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Addressing Human-Elephant Conflict in Sarpang, Bhutan: Challenges and Practices

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Abstract

Asian elephants face threats from human-elephant conflict (HEC), driven by habitat encroachment and fragmentation. In the foothills of the Himalayas, HEC affects a large number of people, causing significant damage to property and crops. Bhutan, sharing elephant habitats with India, faces similar challenges, particularly in the southern regions in Sarpang. We studied the HEC pattern and mitigation strategies adopted by people through a questionnaire survey. Our primary data from the Sarpang division showed that more than 40 % of households experienced HEC. The elephant largely affected maize and paddy along with cash crops such as areca nut, orange, ginger, and cardamom. The study revealed a strong association between crop-raiding incidents and cultivated areas, with most depredations occurring at night. The majority of respondents indicated that crop depredation has increased over the years, which could be linked to the degradation and fragmentation of forest habitat in the landscape. Mitigation measures, such as electric fencing, are preferred but underutilized due to financial constraints. The study emphasizes the need for transboundary cooperation between India and Bhutan, integrating traditional and advanced mitigation strategies, and community involvement. Effective communication, joint patrolling, and habitat restoration are the keys to managing HEC. Transboundary governance should include political and legal support, regional diplomacy, and innovative land use policies.

Keywords: Conservation policy; Conservation strategies; Landscape management; Questionnaire survey; Wildlife Management.

Introduction

Human-elephant conflict (henceforth HEC) is recognized as one of the key threats to the survival of Asian elephants (*Elephas maximus*). Due to their requirements for large home ranges, elephants increasingly come into conflict with humans, especially where human populations and associated activities have significantly increased (Desai & Riddle, 2015). The Indian subcontinent, comprising India, Bangladesh, Bhutan, Nepal, and Sri Lanka, hosts a substantial wild elephant population exceeding 27,312 individuals (MoEFCC, 2017), representing 66.4% of the total Asian population (Kemf & Santiapillai, 2000). The continual encroachment and fragmentation of elephant habitats caused by increasing populations in South Asia has resulted in an increase in human-elephant interactions and conflicts (Fernando *et al.*, 2005). Crop depredation is a prevalent and foremost issue in South Asia as 20% of the human population lives inside and adjacent to elephant habitat areas (Bandara & Tisdell, 2002). Numerous studies highlight the complexity and severity of HEC in South Asia empirically (Sukumar 2006; Desai & Riddle, 2015; Nath *et al.* 2015; Rai & Karthik, 2021; Thant *et al.* 2021; Pandey *et al.* 2022).

Human-wildlife conflict is a significant concern on the national agenda in Bhutan (Nature Conservation Division, 2008), with conflicts developing in many regions of the country. Particularly, the recurring encounters between humans and elephants have been a longstanding issue, inflicting economic burdens and sociocultural strains on farmers inhabiting the southern regions of Bhutan. These confrontations often lead to significant losses in agricultural yield and property damage (Jigme & Williams, 2011). Bhutan shares a contiguous elephant habitat with India, primarily in the southern region of the country. These habitats encompass administrative divisions such as Samtse, Gedu (Chhukha), Sarpang, and Samdrup Jongkhar (comprising Samdrup Jongkhar and Pemagatshel), in addition to protected areas including Phibsoo

Wildlife Sanctuary, Royal Manas National Park, and Jomotshangkha Wildlife Sanctuary (Nature Conservation Division, 2018). A national elephant survey was conducted in Bhutan in 2016 that estimated about 678 elephants confined to the southern foothills adjoining Assam and West Bengal states of India (Nature Conservation Division, 2018).

The Government of Bhutan has consistently recognized local communities as essential collaborators in conservation efforts (Rinzin *et al.*, 2009). Bhutanese people have also been guided by the Buddhist principles of compassion towards all living beings. However, because of frequent conflicts with wildlife, communities now see them as an impediment to their livelihoods and survival. A survey by Wang *et al.* (2006) on the attitudes of farmers towards livestock loss in Jigme Singye Wangchuck National Park in south-central Bhutan showed that 68% of the respondents wanted to exterminate problem animals. Addressing human-wildlife conflict has become a challenging task for the Ministry of Agriculture and Forests, and particularly the Department of Forests and Park Services, which has administrative control over forested areas in Bhutan. Agriculture is the primary focus in the southern region of Bhutan, characterized by its higher human population density. However, farmers in this area face economic losses and significant challenges due to the presence of elephants (Jigme & Williams, 2011; Nagdrel, 2008). Conflicts primarily occur in buffer zones since only a few people live within Protected Areas (Jigme & Williams, 2011). Sarpang is one of the *dzongkhags* (districts) in southern Bhutan impacted by this issue. A similar pattern was also seen in the neighbouring state of Assam (Nath *et al.*, 2009, 2015) in India bordering Bhutan. Legally, the Asian elephant is protected under Schedule I (assigning highest protection) of national legislation in India and Bhutan (as in the Forest and Nature Conservation Act, 1995 of Bhutan and Wildlife (Protection) Act, 1972 of India), but challenges remain in enforcement and implementation (Menon *et al.*, 1997). Hence, to implement species conservation measures and protect livelihoods, baseline information on the status and difficulties of HEC in the region is necessary. Here, we present the results obtained from a baseline study that was conducted to assess the extent of HEC in Sarpang, Bhutan. Additionally, we also discuss the implications for mitigation and governance to address these complex issues associated with HEC.

Study Area

The present study was carried out in the Sarpang forest division (SFD; 26.8632° N, 90.2675° E) of Bhutan. It is located at the southernmost region of Bhutan with Tsirang division and Phibsoo Wildlife Sanctuary in the west, Royal Manas National Park in the east, Jigme Singye Wangchuck National Park in the north and India in the south (Figure 1). It is one of the earliest divisions to be formed (in 1959) under the Department of Forests and Park Services of Bhutan. Currently, the division covers two districts, namely Sarpang and Dagana, comprising 12 *gewogs* (blocks) of a total area of about 1200 km^2. Broadleaf forest constitutes ~82% of the total land area of SFD (Table 1). The elevation ranges from 100 to 3600 m with annual precipitation of 3,500–5,500 mm (Department of Agriculture, 2012). Biological corridor number 3, which connects Royal Manas National Park, Jigme Singye Wangchuck National Park, and Phibsoo Wildlife Sanctuary, also falls within the administrative jurisdiction of the Division, provisioning better connectivity among protected areas (Tenzin *et al.*, 2021). The divisional headquarter is located at Sarpang-Tar, Shompangkha *gewog* of Sarpang *dzongkhag*.

Methods

We conducted interviews with residents in the Sarpang forest division in the spring of 2016, following a stratified random sampling approach (Anoop *et al.*, 2023; Thant *et al.*, 2021). We used a structured close-ended questionnaire (Appendix 1). All *chewogs* (sub-blocks) (n = 48) in a *gewog* under the SFD were included in the survey, and 10% of all households from each of the *chewog* were selected for interview. The questionnaire was pre-tested with ten households to assess its relevance and efficiency. The questionnaire collected comprehensive data on respondents' demographics, education, livelihood, crop cultivation patterns, attitudes towards elephants, and the mitigation measures they adopted (Sampson *et al.*, 2019; Milda *et al.*, 2020). Data collection focused on incidents from the past two years. The choice of selecting 10% of households per *chewog* was made to balance the representativeness and manageability of the sample size, ensuring a statistically significant representation of the study population.

Only the households reporting conflict with elephants were included in the HEC analyses. We quantified conflict incidents by calculating the percentage of households reporting HEC incidents relative to the total number of households interviewed in each gewog. Temporal patterns of crop damage were categorized into four periods – morning, midday, evening, and night – as it was difficult for respondents to pinpoint the exact timing of crop damage. We used Pearson's correlation in SPSS v.16.0 to explore the relationship between crop raiding incidents and the cultivation area of different crops. This approach allowed us to identify associations and better understand the factors relating to HEC. We used ArcGIS v10.3 to create maps illustrating the spatial distribution of HEC incidents.

Results

Characteristics of respondents

Among 249 respondents, 64.43% (n = 160) were male, and 35.57% (n = 89) were female. The age distribution was classified into three categories: 18–35 years (18.3%), 36–59 years (56%), and 60 years and above (25.7%). Approximately 27.1% of the respondents had completed primary education, 4% had completed junior schooling, 2.6% had completed secondary education, and only 0.9% had completed graduation. Notably, 65.4% of the respondents had no formal education. The ethnic composition included 59.7% Lhotsam, 23.4% Sharchop, 14.3% Khengpa, and 2.6% Ngalop tribes. Among these, 42% were relocated from other regions of Bhutan under a resettlement program. The primary sources of household income were agriculture (76.9%), livestock (10.6%), business (7.7%), and wages/salary (4.8%). The main agricultural crops cultivated were maize, followed by areca nut (Table 2).

Conflict Analysis

Out of 249 households interviewed, 104 households (41.8%) reported conflict with elephants. The respondents who reported conflict with elephants mostly cultivated maize and paddy, along with cash crops such as areca nut, orange, ginger, and cardamom (Table 2). An average of 1.45 ± 1.05 ha land per household was also left fallow. The three most important reasons for leaving the land fallow were- 1) crop damage by wildlife (35.21%), 2) irrigation/water shortage (22.54%), and 3) shortage of man power (21.13%), followed by less productivity, landslides, rocky fields, and fodder cultivation (Table 3).

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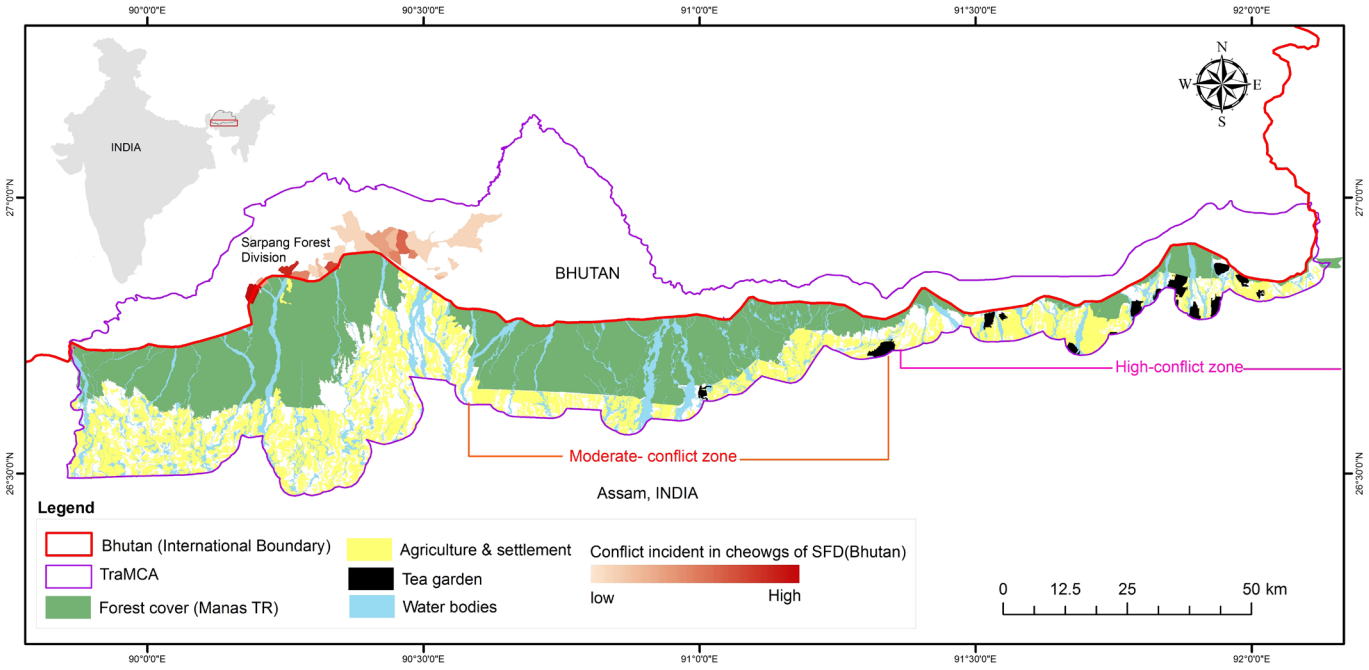

Figure 1. Map showing the conflict incidents in different *chewogs* of Sarpang forest division (SFD), Bhutan, and conflict zone (based on the number of elephant and human death reports) in the Transboundary Manas Conservation Area (TraMCA) region of India

Table 1. Area coverage of land use types in Sarpang Forest Division, Bhutan

Land-use types	Area (km²)
Agriculture	75.80
Built up areas	3.23
Landslide	6.12
Broadleaf Forest	993.13
Mixed Conifer Forest	11.07
Meadows	1.72
Rock outcrop	3.473
Shrub	75.15
Lakes	0.006
Rivers	36.35
Reservoirs	0.053

Table 2. Cultivated crops in the Sarpang Forest Division and correlation between incidence of conflict and area of crops cultivated

Crop Type	Respondents (%)	Area in ha (mean ± SE)	Correlation of crop area with incidents of conflict (Pearson's r)
Maize	27	0.62 ± 0.04	.559**
Paddy	17	0.70 ± 0.06	.527**
Mustard	1	0.26 ± 0.03	.426*
Areca nut	24	0.28 ± 0.03	.374*
Millet	15	0.30 ± 0.02	.333
Cardamom	1	0.77 ± 0.48	-.271
Orange	8	0.54 ± 0.19	.122
Ginger	7	0.12 ± 0.01	.019

*p<.05, **p=<.01

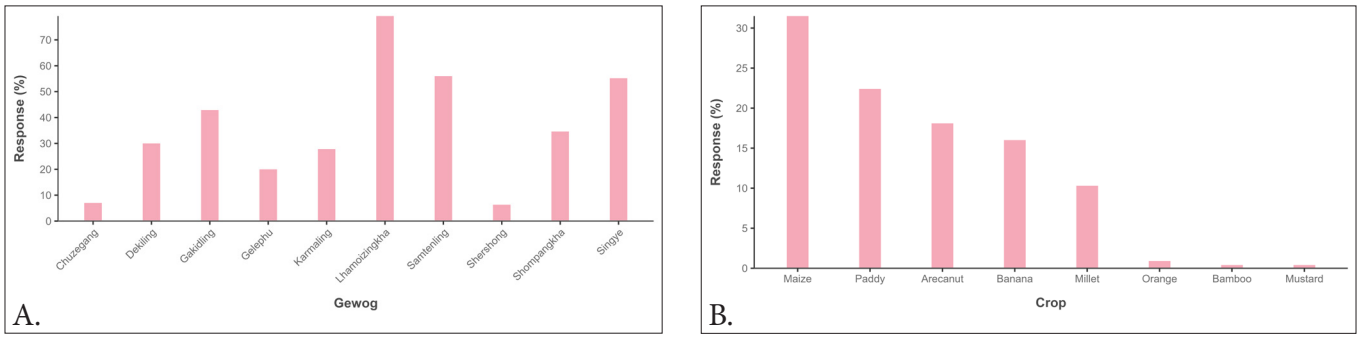

Figure 2. Responses of people about human-elephant conflict status in Sarpang forest division, Bhutan. **A)** Percent of respondents reporting a conflict incident in each gewog (block), **B)** Types of cross raided by elephants in Sarpang forest division.

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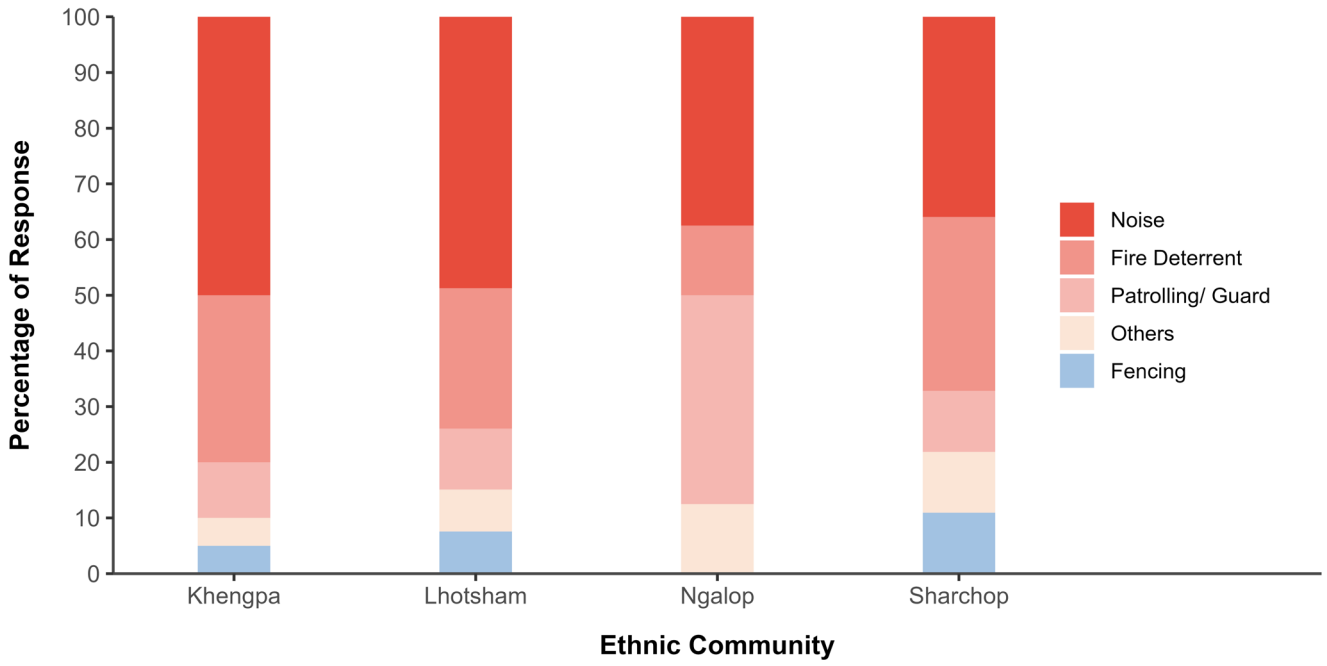

Figure 3 Mitigation measures practiced by different ethnic communities in Sarpang Forest Division, Bhutan.

Table 3. Reasons reported by farmers for keeping land fallow in Sarpang Forest Division, Bhutan

Reason for keeping land fallow	% respondent
Crop depredation by wildlife	35.21
Irrigation/water shortage	22.54
Shortage of manpower	21.13
Low production	8.45
Landslide	5.63
Rugged terrain	2.82
For fodder plantation	1.41
Land adjacent to the international border	1.41
Isolated settlement	1.41

Out of 12 *gewogs* studied, 10 reported conflicts with elephants and the remaining two with wild pigs. The most affected *gewog* was Lhamoizingkha under Dagana *dzongkhag*, followed by Samtenling in Sarpang *dzongkhag* (Figure 2A). Two *gewogs* located at higher elevations from the foothills did not report conflict with elephants.

Our findings reveal a strong association between the occurrence of crop-raiding incidents by elephants and the extent of cultivated crop areas (Table 2). Maize (32%) was the most raided crop by wild elephants, followed by Paddy (22%), as well as other crops including areca nut (18%), banana (16%), and millet (10%) (Figure 2B). Both maize (r= 0.559) and paddy (r = 0.527) cultivation showed strong positive correlations with crop raiding (Table 2).

About 80.3% of the respondents stated that elephants raided crops during the night, followed by evening (16%), morning (2.2%) and afternoon (1.5%). Subsequently, 51.46% of respondents stated that crop depredation has increased. According to them, the most common reasons for such an increase were the degradation of the forest habitat, an increase in elephant populations, an increase in settlements near the forest, and a decrease in hunting due to strict law enforcement. However, 33.98% of the respondents stated that crop depredation has decreased due to mitigation measures such as electric fencing. The rest stated there was no change in the conflict pattern.

Mitigation Measures

Reports of crop and wildlife depredation are important in order to undertake mitigation interventions. However, 36% of the respondents did not report crop depredation incidents to the agencies because i) they were unaware of the reporting system, ii) the damage caused by elephants was minimal, and iii) they were tolerant towards such damage due to their Buddhist faith. Respondents reported incidents to the *gewog* civic administration and the forest department. Local communities have predominantly relied on traditional mitigation. The measures adopted by ethnic communities included keeping night vigils, making fire, and beating drums (Figure 3). Besides, communities expressed demand for electric fences due to their perceived effectiveness.

Discussion

Increasing cases of HEC is a major issue for the communities living in and around the Sarpang division of Bhutan. Agriculture is the main source of income for the people of Sarpang, with maize and paddy being the primary crops cultivated. Subsequently, the frequency of crop raiding incidence was also high for these two crops. This pattern is consistent with observations from both Asia and Africa, where elephants are known to primarily feed on mature staple crops (such as rice, maize, and wheat). Apart from high nutritional value, palatability and ease of handling during foraging have made these crops highly attractive for consumption, especially to adult males (Biru & Bekele 2012; Gross *et al.*, 2018). Moreover, the high proportion

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of respondents involved in agriculture (76.9%) reflects the limited diversification of livelihoods, making households highly vulnerable to crop depredation. This is compounded by the fact that a significant portion of the population relies on subsistence farming, with minimal access to alternative income sources (Barua *et al.*, 2013; Ogra, 2008; Woodroffe, 2005). In Sarpang, elephants often raid crops because of their close proximity to the forest boundary. Desai & Riddle (2015) mentioned that HEC occurs because people live and practice agriculture adjacent to elephant habitats. Therefore, crop protection will continue to have high labour and financial costs (Gross *et al.*, 2018). The present study and studies carried out elsewhere clearly showed that the elephants raid or damage mature crops compared to other stages of growth, but there are multiple other factors that can influence the movement and behaviour of the species (Chiyo & Cochrane, 2005; Desai & Riddle, 2015; Songhurst *et al.*, 2015; Gross *et al.*, 2018). These can broadly be grouped into four factors – habitat quality, elephant population, individual elephant behaviour, and people's tolerance level – that contribute to initiating and escalating HEC in Asia (Desai & Riddle, 2015).

The occurrence of HEC was more during the cropping season (summer). This substantiated the previous studies (Jigme & Williams, 2011) that during the non-growing season of a gricultural crops, elephants would migrate to India and remain there until the next cropping season. Similarly, a study in Manas National Park, India, revealed that elephant density was high during the dry season as compared to the wet season (Das, 2020), which in several ways supports the local movement pattern of elephants in the region. The observation that elephants predominantly raid crops at night in Sarpang is consistent with findings from various studies across different regions, including Bhutan and India (Jigme & Williams, 2011; Sukumar, 2003).

Mitigation strategies employed in Sarpang include traditional methods, which, while helpful, often fall short of providing long-term solutions (Kochprapa *et al.*, 2023; Pandey *et al.*, 2022). The community's preference for electric fencing reflects a shift towards more effective, albeit costlier, measures. Thus, addressing HEC in Sarpang necessitates a multifaceted approach incorporating both traditional and modern strategies. The forest department of Bhutan is taking several steps to mitigate the HEC in this region. Severely affected communities have been equipped with solar/electric fencing, with a total of 153 km of electric fencing established across the entire division. Habitat restoration efforts are also ongoing, including the construction of waterholes, fodder enrichment, removal of invasive Lantana camara, and corridor management. The Forest Department conducts education programs, and awareness initiatives are conducted in schools and communities to promote elephant conservation. In severely affected communities, Quick Response Teams (QRTs) have been established, comprising local members ranging from five to eleven individuals. In gewogs with a high number of HEC incidences, five Elephant Conservation Committees (ECC) have been formed, and crop insurance schemes have been initiated in these ECCs.

While solar-powered electric fencing is the preferred mitigation measure in the TraMCA (Transboundary Manas Conservation Area) landscape, fewer than 1 % of affected farmers in Bhutan have been able to install such systems due to financial limitations. Consequently, there is a pressing need to enhance transboundary coordination between India and Bhutan, particularly concerning governance and conflict management policies. However, conservation and management in the transboundary region present significant complexities and challenges, requiring socio-political consent and approval (Selier *et al.*, 2016).

Therefore, it is crucial to develop a transboundary policy framework that aligns legal and policy adjustments with the landscape-scale movements of megaherbivores.

Lastly, a multi-pronged approach is recommended, to effectively tackle transboundary governance issues as follows- institutional arrangements: establish political and legal support, develop management plans, and implement conflict mitigation strategies, alerts, and penalties; regional diplomacy: foster multi-stakeholder groups and promote regional collaboration; community participation: encourage community-based protection measures, including cooperative crop guarding and fencing; awareness and education: increase community understanding of elephant conservation through initiatives led by Protected Areas and educational agencies; capacity building and law enforcement: provide joint training for officials and local teams on either side of the border to enforce laws and manage relevant data.

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Acknowledgements

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CONFLICT OF INTEREST

The authors have no competing interests to declare that are relevant to the content of this article.

DATA AVAILABILITY

Data and codes are available from the corresponding author on request.

AUTHOR CONTRIBUTIONS

UT, SG, AN conceived and designed the study. UT carried out field sampling. UT, RT & AN analysed the dataset. UT & SG write the first draft of the MS. RT & AN reviewed and edited the final draft.

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