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Human-grivet monkeys conflict in Bire-Kokonu Mountain Forest, Oromo Special Zone, Amhara Regional State, Ethiopia

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Abstract

This study aimed to investigate human-grivet monkey conflict in the Bire-Kokonu Forest, focusing on understanding participants' socio-demographic variables, such as educational level, sex, marital status, source of income, and family size. The conflict arises from grivet monkeys damaging crops in farmlands near the forest, threatening both agricultural productivity and the well-being of the local farmers. The main objective of this research was to assess the nature and extent of human-grivet monkey conflict, identify the most vulnerable crops, and propose effective and sustainable methods to mitigate the conflict without harming the monkeys. A simple random sampling method was used to select 286 respondents. The study was conducted in Dewa Chefa Woreda, specifically in Gur kebele, Bire-Kokonu Manountain Forest. Data were collected between September 2021 and June 2022. The study area was divided into four villages: Gur, Serar, Keyafer, and Kola Gedama. Direct observation was used to assess crop vulnerability in the farmlands. Villages were purposively selected based on the proximity to the forest. The findings revealed that grivet monkeys preferred farmlands near the forest, particularly those cultivated with fruits and vegetables. The primary economic activity in the study area was agriculture, with human-grivet monkey conflict being a major concern. Grivet monkeys caused damage to crops at various stages of development, affecting different parts of the crops. The crops most vulnerable were maize, mango, sorghum, beans, and peas. The local community primarily relied on guarding as a means of protecting their crops. The local community should avoid killing and using slingshots against grivet monkeys as a means of crop damage protection. To protect the species, the government should raise awareness among the local community about the importance of their conservation.

Keywords: Bire- Kokonu Forest, crop damage, Grivet monkey, conflict, local community.

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1. INTRODUCTION

Grivet monkeys are medium-sized African primates that are both semi-arboreal and terrestrial, living in social groups. They are among the most successful primates in Africa, thriving in diverse habitats across southern and eastern regions of the continent. Their range includes countries such as Senegal, Ethiopia, Somalia, and South Africa. As habitat generalists, these monkeys are widely distributed but are absent in deserts, dense forests, and open grasslands [6, 11].

Ethiopia is home to 13 species of primates, encompassing a variety of nocturnal and diurnal species. These primates include smaller nocturnal species, social and adaptable monkeys, and distinctive baboons known for their complex social behaviors. Moreover, the group features arboreal monkeys recognized for their striking coloration and habitat specialization. These primates primarily inhabit wooded areas and are characterized by their long hind limbs, tails, and fur-covered faces, reflecting their adaptation to diverse African habitats [11, 19].

Grivet monkeys have a diverse diet, including fruits, leaves, roots, and various combinations of these food types. They exhibit distinct patterns of dietary specialization across continents. While fruits are a major part of

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their diet in most regions, leaves are also commonly consumed, particularly in certain habitats [7].

Human-primate conflict remains a persistent issue in Africa, driven by the growing human population and the resulting competition for forest resources [17]. The transformation of primate forest habitats into agricultural land has led to significant habitat loss and fragmentation, negatively impacting primates and other wildlife [3, 15]. Primates that damage agricultural crops such as cereals, fruits, and vegetables often face risks of injury, death, or even being consumed by local communities [13, 14]. The success of conservation efforts depends on the interaction between social and ecological factors. Understanding local communities' perceptions of wildlife is crucial for developing effective species management and conservation strategies [5, 18, 4]. A study conducted at Bahir Dar University found that people often complain about grivets stealing food and other valuables, defecating on cars, and spoiling clothes left to dry outdoors after being washed [6]. Similarily, a study at the Zegie Peninsula identified grivet monkeys as the most problematic wild animals, causing extensive damage to fruits and vegetables [8]. In Ethiopia, the human-grivet monkey conflict is more complex, driven by factors such as resource competition, changing land use, and the socio-economic needs of local communities. Agricultural expansion fragments habitats, forcing grivet monkeys into closer proximity with human settlements and leading to increased crop damage [7]. In the current study area, farmers cultivate maize, bananas, coffee, beans, mangoes, and various vegetables as their main sources of income and food. Additionally, there is ongoing conflict between humans and grivet monkeys over the use of these resources in the study area. Hence, the present study aimed to assess the nature of conflict and explore potential mitigation measure in and around Bire-Kokonu Mountain Forest, Dewa Chefa Woreda, Amhara Region, Ethiopia.

2. MATERIALS AND METHODS

2.1. Study area

Bire-Kokonu Forest is situated in the Oromo Special Zone of the Amhara Regional State, Ethiopia. It is located between 39°44'0" and 39°47'0" North latitude, and 39°44'0" and 39°50'0" East longitude, with an elevation reaching up to 1,640 meters above sea level. The forest is situated 325 km north of Addis Ababa, in Dewa Chefa District, approximately 24 km from Kemissie, the town of the Oromo Special Zone. The study area covers an estimated 20 km² (Fig. 1). The landscape is marked by valleys and lowland plains, with the surrounding area mainly consisting of agricultural land. Despite the challenging terrain, farming is prevalent in the region, with most of the agricultural activities occurring at lower elevations within the study area.

The climate of the study area is characterized by distinct wet and dry seasons. Temperature and rainfall data were obtained from the Kombolcha Meteorological Agency. The wet season follows a bimodal rainfall pattern, with a main rainy season (Kiremt or Meher) occurring from June to September and a short rainy season (Belg) from February to May. The highest rainfall was recorded in July, during the main wet season, while the driest month was December. The area's average monthly rainfall was 837.36 mm. The mean minimum temperature was 8.3°C, recorded in December, the coldest month while the mean maximum temperature, 34.9°C, occurred in June, the hottest month.

The common vegetation in the study area includes:- *Croton macrostachys* (Bisana), *Ficus vasta* (Warka), *Acacia senegal* (Girar), *Brucea antidysenterica* (Abalo), *Clausena anisata* (Limech), *Phytolacca dodecandra* (Endod), *Dodonaea angustifolia* (Kitkita), *Carissa spinarum* (Agam), *Ficus sur* (Sholla), *Zehneria scabra* (Hareg Ressa), *Eucalyptus globulus* (Bahirzafe), and *Cynodon dactylon* (Serdo). In addition to observing grivet monkeys, the following wild animals were identified in the study area through direct observation and interviews with the local community members: *Crocuta crocuta* (Hyena), *Hystrix cristata* (Porcupine), *Oryctolagus cuniculus* (Rabbit), *Vulpes vulpes* (Fox), members of the family *Pythonidae* (Python), *Panthera leo* (Lion), *Panthera pardus* (Tiger), and various species of birds.

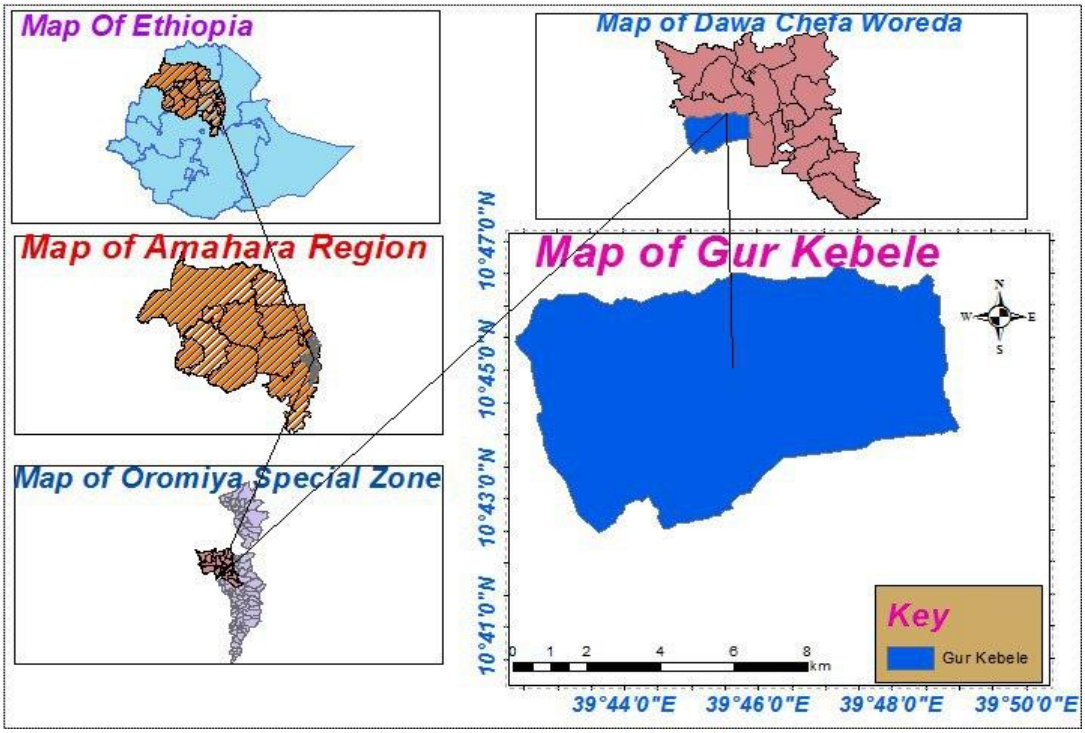

Figure 1. Map of the study area

2.2. Methods

2.2.1. Preliminary survey

A preliminary survey was conducted in the study area prior to the main data collection. This survey gathered essential information on physical features such as climate, topography, biological, socioeconomic activities of the local population, the altitudinal range, study sites, and other relevant information about the area. Furthermore, a pilot survey was carried out in selected villages to refine the data collection process. During this pilot survey, 25 households were randomly selected and interviewed to assess the accuracy and clarity of the questionnaires. Based on the feedback received, the questionnaire was revised and finalized for use in the main data collection

2.2.2. Study Design

Interviews, observations, and focus group discussions were conducted in various villages and areas adjacent to the study site to evaluate the impact of and farmers' attitudes toward conflicts involving grivet monkeys. Four villages were selected using a purposive sampling, and respondents from each village were chosen through simple random sampling.

2.2.3. Study participants

All local community members living adjacent to the Bire-Kokonu Mountain Forest were given the opportunity to participate in the study provided they met the inclusion and exclusion criteria and received a brief orientation about the study's purpose. Participants were included if they were permanent residents near the Bire-Kokonu Forest, had experienced or were currently experiencing damage caused by grivet monkeys, and were willing to participate voluntarily by providing informed consent. However, individuals who were guests, visitors, or tourists were excluded from the study.

2.2.4. Questionnaire survey procedure

A survey was conducted from September 2021 to June 2022 to explore the experiences of local residents living near Bire-Kokonu Mountain Forest regarding conflicts with human-grivet monkeys and their attitudes toward problematic wild animals. Semi-structured interviews were used to collect information, and a random sampling was applied to select participants, including both

men and women who had experienced conflicts with the monkeys. The research followed a community-based, cross-sectional descriptive survey approach. Data were obtained through household interviews, observations, and focus group discussions in villages located near the forest. The questionnaire, available in both English and Amharic, included both open-ended and fixed-response questions. A brief orientation about the study's purpose was given to participants. Villages were selected for the study using purposive sampling, based on their proximity to the forest boundary. A total of 286 households participated in the survey, and the sample size was determined using the formula by Yamane (1967). $n = \frac{N}{1+N(e^2)}$ Where "n" represents the sampled households, "N" is the total number of target households (1000), and "e" is the level of precision. Based on this calculation, 286 households were randomly selected from a total of 1000 households across four villages in the study area. Thus, the sample size was established. Therefore, the sample size $n = \frac{1000}{1+1000(0.05^2)} = \frac{1000}{3.5} = 286$

S = 286

The number of households selected from each village was determined using proportionate allocation procedures. The allocation of sampled households in each village was based on the proportion of household heads residing in each village as shown in Table 1.

$n = \frac{NS}{N\ total}$; Where n = number of required samples

N = number of household in one village

S = total household to be treated

N total = the number of households in all villages

Table1: The total households and the sample size in each selected village.

Villages	Households	Sample size
Gure	370	106
Serare	319	91
Keyafer	172	49
Kola Gedama	139	40
Total	1000	286

2.2.5. Data analysis

The collected data was analyzed using SPSS version 25 software. Descriptive statistics and Chi-square tests were applied to analyze the data, with the p-value set at $p \leq 0.05$ for all tests. A summary of the statistical interpretation and percentage values was presented in tables and figures.

3. RESULTS

3.1. Background of the respondents

A total of 286 respondents were randomly selected from four villages for interviews in the present study area. Of these, 219 were males and 67 were females as shown in Table 2. The distribution of respondents across the four villages showed a statistically significant variation ($\chi^2 = 42.92$, df = 3, $P < 0.01$). Also, the sex ratio among the respondents showed a significant differences ($\chi^2 = 80.78$, df = 1, $P < 0.01$).

Table 2: The proportion of male and female respondents the study area.

Gender	Respondents	Percentage (%)
Male	219	76.6
Female	67	23.4
Total	286	100

The largest proportion of respondents belonged to 30-39 age group, with 141 individuals (49.3%), followed by the 40-49 age

group with 120 individuals (42%) and the 20-29 age group with 25 individuals (8.7%) (Table 3). The distribution of respondents across the villages in the study area showed a statistically significant variation by age group ($\chi^2 = 80.147$, df = 2, $P < 0.01$).

Table 3: Age groups of respondents in the study area.

Age	Respondents	Percentage (%)
20-39	25	8.7
30-39	141	49.3
40-49	120	42
Total	286	100

3.2. Source of income of the respondents

The majority of respondents (229 individuals, 80.1%) reported that agriculture was the primary source of income for local communities in the study area, followed by agriculture and livestock rearing 56 (19.6 %). However, only a few farmers obtained their income from livestock rearing 1 (0.3%) as shown in Table 4. The sources of income among local respondents showed a statistically significant difference ($\chi^2 = 80.1$, df = 2, $P < 0.01$).

Table 4: Income sources of respondents in the study area.

Income sources	Frequency	Percentage
Agriculture	229	80.1
Animal rearing	1	0.3
Mixed	56	19.6
Total	286	100

All respondents had their farmland located very close to the forest border (< 1 km). The proximity of respondents' farmland to the forest showed a statistically significant difference ($P < 0.01$).

The majority of respondents in the study area used resource from the forest (for fire wood collection 263 (92 %), followed by grazing 14 (4.9%), hay grass 7 individuals (2.4%) and the least resources used from the forest was thatching grass 2 (0.7%) (Table 5). However, the level of resources use from the forest varied among the locations as well as with seasons. The local respondents benefited from the forest, and this showed a statistically significant difference ($\chi^2 = 684.881$, df = 3, $P < 0.01$).

Table 5: The type of resources used by respondents from the study area

Benefit	Frequency	Percentage (%)
Fire wood	263	92
Thatching grass	2	0.7
Hay grass	7	2.4
Grazing	14	4.9
Total	286	100

3.3. Types of crops grown

The respondents in the study area reported that they cultivated vegetables, fruits and cereals crops in their farmland (Table 6). Out of the total respondents, 108 (37.8%) respondents cultivated maize followed by 52 (18.2%) of the respondents' were cultivated sorghum, 46 (16.1%) mango and 28 (9.7%) were cultivated teff. The local respondents were cultivated different crop and fruits, and this showed a statistically significant variation ($\chi 2 = 220.350$, df = 7, $p < 0.01$).

Table 6:Respondents response on prioritization of crop cultivation

Type of Crops	Respondents	Percentage
Maize	108	37.8
Sorghum	52	18.2
Mango	46	16.1
Teff	28	9.8
Bean and pea	22	7.7
Barley	15	5,2
Wheat	10	3.5
Avocado	5	1.7
Total	286	100

3.4. Crop losses caused by grivets

In this study area maize was the most damaged crop, with 177 respondents (61.9%) reporting damage followed by mango 47(16.4%), barley 26 (9.1%), sorghum 22(7.7%), bean and pea 8(2.8%) and avocado 6(2.8%) which was due to grivet monkey damage (Table 7). There was

a statistically significant variation in crop loss caused by grivet monkeys ($\chi 2 = 444.03$, df= 5, $p < 0.01$).

Table 7: Type of crops damaged by grivets in the study area.

Type of crops	Frequency	Percentage
Maze	177	61.9
Sorghum	22	7.7
Mango	47	16.4
Barley	26	9.1
Bean and pea	8	2.8
Avocado	6	2.1
Total	286	100

The damage caused by grivet monkeys to crops also varied over time. All the respondents 286 (100%) of the study area responded that crop damage occurred during the day time. Grivet monkey-induced crop damage varied across seasons. Thus, most respondents reported that crop damage occurred in the wet and dry seasons 229 (80.1%) followed by wet season 57 (19.9%) (Table 8). Crop damage by grivet monkeys across seasons showed a statistically significant variation (χ^2=103.44 df = 1, $p < 0.01$).

Table 8: Grivet monkeys crop damage during different seasons in the study area

seasons	Respondents	Percentage
Dry	-	-
Wet	57	19.9
Dry & wet ``	229	80.1
Total	286	100.00

The extent of crops damage caused by grivet monkeys ranged from high to medium in the present study area (Table 9). The majority of respondents (203 individuals, 71%) reported high levels of crop damage. The extent of crop damage showed statistically significant variation (χ^2 =103.44 df = 1, $p < 0.01$).

Table 9: The extent of crop damaged by grivet monkeys.

Level of crop damaged	Respondents	Percentage
High	203	71
Medium	83	29
Low	-	-
Total	286	100

3.5. Causes of human grivet monkey conflict

Out of the total respondents, 245 (85.7%) respondents responded a shortage of food source, followed by 40 (14%) who mentioned habitat degradation, and 1 respondent (0.3%) who cited the absence of a buffer (Table 10). The causes of human-grivet monkey conflict showed a statistically significant variation (χ^2 = 360.42, df= 2, $p < 0.01$).

Table 10: Causes of conflict in the present study area

Causes of conflicts	Respondents	Percentage
Shortage of food	245	87.7
Absence of buffer	1	0.3
Habitat degradation	40	14
Total	286	100

Out of the total respondents, 254 (88.8%) respondents responded that grivet monkeys were killed in retaliation to crop raiding. However, 32 (11.2%) stated that grivet monkeys were not killed with retaliation to crop raiding (Table 11).

Table 11: Grivet monkey killed in retaliation for crop raiding.

Responses	Respondents	Percentage (%)
Yes	254	88.8
No	32	11.2
Total	286	100

3.6. Controlled mechanism of grivet monkey damage

The local communities used different methods to protect their crop from grivet monkey damage. The majority of respondents 204 (71.3%) reported using guarding as a protection method followed by 58 (20.3%) respondents used a combination of chasing, guarding and scarecrows (Table 12). The techniques used for crop protection showed statistically significant variation (χ^2 =349.916, df = 3 $p < 0.01$).

Table 12: Techniques used for crop protection from grivet monkey in the study area.

Responses	Respondents	Percentage
Guarding	204	71.3
Chasing	2	0.7
Scarecrow	22	7.7
Chasing, guarding & scarecrow	58	20.3
Total	286	100

3.7. Attitude of local community towards grivet monkey

Out of the total respondents, 237 (82.9%) had a negative attitude towards grivet monkey conservation; while 27 (9.4%) respondents had a neutral attitude and 22 (7.7%) had a positive attitudes towards grivet monkeys (Table 13). The attitude of the local communities towards grivet monkey conservation showed a statistically significant variation (χ^2 = 315.59, df = 2, $p < 0.01$).

Table 13: Attitude of the local farmers towards grivet monkeys.

Attitude of community	Respondents	Percentage (%)
Positive	22	7.7
Negative	237	382.9
Neutral	27	9.4
Total	286	100

4. DISCUSSION

The current investigation revealed significant conflict between humans and grivet monkeys. Similar studies conducted in several regions of Ethiopia and Africa has shown that grivet monkeys were the major threats on various crops [1, 3, 6 16]. These results indicate that there was negative interaction between grivet monkeys with human in terms of resource and habitat utilization. Because of this, grivet monkeys are categorized as the major agricultural pests and extensive damage to both commercial and subsistence crops [9]. In the present study area, the local community developed negative attitude towards grivet monkeys. Similar result was reported by Alelign and Yonas [1] the majority respondents had negative attitude towards grivet monkeys and they were, reported that the trend of crop damaged by grivets was increased. Due to the negative attitude of the local community towards grivet monkey, there was no conservation of the species and the local communities resorted to killing grivet monkeys. Similar finding was reported by Gebeyehu and Bekele [8] from Zegie peninsula and Zena [21] from Alemsaga Forest, South Gonder, Ethiopia.

According to the local resident, the proximity of farmland to the forest makes crops more vulnerable to grivet monkeys, while farmland located farther from the forest is less susceptible to damage. A similar finding was reported by Regasa [2] and Yitayih et al. [20]. where crops near the forest were more vulnerable to grivet monkeys compared to those farther away. Most respondents have farm land which is close or near to the forest. As a result, the close proximity of their farmlands to the forest edge led to more severe human-grivet monkey conflicts.

The present study showed that farmlands located near protected or forest area are more exposed to primate damage as compared to distant farm lands. A similar finding was reported by Joseline [10] in a study conducted in Tanzania which found that farmlands near rivers and forests were more vulnerable to grivet monkey damage. In the current study area, grivet monkeys damaged crops during both the dry and wet season. However, the level of damage varied between seasons. In the current study area, more crops damaged were recorded during the wet season than dry season. This could be due to the land being covered with crops, attracting the species to cultivated areas. The findings of the present study are consistent with those of Regasa [2], who reported that more crop damage occurred during the wet season than the dry season in

the Chato forest of Horro Woreda in western Ethiopia.

In the current study area, grivet monkeys did not damage all crop types equally. Depending on the sensitivity level, some crops were highly damaged while others were less affected. The results showed that, during the wet season, maize was most severely damaged by grivet monkey while during the dry season; mango and avocado were more vulnerable to damage. This result aligns with the findings of Regasa [2], who reported that maize was the most commonly consumed crop by grivet monkeys in and around the Chato Forest of Horro Woreda, western Ethiopia. In the current study area, grivet monkeys were killed, and the local community expressed a desire to remove the species from the area. This may be due to the damage grivet monkeys caused to crops as well as the local people cutting trees for sale to support their livelihoods. Similar findings also reported by Yitayih et al. [20] from in Zegie peninsula, Bahir Dar, Ethiopia and Haile et al. [12] from Kafa Biosphere Reserve, Kafa Zone, South West, Ethiopia.

5. CONCLUSION

Grivet monkeys in and around Bire-KoKonu forest mostly preferred areas near fruit and vegetable farmlands during both seasons. Most of the time they used the forest for resting and grooming during the morning and noon while they foraged on farmlands for food during late morning and late afternoon. Grivet monkeys were observed damaging of various crops at different developmental stages, from seedling to maturation (harvesting). The most commonly used method for controlling crop damage in the study area was guarding, although killing and slinging of grivet monkeys as control measures were severely affecting their population. The local people in the study area have negative attitude towards grivet monkeys, because they only recognize the harmful aspect of them without knowing the ecological and economic importance of the species.

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Conflicts of interest

The author(s) have stated that there are no potential conflicts of interest related to the research, authorship, or publication of this article.

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