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When Monkeys Raid Farms: Patterns, Economic Costs, and Farmer Mitigation Strategies in a Kenyan Agroecosystem

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Abstract

Human-wildlife conflicts involving non-human primates are increasing in agricultural landscapes, yet such conflicts remain understudied compared to those caused by large mammals. This study sought to assess farmer's perception about patterns of crop raiding events by vervet monkeys, and the methods they use to mitigate the damages in agricultural landscapes east of Mount Kenya. Household questionnaires were used to collect data from a sample of 346 respondents. The results reveal that farmers experience serious crop losses which is undermining food security, and socio-economic wellbeing of the community. The community considers killing of the monkeys as the best crop protection strategy and some have opted to clearing of trees which has serious conservation implications. This study demonstrates the need to act swiftly to develop science-based mitigation strategies for crop losses caused by primates, particularly given that compensation for primate-induced damages is generally absent from most national wildlife management legal frameworks.

Introduction

The conversion of natural land into farmland is associated with biodiversity loss but some wildlife species are drawn into farmlands (Green et al., 2005), resulting to complex interactions with human activities. In most cases the interactions take the form of human-wildlife conflicts when the action of one has a negative effect on the other (Torres et al., 2018; Harris et al., 2023). Many species of non-human primates ranging from the great apes, monkeys, to prosimians like lemurs are known to include cultivated food into their feeding repertoires (Hill, 2017) due to an inherent food niche overlap with humans (Jaeggi & Gurven, 2013). It is therefore inevitable that the expansion of agriculture to natural habitats often leads to conflicts, particularly through crop raiding. Studies in many parts of Asia and Africa reveal that primates demonstrate sophisticated crop selection patterns, with a particular preference for maize and other staple crops, and exhibit strategic timing in their foraging activities (Jaleta & Tekalign, 2023; Karki et al., 2024). Apparently, subsistence farmers living adjacent to protected areas have borne the bulk of the crop depredation associated with nonhuman primates (Mc Guinness & Taylor, 2014).

In Africa, a wide suite of non-human primate species has been previously implicated in human wildlife conflicts. For example, research in the Southern Ethiopia revealed that olive baboon (*Papio anubis*), vervet monkey (*Chlorocebus pygerythrus*), and grivet monkey (*Chlorocebus aethiops*) were the most important crop pests of maize, teff and barley (Alemayehu & Tekalign, 2022; Deneke et al., 2024) and in Southwest Ethiopia, olive baboon and vervet monkey were identified as the most notorious crop raiders (Mamo *et al*., 2021). A similar study in Ghana found that the most troublesome and destructive monkey species were Olive baboons (*Papio anubis*); patas monkeys (*Erythrocebus patas*); and green monkeys (*Cercocerbus sabaeus*) (Wiafe, 2019). Chimpanzees have also been reported to cause antagonistic interactions with humans in countries such as Sierra Leone (Garriga *et al*., 2018), Uganda (Kyokuhaire *et al*., 2023) and Senegal (Dotras *et al*., 2024). Some of the other case studies on human-primate conflicts include Rwanda (Ndayishimiye *et al*., 2023), Kenya (Siljander *et al*., 2020), South Africa (Findlay & Hill, 2020) and DR Congo (Kazaba *et al*., 2020).

Crop damage by primates can lead to substantial economic losses for farmers and threaten food security of local communities, particularly subsistence farmers who rely heavily on their agricultural production. In many regions, especially in Eastern and Southern Africa, maize is the major staple food (Adeola *et al.*, 2018) and is particularly vulnerable to primate foraging. For example, in southern Ethiopia, maize yield losses due to primate damage were reported to be as high as 43.1% in protected fields (Jaleta & Tekalign, 2023). Primates frequently target crops like maize, barley, teff, potatoes, sorghum (Alemayehu & Tekalign, 2022), but a variety of other crops such as butternut squash, beans, macadamia, avocadoes, bananas, sugarcane, irish potatoes and sweet potatoes are vulnerable (Findlay & Hill, 2020; Siljander *et al.*, 2020). Besides direct crop loss, farmers incur additional costs and spend more time protecting their crops, which further impacts on their livelihoods (Manoa *et al.*, 2021). In some cases, primates especially baboons damage unpalatable crops that they don't eat but destroy for their own entertainment (Hill & Webber, 2010). The economic impact of primate crop raiding on smallholder farmers can be severe, threatening both immediate food security long-term livelihoods. Crop raiding affects not only the quantity of harvest but also the quality of crops, with farmers reporting reduced fruiting, stunted growth, poor seed production, and decreased overall yield as consequences of primate damage (Tweheyo *et al.*,2005; Wiafe, 2019; Jaleta & Tekalign, 2023). Unfortunately, the nature of such interactions is intensifying as agricultural expansion continues to fragment primate habitats, bringing humans and primates into closer proximity and more frequent conflict. This necessitates innovative approaches to balance the needs of both humans and nonhuman primates.

The manipulative abilities and social learning capacity of primates make them particularly effective crop raiders, as they can quickly adapt to and overcome traditional deterrent methods implemented by farmers (Naughton-Treves, 1998). Primates, particularly monkeys, are opportunistic omnivores that readily adapt their feeding behaviors to exploit new food sources, including cultivated crops that often provide higher caloric returns than natural foods (Cancelliere *et al.*, 2018). Their manipulative abilities and problem-solving skills allow them to overcome simple deterrents and access crops even when farmers implement protective measures. Studies have documented that primates can become habituated to scarecrows and other traditional deterrents, requiring farmers to continuously adapt their protection strategies (Lee & Priston, 2005). The social structure of many primate species facilitates knowledge transfer about effective raiding techniques, allowing entire groups to quickly learn optimal crop raiding strategies through observation and imitation (Lee, & Priston, 2005; Humle & Hill, 2016). Thus, most traditional methods typically provide only short-term solutions to conflicts with primates.

Although much attention has been given to human-wildlife conflicts in Kenya, most of the studies have focused on trying to understand the nature of conflicts caused by elephants and carnivores (Mukeka *et al.*, 2018; Von Hagen *et al.*, 2023. In the recent years there has been increasing media reports about crop damage caused by vervet monkeys and other primates in the agricultural landscapes of eastern Mount Kenya forest. However, the nature of the conflicts and the conservation implications of the conflicts had not been fully documented and this prompted the conceptualization of this study. Numerous studies have shown that human wildlife conflicts can cause serious negative implications to the rural communities, threatening the socio-economic wellbeing of the people and undermining the support of the local communities towards conservation agenda especially in developing countries (Torres *et al.*, 2018; Schell *et al.*, 2021). Based on this background, the current study aims to provide baseline information about the current situation of the nature of local community interactions with non-human primates in Maara Subcounty, located on the eastern side of the Mount Kenya forest. The study aimed to address

three objectives: (1) determine the frequency of conflicts and the crops targeted, (2) assess the local community perception of the losses caused and their implications, and (3) to evaluate the effectiveness of strategies used to mitigate the conflicts from velvet monkeys.

Material and methods

Description of the study area

The study area lies on the eastern side of Mount Kenya between 37° 34'E and 37° 50'E longitudes and 00°12'S and 00°18'S latitudes and at an altitude of between 1250 and 2000m above sea (Fig. 1). Temperatures range between 8 °C and 32 °C. The area receives an annual precipitation ranging from 600mm to about 1800mm. The rainfall follows a bimodal pattern with longer rains occurring between March to May, and the shorter rains between October to December (Schmocker et al., 2016).

The majority of the households are smallholder farmers who grow a high diversity of crops mainly for domestic consumption but maize (*Zea mays)* and beans (*Phaseolus vulgaris*) are the most preferred type of crops. Other dominant crops include bananas (Musa acuminata), tea (*Camellia* sinensis), coffee (*Coffea spp*) and macadamia (*Macadamia integrifolia*) (Rotich et al., 2025a). Most of the households practice livestock production that comprises of poultry, dairy cattle, goats and sheep. In addition, agroforestry is commonly practiced (Mugambi *et al.,* 2024) and mainly comprises of exotic plant species especially silk oak (*Grevillea robusta*) and gum tree (*Eucalyptus sp.)* trees. Although scattered, remnants of indigenous trees can also be found especially on the steep ridges and forms thickets that are dense enough to provide habitats for monkeys and small mammals. It is also important to note that the upper area borders the Easten side of the Mount Kenya National Reserve. The forest is recognized as an Important Bird Area (IBA) and is home to many wildlife species of conservation concern. Together with the contiguous conservation area, it is a habitat for the African elephant (*Loxodonta africana*); black rhinoceros (*Diceros bicornis*); white rhinoceros (*Ceratotherium simum simum*), the mountain Bongo (*Tragelaphus eurycerus isaaci*) and several species of non-human primates (Rotich et al., 2025b).

Data Collection

A preliminary study was conducted from October to December 2024 to identify areas where cases of human-primate conflicts were being reported. Data for this study was collected from January 2025 to November 2025 using 346 questionnaires that consisted open and closed questions on demographic information of the respondent, basic knowledge of the monkeys, the nature of interactions with the monkeys, types of damages they cause, attitudes and control measures. Permission was obtained from the local administrative offices to conduct the research in the identified areas using a purposive approach whereby villages where presence of conflicts with the vervet monkeys had been reported were targeted. In the villages, households were selected using simple random methods but only respondents who indicated their willingness to participate in the survey and aged 20 years and above were involved. Before administering the questionnaire, the informants were briefed about the purpose of the survey and then their consent to participate was sought and were guaranteed confidential handling of informant data. All the questionnaires were filled on the spot.

2.3 Data analysis

Descriptive statistics in form of percentages and frequencies were used to analyze socio-demographic profiles of the respondents and also to analyze local community perception about their knowledge of vervet monkeys, length and trend in interactions with the monkeys, types of damages they cause and the methods they use to mitigate the damages. Chi-square goodness-of-fit test was use to determine how well the distribution of the frequencies of responses matched the expected distribution. Analysis of variance (ANOVA) was used to compare means for the losses in maize and macadamia. All tests were done at 95% confidence interval. Graphs, tables and figures were used to summarize and present the results. SPSS version 26.0 computer software was used to analyze the data.

Results

Socio-demography of participants

A total of 346 respondents participated in the survey (Table 1), with an almost equal representation of male (51%) and female (49%) respondents in the survey. In terms of age, 21% of the respondents were between 20 years and 35 years, 30% were between 36 and 45 years, 24% were between 46 and 55 years and 26% were aged 55 years and above. Out of the 346 respondents, only 4% had no formal education, whereas 35% had attained primary level education, 33% had secondary level education and 28% had post-secondary education level. All the respondents practiced some level of farming, with 74% depending on farming as their main source of income.

Table 1 Demographic characteristics of respondents in the study area showing the age, gender education level and main source of income

Respondent profile		Frequency	Percent
Age	20-35	72	21
	36-45	103	30
	46-55	82	24
	Over 56	89	26
Gender	Male	178	51
	Female	168	49
Level of Education	No formal education	14	4
	Primary	121	35
	Secondary	114	33
	Post secondary	97	28
Main source of income	Farmer	256	74
	Others	90	26

Crop raiding patterns

All the respondents (n=346) reported that they had seen vervet monkeys before and therefore they could identify the animal (Table 2). However, the respondents differed significantly in terms of the duration of time they had experienced crop raiding events (χ^2 =39.32; df= 3; P <0.001). Most of the farmers revealed that they had experienced conflicts with the monkeys over the last 10 years. Out the 346 respondents, 23% reported that they had experienced conflicts with the monkeys for less than a year whereas 34% and 31% had experienced conflicts between 2 and 5 years, and between 6 and 10 years respectively. Only 12% of the respondents had experienced conflicts with the monkeys for more than 10 years. Most of the respondents (76%) reported that they experienced crop raiding events more than 5 times in a season. As shown in Table 1, 49% of the respondents reported a frequency of 3 to 5 times per season whereas, 10% reported a frequency of less than 3 times per season. These differences differed significantly (χ^2 =280.62; df=2; P<0.001).

In addition, the respondents differed significantly concerning the trend in crop raiding events over the years (χ^2 =129.66; df=2; P-value: <0.001). The majority of the respondents (63%), felt that crop damages by the monkeys were increasing while 20% felt that there had been no change. Only 17% of the respondents felt that there had been a decline in crop damages caused by the monkeys. There were significant differences among the respondents on their perception of the time of the year when they experience crop raiding events (χ^2 =75.63; df=2; P-value: <0.001) and also the time of the day when most of the crop raiding events take place (χ^2 =16.02; df= 2; P-value: <0.001). According to the majority of the respondents (52%), conflicts with vervet monkeys are experienced throughout the year in both dry and wet seasons although a relatively high proportion of the respondents (34%), reported that most of the conflicts are experienced during wet seasons when food crops are in the field. Most of the crop raiding events take place during the morning hours according to 57% of the respondents. Others reported that they have experienced crop raiding activities by the vervet monkeys at midday (20%) and in the evenings (23%). In addition, although statistically the respondents expressed significant differences regarding their views on the seriousness of vervet problem (χ^2 =220.91; df= 4; P-value: <0.001) it is was clear that most of the respondents felt that vervet monkeys were a serious problem in their farms (Fig. 2). In this case, 45% of the participants said that the problem was very serious whereas only 3% said that vervet monkeys were not a problem at all.

Table 2 Patterns of crop raiding events by vervet monkeys in Maara Sub County according to the farmers

		Nature of the interaction	Responses
1		How frequently do you see monkeys in this area	1. Rarely- Less than thrice per
			2. Sometimes 3-5 times per se
			3. Often- More than 5 times pe
2		For how long have you experienced crop damage from primates?	1. Less than 1 Year,
2.	2 to 5 years,		119
3.	5 to 10 years,		106
4.	Over 10 years	43	12
3		How do you rate the trend in crop damage by primates:	1. Increasing
2.	Not changing		68
3.	Decreasing		59
4		What time of the year do you experience crop raiding by the monkeys?	1. Rainy season,
2.	Dry season,		48
3.	Both dry and wet seasons		180
5		At what time of the day do you experience most of crop raiding events by the monkeys?	1. Morning
2.	Midday		69
3.	Evening		78

Implications of crop raiding behaviour

All the respondents practiced mixed farming which included a variety of food crops and cash crops. Maize was the most common crop that was targeted by the vervet monkeys according to 98% of the respondents. Other major food crops that were cited included beans (47%), vegetables (34%), and bananas (26%) whereas macadamia was the most vulnerable cash crop according to 30% of the respondents (Fig. 3). Estimates of the percentages of maize crop that had ever been damaged or lost during the most serious raiding event by vervet monkeys included losses of between 25% and 50% reported by most of the repondents (38%), while 18% of the respondents reported losses of over 75%. The differences among respondents concerning the proportion of maize damaged by vervet monkeys differed significantly (χ^2 =51.55; df= 3; p <0.001). Additionally, estimates on the cost of maize and macadamia lost to vervet monkeys within a period of one year amounted to about USD 41.77 and USD 66.44 respectively (Fig. 4). These differences were statistically significant ($F_{(1, 440)}$= 28.82; p<0.001).

All the respondents in this survey (n=346) perceived that vervet monkeys were of no benefit to them. However, using a Likert scale, it was found that about half of the respondents revealed that some members of the local community could readily consume meat from vervet monkeys. Results indicated that 30% of the respondents agreed while 15% strongly agreed to the idea that vervet monkeys are considered as source of meat in the community. On the other hand, 20% disagreed whereas 22% strongly disagreed. On the idea of velvet monkeys being a delicousy (Fig. 5).
There were significant differences on the perception of the respondents regarding the negative implications of the presence of vervet monkeys in the area (χ^2 =51.97; df=4; p<0.001). Almost all of the respondents (98%; n=339) cited loss of food as the main problem associated with vervet monkeys in the study area (Fig. 6). This was closely followed by loss of income (82%) and loss of time that is spend safeguarding the crops from vervet monkeys. 43% of the respondents also reported that the vervet monkeys had led to loss of trees because some farmers were forced to cut down trees and clear bushes in their farms as a way of discouraging the monkeys from invading their crops. In addition, 27% of the respondents reported two negative implications attributed to vervet monkeys that included loss of time spent by men guarding the crops and chasing away the vervet monkeys as well as conflict between landowners and parties chasing the monkeys when they have to clear some thickets to force the monkeys away. An example cited by one of the respondents demonstrated that some community members who love agroforestry have been blamed for providing habitats for the monkeys that are invading crops and impoverishing the community.

Vervet monkey control strategies

Respondents employed five strategies to reduce damages caused by vervet monkeys which included hunting, shouting, use of dogs, poison and installing scarecrows (Table 3). Hunting and killing was considered the most effective method of dealing with the problem according to 69% of the respondents. In addition, shouting and chasing the monkeys were reported to be effective by 52% of the respondents. However, some of the respondents reported felt that this method required a lot time and some groups of vervet monkeys would not move away when women and children tried to chase them away.' Use of dogs to scare away the monkeys was reported by 43% of the respondents However, as summarized in Table 4, it was found out that hunting was not a popular method in controlling vervet monkeys because of lack of participation from most of the community members (24%), it was also time consuming (54%) and that there was lack of effective tools for hunting down the monkeys (36%). It was also found that relatively few respondents had ever used poison (8%) and scarecrows (6%) mainly because these methods were considered as the most ineffective strategies for controlling crop raiding by vervet monkeys.

Table 3 Types and effectiveness of measures used by farmers to mitigate crop raiding in Maara Sub County

Types of measures	Very effective	Effective	Neutral	Slightly effective	Not effective at all	Rank
1. Hunting and killing	29	40	8	20	3	1
2. By shouting and chasing	14	38	8	28	12	2
3. Use of dogs	16	27	7	34	16	3
4. Use of poison	3	5	28	34	30	4
5. Use of Scarecrows	2	4	15	27	52	5

Table 4 A summary of the reasons cited for ineffectiveness of measures used by farmers to mitigate crop raiding in Maara Sub County

Types of measures	Proportion of respondents	Reasons why the method is not perceived as effective
Hunting and killing	69	• Unwillingness of most of the members to participate (24%) • Time consuming (54%) • They are not easy to hunt with available tools (36%)
By shouting and chasing	52	• Requires a lot time (52%) • Some groups are not scared of women and children (28%) • Change in raiding time (16%)
Use of dogs	43	• Very few households have dogs (40%) • Dogs were effective only when accompanied by their owners which is time consuming (32%) • Some groups easily learn how to avoid the dogs (36%)
Use of poison	8	• Monkeys easily avoided poisoned bait (76%) • Extremely few people have ever tried use of poisonous bait (90%)
Use of Scarecrows	6	• Very few people have ever tried to use this method (87%) • Vervet monkeys are not scared because they quickly learn that the scarecrow is harmless (76%)

Discussion

Human-wildlife conflicts are a serious conservation problem especially near protected areas (Gross et al., 2021). However, some wild animals such as primates, are able to adapt and live in pockets of thickets or woodlots in agricultural landscapes where they can consistently be a problem to farmers through crop raiding (Haile et al., 2024). In the present study, we sought to understand the nature of interactions with the local community and the implications arising from the interactions. The results showed that human-vervet monkey conflicts are very common in the study area. From the local community perspective, the monkeys reside within thickets and woodlots found within the landscape and do not move into the Mount Kenya Forest. Studies have shown that primate use of human-modified environments has become more common in recent years due to alteration of their natural habitats (Galán-Acedo et al., 2019; Torres-Romero et al., 2023). However, even in the absence of habitat alteration, vervet monkeys are highly adaptable and opportunistic in feeding on different crops which enable them to take advantage of utilizing new resources in agricultural landscapes (Cancelliere et al., 2018). Considering that Maara Sub-County has the culture of agroforestry (Mugambi et al., 2024), it is easy for the vervet monkeys to disperse and occupy available ecological niche in the woodlots without depending on the adjacent Mount Kenya forest.

The results suggest that the vervet monkeys are now found in areas where they never used to be found ten years ago indicating an expansion in their range. This has led to an increase in the frequency of crop raiding cases reported in the study area. In addition, we found that some farmers had abandoned farming in areas that are most prone to raiding. When left fallow for long, such areas turn into thickets through the process of ecological succession leading to an expansion of habitats for the monkeys and ultimately exposes more farms to crop raiding. Vervet monkeys show an accelerated life history (Henzi et al., 2025) and with fast reproduction they are able to disperse into available habitats. Sengupta and Radhakrishna (2018), also noted that crop raiding, especially of calorie-dense foods, can result in increased fertility and increased primate group size leading to increased crop damage and increased human-wildlife conflicts. From this perspective, further studies to understand the demography and the distribution patterns of the vervet monkeys within the landscape are necessary in order to project and manage human-vervet conflicts in the agricultural landscape.

According to the majority of the respondents, conflicts with vervet monkeys occur throughout the year in both wet and dry seasons. This observation could be attributed to three reasons which include: the farmers growing a mixture of annual and perennial crops with different phenological characteristics that provide a variety of foraging opportunities across seasons, and the third reason being crops such as sugarcane occurring throughout the year being attacked

by primates regardless of the age of the plant (Tweheyo et al., 2005). Irrigated crops become a primary target for the monkeys (Ukizintambara, 2008) where they cause massive losses. Most of the incidences of crop raiding activities were noted to occur in the mornings and evenings, an observation similar to other research findings on temporal crop raiding behaviour of a number of other non-human primates such as L'hoest's monkey (Ukizintambara, 2008), Assamese macaques (Regmi et al., 2013) and Orangutans (Campbell-Smith et al., 2011). Olive baboons have also been observed to forage more frequently in the morning and grivet monkeys in the afternoon (Deneke et al., 2024). However, it is important to note that most primates are able to alter their behavioural strategies resulting in change in ranging patterns and group size (Hill, 2018), and therefore farmers are faced with the challenge of noting such changes in order to protect their crops effectively.

We found that the farmers grew a wide variety of crops but twelve types of crops were mostly targeted by the vervet monkeys. This attests to the rich diversity of crops that characterizes the mixed type of cropping practiced in the area (Wawire et al., 2021). In the study area, maize is commonly grown alongside with beans by the majority of the households but unfortunately this is the crop that is mostly targeted by the vervet monkeys. Most non-human primates have been known to target maize causing devastating losses to farmers (Hill, 2017). In this study, it was reported that some farmers lost more than 75% of the crop. The study also found that other cultivars such as beans (*Phaseolus vulgaris*), vegetables such as kales (*Brassica oleracea*) and tomatoes (*Solanum lycopersicum)*, and bananas (*Musa sp*) were also targeted which agrees with other reports that non-human primates are able to access and consume a wide range of cultivars (Osborn & Hill 2005) because of their high dietary and behavioral flexibility (Hohmann, 2009).

Among the cash crops, macadamia (*Macadamia integrifolia*) was most prone to depredation by the monkeys and the respondents reported that the monkeys consumed the young nut leading to heavy losses. Given the hilly terrain of the landscape, most of the farmers grow the macadamia in the relatively steep areas where other crops such maize cannot do so well. Down in the ridges, the macadamia trees are most vulnerable to depredation. This scenario mirrors the challenge faced by farmers in countries like South Africa, - the world's largest producer of macadamia (Weier et al., 2020), where farmers experience high crop raiding pressure from vervet monkey inhabiting patches of natural vegetation in and around agricultural lands (Linden et al., 2019). The report shows that on average, the macadamia farmers suffered losses of about USD 66.44 (SE = 6.65) compared to maize USD 41.77 (SE = 1.53). Although the actual losses are difficult to ascertain, these figures signify a substantial loss for the farmers who depend heavily on what they can get from their relatively small farms. Considering that maize is one of the most significant food crops in Kenya (Mwendwa et al., 2025), and that it is the staple food for the community, the losses caused by vervet monkeys are a serious threat to food security in the community especially considering that some farmers had been forced to abandon maize farming.

The results revealed that the community perceive vervet monkeys as a notorious pest in their farms from which they do not derive any benefits. However, it was observed that some members of the community consumed vervet monkey meat opportunistically. Although this could not be ascertained because of unwillingness of the participants to disclose more information and in recognizing that in Kenya, it is illegal to hunt and kill wildlife including those that are perceived as agricultural pests. We found that the community perceive loss of food as the main problem associated with vervet monkeys in the study area. The loss of food crops such as maize, beans and bananas can have a serious negative impact on nutrition of vulnerable members of the community. The problem is compounded by the losses incurred on cash crops such as macadamia which is an important source of income to some households.

Protecting the crops by guarding has been reported in some studies as being effective (Adeola et al., 2018) as well as in this study. However, the method has been criticized for being labour intensive and requiring a lot time that could be allocated to other meaningful socio-economic activities (Hill, 2000; Tweheyo et al., 2012). Moreover, cutting down trees and clearing of bushes against the will of the landowners could undermine social cohesion within families and the community at large. Although such indirect costs are difficult to quantify, they can significantly impact people's socio-wellbeing (Hill, 2018). In addition, the interpersonal conflicts discourage people from agroforestry since its supporters were perceived as 'enemies of the people' because of creating habitats for the monkeys. Such perceptions have been reported elsewhere in Ethiopia where rural forests were perceived as a source of pests and wild mammals that affect crops and livestock (Dorresteijn et al., 2017). This kind of sentiment was also shared by a respondent who lamented that '*some community members who love agroforestry have been blamed for providing habitats for the monkeys that are invading crops and impoverishing the community*.' Although farmers in Maara Sub-County practice agroforestry (Mugambi et al., 2024), the current invasion of their farms by vervet monkeys is likely to undermine the gains achieved from planting trees and might encourage deforestation.

Our findings indicate that methods such as hunting, continuous guarding, use of dogs, poison and installing scarecrows are used to protect crops from vervet monkeys in the study area. However, hunting and killing wildlife including monkeys is unlawful but cases of community members retaliating and killing wildlife in the country are common (Muriuki et al., 2017). In many instances, community members have blamed the government from being too slow to respond to the threats caused by wildlife (Ontiri et al., 2019). The fact that most of the respondents felt that killing the vervet monkeys was most effective method of dealing with the problems shows extreme negative attitude towards the animals and has been reported in many other areas where human-wildlife conflicts occur (see Muriuki et al., 2017, Mukeka et al., 2022).

The results also show that people use dogs to protect their crops. Dogs are known to be effective in detecting crop raiders before humans (Hsiao et al., 2013 but very few households had dogs. In addition, it was claimed that some groups of monkeys had learnt how to avoid dogs especially if the dog was tethered on a particular point in the farm. Some community members used poison to control vervet monkeys although its use as a control strategy raises a lot concern especially considering that some pesticides are known to cause serious environmental damages including killing of non-target species (Bamal et al., 2024). Kenya has a comprehensive legislation against the use of poisons and pesticides to control wildlife, but cases of animal poisoning are common (Odino & Ogada, 2021) and are regarded as a serious threat especially to carnivores (Didarali et al., 2022) and non-target animals such as vultures, (Plaza & Lambertucci, 2021). Therefore, there is need for further evaluation of the use of this strategy in the study area.

Other mitigation strategies like shouting and chasing the monkeys were reported to be effective by 52% of the respondents. However, some of the respondents reported that *this method required a lot time and some groups of vervet monkeys would not move away when women and children tried to chase*

them away. Although use of scarecrows was the least effective method used by the community to mitigate crop raiding by vervet monkeys, it is used in many places in Africa and Asia as an effort to mitigate crop damages by primates (Marchal, & Hill, 2009).

Conclusion

Based on the findings from this study, numerous groups of vervet monkeys are found in woodlots far from the forest boundary where they have access to crops. As a result, there are numerous cases of human-vervet monkey conflicts which have been on increase over the last ten years and are negatively affecting the livelihood of the community. The monkeys cause serious losses to crops especially maize and macadamia and in the process are undermining food security and socio-economic wellbeing of the community. They also contribute to loss of vegetation cover by forcing farmers to clear trees and bushes in a desperate effort to keep the monkeys away from their farms. In addition, we report cases of household conflicts arising from the implications of the vervet monkeys. Generally, the community perceive vervet monkeys as wild animals with no conservation benefit to them. The revelation that they consider hunting and killing them as the best strategy to handle the conflict shows a serious negative attitude. This is understandable given that there no provision for compensation for losses caused by non-human primates in Kenyan legal framework. The community employs a variety of methods to protect their crops but with marginal success. This therefore necessitates considerations of agricultural farmlands near forested areas as possible future biodiversity hotspots especially if approaches used to control wildlife are lethal. The government as well as surrounding communities should gear towards promoting conservation friendly multiapproach in the control of velvet monkeys and other primates, ranging from planting more sacrificial fruit trees/crops near the periphery of the forests while most preferred crops by primates be planted further away from forest edges, among other mitigation approaches. Moreover, humans should be discouraged from deforestation activities which diminish wildlife habitats/food sources leading them to colonize farmlands.

Declarations

Ethical declaration: All participants provided written informed consent after being briefed on the study objectives, their voluntary participation, and the confidentiality of their responses. The research adhered to the principles of the Declaration of Helsinki.

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

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Figures

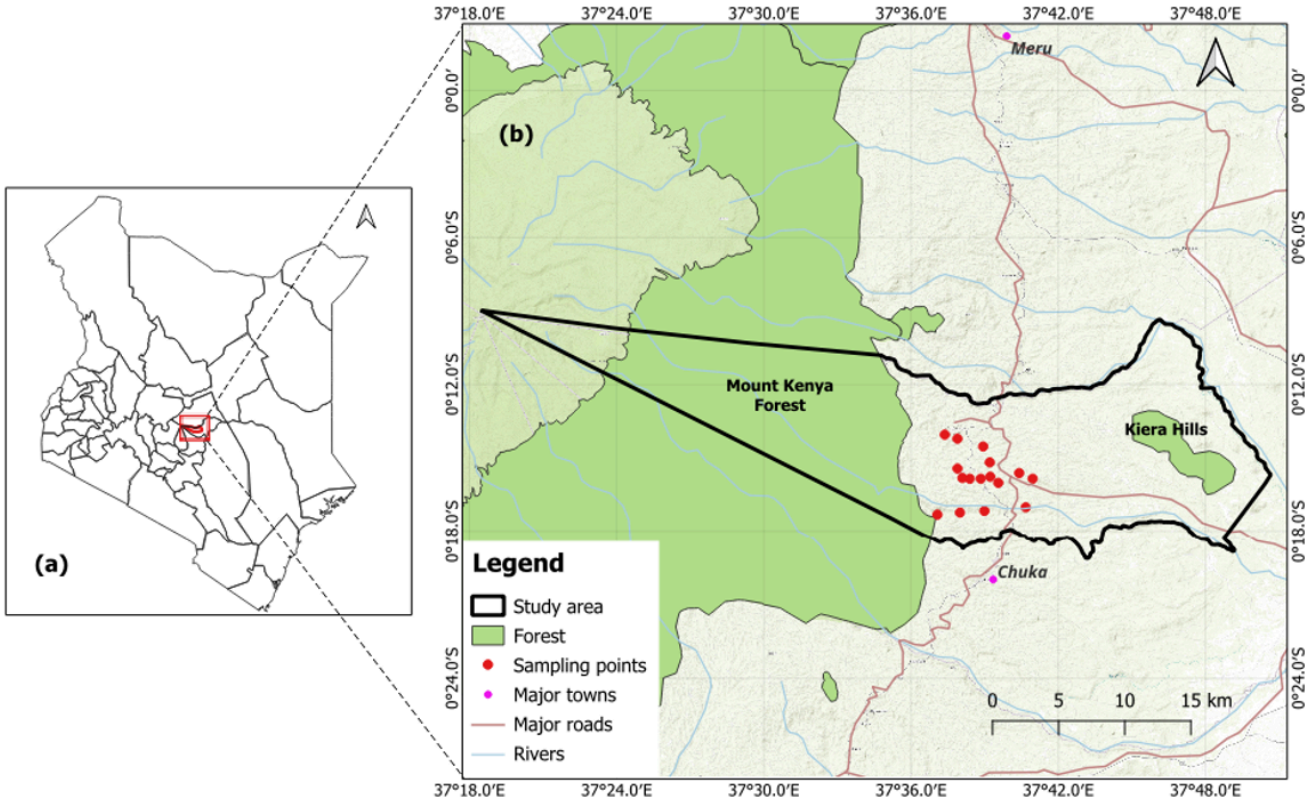


Figure 1

Map showing (a) The location of Maara Sub County in Kenya, (b) Sampling points on Eastern side of the Mount Kenya Forest

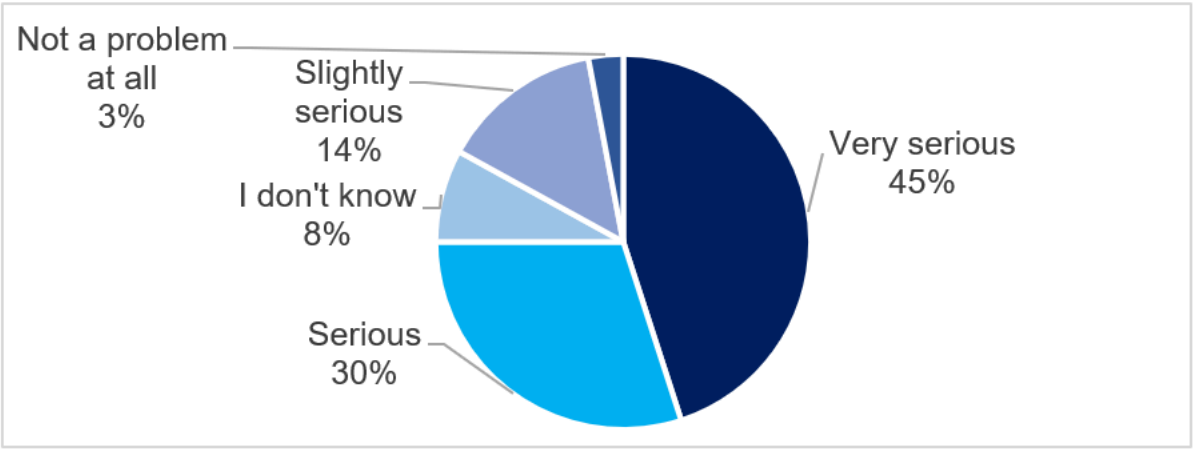


Figure 2

Responses concerning the extent to which vervet monkeys are a problem to the farmers

Implications of crop raiding behaviour

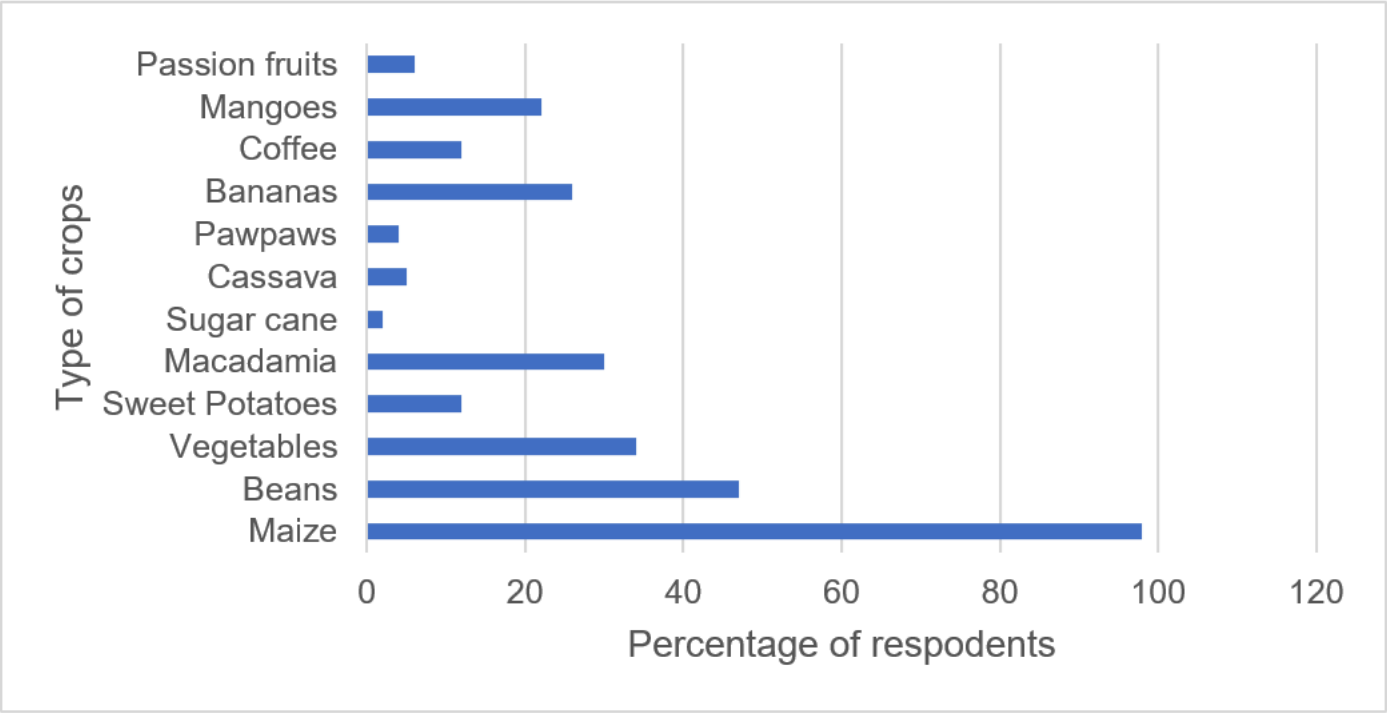


Figure 3

Types of crops mostly targeted by vervet monkeys in Maara Sub-County

pes of crops mostly targeted by vervet monkeys in Maara Sub-County

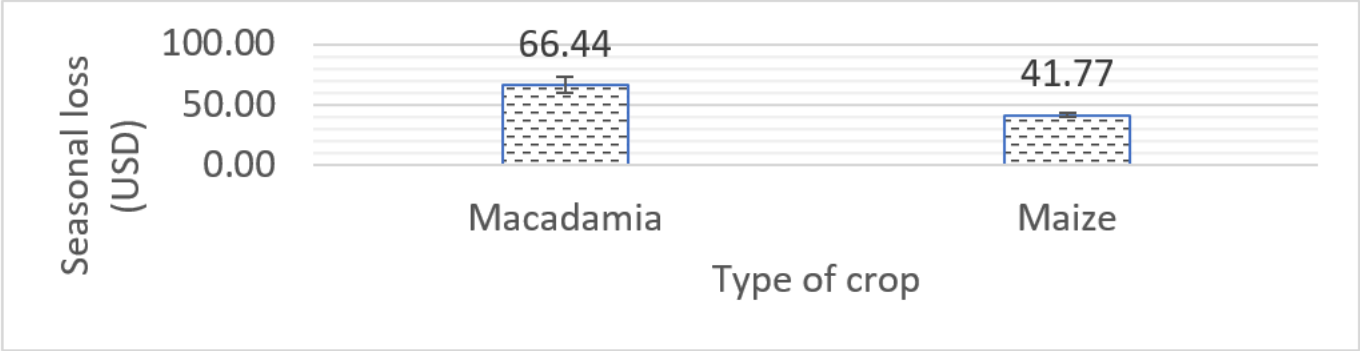


Figure 4

Seasonal losses in macadamia and maize that were attributed to vervet monkeys by the respondents in Maara Sub County

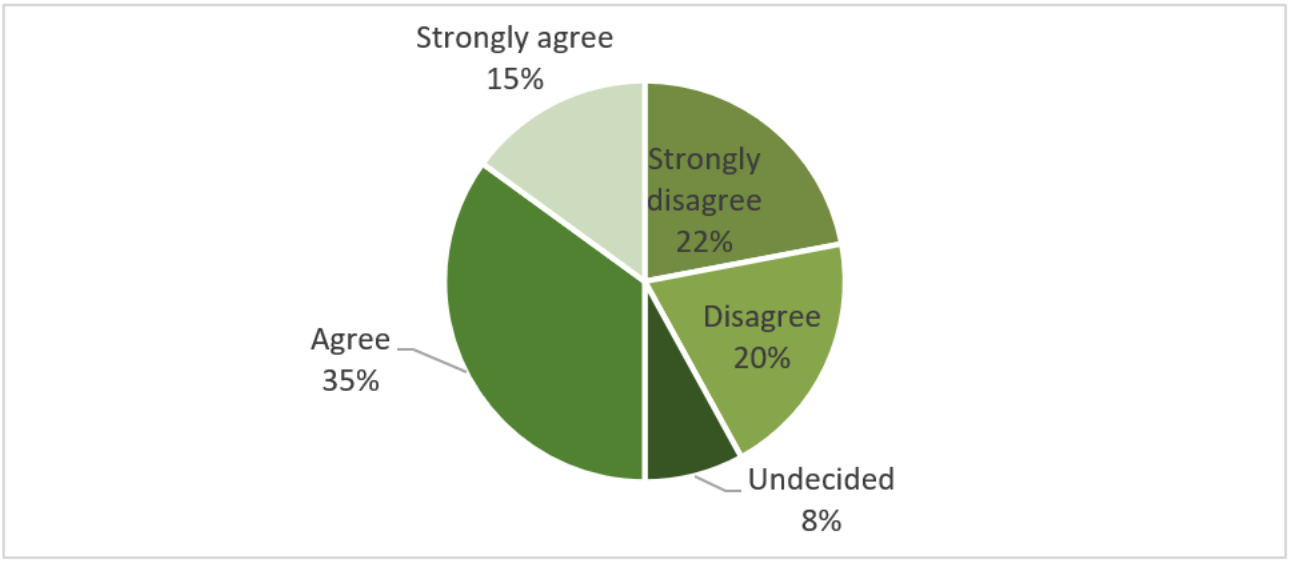


Figure 5

Responses on whether some members of the community consume meat from vervet monkeys in Maara Sub County

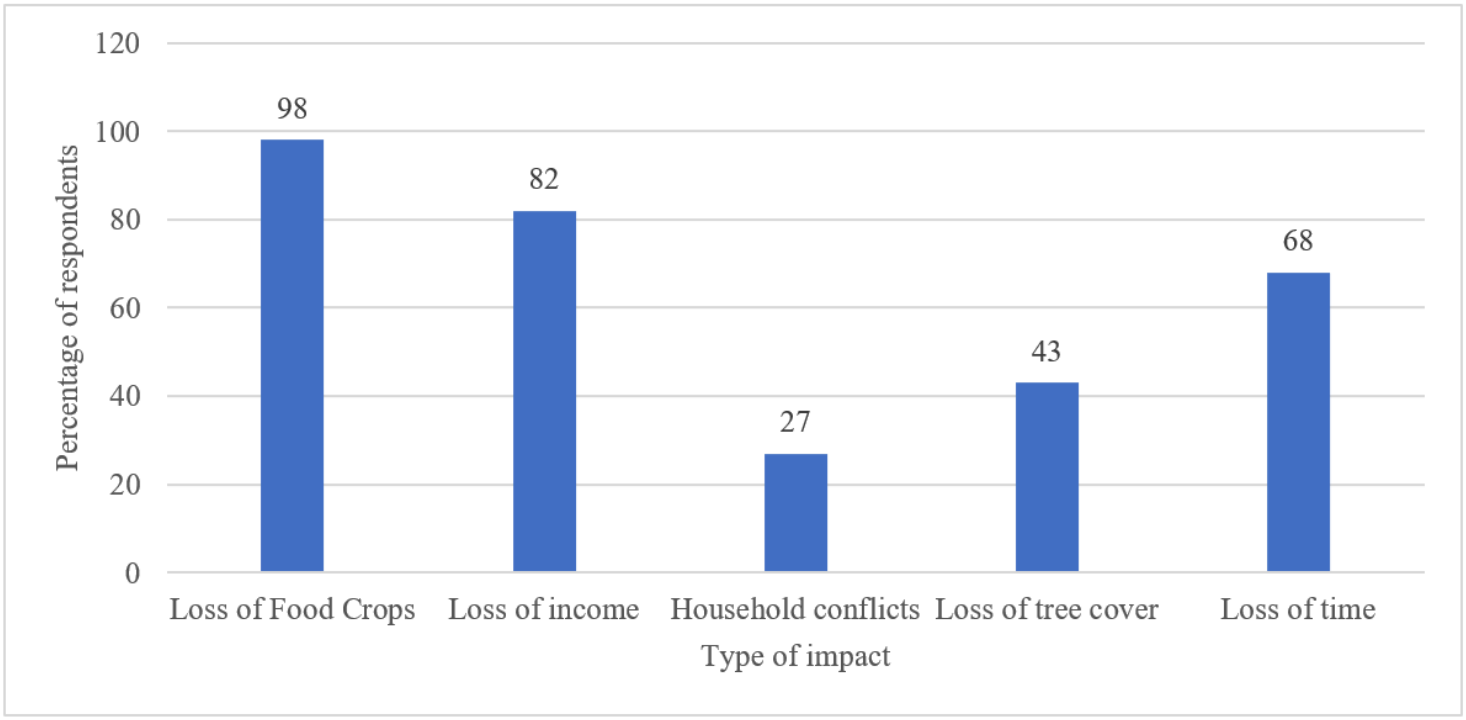


Figure 6

Perceptions about the impacts of vervet monkeys to the local community in Maara Sub County