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Human-primate conflict: The case of grivet monkeys in and around Harego Forest, South Wollo, Ethiopia

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Abstract

Human–wildlife conflicts are most extreme in croplands where the farmers and their livestock share the similar resource with wildlife. From September 2022 and June 2023, this investigation was conducted to evaluate human and grivet monkeys conflict in and around Harego Forest, South Wollo, Ethiopia. The aim of the current study was to identify the outcome of human and grivet monkeys' conflicts in the study area. Data were collected via questionnaires, interview, and observation. The study was conducted in five villages based on purposive sampling techniques. The result indicated that grivet monkey was the main species that damage crops. The main raided crops were maize (51.16 %) followed by sorghum (25.58%). The vulnerable growth stage of the crops damaged by grivet monkey showed statistically significant variation. Shortage of food source, absence of buffer and habitat degradation were identified causes for human and grivet monkey conflict in Yogof forest. There was a significance difference in the perception of the households to grivet monkey. To reduce crop injury affected by grivet monkey, farmers used guarding, chasing and trapping as the main traditional control methods to avoid crop injury. The present study identified that habitat disruption and increase subsistence cultivation were the main causes of human-grivet monkey conflict in the study area. Therefore, based on the finding, it was recommended that there should be buffer zone near the forest edge and training for local community on benefits of wildlife conservation

Keywords: Conflict, crop raiding, grivet monkey, Harego Forest

1. INTRODUCTION

Ethiopia is known as one of the most bio-diverse countries worldwide, with a rich array of plant and animal species [10]. The country is home to a diverse mammal species, encompassing 325 species. Among these, 57 species are native [16, 26, 28]. The presence varied topography ranges from 125 m bsl to 4, 640 m asl results to found the highest biodiversity in the country [11].

Africa hosts approximately 216 species of primates [22], with Ethiopia supporting around 13 species [10]. Among these species the grivet monkey (*Chlorocebus aethiops*) also known as the savannah monkey, which is endemic to the savannas of eastern Africain the grivet is primarily distributed across Ethiopia, Sudan, South Sudan, Eritrea, and Djibouti [14, 21, 27]. They are found in various habitat types [19, 27]. However, the increasing challenges of habitat fragmentation, agricultural expansion, human population growth and urbanization are posing significant threats to wildlife. These factors have exacerbated human wildlife conflict, highlighting the urgent need for effective conservation strategies and sustainable land-use practices to protect Ethiopia's unique biodiversity [19, 21].

Human-animal conflict is a severe problem in the wildlife conservation effort and the poses substantial risks to human livelihood across the globe. This issue has become increasingly prevalent as human population increases, urbanization expands and climate change intensifies, leading to more direct competition between humans and wild animals for limited resources. One of the primary sources of

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conflict, particularly in Africa, is crop raiding by wild animals [23].

Human-wildlife conflict is adversely affects human social, economic, cultural life, wild animals' conservation, or the environment. It is predicted to increase worldwide and occurs in several different contexts and spans a range of animal taxonomic groups [30, 33]. Human-animal conflict is a worldwide problem, both in urban and rural areas with particular intensity in developing countries. In Africa including Ethiopia, mainly in and around protected areas where human and wildlife live in proximity and damage manifestations in terms of crop damage and livestock depredation are common in Ethiopia [1, 4].

Currently, human-animal conflict is an international issue that has adverse costs for both humans and animals [7]. Human-animal conflict is one of the biggest threats to the survival of several animal species and which is difficult to conserve animals including grivet monkeys [29]. The mammals' status analysis on the global scale shows that primates are the most threatened species [35]. Primates are large, charismatic mammals found in several parts of the world [18].

The main threats of primates in several nations of the world are changing of their habitat into farming, urbanization, hunting them for meat source, trapping for biomedical purpose [39]. Crop growing and livestock rearing are the main source of income and food source for several households in developing countries. This also leads to the conflict of primates and the local communities in farmland [12].

Human-grivet monkey conflict is extreme in developing countries where their source of income is farming [12]. Wild animals continue to move outside the protected area or their habitats, thus destroying crops and domestic animals. As a result, local communities live in and around Harego Forest commonly have conflicts with grivet monkey to protect their crops. These activities will increase human-grivet monkey conflict in and around Harego forest. The conflict resolution mechanisms benefit the communities as a whole and the households. The purpose of this study was to explore human grivet-monkey conflict and possible mitigation measure in and around Harego forest, South Wollo, Ethiopia. This study aimed to provide an overview of the current conflict in the areas surrounding the Harego Forest and to propose potential strategies for mitigating these conflicts and promote peaceful coexistence between rural communities and wildlife.

1. MATERIALS AND METHODS

1.1. Study area

Harego Natural Forest is located in South Wollo Zone, which lies between 11°03' 30 ″ - 11°08' 0″ N latitude and 039° 38' 0″- 039°44' 0″E longitude and an altitude between 1950 to 2525 m asl. It is 400 km faraway in the north of Addis Ababa, which is the capital city of the country (Fig. 1).

Climate: The study area climate is characterized by wet and dry seasons. The wet season of the study area categorized as one main rainy season (from July to September) and one minor rainy season (from February to May). Data for temperature and precipitation were obtained from Kombolcha Metrological Station. The highest rainfall recorded during the wet seasons in the study area and lowest rainfall recorded during the dry season. The yearly precipitation of the current study area was 1104 mm and average temperature of the study area was 20.04 ºC.

Flora and fauna of the study area: The vegetation in Harego Natural Forest is characterized by a mix of tall and short natural vegetation. The forest hosts a diverse range of plant species, including tall trees, bushes, and Erica shrubs, which vary depending on the area's topography and soil types. High-altitude locations are predominantly covered with Erica species, while lower altitudes are characterized by tall trees and woody plants.

Harego Natural Forest is also home to a variety of mammals, *including Canis aureus, Chlorocebus aethiops, Procavia capensis, Lupus starcki, Histrix cristata, Crocuta crocuta, Sylvicapra grimmia, Colobus guereza, Panthera pardus, Theropithecus gelada, Genetta abyssinica,* and *Oryctolagus cuniculus*. Among these, the Grivet monkey (Chlorocebus aethiops) and Gelada baboon (*Theropithecus gelada*) are the dominant species in the study area.

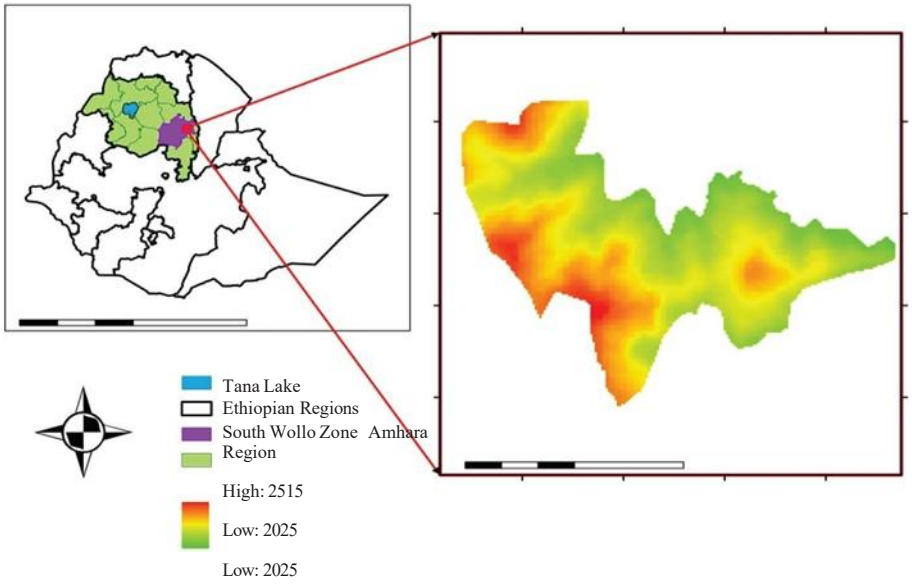

Figure 1. Location map of the study area.

2.2. Methods

2.2.1. Pilot survey

Pilot survey was conducted before the actual data collection during September, 2022. Information on topography, biological, and livelihood of the local communities were gathered during this time in the current study area.

2.2.2. Data collection

The current investigation was conducted from September, 2022 to June, 2023 during none harvesting and harvesting seasons.

2.2.3. Questionnaire survey

Human-grivet monkey conflict was collected from five nearby villages of Harego Forest through interviews, observation and focal group discussions. Human-grivet monkey conflict was gathered from households using the semi structured interview as reported by Abie et al. [1, 2]; Alemu et al. [6]; Goudar et al. [20] ; Merkebu and Dereje [30]; Mohammed et al. [31] . To select villages from the study area, purposive random sampling technique was used. However, respondents from each village were chosen using simple random sampling. The respondents were chosen based on specific inclusion and exclusion criteria. Individuals who owned farmland adjacent to the forest, had encountered pest grivet monkeys, and voluntarily agreed to respond to the prepared questions were included. Conversely, individuals who were guests or visitors to the forest and unwilling to provide informed consent were excluded from the study.

2.2.4. Sample size and sampling methods

During this study, purposive sampling technique was used to sample representative villages based on their proximity to the forest boundary. For this survey, 215 households were used. The sample size was determined by using the formula's of Yamane [40].

$$n = \frac{N}{1 + N(e^2)}$$

Where n=the required sample size; N=total population size and e=Margin of error=0.05. Based on Yemane [40] population correction factors, 215 sample household heads were chosen using random sampling techniques from 694 households from five villages. The sample size of household from each village was also fixed using equivalent allocation procedures as shown in Table 1.

$$n = \frac{HS}{N\ total}$$

Where n =Size of required samples

H= Size of households in one village

S= Households to be treated

N= total the number of households in all village.

Table 1: Number of respondents in the study area.

Villages	Total Household	Sample Size
Roba ager	108	34
Qelina	180	56
Derek Woyira	101	31
Harego	188	58
Tebissa	117	36
Total (5)	694	215

Focus Group Discussions (FGD): A total 6 focus group discussions were organized to explore personal perception and group dynamics related to human-grivet monkeys' conflict. They were used to gather diverse perspective of respondents on grivet monkey conservation and their effects on crops. Each discussion group consisted of 4 to 6 individuals, allowing for diverse perspectives on the conflict in all villages. The investigator served as the facilitator, guiding the conversation to extract valuable insights regarding community attitudes and experiences.

Household Interviews: They were used to gain detailed personal perceptions of the respondents on the grivet monkey conflict. They also enabled to collect in-depth information from the respondents based on their experiences with grivet monkeys' conflict.

Observation: This was used to collect real information from natural setting. To complement the survey data, direct observations were made to assess the extent of crop damaged by grivet monkeys. It was conducted in the morning and afternoon when grivet monkeys are more active and hunger. It allowed for a direct comparison of reported damage with actual conditions in the fields.

2.2.5. Data analysis

Data analysis was made using Excel and SPSS software version 25. Descriptive statistics, frequency analysis, and chi-square tests were utilized to summarize the data. The results were presented in tables and figures.

3. RESULTS

3.1. Background of the respondents

A total of 215 respondents from five villages were participated in this study. Out of the total households, 194 respondents were males and 21 respondents were females. Among 215 respondents, 199 (92.56%) respondents used agriculture and livestock rearing as main source of income. However, few farmers obtained their income only from agriculture 16 (7.44%). The households' source income among various villages in the current study area revealed significant difference ($p < 0.05$). Out of the total households, 92 (42.79) had their farmland far away from 1-3 km from forest border, followed by 81 (37.67%) less than 1km and 42 (19.53%) respondents far away from 3 - 6 km (Table 2).

Table 2: Household characteristics of the study area.

Variables	Responses	Sex		Total	Percentage (%)
		Male	Female		
		194	21	215	100
Source of income	Agriculture	182	17	199	92.56
	Livestock rearing	12	4	16	7.44
Distance of farm	< 1km	72	9	81	37.67
	1-3km	82	10	92	42.79
	3.1-6km	40	2	42	19.53

3.2. Resource use in and around Harego forest

Out of the total, the majority of respondents 51 (23.72%) used resource from the forest (for firewood collection) followed by grazing 50 (23.26%) and the minority used for thatching grass 5 (2.33%) from Harego Forest (Table 3). The level of obtaining resources from the Harego forest, varied among the locations as well as with seasons.

Table 3: Resources use from Harego forest

Resources	Villages					Total (N)	Percentage (%)
	Roba ager (n=34)	Qelina (n= 56)	Derek Woyira (n=31)	Harego (n =58)	Tebisa (n=36)		
Firewood	2	7	8	21	13	51	23.72
Thatching grass	-	2	-	1	2	5	2.33
Hay grass	6	13	9	2	2	32	14.88
Grazing	7	9	9	19	6	50	23.26
Hunting	6	9	2	5	1	23	10.70
Medicine	2	4	1	2	3	12	5.58
Construction	7	9	2	1	1	20	9.30
Honey production	4	3	0	7	8	22	10.23
Total	34	56	31	58	36	215	100.00

3.3. Types of cultivation

Teff, maize, sorghum, pea, beans and other various crops were grown in the study area. However, maize, sorghum and teff were the main crop types grown by local communities (Table 4). Out of the total households, 40 (18.60%) households cultivated maize followed by sorghum 31 (14.42%), teff 24 (11.16 %) and potato 20 (9.3%).

Table 4: Types of cultivation in and around Harego forest.

Types of crops	Villages						Percentage (%)
	Roba ager (n=34)	Qelina (n= 56)	Derek Woyira (n=31)	Harego(n =58)	Tebisa (n=36)	Total (N)	
Maize	3	8	10	17	2	40	18.60
Sorghum	4	9	3	13	2	31	14.42
Teff	7	6	3	3	5	24	11.16
Wheat	2	3	1	4	3	13	6.05
Bean	2	2	-	-	4	8	3.72
Pea	-	-	-	5	8	13	6.05
Haricot bean	2	4	4	2	-	12	5.58
Chick pea	2	2	2	5	-	11	5.12
Papaya	3		3	5	6	17	7.91
Banana	1	6	2	1	-	10	4.65

Coffee	4	8	2	1	1	16	7.44
Potato	4	8	1	2	5	20	9.30
Total	34	56	31	58	36	215	100.00

3.4. Crop damage by grivet monkey

Out of the total household, 110 (51.16%) respondents responded that grivet monkey raided maize followed by sorghum 55 (25.58%), teff 17 (7.91%) and rarely pea 11(5.12%) and beans 9 (4.19%) (Table 5).

Table 5: The types of crop injury by grivet monkey.

Crops	Villages					Total (N)	Percentage (%)
	Roba ager (n=34)	Qelina (n= 56)	Derek Woyira (n=31)	Harego (n =58)	Tebisa (n=36)		
Maize	16	38	18	27	11	110	51.16
Sorghum	6	7	6	18	18	55	25.58
Teff	4	4	2	5	2	17	7.91
Wheat	3	3	3	2	2	13	6.05
Pea	3	2	1	4	1	11	5.12
Bean	2	2	1	2	2	9	4.19
Total	34	56	31	58	36	215	100.00

3.5. Stage of crop damaged

Among the total respondents, 86 (40.00%) replied that crops were damaged by grivet monkey at the vegetative stage followed by harvesting 50 (23.26%), sowing 41 (19.07%) and seedling stage 38 (17.67%) (Table 6).

Table 6: Stage of crop damage by grivet monkey.

Stages	Crop types					Total (N)	Percentage (%)
	Bean	Barley	Pea	Teff	Maize		
Sowing	17	2	11	-	11	41	19.07
Seedling	18	1	9	-	10	38	17.67
Vegetative	33	12	18	2	21	86	40.00
Harvesting	14	2	14	3	17	50	23.26
Total	82	17	52	5	59	215	100.00

3.6. Causes of conflict

Out of the total respondents, 111 (51.63%) replied that the main cause of human-grivet monkey interaction was a shortage of food sources, followed by the absence of a buffer 68 (31.63%) and habitat degradation 36 (16.74%) (Table 7). The responses of the local farmers regarding the causes of human-grivet monkey conflict showed significant difference ($p < 0.05$).

Table 7: Causes of human grivet monkey conflict.

Causes	Villages					Total (N)	Percentage (%)
	Roba ager (n=34)	Qelina (n= 56)	Derek Woyira (n=31)	Harego(n =58)	Tebisa (n=36)		
Shortage of food	17	29	9	34	22	111	51.63
Absence of buffer	9	22	5	21	11	68	31.63
Habitat degradation	8	5	17	3	3	36	16.74
Total	34	56	31	58	36	215	100.00

3.7. Grivet monkey damage control techniques

In the study area, the farmers were used chasing, scare crows, fence and guarding as mitigation measures to avoid grivet monkey damaged. Out of the total respondents, 117 (54.42 %) respondents were used guarding, followed by scarecrow 44 (20.47 %), chasing 23 (10.70%) and trap 19 (8.84%) and chemicals 12 (5.58%) were used to control grivet monkey damage in their cropland (Table 8).

Table 8: Human-grivet conflict mitigation measures taken by local farmers.

Mitigation measures	Villages					Total (N)	Percentage (%)
	Roba ager (n=34)	Qelina (n= 56)	Derek Woyira (n=31)	Harego(n =58)	Tebisa (n=36)		
Guarding	15	29	16	31	26	117	54.42
Chasing	3	6	4	7	3	23	10.70
Scare crows	8	16	7	11	2	44	20.47
Traps	5	3	3	5	3	19	8.84
Chemicals	3	2	1	4	2	12	5.58
Total	34	56	31	58	36	215	100.00

3.8. The local community's attitude towards grivet monkeys.

Out of the total 215 respondents (100%) in the study area, 189 (87.91%) had a negative attitude towards grivet monkeys, while 26 (12.09%) had a neutral attitude, and none expressed a positive attitude towards grivet monkeys (Table 9). During the investigation, the majority of respondents, 183 (85.12%), stated that conserving grivet monkeys was not important, while 32 (14.88%) believed it was important to conserve them in the study area (Table 9).

Table 9: Attitude of local community towards grivet monkeys.

	Response	Villages						Percentage (%)
		Roba ager (n=34)	Qelina (n= 56)	Derek Woyira (n=31)	Harego(n =58)	Tebisa (n=36)	Total (N)	
Attitude of people towards grivet monkey	Negative	29	52	28	49	31	189	87.91
	Neutral	5	4	3	9	5	26	12.09
	Positive	0	0	0	0	0	0	87.91
Attitude towards Conservation	Positive	5	7	5	11	4	32	14.88
	Negative	29	49	26	47	32	183	85.12

4. DISCUSSION

As human populations expand and habitats shrink, conflicts between local communities and wildlife for ecological resources have become increasingly common. The growth of human population has driven agricultural land expansion led to farmers and grivet monkey competition for inadequate resources in the study area. Respondents from five villages stated that grivet monkeys caused significant loss to various yields. Similar studies conducted in other countries have shown comparable conflicts in areas borders to nature reserves and wildlife habitats [39].

The study revealed a predominance of male respondents, as male household heads, typically engaged in farming, were more likely to interact with grivet monkey due to their direct involvement in agricultural activities. Similarly, studies by Asmare [8] and Yazezew [41] reported that the majority respondents were males in their study area.

The main source of income for 92.5 6% of respondents in the study area was agriculture, a dependency that heightened their vulnerability to human-wildlife conflicts. This finding aligned with the studies by Ejigu and Bekele [16] and Yazezew [41]. Farmland distances from the forest border emerged as another critical factor influencing the severity of conflicts [20]. Most respondents (42.79%) reported that their farmland was located 1–3 km from the forest, with closer proximity being positively correlated with the frequency of crop raids by grivet monkeys. This spatial trend was consistently documented in previous research, including by Saj et al. [34], who observed higher conflict intensity near forest edges in Uganda. Similarly, Newmark et al. [32] highlighted the role of habitat proximity in exacerbating human-wildlife interactions.

The findings indicated that resource utilization by local communities around Harego Forest was primarily dominated by firewood collection (23.72%), followed by grazing

(23.26%) and hay grass collection (14.88%). Similarly, Yitayih et al. [42] reported that firewood collection was a predominant activity near the Zegie Peninsula forests. This trend could be attributed to the primary income source of respondents in the study area being agriculture and livestock rearing, which was insufficient to meet their needs. Consequently, people relied on cutting trees for firewood, charcoal production, and sale to supplement their income.

Agricultural practices in the study area revealed a diverse range of crops, with maize (18.60%), sorghum (14.42%), teff (11.16%), and potato (9.30%) being the most commonly cultivated. These findings were consistent with studies conducted by Yazezew [41] and Asmare [8]. In these studies, communities predominantly grew maize, wheat, and teff crops that were heavily targeted by grivet monkeys. Farmers reported frequent crop raids by grivet monkeys, which led to significant economic losses and heightened human-wildlife conflict. This pattern was attributed to the feeding behavior of grivet monkeys, which influenced their crop preferences.

Maize, in particular, was found to be highly susceptible to crop raiding, accounting for about 51.16 % of reported incidents in areas near grivet monkey habitats. This vulnerability stemmed from maize's high nutritional value and widespread cultivation along forest edges, which provided easy access for the monkeys [8]. The findings of this study similarly revealed that grivet monkeys caused substantial damage to various crops, with maize being the most affected. Farmers consistently reported that maize experienced the highest levels of destruction, as highlighted in Asmare's [8] study in Alemsaga Forest. Comparable patterns were observed in Limu Woreda, East Wollega Zone, where Tafesse et al. [37] identified maize and wheat as the most affected crops.

Several factors contributed to this trend, including the nutritional content, palatability, and accessibility of these crops. Maize was particularly attractive to grivet monkeys due to its high sugar content, which provided a quick and efficient energy source. This caloric reward, combined with maize's sweet taste, made it highly preferred by primates. These preferences were documented in other studies, highlighting the tendency of primates to favour crops that offer high energy yields [25]. Additionally, maize offered a variety of edible parts during different growth stages, from germination to ripening, ensuring a continuous food source throughout the growing season. These growth stages also provided physical structures that facilitated foraging and shelter, reducing the risk of predation or human retaliation during crop raids [19].

Crop losses caused by grivet monkeys were a major concern among respondents, with maize and sorghum being the most affected crops. This finding aligned with studies conducted by Asmare [8] in Alemsaga Forest and Tafesse et al. [37] in Limu Woreda, East Wollega Zone. Maize was identified as the most targeted crop due to its high nutritional value and accessibility. Similar trends were observed by Saj et al. (2001) in Uganda, where vervet monkeys regularly raided corn, and various farmers reported reduced crop raiding when they stopped growing maize. This preference for maize could be attributed to its high sugar content, which provided a quick and efficient energy source, as well as the tendency of primates to target crops offering high energy yields [25]. Maize was one of the highest regularly cultivated crops in the study area, further increasing its susceptibility to grivet monkey raids.

During the investigation, most households stated that the vegetative stages of crops were mainly vulnerable to grivet monkeys' damaged. Similarly, Hill [24] described that cereal crops in Uganda were primarily damaged during their vegetative stages. This susceptibility might be due to the energy-rich content of crops during this stage, which attracted grivet monkeys.

This study also recorded various techniques employed by local farmers to mitigate crop damage caused by grivet monkeys. Guarding (54.42%) was identified as the most commonly used method. These findings were consistent with previous studies, such as those byTesfaye and Megaze [38], which also highlighted guarding as a prominent mitigation strategy. FAO [17] stated that guarding was active measures to mitigated human-animals conflict in Ethiopia. The preference for guarding could be attributed to its effectiveness and adaptability across different farming contexts, as noted by Gebeyehu and Bekele [19]. Moreover, scarecrows and chasing were

common used by households to minimize human-grivet conflict. Tesfaye and Megaze [38] similarly reported the use of scarecrows and chasing, often with the help of guarding dogs.

The highest respondents (87.91%) expressed a negative attitude toward grivet monkeys in the study area, while a small fraction (12.09 %) had a neutral attitude, and none demonstrated a positive attitude. These findings aligned with studies by Asmare [8] and Alelign and Yonas [5], which documented widespread, negative perceptions of grivet monkeys among local communities in Ethiopia. This negativity was likely driven by the crop-raiding behavior of grivet monkeys and the resulting economic losses experienced by farmers. Grivet monkeys were frequently perceived as agricultural pests, causing substantial crop damaged [3, 36]. Additionally, these animals were known to cause damage to human livelihoods and livestock, further exacerbating conflicts between rural communities and wild animals [9, 13]. This issue was aggravated by the subsistence farming practices in the area, which left farmers intolerant of even minor losses caused by grivet monkeys and other primate pests [5, 41].

5. CONCLUSION

In conclusion, the investigation revealed significant human-grivet monkey interactions in and around Harego Natural Forest, primarily driven by habitat degradation, lack of buffer zones, food scarcity, and the encroachments of human settlements within the forest. Maize, as the primary crop in the area, was highly susceptible to damage, particularly during its vegetative stage. Farmers employed various mitigation strategies, such as guarding, scare tactics, and fencing, but the increasing grivet monkey population has intensified the conflict over time. To address this issue, it is recommended that there should be implementation of sustainable conservation measures, including the establishment of buffer zones, habitat restoration, and community-based awareness programs to foster coexistence. Additionally, alternative livelihood options and crop diversification could reduce farmers' reliance on vulnerable crops, while innovative deterrent methods and compensation schemes may help mitigate economic losses and promote tolerance toward wildlife.

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Conflicts of interest

The author has stated that there are no conflicts of interest related to the study and publication of this article.

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