiding and only 2% bull elephants alone involved in such incident. Within 1 Km crop raiding by elephants was extremely assembled (Sitati et al. 2003). Similarly, in some areas like Assam most crop and property damage occurs in the early hours of the night (Wilson et al. 2015).

Due to the depreciation of elephant habitat, they came into alliance with humans which may result in a persistent and raucous conflict beyond different resources like crop damage and human casualties (White & Ward 2010). In Northeast India, due to the increase in human population and development work, wildlife habitat has suffered from human encroachment and deforestation (Choudhury 2004). In India crop damaged by elephant was worth up to 3 million US$ and 10,000 to 15,000 houses damaged incident were recorded annually (Bist 2006). Crop damage is widespread from human-wildlife

interaction with an animal having immense body size, such as the elephant being recognised as the greatest peril by a farmer.

In Nepal, crop damage and property loss are problems caused by an elephant. They are accountable for 40% of HWC 70% of the wildlife-caused human casualties and 25% of the loss in crop production in Nepal (Neupane et al. 2017). The total average damage of paddy per year per household was 834.1 kg followed by wheat 153.7 kg, and mustard 2.12 kg. The economic value of average annual crop damage per year per household accounted for NRs. 22669.70. Among total household, 84% of the respondents said that the trend of crop damage is increasing (Chaudhary et al. 2021). Crop raiding was perceived as the most serious conflict between the elephants and other wild species like blue bull, pangolin, spotted deer and gaur in different rural municipalities in Parsa districts which directly affect the livelihood of local farmers closest to the park (Kurmi & Koju 2021). Elephants have eminently developed olfactory organs which help to smell the ripening crops and travel nearly 10 km from their habitat to raid the crops (Santiapillai & Read 2010). In Kakadi and Sapahi village in Bara District in Nepal, conflict mostly happened near the forest boundaries where female elephants with babies were responsible for most of the damages (Chaudhary et al. 2021).

2.2 Preventive measures applied by local people

In Sri Lanka, people guard their crops by making tree houses near their farms, tins and bottles were used to make alarms by hanging in the trip wire and also applied by throwing things to the elephants, and making loud noises to chase the elephants which was the mostly used methods around the country (Fernando et al. 2008). Planting unpalatable crops and constructing a solar fence around the National park help to minimize various damage caused by elephant (Kurmi & Koju 2021). However its effectiveness couldn't be assessed because fence equipment were unmanaged due to the lack of proper coordination between the government and the local community (Pradhan et al. 2011). Human-elephant coexistence could be the only imperishable model for successful mitigating measures to conserve the elephants in Sir Lanka (Fernando et al. 2021).

Most of the respondents used mitigation methods like noise making, lighting fires during the night, and launching stones with hand catapults. Other methods included employing someone to guard the fields, planting unfavorable crops such as chilli around the farm,

seeking help from wildlife rangers, who used disturbance shooting and placing hives of honeybees *Apis mellifera* around the crop field (Hariohay et al. 2020).

Effective mitigation methods are crucially needed in order to resolve the problems and a wide range of technical approaches exist for damage limitation (Landry et al. 2005). The development of different technologies like GIS and remote sensing have increased the potential for the analysis of patterns relating to wildlife management and research (Wilson et al. 2015). Farmers in Assam practice wide range of methods to deter the elephants. They employed traditional impediments such as beating drums, shining torch lights, shouting and bolem (Lahkar et al. 2007). Construction of tangis during harvesting time to guard the field was another method applied by farmers around Kaziranga National Park (Di Fonzo 2007).

Elephants are the major problematic animals in the eastern corridor of Nepal. Various studies have been carried out in the lowland Terai in terms of damage caused by elephants. However, some places in the Terai were still left to study the impact of elephants**.** Different villages along the corridor of eastern and western Terai near the community forest faced the problems of wild elephants. The patterns of conflict problems and their preventive measures vary greatly depending on different locations in Terai. In my study area and even in the Dhanusha District no study has been carried out in terms of damage caused by elephants. Although people in that area face various problems with elephants there is lack of proper official records about the damage caused by elephants. So, this study was carried out to fulfil the gap of research in the community forest area in Dhanusha District.

3. MATERIALS AND METHODS

3.1 Study area

The research was conducted in Bhatighari Community Forest and Murgiya Hariyali Community Forest area in the Dhanusha District. It is a district of the Janakpur zone, administrative headquarter of this district is Janakpur, situated in Madesh Pradesh of Nepal. It is situated in outer Terai. It is located at a height of 61 meters to 610 meters from the water level and it is area is 1180 sq. km. Agriculture is the major economy of the Dhanusha district. About 90% of people are involved in agriculture. There are two main rivers the Kamala and the Hardinath. These rivers are useful for farmers for irrigating the land. Bhatighari community forest and Murgiya Hariyali community forest are interconnected with each other. These two forests are distributed within the Dhanushadham and Mithila Municipality.

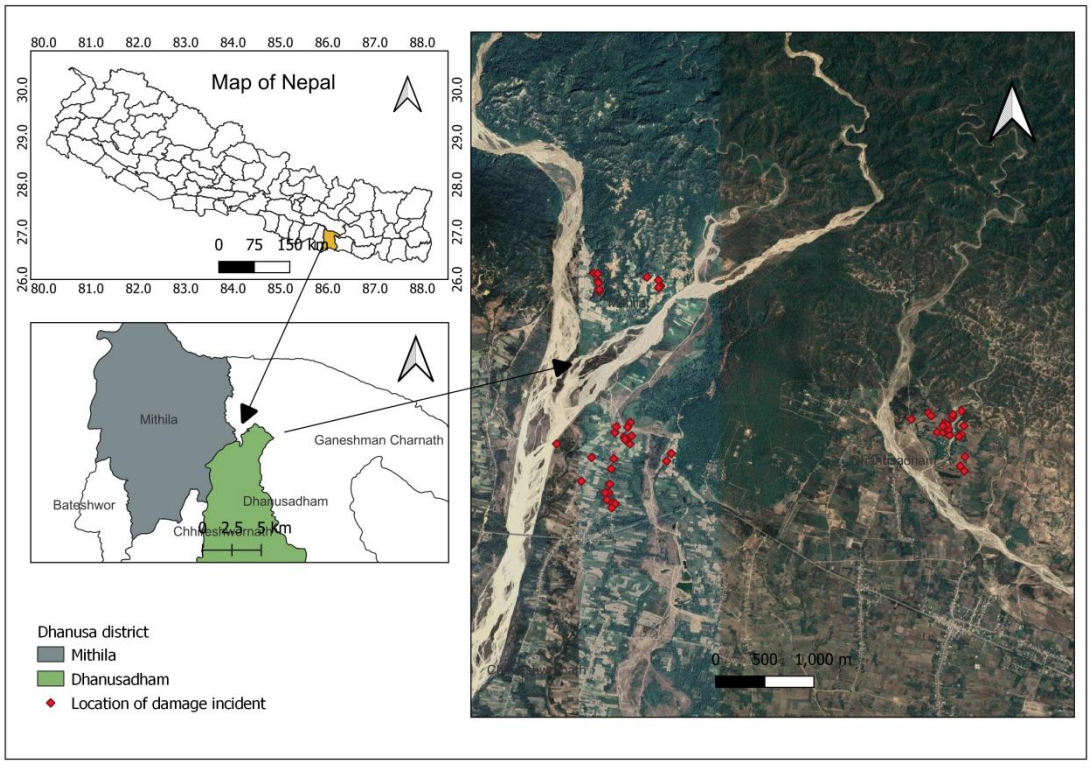

Figure 1. Map of the study area showing points of damage incident caused by elephants.

3.1.1 Flora and fauna

In the Dhanusha district about 40 species of trees were recorded like Sal (*Shorea robusta*, Cotton tree (*Bombax ceiba),* sisoo (*Dalbergia sissoo*), river red gum (*Eucalyptus camaldulensis*), satisal (*Dalbergia latifolia*), *Khair* (*Acacia catechu*) *are the major species*, among them Sal (*Shorea robusta*) was found to be in high density. 31 species of shrubs like *Lantana* camera, *Carissa carandas*, *Clerodendrum indicum* and 40 species of herbs like *Croton bonplandianus*, *Eupatorium odratum* etc were found in the Dhanusha district. 10 species of mammals like Blue bull (*Boselaphus tragocamelus*), Wild boar (*Sus scrofa*), Golden jackal (*Canis aureus*), jungle cat (*Felis chaus*), Rhesus monkey (*Macca mulata*) etc were found. Likewise birds like Peafowl (*Pavo cristatus*), Red jungle fowl (*Gallus gallus*) reptiles like King cobra (*Ophiophagus Hannah*), Monitor lizard (*Varanaus flavescens*), Indian cobra (*Naja naja*), Tortoise (*Indotestudo elongate*) were found and amphibian species like *Bufostomatus*, *Hoplobatrachus crassus* etc were found in Dhanusha district (KC, 2018).

3.2 Methods

3.2.1 Data collection

Household survey

Household surveys were conducted from November 3rd to November 15th and from February 25th to January 5th using a semi-structured questionnaire survey to find the crop damage, property damage and mitigation methods used by people to reduce damage incidents. GPS point of property damage and crop damage was also recorded.

Sampling

The sample size was determined based on the number of households present in the study area. The household number was available from the Chairman of the community forest committee of both the Bhatighari and Murgiya Hariyali community forests. A simple random sampling method with a 95% confidence interval was adopted. Some information was taken from Mithila wildlife trust and local leaders. In the Bhatighari community forest area, there are 210 houses and in the Murgiya Hariyali community forest, 137 houses are present altogether 347 houses. The sample size was determined by using Solvin's formula.

Sample size (n) = $N/1+Ne^2$

Where n=sample size, N= total population

Altogether 185 houses were selected for the survey. The question was asked with the head of the family in the absence of a head member other members above 20 years were asked. Mainly the questionnaire survey was focused on an economic loss like crop damage, property damage human injury etc. A Semi-structured questionnaire was made to ask the respondent. The questionnaire set is given in Appendix I.

Focus group discussion

It was carried out with the local representative and staff of Mithila wildlife trust to get information about the patterns of damage, cause and impact caused by an Asian elephant.

3.3 Data analysis

The data collected involved the tabulation of the information collected through a household questionnaire survey. All the information was carried out in the form of property damage, crops damage and the preventive measure applied by the local people to minimize the damage. The monetary value of crop loss and property loss were calculated by using the local market price of the crop loss from the study area. The collected data were entered into the MS Excel program to analyze and generate tables and figures and charts. Simple statistical analysis like frequency and percentage were calculated using the gathered data from household survey.

The study area's point where the damage incidents occurred was recorded using GPS coordinates along with interview was carried out in the study area. Pearson Chi-square test of independence ($\alpha = 0.05$) (Franke et al. 2012) was performed to compare socio-economic status and escalation of conflict incidents. Chi-square test of goodness of fit was done to find the significant of the various data. Furthermore, the QGIS software was employed to create a map of the study area, including the locations where the conflict incidents occurred.

4. RESULTS

General information of respondents

During the field survey questions were asked to the head member of the house. It was found that males represent (23.25%), and females (76.76%) during the household questionnaire survey. To collect the actual data, respondents above 18 years were selected.

It was a fortune that the entire respondents were above 20 years of age. Respondents represent more than 13 ethnic groups which were classified into five groups. The majority of respondent belongs to the Mongolian tribe like Lama/Tamang/Newar/Magar, similarly from Dalit (36.2%), Yadav/Shah (14%) and Tharu (1.62%) and very few from Brahmin/Chhetri (1.62%) found. About 64.31% of respondents were illiterate while 32.9% of people had school-level education and very few had college and university-level of education. The major occupation of the respondent was farming. About 50.27% of people engage in farming including animal husbandry. 24.32% of people were wages, 8.64% of people did business, and 5.94% of people engaged in other occupations. The majorities of people in the study area were low economic status and got very few land for agriculture. About 42.16% respondents have land 1-5 kattha, 23.24 % of people were landless, 16.21% of people have 6-10 kattha and 7.02% of people have 11-19 kattha and about 11.35% of people only have 1 bigha or more than 1 bigha land. (Table 1)

Table 1. General information of respondents

S.N	Category	Indictors	Percentage of respondent
1.	Sex	Male	23.25
		Female	76.75
2.	Age group	20-40	41.04
		40-60	41.04
		60 and above	17.87
3.	Ethnicity	Mongolian/Newar/Tamang/Magar	46.48
		Dalit	36.2
		Yadav/shah	14
		Tharu	1.62
		Brahmin/Chhetri	1.62
4.	Education	Illiterate	64.31
		School level	32.9
		College	2.2
		University	0.5
5.	Occupation	Farmer	50.27
		Wages/Labour	24.32
		Job	5.94
		Business	8.64
		Others	10.81
6.	Land	Landless	23.24
		1-5 kattha	42.16
		6-10 kattha	16.21
		11-19 kattha	7.02
		more the 1 bigha	11.35

4.1 Crop and property damaged by elephant

4.1.1 Crop damage by elephants

Due to the crop raiding and demolishing the stored grain by elephants, the residents in the study area bear a huge loss. Paddy was the most liked crop by elephants followed by maize, mustard, wheat and others. According to the respondent the highest loss was found to be paddy (86.95%) followed by maize (5.43%), wheat (2.16 %), mustard (2.95%), and other (2.48%). In total around NRs. 914250 (US$ 7142) (Table 2) was loss for crops damaged by elephants. About NRs 175000 (US$ 1367) was loss for property damage (Table 2), Similarly, altogether 245 kattha land out of 820 kattha crop land was damaged by an elephant within a year in which paddy was raided in a large area (Table 2).

Table 2. The monetary value of crops damage by elephants

Crops	**Estimated damage in kg**	**Market price in Rs.**	**Total loss in Rs.**	**Estimated % of loss**
Paddy	26500	30	795000	86.95
Maize	1420	35	49700	5.43
mustard	110	180	19800	2.16
Wheat	450	60	27000	2.95
others	350	65	22750	2.48
			914250	

About 1400 kg of crops was demolished by elephants, while about 1250 kg was damaged through raiding, similarly, in the case of maize, 820 kg of crops were demolished by elephants whereas 600 kg were raided in the field. Elephants also caused damaged to mustard crops, with 60 kg being demolished and 50 kg being raided. Wheat suffered 250 kg of damaged through demolition and 200 kg raiding in the field by elephants. Additionally, around 150 kg of crops were demolished and 200 kg were raided in the field by elephants figure (2).

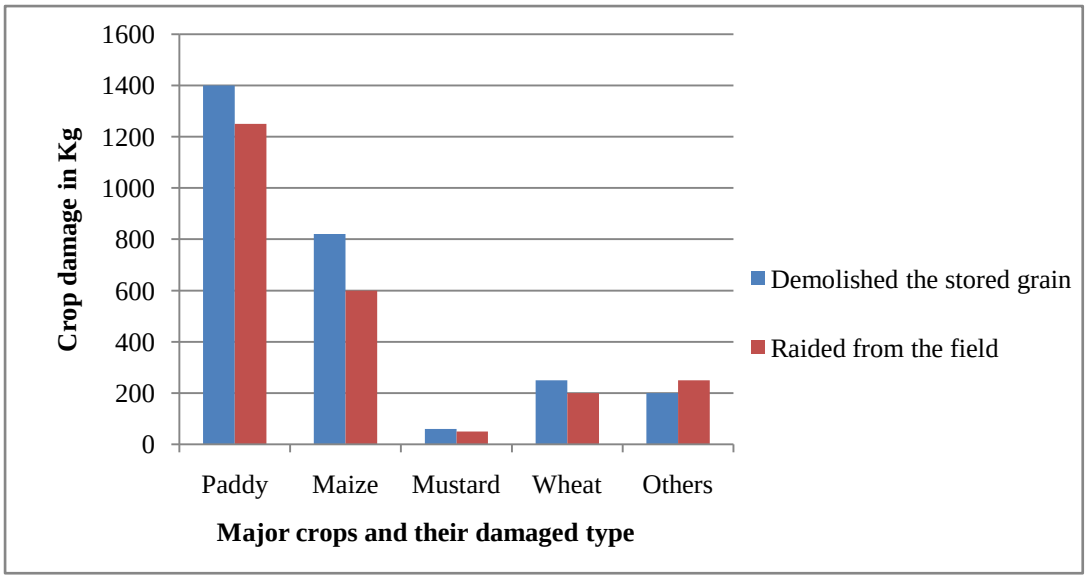

Figure 2. Major crops and their damage in kg

4.1.2 Property damaged by elephant

Property damage due to elephant attack in the house was another main issue in the study area**.** Property damage by wild elephants include house damage and cattle shed. Most of the damaged houses were made up of bamboo and mud so that elephants can easily damage the house and shed while searching for grains in the house. Altogether 31 incidents of property damage were done by elephants within one year of time. In terms of monetary value, the total estimated property damage amounted to NRs. 135000(1054 US$) in a single year. (Table 3).

Table 3. The Monetary value of property damage

Property damage	**Estimated Amount(NRs.)**	**Estimated % of damage**
House cattle shed	110000 25000	81.48% 18.52%
Total	1,35,000	

Although two community forests were interconnected, the adverse effects of damage caused by elephants were found to be most pronounced in Murgeya Hariyali Community Forest compared to the Bhatighari community forest. The financial implications were significant as well. Murgeya Hariyali community forest incurred a crop loss of NRs. 550000 out of the total NRS. 914250, while the Bhatighari community forest recorded a loss of NRs. 364250, whereas in case of property damage, the Bhatighari community forest incurred property loss of NRs. 85000 and the Murgeya Hariyali community forest incurred property loss of approximately NRs. 50000 (Figure 3).

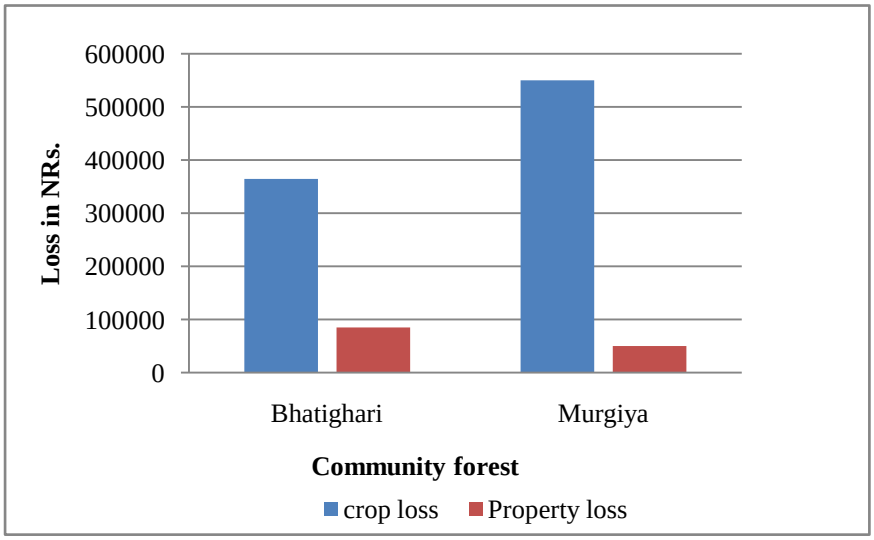

Figure 3. Impact of elephants in two community forest area

4.1.3 Month-wise intensity of crops damage and property damage

Incident of crops damage occurred higher (50%) in November and fewer incidents occur in December (10%). Similarly in case of property damage higher incident happened in December (50%) and fewer incident happened in April (20%). In the case of grain stored demolished 50% of incidents occurred in December and very less in March (20%) (figure 4).

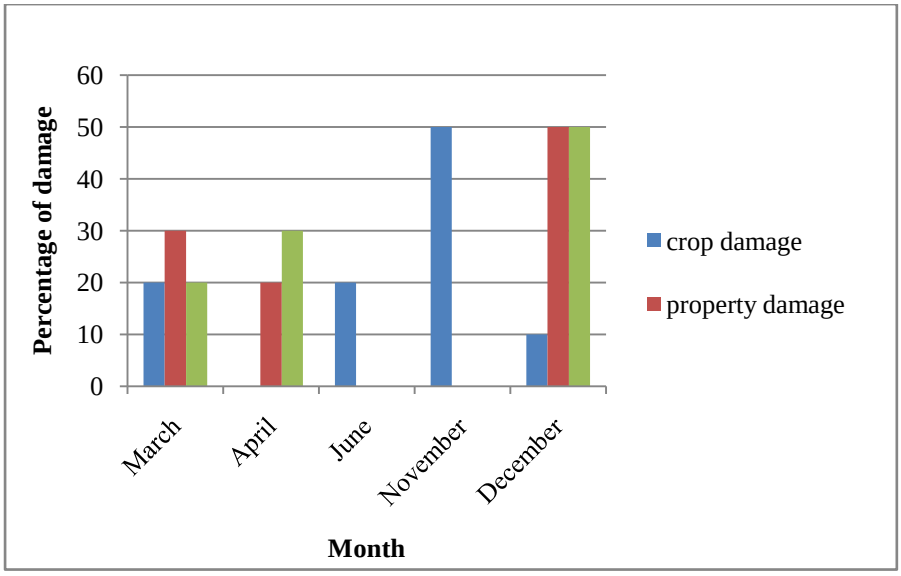

Figure 4. Month-wise intensity of damage caused by elephants

4.1.4 Major causes of damage caused by elephants

About 49% of respondents said that the main cause of damage caused by elephants is human settlement and farmyards close to forest, 21% of respondents said that during winter and April/May there was a scarcity of food in the forest due to this reason elephant enters in the village in search of food. Similarly, 12% of respondent said that damage is caused when elephants enter the village in search of highly palatable food. Similarly damaged caused by elephant is due to the elephant looking for water in the village. 11% of respondents said that elephants prefer to feed highly palatable crops and 7% said that due to the smell of alcohol elephants enter the village and damage property and crops (Figure 5).

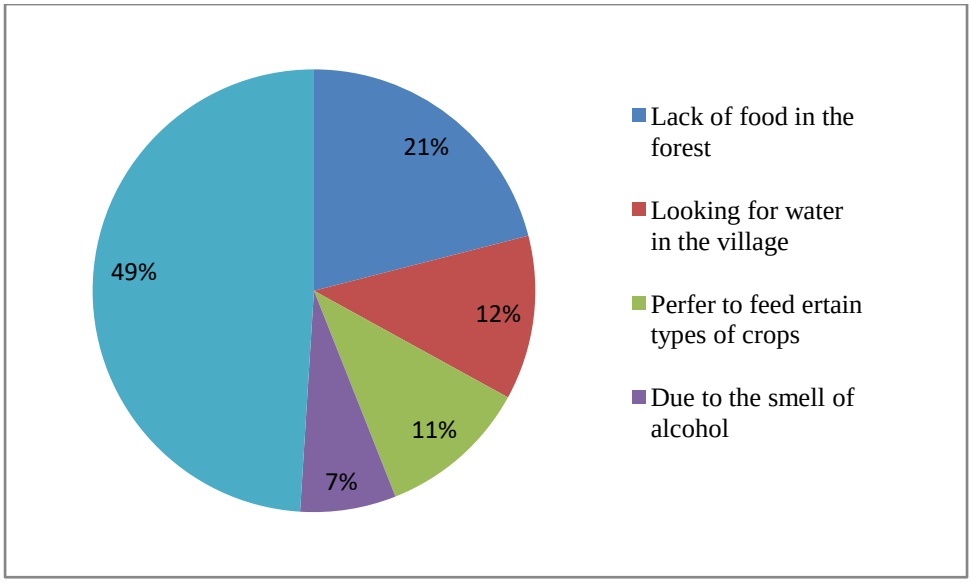

Figure 5. Major causes of damage caused by elephant

4.2 Preventive methods used by local people

About 34% of people are making noise by beating different sound-making objects like tins to chase elephant. 31.35% of people lightening agarbatti, 12.43% of people use fire, 13.15% of people stay quietly inside their house and 24.32% (χ^2 = 18.435, df= 3, p-value= <0.05).

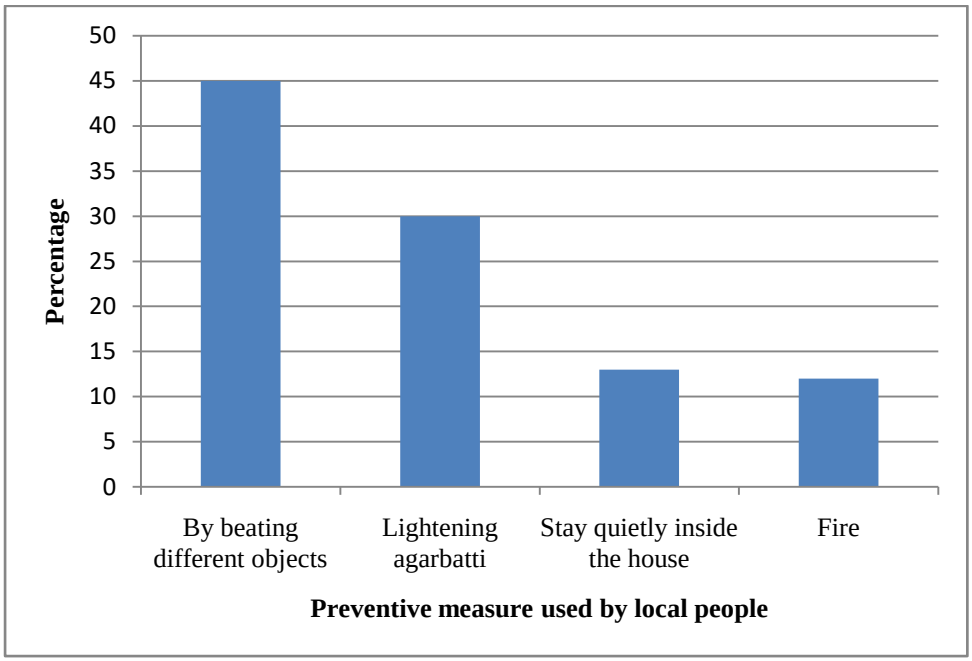

Figure 6. Preventive measures used by the local people

People in the study area use different types of preventive measures and the effectiveness of preventive measures were different from person to person. Altogether 63 people applied sound-producing objects to chase elephants, 20 of them said that method was effective while 43 of them said that was not so effective. Likewise, 40 people said that lightning aagarbatti was effective while 19 of them said that was not so effective. Similarly, 15 people out of 23 said that burning firewood on the road was effective and 8 people said that that was not so effective. About 24 respondents used the technique to stay quietly inside the house, 20 of them said that method was effective while 8 of them said that method wasn't effective. Table 4. shows the Chi sq test between the effectiveness of preventive methods used by the local people.

Table 4. Effectiveness of preventive measures used by local people

Mitigation measures	Effectiveness of mitigation methods		chi sq test	p-value
	effective	not effective		
Beating sound producing objects	20	43	26.468	0.00000761
Agarbatti	40	19		
Fire	15	8		
Stay quietly	20	4		

There is significant difference ($P<0.05$) in preventive methods and their effectiveness according to the respondents**.** (χ^2=26.468, df =3 and p- value=0.00000761).

4.2.1 Effective mitigation measures that should be implemented from the government level

The preventive measure used by the local people isn't so effective. Proper mitigation measure should be applied in that area. About 25% of people said that translocation of the problem elephants was the best method for mitigating the damage caused by elephant,

30% recommended evicting people from the conflict zone, and 35% referred to build electric fences around the community forest area. The number of people and mitigation measures were found to be statistically significant ($\chi 2$ =14, df =2, p-value<0.05) (Figure 7).

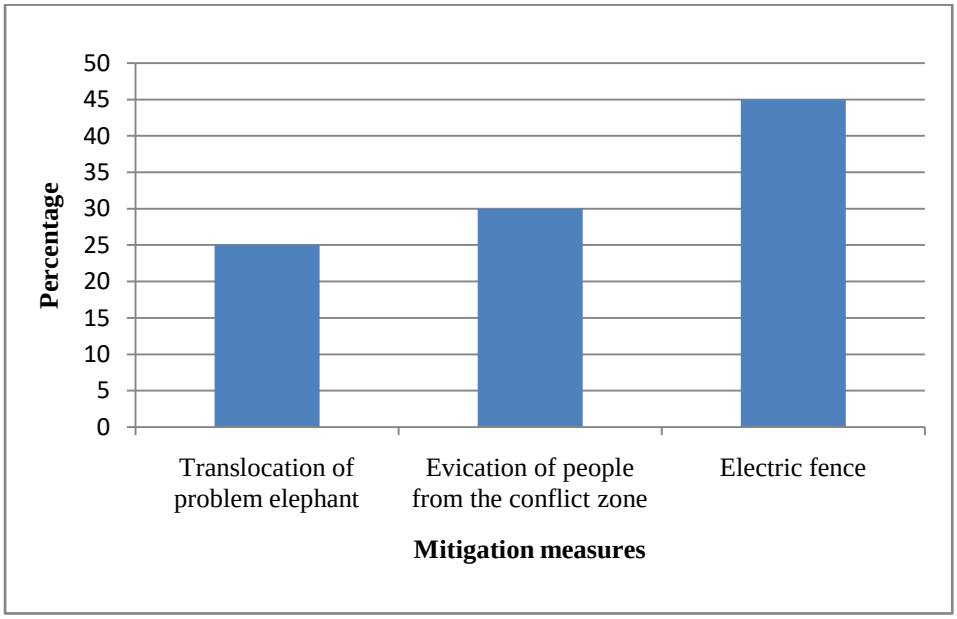

Figure 7.Effective mitigation measures that should be implemented

4.2.2 Perceived relationship between socio-economic status and escalation of damage caused by elephants

Out of 185 respondents in the study area, approximately 70% of respondent reported that the level of damage caused by elephant had increased, while only 30% said that it was decreasing. A chi-square test of Independence was conducted to determine the relationship between different categories such as age, sex, ethnic group, land ownership, education and occupation and the significant escalation of damage incidents. The results indicated that all categories except for age group had a significant relationship ($p<0.05$) with the escalation of damage incidents (Table 5).

Table 5. The perceived relationship between socio-economic status and escalation of conflict

S.N	Category	Indictors	Number of respondents		Chi sq test
			Increase	Decrease	
1.	Sex	Male	30	13	χ^2=10.79, df= 1, p value=0.00102
		Female	100	42	
2.	Age group	20-40	40	36	χ^2= 6.41, df= 3, p value= 0.0507
		40-60	45	31	
		60 and above	20	13	
3.	Ethnicity	Mongolian/Newar/Tamang/Magar	40	46	χ^2= 18.97, df= 4, p value= 0.00079
		Damai/kami/Mijar/Sunar	47	20	
		Yadav/shah	12	14	
		Tharu	1	2	
		Brahmin/Chhetri	2	1	
4.	Education	Illiterate	80	39	χ^2= 0.8498, df= 2, p value= 0.00407
		School level	31	30	
		College	2	1	
		University	1	0	
5.	Occupation	Farmer	50	43	χ^2= 9.6117, df= 4, p value= 0.0457
		Wages/Labour	25	20	
		Job	10	6	
		Business	8	4	
		Others	10	5	
6.	Land	Landless	15	28	χ^2= 21.055, df= 4, p value= 0.0003
		1-5 kattha	40	38	
		6-10 kattha	15	15	
		11-19 kattha	10	3	
		more the 1 bigha	10	11	

5. DISCUSSION

5.1 Crop damage and property damage by elephants

It was found that the total number of damage incidets were 91 within a year in two community forests (Bhatighari and Murgiya Hariyali) area in the Dhanusha district. Mostly damaged crops were found to be paddy, maize and wheat. A similar study carried out by (Neupane 2011) revealed that crop damage was the major impact followed by property damage and paddy was the most frequently damaged crop by the elephant. This study shows that most of the damage occur in November-December during rice harvesting time and during March-April during wheat harvesting and occasionally in June during maize maturing time. Study from (Pradhan et al. 2011) revealed that most of the crop damage by wild elephants were recorded mostly in two seasons during paddy harvesting (September-November) and during wheat and maize maturing time(June-July). Study from eastern Nepal revealed that incidences of crop damage was higher in November –December, August and June (Shrestha & Koirala 2013). Study from (Fernando et al. 2022) in Wasgamuwa reported that elephant incursions into the agricultural areas when available crop resources were plentiful.

In winter when there was a scarcity of food in the forest elephants enter human settlements seeking the stored grains. A study conducted by (Dangol et al. 2020) revealed that elephants don't have the intention to damage the houses but they are just the consequence of massive elephant searching for food products inside the house (Bhandari & Bhatta 2022). Elephants visit human-dominated areas by night, with a possible influence of nocturnal illumination on family groups. The close temporal association between elephant movements and crop damage advocates elephant visitation to human-dominated environments is driven by crop accessibility (Fernando et al. 2022).

From the focus group discussion, it was found that elephants prefer ripen fruits and the majority of people in the study area used to fermentation of alcohol and alcohol smells like ripened fruits so the elephant move to the village in search of food due to the smell of alcohol. From the study of (Sitati & Ipara 2012) revealed that, that drunk people are more likely to be attacked by an elephant.

Most of the damage incident was highest in the migratory route along the eastern Indo-Nepal border region, and increased in the migratory route along the eastern Indo-Nepal border region during rice harvesting time. Eastern and western Terai contain trans-border mobile routes for elephants, and HEC is primarily associated with these mobile herds (Yonzon 2008). From this study, it was found that the major cause of the human-elephant conflict was due to lack of food in the forest due to fragmentation and deforestation then elephants enters into the village which results in various conflicts like crop damage, property damage etc. Due to the degraded forest, the wild elephant comes into direct interaction with local people while searching for their food. In this way they have been habituated towards food crops which are more palatable and nutritious than wild browse plants (Thapa & Dhakal 2014). The forest fragmentation is likely to increase in the coming days with the expansion of linear infrastructure, degradation of forests and rapid expansion of settlements along the forest boundary which could be the major cause of the damage (Ram et al. 2022). Shrinkage of the forest area and lack of food materials inside the forest was the major cause of HEC (Chaudhary et al. 2021). Humans and elephants often share water resources, so elephants may enter human-dominated landscapes more frequently during the dry season to access water (Fernando et al. 2022).

People around the community forest depend on firewood and fodder for cattle. For cooking purposes, most people use firewood, which may result in the deforestation of forest and a lack of food for wild fauna so in search of food wild fauna like elephants, wild bore, blue bull enters the nearest village. A similar condition was reported by (Kurmi & Koju 2021) it was found that the use of firewood in the kitchen and visiting forests area frequently to collect firewood thus increased the number of conflict incidents in comparison to local people who use liquid petroleum gas in their kitchen.

5.2 Preventive measures used by the local people

Most of the respondents in the study area applied traditional types of preventive measures like firing, lightning agarbatti, beating drums etc. No one is aware of modern techniques like electric fencing and vehicle chasing. Traditional methods can be used without cost, firewood can be available everywhere as most people were firewood dependent for cooking purposes for the modern technique huge amount of budget has been needed and can't be afforded by the local people. The Same types of mitigation measures are applied in the study done by (Choudhury 2004), in his study it was found that elephants have

annexed settlements and cropland and people have tried to reduce vandalism by creating loud noises with different sound-making objects, or by using fire or fog lights to chase away elephants. A study conducted by (Chen et al. 2016) reported that most of the respondents made noise and lighten the fire for chasing the wild elephants. Similarly (Shrestha 2007) delineated that making loud noises like firecrackers or drums at night time prevents elephants from crossing the border along the eastern corridor connected to India. With respect to mitigation measures, community members had tested various activities like beehives, patrols, trenches and fencing-bio, general, electric etc but all were unsuccessful for practical measures (Neupane 2011).

In the lowlands of Nepal, the commonly practised mitigation measures were firecrackers, shouting and beating drums (Chaudhary et al. 2021). In Bahundangi VDC in Jhapa, about 17 Km of solar-powered fence was installed which was a highly effective mitigation measure in that area (Portel 2016). Most of the people in the study area stay adjacent to the community forest and those people were highly affected by damage incidents caused by elephants. The findings of (Neupane et al. 2018) suggested that the priorities of the mitigation measures in the affected areas should be carried out regardless of the type of management regime of the forest. Besides using different mitigation measures people in Saphai village used night stay in the tree houses to guard the field crops (Chaudhary et al. 2021). In some places, chilli-based mitigation methods were adopted. It was shown in the study conducted by (Hedges & Gunaryadi 2010) as a chilli-based elephant distinctive encouraged as a tool for reducing the conflict with the elephant but that method have been little tested. So chilli method was expensive and didn't have any significant preclusion effects.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The study concluded that elephants damage the stored grains higher than raiding from the field. Paddy was the most damged crop either from the field or from the stored place in the house followed by maize and wheat. Damage caused by elephant was seasonal the study area were seasonal i.e. most conflicts happen in two times during winter (November-December) and during spring (March-April) and occasionally in June and mostly happened during the nighttime while human activity was lowest. Marginalize people faced the damage of house and cattle shed in the study area. One of the major factors contributing to the damage incident was the presence of human settlements in close proximity to the community forest and water bodies. Due to the fragmentation and encroachment of the community forest elephants enter the nearest village in search of food and water. The preventive measure applied by the local people weren't so effective. Lack of effective mitigation measures caused a huge economic loss in the study area. Most people regard elephants as lord Ganesh and showed their gratitude towards elephants, but some people were aggressive towards wildlife authorities and the government for their ignorance towards proper mitigation measures. The proper way of mitigating damage caused by elephants are crucial which can be attained by the diligent contribution of affected people, the conduction of awareness program about elephants, a proper compensation scheme and proper supervision of the affected areas from the government level.

6.2 Recommendations

- Alternative methods of farming practices should be done. Cash crops should be grown**.**
- An elephant corridor should be established to circumscribe the elephant route and various programs should be launched which help to advocate co-existence in the region so as to conserve the elephants and their route.
- Besides farming other skilled-based training should be given to people from which they can make money.

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APPENDICES

Appendix I: Questionnaire for household survey

A .General Information

1. Name of Respondent 2. Date_____

3. Address; Municipality ward/Tol_____

4. Age_____ Gender M____ F___

5. GPS location_____

6. Education No education/ school level/college/university

7. Occupation 8. Family size_____

9. Main source of income_____

Do you have livestock? If yes

S.N	Types of livestock	Numbers
1.	Cow	
2.	Buffalo	
3.	Goat	
4.	Chicken	
5.	Duck	

B. Nature and types of damage

1. Have you ever experienced damage caused by elephants in your village within a year?

a. Yes ( ) b. No ( )

If yes what types of damage do you face?

……..

2. What are the possible reasons/conditions that influence elephants to attack people, damage crops and other property based on the following alternatives?

a. Elephants looking for water in the village b. lack of food in the forest

c. Farm yard and settlement close to forest d. Due to the smell of alcohol

e. Elephants prefer to feed a certain kind of crops f. Human settlement and farmyard along the elephant corridor

3. What is the average distance from your home to near forest resources?

a. From 0 to 0.5 Km b. From 0.5 to 1km c.From 1 to 1.5 km d. From 1.5 to 2 km ( ) e. 2 >2k.m

4. Where do you fetch water for domestic use?

a. Natural springs rivers, dams or basins in the public land b. Natural springs, rivers, dam, or basins

c. Piped water d. Shallow wells e. 5. Other sources (Specify)_____

5. Do you share the same water sources with elephants?

a. Yes b. No

6. If the answer for the above question is "yes" what are they?

a. Natural springs rivers, dams or basins in the public land b. Natural springs, rivers, dam, or basins

c. Others (Specify)

_____

7. What is the amount of crops damaged by an Asian elephant in 2078-79?

Major corps	Total production if not damaged per year(A)	Total production after damaged per year(B)	Total damaged(A-B)	Compensation received (NRs.) if any?

c. Relation and Attitude of local communities toward elephants and elephant conservation

8. Have you ever heard of elephant killed in the village land?

a. Yes b. 2. No

9. Can you share the same land with elephant?

a. Yes b. No

10. Is there any importance of conserving elephant and other wildlife?

a. Yes b. No

_____

11. Do you like elephants in wild?

a. Yes b. No

12. What is your attitude towards elephant conservation?

a. Positive b. Negative

13. Are you aware of mitigation measures that have been applied to control the damage caused by elephants?

a. Yes b. No

14. What are the mitigation measures currently in place for the damage control?

a. Beating different objects and making noise b. Lightening aagarbatti

c. Stay quietly inside the house d. Fire e. Don't know

15. What are the other mitigation measures which you think will be effective when applied?

a. Translocation of problem elephants b. Eviction of people from the conflict zone. c. Electric fence

16. Is crop raiding seasonal? a. Yes ( ) which months _____ b. No ( ) or year round, for which crops_____

17. At what time of the day do most of the damage incidents occur?

a. Day b. Night

18. Do you enter the forest for fodder, firewood and timber?

19. What suggestion would you like to give to wildlife authorities or political leaders?

Appendix 2: Photographs

Figure 1. Taking questionnaire

Figure 2. Cattle shed damaged by elephant

Figure 3. Property damaged by elephant

Figure 4. House damaged by elephant