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ASSESSING FARMERS' PERCEPTIONS OF CROP RAIDING INCIDENCES BY LARGE MAMMALS AROUND VOLCANOES NATIONAL PARK, RWANDA

A thesis submitted in partial fulfilment of the requirements for the degree of Master in Biodiversity Conservation and Natural Resource Management

By

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Kigali, October 2024

Declaration

I, Noel KWIZERA, hereby declare that this master's thesis titled "Assessing Farmers' Perceptions of Crop Raiding Incidences by Large Mammals Around Volcanoes National Park, Rwanda" is my original work, conducted in partial fulfillment of the requirements for the Master's degree in Biodiversity Conservation and Natural Resources Management at the University of Rwanda, College of Science and Technology. This work has not been submitted for any other degree or academic qualification at this or any other institution. All sources of information and references used have been duly cited and acknowledged.

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APPROVAL

I certify that this research project entitled "ASSESSING FARMERS' PERCEPTIONS OF CROP RAIDING INCIDENCES BY LARGE MAMMALS AROUND VOLCANOES NATIONAL PARK, RWANDA" was done under my supervision and has been submitted for examination with my approval.

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DEDICATION

To the God Almighty

To my parents

To my brothers and sisters

ACKNOWLEDGEMENT

I would like to thank my family for their unwavering support throughout my academic journey. Their encouragement, advice, and prayers have been a constant source of motivation for me.

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PA: Protected Area

VNP: Volcanoes National Park

HWC: Human wildlife conflict

IUCN: International Union for Conservation of Nature

RDB: Rwanda Development Board

DFGF: Dian Fossey Gorilla Fund

ABSTRACT

Crop raiding causes human-wildlife conflicts across Africa, negatively affecting people's livelihoods and conservation efforts. Here, I present a case study focusing on the landscape adjacent to Volcanoes National Park (VNP), Rwanda, home of several globally threatened large mammals and an area that has experienced an increase in crop-raiding incidences over the past decade. In 2022, I used surveys and focus group discussions to assess farmers' perception of these crop-raiding incidences, the results of which I subsequently compared to the findings of an earlier survey conducted a decade ago. Two overarching research questions were addressed: 1) what are the understandings and opinions of farmers about the socio-economic effects of crop-raiding on their livelihoods 2) how have farmers' perceptions of crop-raiding changed over time? By using perpendicular line transects of one kilometer (km) from the park edge, respondents were sought every circa 200 meters, while also maintaining a one km distance between transects. The majority of farmers reported experiencing an increase in crop-raiding incidences over the last decade. Some respondents perceived that they nowadays experience animal visits almost every single day and that this increase in crop-raiding incidences is linked to an increase in wildlife population inside the park, insufficiency of food inside the park, inadequate defense/physical deterrent, insecurity inside the park, the small park size, and an increase in the availability of palatable crops planted around the park. The most frequent crop raiders reported by farmers are african buffaloes (*Syncerus caffer*) and golden monkeys (*Cercopithecus mitis kandti*). Mountain gorillas (*Gorilla beringei beringei*), which were reported to damage various tree species in farmer's fields, were not thought to pose a significant threat to crop production, while black-fronted duikers (*Cephalophus nigrifrons*), bushbucks (*Tragelaphus scriptus*) and african elephants (*Loxodonta africana*) were the least reported and were also thought to cause less crop damage. According to respondents, crop-raiding affected food availability and induced additional opportunity costs such as a loss in dietary diversity, and monetary losses which led to an inability to afford health insurance and school fees for their children. Farmers expressed their dissatisfaction with a compensation scheme implemented to support those who suffer crop damage. Although some farmers claim to have received some compensation for damages incurred, they do not perceive it to adequately cover the value of their crop losses. Some reported that it takes a long time to receive compensation after crop losses have been verified. Although most of the farmers reported that they protect their crops against raiders, they felt that the current rise in crop-raiding incidences was something they could no longer manage on their own in the future. These findings reveal that farmers perceive crop-raiding to be an increasingly large and frequently occurring problem, findings that coincide with actual incidence reports. This increase is also noticeable when comparing perceptions in 2022 with those a decade ago.

CHAPTER 1: INTRODUCTION

1.1 Background

Human-Wildlife Conflicts (HWC) across the globe, negatively affect people's livelihoods and wildlife (Treves et al., 2006). In Africa, HWC has been one of the most frequently cited problems, as revealed by various studies conducted across different protected areas (FAO, 2009; Gemeda & Meles, 2018). These conflicts may vary depending on the types of wildlife and people involved, as well as the problems they create. For example, conflicts may occur when carnivorous species leave the park to attack and kill domestic livestock owned by local communities (Treves & Karanth, 2003), or when animals from the park forages on agricultural crops cultivated by farmers on land adjacent to the protected areas (Fehlmann et al., 2021). On the other hand, conflicts may occur when farmers retaliate against animals that have foraged their crops. Although the forms of HWC may differ, they all occur when interactions between people and wildlife result in harm that is intolerable to one or both parties (Conover, 2002).

Crop raiding is a common form of human-wildlife conflict across Africa, particularly around protected areas (Gemeda & Meles, 2018). It occurs when wild animals damage farmer's crops either by foraging or trampling on them. Studies have identified various factors that contribute to crop raiding. For example, animals may forage on crops near protected areas because these croplands are in close proximity to their home range, making access easier. Additionally, the crops planted around the park may be highly preferred by the animals, attracting animals to the area (Naughton-Treves et al., 1998). The increase in crop raiding could also be due to a reduction in the food available within the park, which is insufficient to meet the demands of the animal population (van der Hoek et al., 2019).

Crop raiding may be influenced by the ineffectiveness of current mitigation measures. Some protected areas use physical barriers such as walls, ditches, and electric fences to prevent animals from entering nearby farms and damaging crops. However, these measures may not be fully effective. While physical barriers can help prevent crop raiding by large animals around PAs, they are often ineffective against smaller animals, such as golden monkeys, which can easily jump over these barriers. Studies have also revealed that the maintenance cost of physical barriers around PAs is often high (Hsiao et al., 2013). This is problematic because the physical barriers are frequently destroyed by large animals from the park or other factors over time. Active guarding is another common and effective measure to prevent crop raiding around

protected areas PAs (Killion et al., 2021). This is often carried out by household members or hired personnel. In addition, compensation has been used to mitigate the impact of crop raiding by providing payments to those affected after the damage occurs. However, compensation is often criticized for failing to deliver timely and adequate payments compared to the actual crop losses. Additionally, it can create a moral hazard, as individuals may intentionally expose their crops to animals in order to receive compensation (Shilongo et al., 2018).

Crop raiding negatively impacts farmers' livelihoods in various ways. Studies have shown that, in addition to crop losses that can lead to food insecurity, other adverse effects include the opportunity costs associated with this conflict. For example, some studies have shown that guards often spend extended periods in the fields to protect crops, which can sometimes expose them to zoonotic diseases (Barua et al., 2013). Due to crop raiding, some farmers around protected areas have stopped growing certain preferred crops because these crops are particularly vulnerable to animals from the PAs. Additionally, the study found that some farmers have their children guard the crops, which often leads to lower school attendance and negatively affects their academic performance.

Addressing human-wildlife HWC requires a variety of approaches and a focus on long-term solutions. These approaches should include scientists, park managers, local communities, government officials, and non-governmental organizations (IUCN, 2023). As with conflicts between people, it is crucial to understand each party's perspective and role before pursuing reconciliation. Scientists contribute by conducting studies, such as those examining the perceptions of individuals who suffer from crop losses (Dickman, 2010). These studies offer a comprehensive understanding of the experiences of those directly affected and the extent of the problem, which can then inform the development of more effective solutions. Studies have shown that solutions for human-wildlife conflict should focus on preventing and mitigating the negative effects of crop raiding or, at the very least, increasing tolerance towards the animals that cause crop damage (Treves & Naughton-Treves, 2009).

A study conducted a decade ago around Volcanoes National Park (VNP) in Rwanda provided a comprehensive understanding of farmers' perceptions of crop raiding (Mc Guinness, 2014). Since then, this land adjacent to the park has seen an increase in crop-raiding incidents over time. This study aims to understand the current perceptions of crop raiding among farmers around VNP and compare these perceptions with findings conducted a decade ago.

1.2 Problem statement

Large mammals in Volcanoes Nationa Park (VNP), many of which are threatened and of high conservation value, were known to be decreasing until through the 90s, due to different threats including poaching, illegal resource use as well as land-use change. Since 2000, the number of large mammals started to show a positive trend, and this increase was coupled with expansion gradually, according to current surveys conducted inside VNP (Twahirwa et al., 2023). This increase is believed to be directly linked to the rising reports of crop-raiding incidents, which may have negatively impacted conservation efforts involving the local community around VNP (Dian Fossey Gorilla Fund unpub. data). Although measures such as building a stone wall, active guarding, and establishing a compensation scheme were implemented to reduce crop-raiding, the problem persists. It remains unclear whether the current increase in crop-raiding incidents is due to the rising numbers of large mammals inside the park, the intensification of agriculture outside the park, changes in animal behavior, or heightened scientific interest. A study conducted a decade ago revealed much about farmers' perceptions around VNP. However, perceptions may have changed over time. Therefore, there is was a need to conduct a similar study to understand the current perceptions of crop-raiding and to compare these with the findings of the previous study to identify any changes in perception.

The current study will focus on assessing farmers' perceptions of crop-raiding caused by six mammal species found in VNP: The Mountain gorilla (*Gorilla beringei beringei*), african savanna elephant *(Loxodonta africana*), african buffalo (*Syncerus caffer*), bushbuck (*Tragelaphus scriptus*), golden monkey (*Cercopithecus mitis kandti*), and black-fronted duiker (*Cephalophus nigrifrons*).

1.3 Objectives

1.3.1 Main objective

Understanding farmers' perceptions of crop raiding incidences by large mammals around Volcanoes National Park

1.3.2 Research questions

1) What are the understandings and opinions of farmers about the socio-economic effects of crop-raiding on their livelihoods?

2) How have farmers' perceptions of crop raiding changed over time?

CHAPTER 2: MATERIALS AND METHODS

2.1. Study area

Volcanoes National Park (VNP) is part of the Virunga Massif Transboundary Protected Area situated in the northern part of Rwanda (Map illustrating the study area and the locations of respondents along the transects around Volcanoes National Park.

). It is home to several globally threatened large mammals including mountain gorillas. It borders with Uganda to the northeast and the Democratic Republic of the Congo (DRC) to the northwest (Mc Guinness, 2016). It includes a variety of montane habitats, from closed forest to open Alpine vegetation, across an elevation range from 2,500 to 4,500 m a.s.l. (Plumptre et al., 1997). The park spans twelve sectors across the districts of Rubavu, Nyabihu, Musanze, and Burera, all located in the north-northwest part of the country (Figure *1*).

Communities around VNP were known to rely on the park's resources, particularly for hunting, extracting wood and non-wood products, and collecting water for domestic use within the park (Munanura et al., 2018). The park management collaborates with local communities to conserve the park while also providing a portion of the tourism revenue, which is used to support local cooperatives and improve community livelihoods (Munanura et al., 2016).

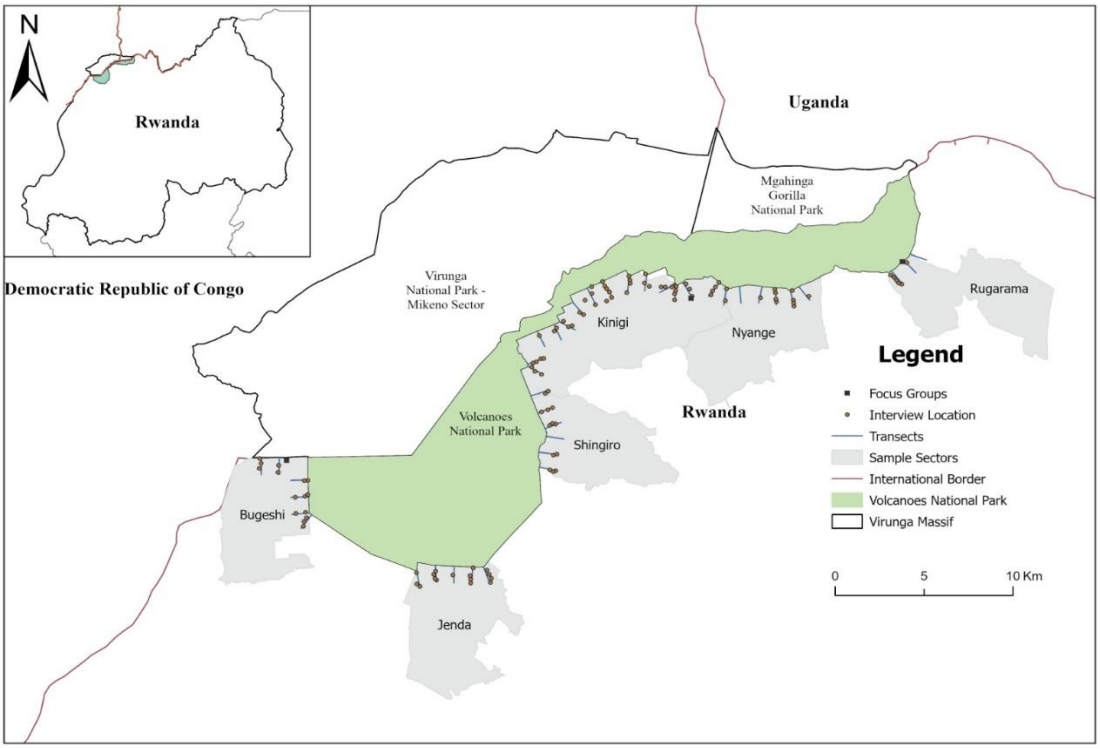

Figure 1: Map illustrating the study area and the locations of respondents along the transects around Volcanoes National Park.

2.2 Data collection

2.2.1 Household surveys

During data collection, I replicated the methodology used in a previous similar study conducted around VNP (Mc Guinness, 2014). During three months between March to June, 2022, with the help of two research assistants, I conducted surveys among the local farmers around VNP from six sample sectors namely Rugarama, Nyange, Kinigi, Shingiro, Jenda, and Bugeshi. By using perpendicular line transects of one kilometer (km) from the park edge, respondents were sought every circa 200 meters, while also maintaining a one km distance between transects. Following this pattern, and by using a GPS device, a total of 40 line transects were identified along the sample sectors, and yielded six transects in Bugeshi, five transects in Jenda, six transects in Shingiro, fifteen transects in Kinigi, five transects in Nyange, and three transects in Rugarama. Adult household heads were the primary respondents interviewed. In cases where they were unavailable, any household member aged 18 or older with knowledge of past crop-raiding incidents was selected. I intended to interview respondents in their households, however, in cases where respondents were at their farms, which were a bit far from their homes, I conducted the interviews on the farm while they continued their activities. I collected raw

data using an audio recorder after the respondents were introduced to the study and provided voluntary consent. They were assured of the confidentiality of the recorded data and informed that it would be used exclusively for this research. Data collection employed a semi-structured questionnaire administered to respondents in sampled sectors. I asked follow-up questions to obtain clarification or additional information when responses were unclear or incomplete. The questionnaire for the focus group meetings is included in the appendix.

A total of 110 farmers were interviewed using surveys from 37 transects across six sample sectors, where 45 % (N=50) were female and 55% (N=60) were male. The average household size of respondents was five people, and interviews lasted an average of 29 minutes. Out of 40 original transect lines, respondents were found in only 37 transect. No respondents were found in the three transects located in the Shingiro, Nyange, and Rugarama sectors. Some transects yielded fewer respondents, especially in areas where farmers were relocated or where other activities such as hotel construction have replaced agricultural activities.

2.2.2. Focus group discussions

After surveys, I also conducted six focus group meetings from three sectors namely Rugarama, Kinigi, and Bugeshi. Three of the focus groups were for males, while the other three were for females Each focus group had an average of five participants, and each meeting lasted about one hour. Participants in focus groups were selected based on their wealth categories to ensure a diverse mix. A semi-structured questionnaire was used to assess farmers' perceptions of these crop-raiding activities. I also asked follow-up questions to obtain clarification or additional information when responses were unclear or incomplete. The questionnaire for the focus group meetings is included in the appendix.

2.3 Data analysis

I transcribed and translated all raw recordings from both administered surveys and focus groups into English. I created a dataset of quantified numerical and categorical data in an Excel sheet, which I then imported into R programming software for further manipulation and statistical analysis. Textual data were coded and organized manually into themes using Excel for qualitative analysis.

CHAPTER 3: RESULTS

3.2 Priority problems in the study area

During focus group meetings, I asked farmers to list their top priority problems in their locality. After the problems were listed, I asked them to rank each priority problem by pairwise ranking. The results from focus groups identified thirteen problems from six focus groups (**Error! Reference source not found.**). Some of the problems were commonly identified among all focus group meetings while other problems were specific to a particular gender or sector. Two problems were commonly cited among all six focus group meetings, and they include crop-raiding and lack of fertilizer/pesticides. There have been instances where a problem was listed constantly but outranked when farmers were asked to rank it together with problems mentioned (Figure *2*).

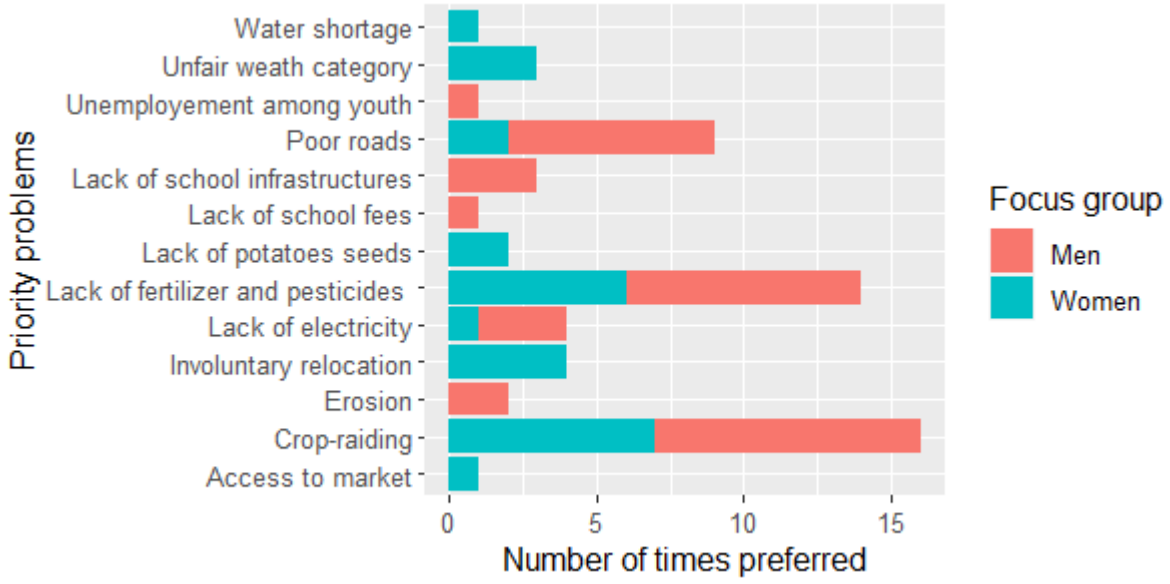

Figure 2: Identified priority problems recorded within the community in the sample area, around Volcanoes National Park, Rwanda

3.3 Animal crop pests reported

I asked respondents if they had ever experienced crop-raiding, and all of them (N=110) reported having faced at least one crop-raiding incident at some point (**Error! Reference source not found.**). Buffaloes and golden monkeys were the most frequently reported animals, with the majority of incidents occurring in the Kinigi sector (Figure *3*). Of 110 farmers, 91.81% (N=101) reported buffalo visits, 59.09% (N=65) experienced golden monkey visits.

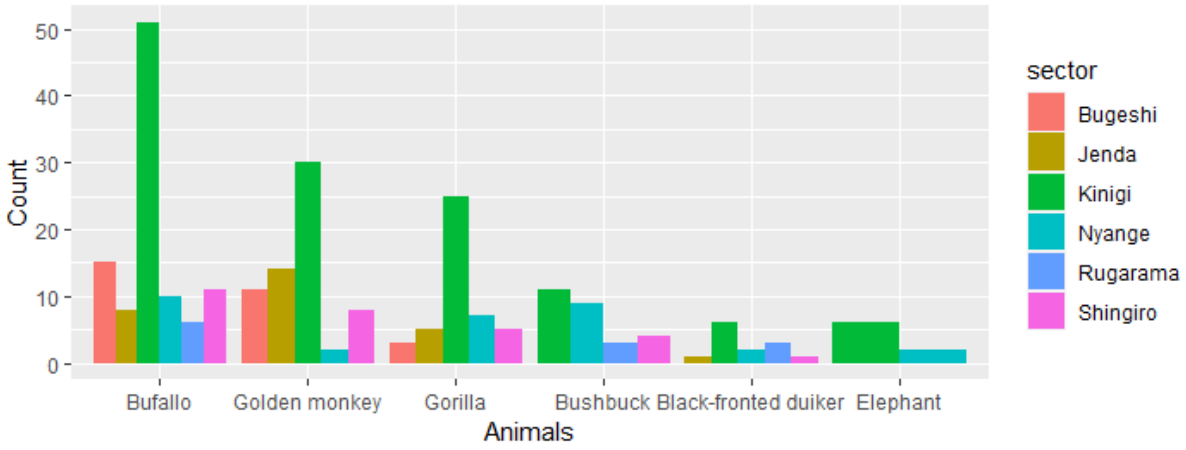

Figure 3: Number of reported crop raiding incidences reported aggregated per wildlife species, around Volcanoes National Park, Rwanda

According to the farmers interviewed in this study, buffalos and golden monkeys cause more crop damage than any other animals. Gorillas have been blamed for mainly causing Eucalyptus

tree damage**. "***They (Gorillas) only come and damage the Eucalyptus trees" _MT-120622-01*. Farmers placed less blame for crop damage on black-fronted duiker, bushbuck, and elephant.

3.4 Causes of crop-raiding

I asked farmers about their perceptions of what causes animals to visit their farms to raid crops, and different opinions were reported. The most perceived cause of crop raiding was the lack of food inside the park (58.18%), *"The animals come to raid our crops because there is no food available inside the park" _ KMFG.* The decline of bamboo shoots inside the park was cited by farmers to be the cause of this lack of food. "*Bamboo shout regenerates in April and September, and in the meantime, buffalos come to raid our crops heavily because they lack food" _BWFG.* Other factors that farmers perceived to be the causes of crop raiding include a preference for cultivated crops (18.18 %), open space enjoyment (17.27%), inadequate defence (11.81%), numbers of animals increasing (6.36%), small park size (4.54%), insecurity inside the park (2.72%), while 8.18% of respondents reported "do not know" any reason why animals raid their crops.

3.5 Socio-economic impacts of crop raiding – Asset loss

3.5.1 Crop loss

Farmers reported significant losses in crop production due to animal raiding. Potatoes (*Solanum tuberosum*) were the most frequently damaged crop, followed by maize (Zea mays) and pyrethrum (*Chrysanthemum cinerariaefolium*) (Figure *4*). Crop losses were attributed not only to animals foraging but also to damage from trampling. Pyrethrum which is one of the most affected by crop pests is a popular crop in the area, grown on consolidated lands as instructed by the government. Any farmer participating in the consolidated land program around VNP is required to grow this crop for at least one whole year. Afterward, they are allowed to plant any other crop of their preference for the next season. These shifts must be alternated each year as one farmer stated: "*We know when to rotate crops and when it is time to grow pyrethrum in a particular year" _MT-090522-01*.

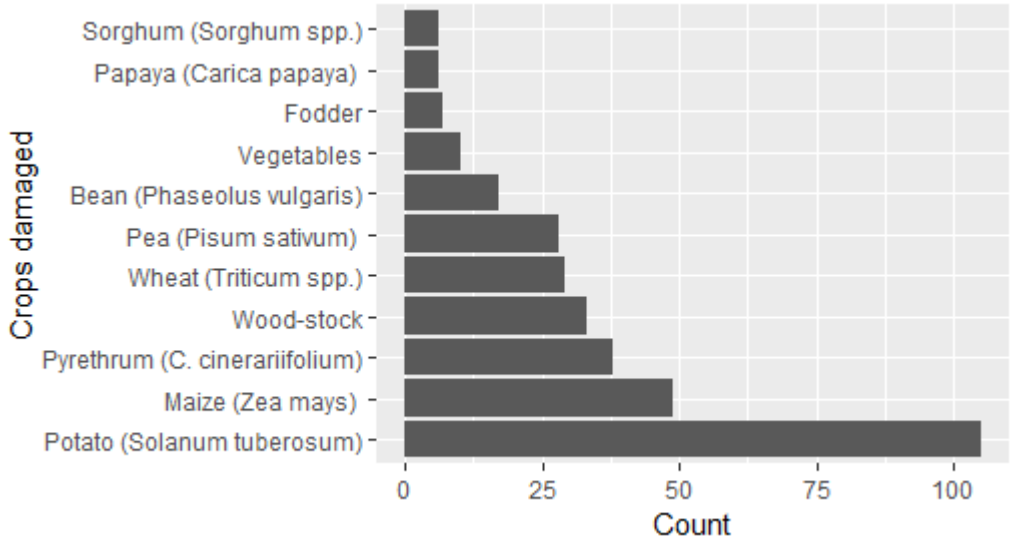

Figure 4: Frequencies of crops affected by wildlife crop-raiding around Volcanoes National Park, Rwanda

3.5.2 Perceived value of crop losses

Some farmers were able to estimate the value of crop losses they experienced while others were not. Of 110 who were asked to estimate the value of their crop losses in terms of money during the previous year, only 69.09 % (N=76) were able to estimate their losses (**Error! Reference source not found.**). The average value of crop loss per season as estimated by farmers was 159,750 Rwandan francs (SD=144,101.2), with a minimum value equal to 6,000 Rwandan francs (Rwf), and a maximum value equal to 700,000 Rwf.

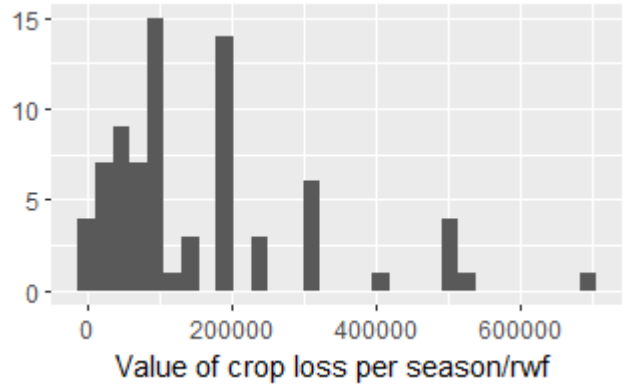

Figure 5: Estimated value of crop losses per household by season (three months period), around Volcanoes National Park, Rwanda

3.6 Socio-economic impacts – development and opportunity costs

3.6.1 Loss of dietary diversity

During focus group discussions, farmers claimed to have stopped cultivating some crops in recent years due to their higher vulnerability to animals. In addition, some farmers mentioned during surveys that they are restricted by the government from practicing intercropping. As a result, 79% reported that they no longer engage in intercropping, which exacerbates the problem.

3.6.2 Inability to pay health insurance and school fees

During focus group meetings, farmers mentioned crop raiding to be the cause of their lack of money to pay for health insurance (Mutuel de sante) and to afford the payment of school fees. *"We are going hungry and don't have enough money to pay for health insurance because of crop raiding. These days, our children's school fees are extremely expensive, and we are unable to pay them" _RWFD.*

3.6.3 Opportunity cost

Active guarding of farmers' fields was a response to limit crop-raiding by wildlife from the park, and mostly requires farmers to spend day and night in the field. Active guarding during the day was cited to be done to prevent golden monkeys while guarding during the night is mostly done to prevent crop raiding by buffalos. "*No one in this region can sleep well, but we must be vigilant at all times because animals may come to raid our crops at any time "_KMFD.* Farmers sometimes have to send their children to guard crops in their absence, something that

might affect children's performance at school and expose them to diseases. Additionally, some farmers reported to have stopped growing certain crops, such as maize, because they are highly vulnerable to crop raiding.

3.7 Perceived current mitigation measures and their limitations

3.7.1 Active guarding

I asked farmers whether or not they guard their crops, and 97 farmers (88.18%) said they did, while 13 farmers (11.81%) said they did not. Guarding was reported to be done by farmers themselves (39.17%), employed children (16.49%), employed adults (71.13%), and farmer's children (6.18%). There have been instances where farmers reported that they employed more than one of the aforementioned guard categories to protect their crops. Guarding is reportedly done by making noise to chase away animals and using a torch, especially at night. Additionally, farmers often construct small huts to stay in while protecting their crops from animal pests.

One of the limitations of active guarding reported by farmers was that they have to spend most of their time in the field protecting crops because when they are away for a certain moment, animals would come and destroy crops**.**

3.7.2 Physical barriers

The use of a stone wall and trenches around the park's edge was cited frequently among focus groups and surveys as one of the current mitigation measures across sample sectors. A stone wall of one meter in height was built across most parts of the park's edge to limit animals from visiting farmer's fields. Respondents in the Rugarama sector, particularly, claimed that there is no stone wall between the park and their farms to prevent animals from reaching their fields.

Farmers claimed that while at a certain point, this physical barrier made of stone wall kept buffalos out, it was reported to be ineffective against golden monkeys which could easily climb it and then cross out of the park**.** The existing stone wall, made of volcanic stones without cement, does not appear strong enough to prevent buffaloes, which farmers consider extremely powerful animals. This assessment is based on both farmers' reports and my field observations**.** It was reported that in some areas this wall had been destroyed and had since become a path for animals to leave the park and damage farmers' crops. During focus group meetings, farmers

have suggested that constructing a sturdy cement wall along the park's edge could be a viable solution to crop raiding. For some farmers, that would be better than even compensating them for crop losses they experienced.

3.7.3 Compensation

During surveys, 35% of respondents reported receiving compensation after experiencing crop raiding. Additionally, in focus group meetings, farmers frequently mentioned the compensation scheme as a new mitigation measure introduced by the government within the last ten years to address the problem of crop raiding. Farmers also reported some limitations attached to this compensation scheme; for example; even for those who receive compensation, the amount of money they receive as payment tends to fall below what farmers lose in crop loss. "*The compensation we are receiving is tiny in comparison to the value of crop loss." _KWFGD.* Farmers reported that the park management took a long time to verify the amount of crop losses, which caused delays in payment. "*It takes a very long time for the authorities to reach our farm after crop-raiding occurs, delaying the compensation process*" *_MT-160622-01*. The length of time it takes for the park to assess farmers' claims following crop-raiding activities discourages some from even trying to ask for compensation as reported by farmers**.**

3.8 Perceived increases in crop-raiding activities

During surveys, most farmers 67.27% (N=74) reported that crop raiding was an increasingly large and frequently occurring problem in the last decade, while 32% (N=36) perceived a decrease in crop raiding activities. The current survey showed that all 110 respondents (100%) had experienced at least one crop-raiding event in the past 10 years. The increase in crop raiding over the last ten years was also commonly cited among focus group meetings. Some farmers could not even estimate how often animals visited their land to raid crops in the last six months. They said the visits have increased so much that they cannot remember to count each incident as one farmer stated "*Animals have come so many times that I can no longer count how often it has happened" _ XH-220422-04*.

3.9 Perceived managed relocation plan

During one focus group meeting in a pairwise ranking exercise, farmers listed a planned government decision to relocate them away from the park as one of their current priority

problems. Though this problem was listed once in a female focus group in the Kinigi sector, it scored number one when farmers were asked to rank it with other listed problems. Furthermore, though this problem was not listed among the priority problems for the male focus group in Kinigi, it was later raised when we started a deep discussion on crop raiding topic. Even though there were no particular survey questions posed to farmers about this relocation plan, some farmers would raise it as a new topic of their interest on which they wanted their perceptions to be shared in this study. Respondents sometimes shared this feedback at the end of the survey when given the opportunity to add comments. This was particularly raised as a problem among the respondents from the Kinigi sector. Farmers reported during the focus group that they have already experienced the negative effects of relocation and park expansion even though it has not yet been implemented. During focus groups and surveys, farmers perceived crop raiding to be linked with the government relocation plan, on which they expressed their dissatisfaction. "*The problem is that they intend to relocate us from here to avoid crop-raiding, but this is not a viable solution. As the population of animals grows, they will continue to raid the crops of those who have been relocated" _KWFG*. Some farmers expressed concern about a planned relocation because they fear losing their farmland. Some farmers perceived that the relocation and the expansion of the park were decided by the government to provide enough space for animals which has currently increased. "*If the park is expanded now, animals will continue to increase, leading to the same crop-raiding problems for people living near the expanded area, and this will be similar to what we have been experiencing" _ KMFGD.*

CHAPTER 4: DISCUSSION

This research was conducted to get to know the understandings and opinions of farmers on crop-raiding in terms of socio-economic aspects, and to see if farmers' perceptions of crop-raiding have changed since a similar study a decade ago. Following the same methodological pattern that Mc Guinness (2014) used, the findings show that crop raiding is an increasingly perceived problem among farmers around Volcanoes National Park.

4.1 Reported Animals

Six mammals namely buffalo, golden monkey, gorilla, bushbuck, black-duiker and elephant cause crop raiding in the farms around VNP. Though all these animals were reported to cause crop raiding, however, farmers blame them differently. For example, according to the majority of respondents, golden monkeys, and buffalo were mostly reported and blamed for the majority of raiding incidences that farmers experienced than any other animals. The findings of this study, which reported an increase in large mammals on farmers' lands, coincide with a recent study inside VNP that also found an increase in the number of meso- and mega herbivores (Twahirwa et al., 2023).

4.2 Causes of crop raiding

Perceived causes of crop raiding in this study indicate how farmers are quite knowledgeable about some of the actual ecological factors that might influence crop raiding. For example, the lack of food inside the park was reported to be one of the causes of crop raiding, a perception that is also similar to the findings of a recent study conducted inside VNP, which showed a current decline in bamboo shoots (van der Hoek et al., 2019). The perceived increase of animals inside the park is also parallel to the findings from a recent study which demonstrated the current expansion of large mammals' population inside VNP (Twahirwa et al., 2023). Farmers' perceptions of what causes animals to raid their crops have changed in some ways since a similar study a decade ago. In the previous study, farmers reported only four causes of crop raiding namely, lack of food inside the park, the number of animals increasing, preference for cultivated crops, and inadequate defenses (Mc Guinness, 2014), however, the current findings show novel perceived causes of crop raiding. These include the size of the park which is small, insecurity within the park, and the animals' need for an open space. The fact that the park is small as reported by farmers, in addition to the increase in population of large mammals, is perhaps the main cause of the current increase in crop raiding incidences around this park. Studies have shown that the two main factors that lead to the increase in human-wildlife conflict are, changes in land use patterns, which occur when people spread on wildlife habitats (Messmer, 2009), and the expansion of wildlife distribution into human-occupied areas(Baruch-Mordo et al., 2014) This seems also to be the case for VNP, a park that was once larger but had a portion of it later reduced and converted into human-occupied areas. These are also some of the reasons cited by the government to support the current plan to expand VNP,

aiming to provide more space for animals. However, while this expansion may help, some farmers perceive it will not fully address the issue of crop raiding.

4.3 Effects of crop raiding

Findings show that crop raiding affects negatively farmers' livelihoods through the loss of their crops while also exposing them to other related development and opportunity costs. Eleven types of crops were reported to be damaged by animals during crop-raiding activities. The most top five damaged crops as reported by farmers are potatoes, followed by maize, pyrethrum, wood stock, and wheat. These same crops were also the most vulnerable in the previous study a decade ago, though there have been a few changes in how they are ranked in terms of their vulnerability over the last ten years. For example, maize is now ranked second most vulnerable crop on the list, while pyrethrum is ranked third, which is the opposite of the previous similar study conducted a decade ago. However, pyrethrum remains among the top three vulnerable crops to crop raiding, even though most farmers are obligated to grow it rather than other crops of their preference. A previous study demonstrated that land consolidation and government-controlled agro-industry programs for growing pyrethrum influenced crop-raiding around VNP (Mc Guinness, 2016). It is important to note that the three top crops reported to be the most damaged by animals are also the primary crops grown in these areas by the majority of farmers. There is a need to explore other crop species that would be both suitable and productive for cultivation around VNP while being less preferred by animals. Another finding from this study reveals that farmers reported fewer crop types damaged by raiding activities compared to a previous study where eleven crop types were listed as affected. In addition to this, maize was reported more frequently in this study than in the previous one, and the current findings do not explain why this change occurred. It might be possible that more farmers have planted maize in the last decade, despite its vulnerability to pests.

Crop raiding has been shown in various studies to harm farmers by contributing to food insecurity while also leading to poverty (Barirega et al., 2010). This may also be true for farmers near the VNP, where the majority rely on agriculture for their livelihood. In addition to crop losses, the findings highlight the opportunity costs farmers face when actively guarding their crops day and night as was found in other studies (Manoa et al., 2021). For example, studies have found that the time farmers spend guarding their crops exposes them to zoonotic diseases, farmer's kids' low performance in school, and a decline in social interaction (Linuma et al., 2022).

4.4 Perceived mitigation measures

These findings show three perceived current mitigation measures namely, active guarding, physical barriers, and compensation scheme. Active guarding for example which was reported to be employed by the majority of farmers around VNP has been shown in other studies to be one of the successful measures against crop raiding (Thapa, 2010) . These findings show that farmers blame the current compensation scheme for failing to provide them with fair and timely compensation as expected, an issue that has been also identified in other similar studies (Nyhus, 2016). While compensation can be used to mitigate conflicts between farmers and the park, it can sometimes reduce farmers' sense of ownership in conservation and create additional conflicts that were not intended including moral hazards (Wilson-Holt & Steele, 2019). Different studies show that compensation is more effective when it is combined with an assurance scheme (IUCN, 2023), which a previous study in VNP suggested a decade ago (Mc Guinness, 2014). Physical barriers such as stone walls, electric fences, and trenches have been used around different protected areas as in VNP to limit crop raiding, but the cost of maintaining them is frequently reported as problematic, in addition to the fact that they are also limited to prevent the raiding of some animals such as primates. For example, a stone wall around the VNP was considered ineffective in preventing crop raiding by golden monkeys because they can jump over it at any height. However, in such cases, other mitigation measures should be applied. For instance, a recent study on human-wildlife conflict involving golden monkeys experimented with a taste aversion method to prevent monkeys from raiding potato crops. (Ndayishimiye et al., 2023). According to the findings of that study, the novel mitigation measure, tested as an experiment, suggests that it could reduce potato raiding by Golden monkeys around VNP.

Though each perceived mitigation measure has limitations, farmers around VNP reported that each has helped reduce the negative impacts of crop-raiding to some extent. The findings of this study showed that given the increase in crop raiding incidents, farmers feel that the level of crop raiding exceeds their capacity to control. However, they also express a strong desire for a sustainable solution that would reduce crop raiding events on their farms.

4.5 Implication of perceived current increase in crop raiding incidence compared to a decade ago

According to this study's findings, farmers perceive crop-raiding as a problem that has increased significantly in the last decade. These farmers' perceptions coincide with the actual crop-raiding reports in VNP (Dian Fossey Gorilla Fund unpub. data). Though this study did not investigate the negative consequences of increased crop raiding on animal pests involved, other studies have shown that this type of conflict may lead to farmers retaliating against problem animals (Treves, 2008). A recent study in VNP on human-wildlife conflict involving golden monkeys found that farmers' negative attitudes toward golden monkeys were caused by crop raiding they had experienced (Ndayishimiye et al., 2023). In addition, an increase in human-wildlife conflict, such as crop raiding, may reduce the conservation efforts of the affected local communities. To resolve these conflicts sustainably, a participatory partnership involving all stakeholders, including local people, scientists, park managers, and non-governmental organizations, is required (Treves et al., 2006)). This approach might be helpful in promoting human-wildlife coexistence around VNP and reshaping the human-wildlife narrative, thereby benefiting both human populations as well as wildlife conservation.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

This study reveals that farmers perceive crop-raiding to be an increasingly large and frequently occurring problem, findings that coincide with actual incidence reports around VNP. This increase is also noticeable when comparing perceptions in 2022 with those a decade ago.

Based on the finding of this study, I recommend the following:

1. **Construction of a strong physical barrier around VNP**: The current physical barrier, made of stones stacked without cement, is frequently destroyed by animals, allowing them to easily access farms around the park raid crops. I recommend using strong

materials to build a wall that will last over time and keep most animals inside the park. Where a strong wall has not yet been built, repairing the existing physical barrier is critical to preventing increase in animal visits to farmland near the park.

2. **Providing a fair, and timely compensation for farmers who suffer crop loss:** Given that some farmers have criticized the compensation process due to delays, I recommend that park management improve the effectiveness of compensation by ensuring timely verification and fair, transparent payments for those who have suffered crop losses.
3. **Collaboration between farm owners and park management for effective guarding**: Active guarding should involve hiring full-time guards through a partnership between the park and the local community. I recommend that the park and local community collaborate to employ full-time guards dedicated to preventing animals from raiding crops.
4. **Conducting research on new crop species not preferred by animals:** Since the most commonly grown crops around the park are also the most vulnerable to crop raiding, future studies should explore alternative crop species that are suitable for the area but less appealing to animals. Research should also investigate whether mixed cropping around VNP could be more effective than the currently popular mono-cropping in reducing the severity of crop raiding.
5. **Need for in-depth research on farmers' perceptions of local community relocation and park Expansion:** This research revealed unexpected concerns from interviewees about the government's plans for relocation and park expansion. This finding highlights the need for a specific study on how these plans will impact the local communities. Such study should aim to understand the concerns of those who will be affected and develop strategies to prevent potential conflicts between local people and wildlife.

Finally, I recommend that park management develop mitigation measures with the active participation of local communities. Ensuring the full involvement of those vulnerable to crop raiding in decision-making would help shift the narrative from human-wildlife conflict to human-wildlife coexistence.

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Appendix 1: List of survey questions of the study

Interview Code: _____

Village: _____ Longitude: _____ Latitude: _____ Elevation: _____

List of questions for administered surveys

A. Personal information

1. How many people are in your family?
2. What wealth category are you classified under?
3. How many children do you have?
4. How long have you lived here?
5. How long have you been cultivating around the park?

Observations about wealth status.

- Construction of the main dwelling

- Mudbrick

- Wattle and daub

- Volcanic stone

- Wood plank

- Hedge present around the house – Y/N
- Outside cooking house – Y/N
- No. of permanent buildings
- Cattle owned – Y/N 1 cow and 1 sheep
- Flowers planted around the house – Y/N

B. Agriculture and Land Tenure

1. Do you own your land or do you work on someone else's land?
2. How big is your land?
3. What crops do you grow?
4. What seasons do you follow in growing your crops?
5. When do you start your crop season?
6. Do you grow them together or apart?
7. Do you choose what to grow on your land?

8. Why, in your opinion do they tell you what to grow?
9. Do you agree with this?
10. Do you grow pyrethrum?
11. How much of your land is taken up by this?
12. Whose choice was this?
13. Is growing pyrethrum a good thing or a bad thing?
14. Do you gain money or lose money from growing this?
15. Do you sell your crops in the market?
16. How do you get your crops to the market?
17. Which crops do you send to the market?
18. Do you intercrop on your farm?
19. Can you estimate the total value of all your crops?
20. Where do you collect water during the dry season?
21. How far is this from your house?
22. Where do you collect water during the wet season?
23. How far is this from your house?

C. Human-wildlife conflict

1. Do animals ever visit your land?
2. Where do these animals come from?
3. Which animals come?
4. Do they damage crops?

a. If yes,

i. Which crops are damaged/ lost?

ii. Can you estimate how much money you lose because of this every time it happens?

5. Do gorillas ever come onto your land?

   a. If yes, do they damage anything?

6. How often do these animals visit your land?

a. In the last year, how many times has this occurred?

b. In the last 10 years, how many times has this occurred?

7. In the past which animals came?

8. Is this the same today? What animals come nowadays if it is different?

9. When was the last visit?

10. Is anything done to stop this?

a. If yes, what is done?

b. If no, why not?

11. Do you guard your land?

a. If yes,

   i. Who does this guarding?

   ii. How is this done?

   iii. How much time/money do you spend doing this?

12. Do you think you can do anything to solve this problem?

Appendix 2: Protocol and questions for focus group discussions

1. Introduction

2. Exercise 1 – Pair-wise ranking of problems

Use sticky notes to list problems of living in the area, ensuring that not just one person lists these problems. Then hold them up and gain consensus on which is more important in each comparison. This should reveal a good picture of the problems that are most important in the

area. If crop raiding is not mentioned in this, it might be worth bringing up why they did not mention it.

3. Exercise 2 – Trend Lines of issues. Discuss relationships.

Using extensive description of the idea of a graph. If they do not understand this, simply ask them by year what the levels of each problem were. Ask the group which unit of time should be used. The amounts of yield. The numbers of crop-raiding events they experienced. This is designed to investigate the change in problems over time. And if patterns in this become clear ask questions about why they think these patterns exist. It is very important that participants feel they are helping to solve the problem and are working together to find a solution.

4. Analysis of problem – focusing on crop-raiding.

People will be asked about the most important problems they have outlined. First, we ask about the causes they think are attached to these problems. Then they are asked how they deal with these problems now. Finally, they are asked how they would deal with this in the future. So, causes, coping strategies, and possible solutions. If crop raiding is not mentioned in this, it might be worth bringing up why they did not mention it. Do they see this as a problem or an environmental condition? Does the group consider it a problem that they can control themselves? Who is responsible for solving these issues?

5. Perception of the park – Responsibility, revenue sharing, and relationship with RDB

How are they currently controlled, and who does this? What actions would you take if you had the resources to do this?