An Assessment of Human-Elephant Interactions, Elephant Dispersal and Migration, and Community Attitudes around Northern and Southern Selous Game Reserve/Nyerere National Park, Tanzania

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i. Executive Summary

Human-Elephant Conflict (HEC) has become a pressing conservation and poverty issue in recent years in Tanzania. A major factor is the increase in crop losses from elephants, especially in communities that share space and resources with them. HEC threatens elephant populations through retaliatory killing and increased hostility towards elephants, leading to tolerance of poaching. It harms the livelihoods of farmers, as crop-raiding results in economic losses and reduced food security. It also deteriorates relations between communities and wildlife authorities. Elephants, despite their population decline across Africa, are a key driver of conflict between local communities, and park management. A rapid assessment survey of human-elephant interactions, elephant dispersal and migration, and community attitudes around Selous Game Reserve (SGR)/Nyerere National Park, Tanzania was carried out between December, 2019 and January, 2020. By means of this survey, we aimed to assess HEC with the aim of gathering information about attitudes towards elephants and Protected Areas, identifying forms and distribution of human-elephant conflict around SGR, collecting information about elephant movements and historical range (buffer zones and dispersal areas), understanding how village governments and farmers currently manage HEC, identifying other sources of income- generating activities to buffer financial losses from elephant crop-raiding, and identifying the needs for conservation education and awareness campaigns about elephant conservation in local communities. 170 Interviews were conducted, including 19 for village leaders and 151 for farmers. There is a large HEC in areas around SGR, where elephants often injure/kill humans and destroy crops. We hope that this project identifies fundamental drivers of HEC around SGR/ Nyerere NP and facilitates community-led projects that diversify income, reduce crop losses from elephants, and conserve biodiversity.

ii. Acknowledgments

We thank The Rufford Foundation for providing funding for this project. We thank the Tanzania Wildlife Research Institute (TAWIRI) and Tanzania Commission for Science and Technology (COSTECH) for allowing this project to be conducted. We wish to thank District Executive Officers of Morogoro and Tunduru for issuing permission to carry out this assessment survey in their areas. We are also grateful to District Game Officers (Morogoro and Tunduru), village leaders and farmers who participated in this survey, and we hope this assessment will be fruitful.

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List of abbreviations

HWC	Human-Wildlife Conflict
HEC	Human-Elephant Conflict
SGR	Selous Game Reserve
Nyerere NP	Nyerere National Park
TAWIRI	Tanzania Wildlife Research Institute
TANAPA	Tanzania National Parks
COSTECH	Commission for Science and Technology
UNESCO	United Nations Educational, Science and Cultural Organization
DC	District Council
DED	District Executive Director
DGO	District Game Officer
HEP	Hydro Electric Power
PA's	Protected Areas
WMA	Wildlife Management Area
NBS	National Board of Statistics
SEAP	Selous Emergence Action Plan

1.0 Introduction

African elephants (*Loxodonta Africana*) are a species with large range requirements and migratory behaviour (Douglas-Hamilton et al., 2005), spending considerable time outside of Protected Areas. Although Tanzania's Protected Area network covers over 30% of the country, elephant distribution comprises at least 42% of the country (Thouless et al., 2016). As such, there is potential for human-elephant conflict (HEC) when elephants come into contact with people outside protected areas (PAs).

Furthermore, the human-elephant interface at which conflict can occur may be expanding due to rapid demographic, socio-economic and land-use change in Tanzania (Devisccher, 2010). In addition to the pressures of population growth, internal migration of rural people driven by access to available and productive land may lead to increased settlement and land conversion around PA's. Human-elephant conflict appears widespread in Tanzania, particularly in regions bordering PAs and in wildlife corridors, buffer zones and dispersal areas (Mduma et al., 2010).

In Tanzania, the communities living adjacent to PAs, are poor and live below basic needs and food poverty lines e.g. those living around the boundaries of the Selous Game Reserve (SGR)/Nyerere National Park (SEAP, 2016). In rural areas of Tanzania, the population below food poverty line is approximately 13.5%, while the population below basic needs poverty is approximately 39.4% (Tanzania NBS report, 2019). These villagers bordering the SGR are easily maneuvered by commercial poachers to facilitate killing of the high valued species, especially elephants.

The goal of this assessment is to understand human-elephant interactions around the northern and southern boundaries of SGR/Nyerere NP in more detail, and to provide stakeholders with information and recommendations to help manage HEC. We hope this assessment will encourage greater collaboration between communities living alongside protected areas, wildlife management authorities, district and regional governments, and conservation organizations in working towards achieving human-elephant coexistence around the SGR/Nyerere NP.

It is known that conservation can introduce new or additional economic burdens or risks. For communities living near protected areas, the close proximity to wildlife can lead to considerable economic burden and personal risk. These costs include crop loss and property damage; opportunity costs associated with time spent on protecting against wildlife damage; loss of livestock and disease transmission; strains on families and relationships; and injury and loss of life. These costs can contribute to tensions and confrontations between communities and conservation actors. This work is going to help to manage and reduce conflicts between

local communities and wildlife authorities through identifying the need for conservation education in the communities living near the SGR. Conservation education will focus on making the local communities aware of the best methods or techniques to deter or reduce elephants into their farms or settlements.

Knowing the extent of human-wildlife interactions in the northern and southern parts of the SGR/Nyerere NP, while highlighting elephants which are the main inhabitants of the reserve will help facilitate increased protection and identifying buffer zones and dispersal areas which are essential for the maintenance of ecosystem ecological processes, local and regional migration, ecological range expansion, and breeding areas.

Several options for mitigation of HEC are available, including human vigilance, barriers and deterrents. Mitigation trials have demonstrated that no single intervention will adequately control HEC, and often several different combinations of measures need to be combined to avoid elephant habituation and to produce an effective synergy. Instead an integrated approach to reducing HEC is often the most effective solution; incorporating several simple, low cost methods that can be easily applied by communities, such as chilli deterrents, cooperative guarding, simple alarms and buffer zones. Local communities quickly adopt mitigation methods when even minor successes are achieved, and self-defence measures can reduce dependence on Park Rangers and other authorities when communities use HEC mitigation realize they can take primary responsibility for crop protection. This is likely to occur when villages are involved in community- based conservation programs, where communities who bear t h e cost of living with elephants derive a share of benefits from their sustainable utilization through tourism (Mduma et al., 2010).

There is also great potential for using land – use planning at the local level to try to prevent HEC from emerging, or to reduce HEC to acceptable levels. Land use planning can involve better zoning to avoid agriculture near key elephant habitats and migration routes, and changing the location of fields to facilitate communal defence against problem elephants. The best way to achieve success in the long-term is to integrate HEC consideration in regional and national and-use planning process; all sectors involved in current or potential developments in wildlife should take HEC and human-wildlife conflict (HWC) considerations into account during their planning and feasibility assessments. Studies indicate that relatively high densities of elephants and people can co-exist if land transformation is not too widespread, and if elephants are not subjected to high levels of deliberate disturbance (Parker et al., 2007).

Successful long-term management of HEC requires solid support from all levels of

government, strong commitment from wildlife management authorities and communities, and the informed use of available tools and methods. Continuing research and active monitoring are also essential. Experience from other countries suggest that it is unrealistic to expect total prevention of conflict, and therefore the strategy must be one of mitigation and integrated management to reduce the problem to levels that are tolerable by communities (Mduma et al., 2010).

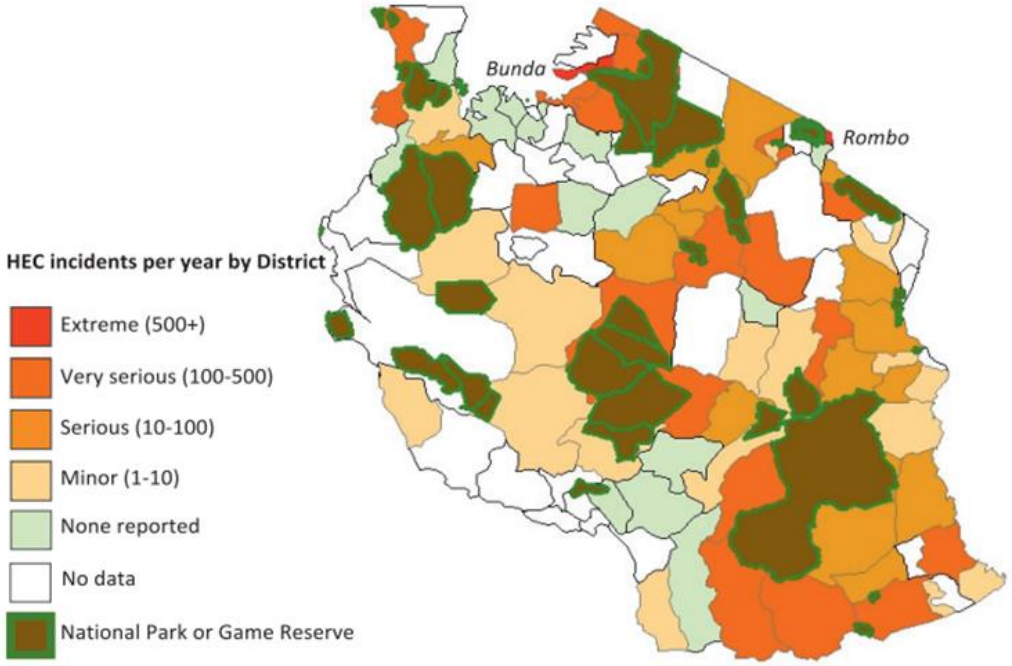

Figure 1: Map showing severity of HEC incidents from 2007-2009 for 109 surveyed Tanzanian districts. Source: Tanzania Elephant Management Plan, Mduma et al., 2010**.**

2.0 Assessment purpose and activities

2.1 General objective

The general objective of this project was to determine baselines and increase understanding of human-elephant interaction, elephant dispersal and migration, and community attitudes in villages around SGR/Nyerere NP, Tanzania, as well as to suggest innovative measures to be adopted and implemented to curb the threats of HEC.

2.2 Project Activities

In order to achieve the project objective, the following activities were conducted;

(i) To identify forms and distribution of HEC in villages around SGR/Nyerere NP;

(ii) To collect information about elephant movements and historical range (buffer zones and dispersal areas);

(iii) To gather information about attitudes towards elephants and PA's;

(iv) To understand how village government and farmers currently manage HEC;

(v) To identify the need for providing conservation education and organizing awareness campaigns to educate the local communities;

(vi) To identify other sources of income-generating activities to buffer financial losses from elephant crop-raiding.

3.0 Methodology

The dataset for this assessment was collected in two districts bordering SGR/Nyerere NP. These districts are Morogoro DC in Morogoro region and Tunduru in Ruvuma region. A rapid questionnaire survey of village leaders and farmers was carried out in 10 villages in respective districts between December, 2019 and January, 2020. Phone interviews to village leaders where the survey team could not manage to visit were also carried out in four villages in the same period of time.

3.1 Study area

The SGR is the largest single Protected Area in Africa, located in the south of Tanzania. It was declared as a protected area of about 2,000 km^2 in 1896. The Reserve was named after Englishman Sir Frederick Selous, a famous big game hunter and early conservationist. It became a hunting reserve in 1905 and was designated as a UNESCO World Heritage Site in 1982 because of its relatively undisturbed nature and exceptionally high diversity of species. After the independence of Tanzania in 1961, SGR was expanded to a total area of 50,000 km^2 or 5.2% of Tanzania's land surface within four mainland regions: Morogoro, Coastal, Ruvuma, and Lindi. However, on 19th November 2019, the largest section of the SGR (30,893 km^2) underwent a shift of conservation status, from a Game Reserve hosting game hunting to a new National Park (Nyerere National Park) providing total protection (photographic tourism) when the President of Tanzania, His excellence, Hon. Dr. John Pombe Joseph Magufuli signed the declaration passed by the Parliament of Tanzania on 9th September, 2019. Following this declaration, only 19,107km^2 remained for other uses (trophy hunting).To the North- East, the new park is bounded by two sectors of the SGR Kingupira and Miguruwe, while to the South-East, the park is bounded by Liwale sector of the SGR. Also, to the North-West, the new park is bounded by Mikumi and Udzungwa Mountains national parks. Within the northern part of the new park, construction of a Hydro-Electric Power (HEP) station at the Stigler's Gorge area is ongoing (Nyerere Hydro-Electric Power Station).). However, all human entry and exit is carefully controlled by Tanzania National Parks (TANAPA) of the Tanzanian Ministry of Natural Resources and Tourism.

The Selous ecosystem has a higher density and diversity of species than any other Miombo woodland (*Brachystegia*) area. Over 2,100 plants have been recorded and more are thought to exist in the remote forests in the south. Similarly, the ecosystem protects an impressive large mammal fauna, although some species have seriously plummeted due poaching. Previously, the Selous ecosystem contained globally significant populations of African elephant (*Loxodonta africana*), but the population has been reduced by almost 90%. Selous ecosystem is also one of the strongholds for wild hunting dogs (*Lycaon pictus*) in Africa. It also includes one of the world's largest populations of hippopotamus (*Hippopotamus amphibius*) and Cape buffalo (*Syncerus caffer*). There are also important populations of ungulates including sable antelope (*Hippotragus niger)*, Lichtenstein's hartebeest (*Alcelaphus lichtensteinii)*, greater kudu (*Tragelaphus strepsiceros*), eland (*Taurotragus oryx*) and Nyassa wildebeest (*Connochaetes albojubatus*). In addition, there is also a large number of Nile crocodile (*Crocodilus niloticus*) and 350 species of birds, including the endemic Udzungwa forest partridge (*Xenoperdix udzungwensis*) and the rufous winged sunbird (*Nectarinia rufipennis*). Because of this high density and diversity of species, the Selous ecosystem is a natural habitat of outstanding importance for in-situ conservation of biological diversity.

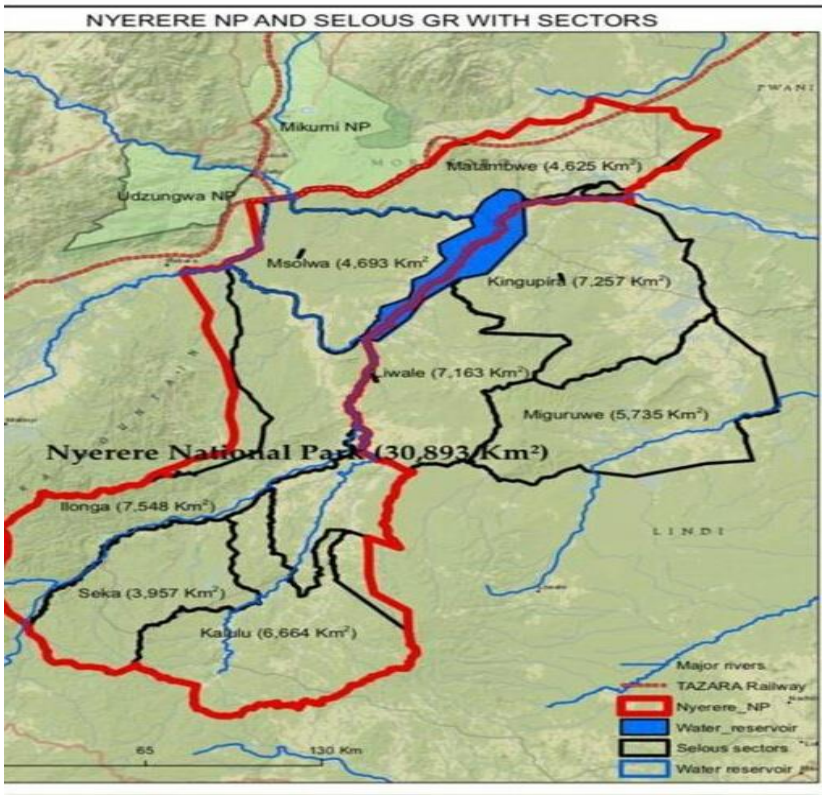

Figure 2: Map showing the administrative boundaries of Nyerere National Park Selous Game Reserve (Source, Tanzania National Parks).

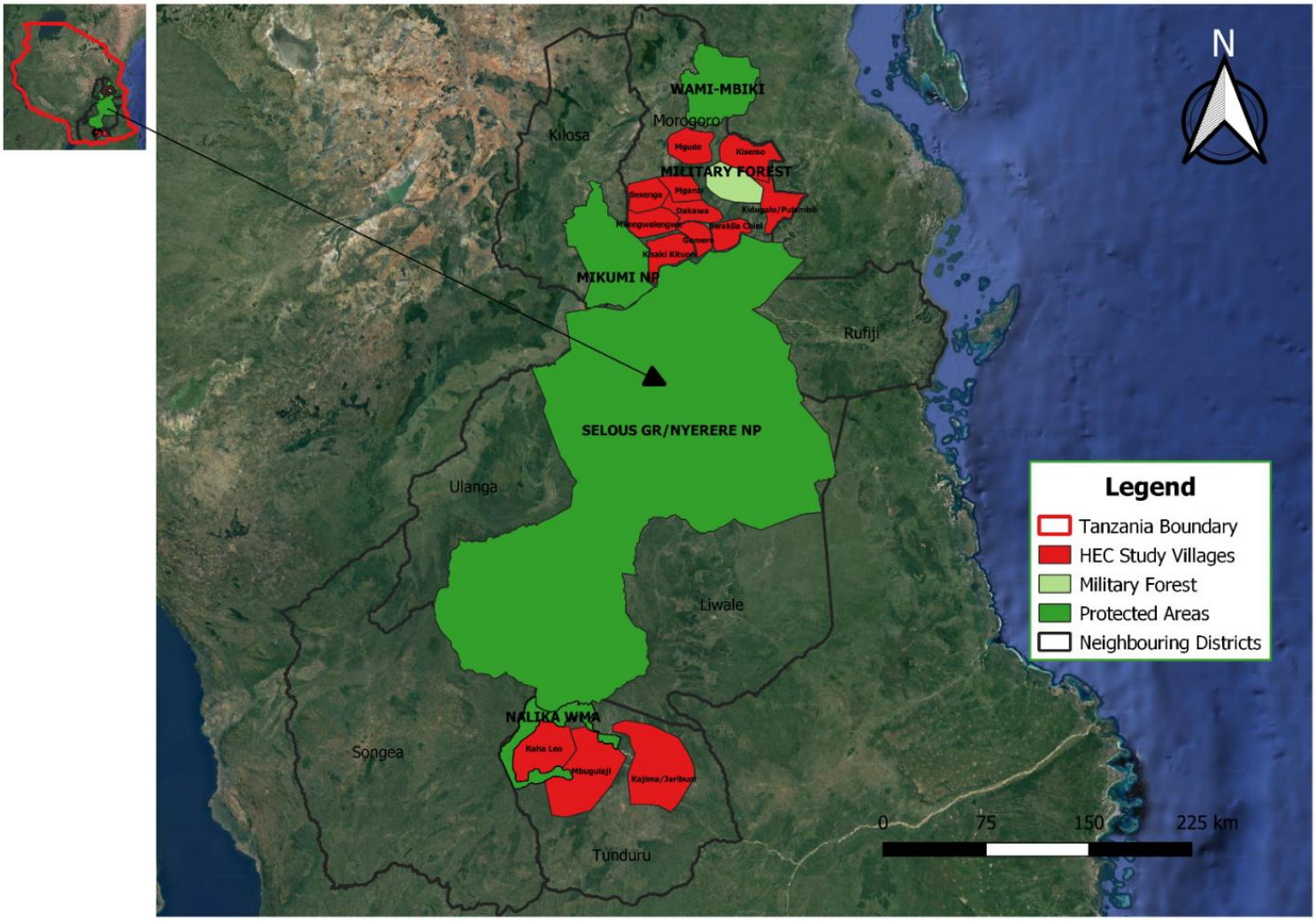

Figure 3: Study area showing area surveyed and villages around SGR/Nyerere NP

3.2 Methods

A rapid assessment survey was carried out in 14 villages within two districts bordering SGR (Morogoro DC and Tunduru) using a combination of questionnaire and phone interviews. Prior to the survey, introductory letters were sent to the respective District Executive Directors (DED) stating the purpose of the survey. Prior to the main survey, a brief reconnaissance survey was carried out to identify which areas were vulnerable to HEC based on local knowledge from government officials (DGO's). Informal discussions with DGO's, village leaders, farmers, and local experts guided our selection of villages for the main questionnaire-based survey. In areas for which the survey team could not manage to visit the village, we conducted phone interviews with village leaders where HEC was reported.

3.2.1 Questionnaire Interviews

The questionnaire-based survey was conducted in Morogoro DC and districts. Two types of questionnaires were administered, one for village leaders and one for farmers. A total of

170 interviews were completed with 19 village leaders, 151farmers. At least one to two village leaders and one to 17 farmers were interviewed in each village.

The questionnaires investigated human-wildlife interactions while highlighting elephants which are the main in habitants of the landscape and peoples' perceptions of human-elephant conflict. Interviewers asked questions to identify the types of HEC occurring, as well as temporal and spatial patterns in elephant crop-raiding. The questionnaire also included questions about how villagers, farmers, and pastoralists were currently managing HEC, and about beekeeping activities and honey markets. Other components of the questionnaire included questions about elephant movements, possible threats facing elephants and a basic assessment of attitudes towards elephants and PA's.

The team was versed in proper research and interviewing techniques, including how to obtain consent of interviewees, explain the aims of the survey, and administer the questionnaires. All interviews were conducted in Swahili language for a better understanding between interviewees and the interviewer and responses recorded on paper questionnaires. All interviewees were assured of their responses to remain confidential to avoid biased statements. Data entry and analysis were done in Microsoft Excel.

3.2.2 Phone Interviews

A total of 5 villages in Morogoro DC and Tunduru districts for which the survey team could not manage to field visits were surveyed by phone interviews with village leaders. Phone interview questionnaires for village leaders included questions to determine whether villages were experiencing HEC, which forms of HEC were occurring, temporal trends and spatial patterns in HEC, and actions that village leaders and farmers were taking to manage HEC.

3.2.3 Expert consultations

We consulted four area experts about HEC. Experts were interviewed to obtain information about the spatial distribution and intensity of HEC, and the location and status of elephant movements in areas around SGR/Nyerere NP

1. WahidaBeleko-District Game Officer, Morogoro DC
2. Hassan Ally Limbega-District Game Officer, Tunduru
3. DeogratiusGervas–Selous-Kalulu sector ecologist (TAWA)

4.0 Results

4.1 Forms and distribution of HEC in villages around SGR/Nyerere NP

4.1.1 HEC hotspots areas

HEC is a leading conservation challenge in areas around SGR/Nyerere NP, with the majority of farmers and village leaders having negative feelings on elephants (Figure 33 and 34). The extent of the problem differs significantly across areas. Morogoro district seems to have higher perceived rate of HEC. However, this is because of higher sample size obtained in Morogoro district due to a more geographically thorough survey than in Tunduru district, whereby the surveying effort was lower because poor road infrastructure prevented the survey from covering a large area-even thoughTunduru district has worse HEC incidences (higher damages). We surveyed six villages in Morogoro DC and three villages in Tunduru using a questionnaire-based survey. The phone interviews to village leaders were conducted in four villages and two villages in Morogoro and Tunduru districts, respectively (Figure 4).

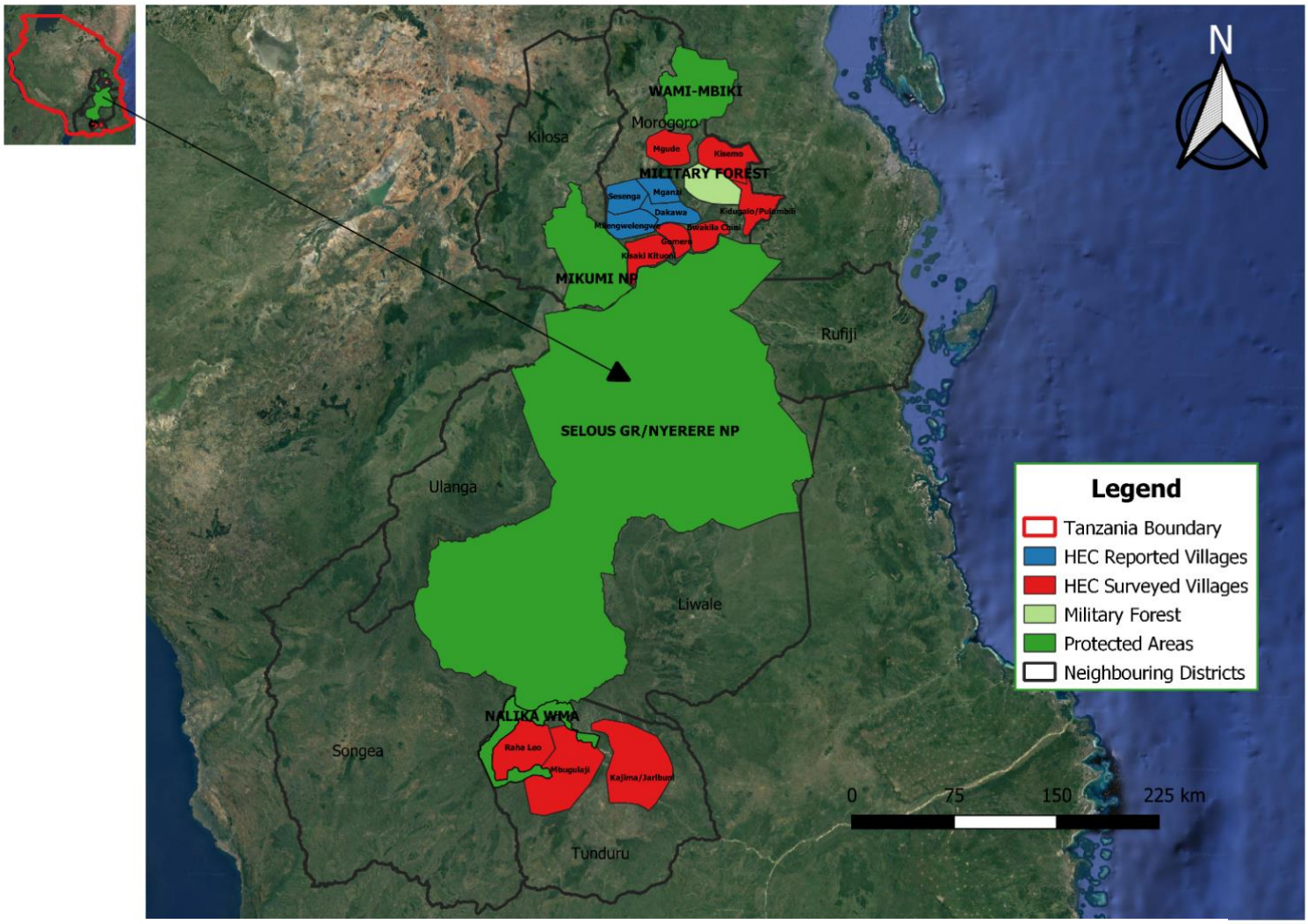

Figure 4: HEC hotspots in villages around SGR/Nyerere NP

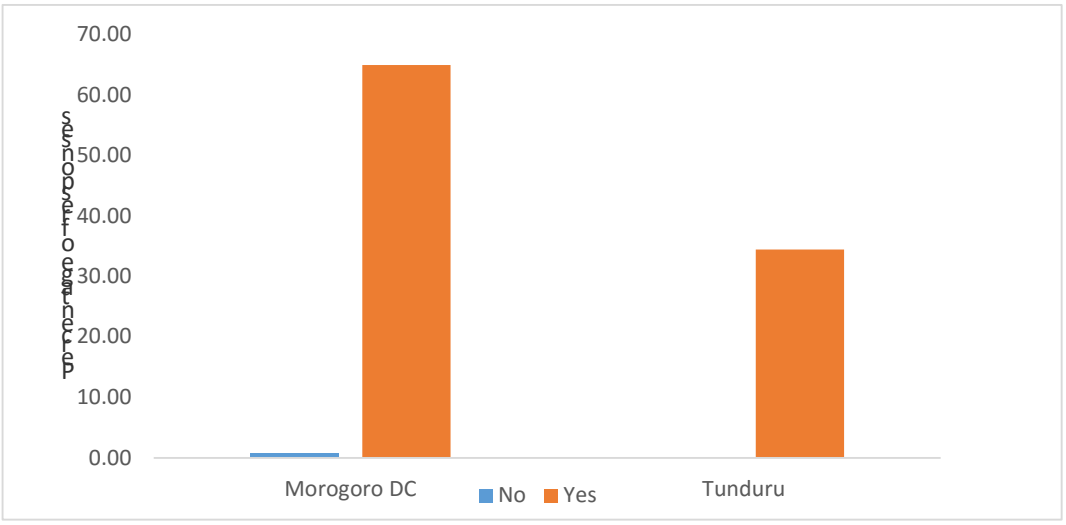

Figure 5: Perceptions of HEC in the surveyed districts around SGR. N=151

Table 1: Villages in which majority of respondents perceived and reported conflict with elephants in villages around SGR/Nyerere NP

No.	Village Name	District	Region	Surveyed/Reported
1	Raha Leo	Tunduru	Ruvuma	Surveyed
2	Mbugulaji	Tunduru	Ruvuma	Surveyed
3	Mgude	Morogoro DC	Morogoro	Surveyed
4	Kisemo	Morogoro DC	Morogoro	Surveyed
5	Kidugalo	Morogoro DC	Morogoro	Surveyed
6	Pulambili	Morogoro DC	Morogoro	Reported
7	Kisaki Kituoni	Morogoro DC	Morogoro	Surveyed
8	Gomero	Morogoro DC	Morogoro	Surveyed
9	Kajima	Tunduru	Ruvuma	Surveyed
10	Jaribuni	Tunduru	Ruvuma	Reported
11	Bwakila chini	Morogoro DC	Morogoro	Surveyed
12	Nyalutanga	Morogoro DC	Morogoro	Reported
13	Milengwelengwe	Morogoro DC	Morogoro	Reported
14	Dakawa	Morogoro DC	Morogoro	Reported
15	Mganzi	Morogoro DC	Morogoro	Reported
16	Sesenga	Morogoro DC	Morogoro	Reported
17	Dutumi	Morogoro DC	Morogoro	Reported

4.1.2 Mostly Grown Crops in Villages around SGR/Nyerere NP

The most common crops being grown and reported by local people in villages around SGR include: Maize, Cassava, Vegetables, Cow peas, Green gram Banana, Fruits, Cashew nuts, Coconuts, Millet, Sugarcane, Sweet potatoes, Beans, Pumpkins, Water melons, Sun flowers, Rice, Sesame, Groundnuts, and Sisal (Figure 6-7).

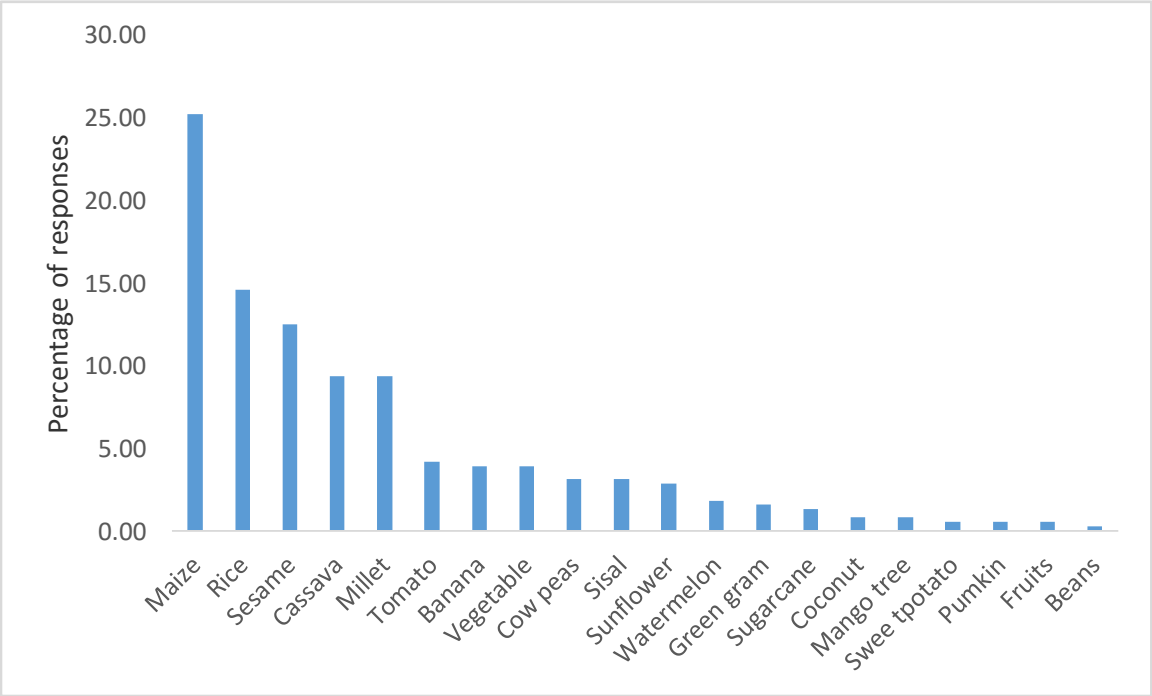

Figure 6: Percentage of response of crops mostly grown in Morogoro district. N=385

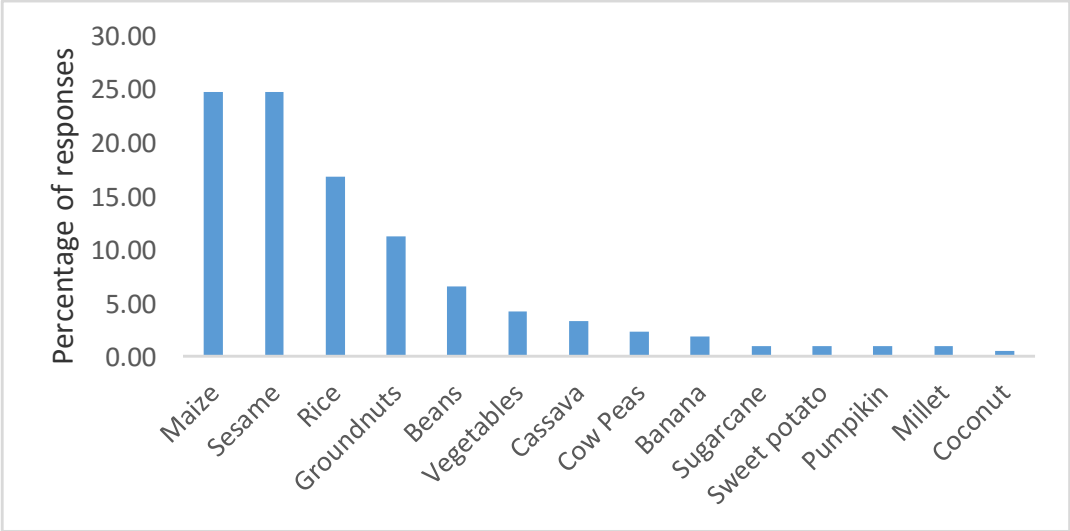

Figure 7: Percentage of response of crops mostly grown in Tunduru district. N=214

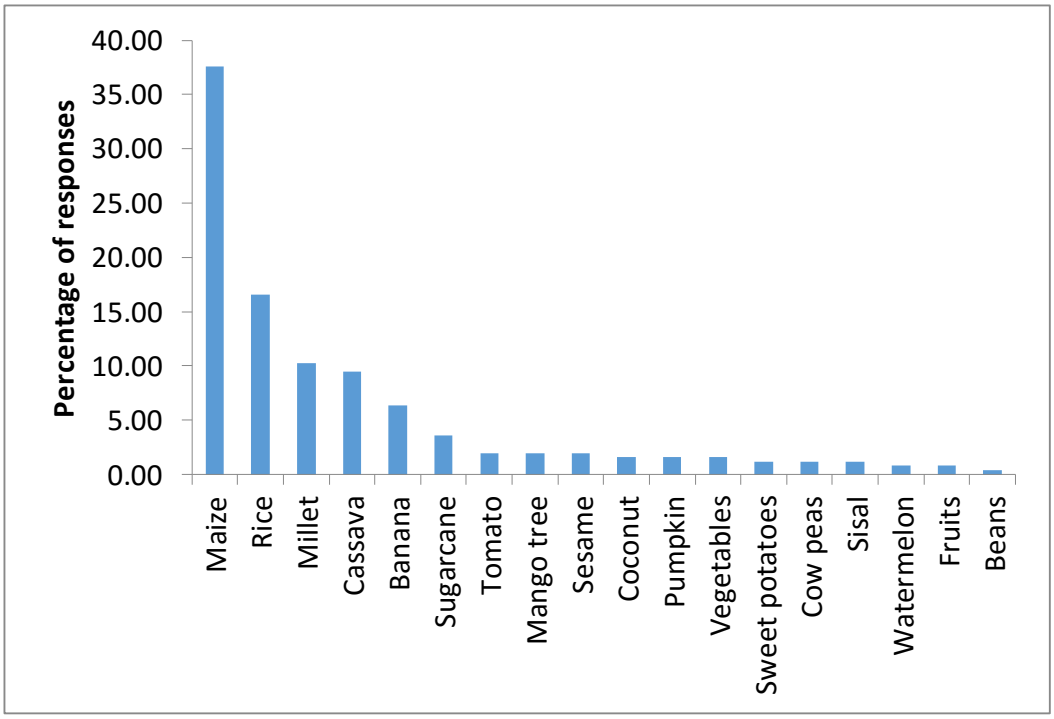

Figure 8: Percentage of most frequently raided crops by elephants in Morogoro district. N=253.

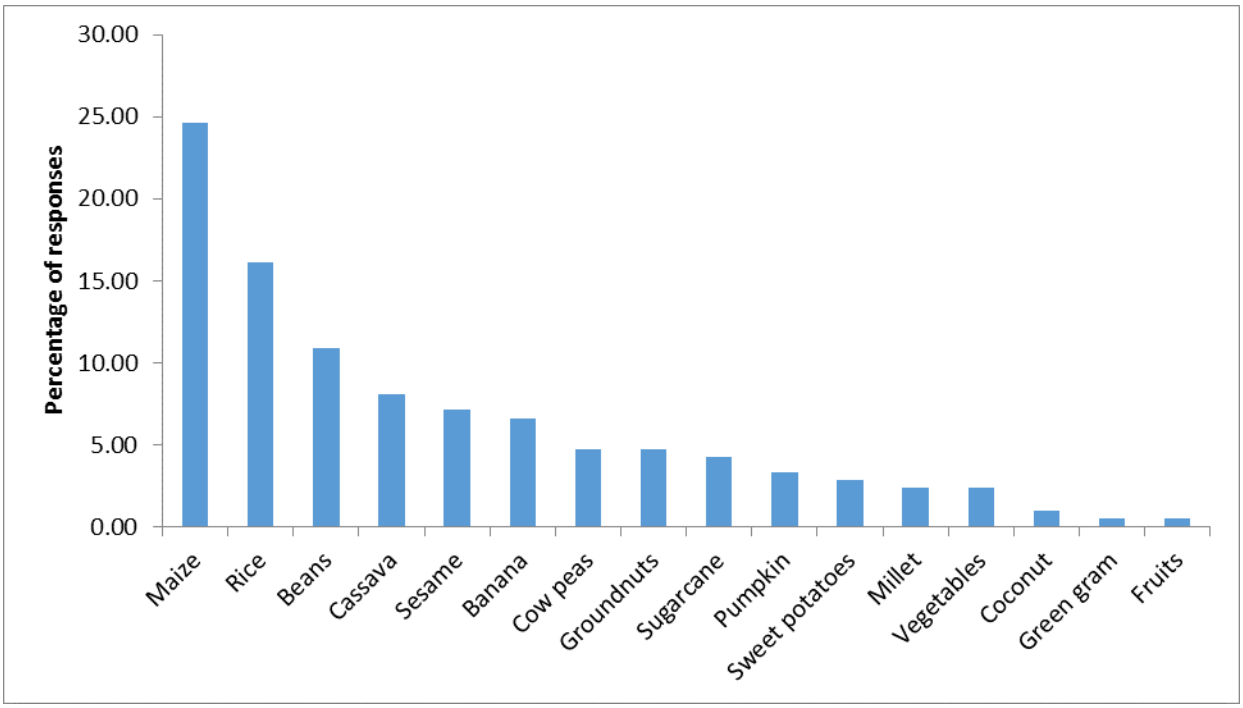

Figure 9: Percentage of most frequently raided crops by elephants in Tunduru district. N=211

Synthesis

About 82% (14 villages) of the 17 villages included in this assessment perceived HEC. 13 villages reported current crop-raiding by elephants. The farmers and village leaders have reported regular incidences per year, with increased rates between 2015 and 2019. Three villages (Dakawa, Mganzi and Sesenga) reported minimum HEC as a results of elephant movements with minimum crop-raiding incidences. Over 50% of these villages perceiving HEC (Kisakikituoni, Gomero, Bwakilachini, Rahaleo, Mbungulaji, Kajima and Jaribuni) are located in a close proximity to the park boundaries. Other villages such as Mgude, Kisemo, Kidugalo and Pulambili are located near to the historical wildlife corridor that connect Wami-Mbiki WMA and the SGR/Nyerere NP (Figure 4).Since animals (elephants) do not recognize physical boundaries and their high migratory and ranging requirements make them remember their historical and ecological boundaries, contact with people and conflict occur.

Interestingly, elephants in transit between the Wami-Mbiki WMA and the SGR/Nyerere NP are known to have entered the military forest (the forest used by Tanzania Defence Force, 92KJ and 121KJ for military training)) around Ngerengere areas due to the blockage of wildlife corridor by human activities and settlements. They have been staying and

reproduced in the military forest for some years now (at least 10 years)), and their population number has increased to an estimated 100 or more individuals. These elephants have caused huge crop-raiding and human casualties around the areas in Mgude, Kisamo, Kidugalo and Pulambili villages, as well as threatening the lives of schoolchildren who are studying to the nearest school villages.

4.1.3 Effect of elephants in villages around SGR/Nyerere NP.

4.1.3.1 Crop losses and damages caused by elephants

Communities in areas around SGR/Nyerere NP have reported high crop losses caused by elephants relative to other agricultural problems. Crop-raiding by elephants was ranked as the primary agricultural threat by the majority of respondents. Other lesser problems faced by farmers included pests, drought, and plant diseases as well as flooding (Figure 10-17). Most people have reported elephants as most problematic animals especially in crop-raiding. Other reported elephant-caused damage includes human injuries and fatalities, damage to food stores, damage to homes, damage of trees, soil erosion and hardening, damage of water ponds, and killing livestock at water points. Other problematic wild animals reported include Baboons/Vervet monkeys, Bush pigs, Warthogs, Buffalo, and Hippos.

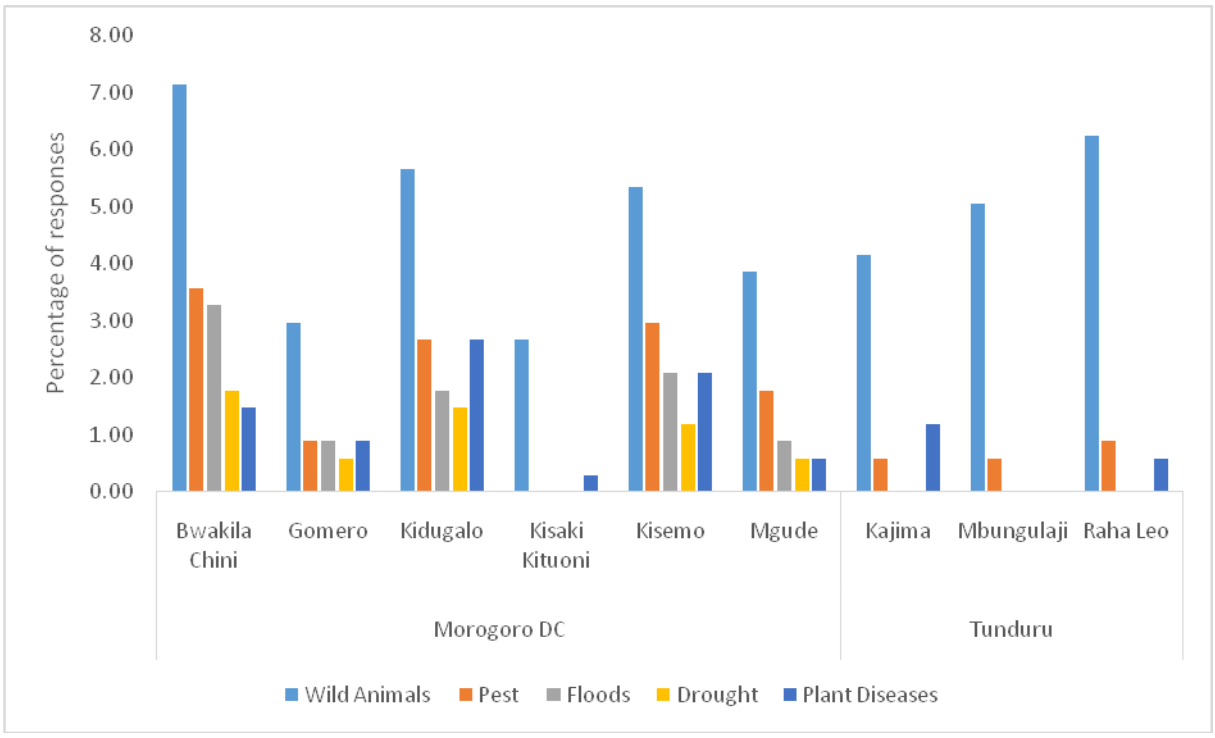

Figure 10: Threats to crops in rank order in surveyed villages around SGR/Nyerere NP. N=336

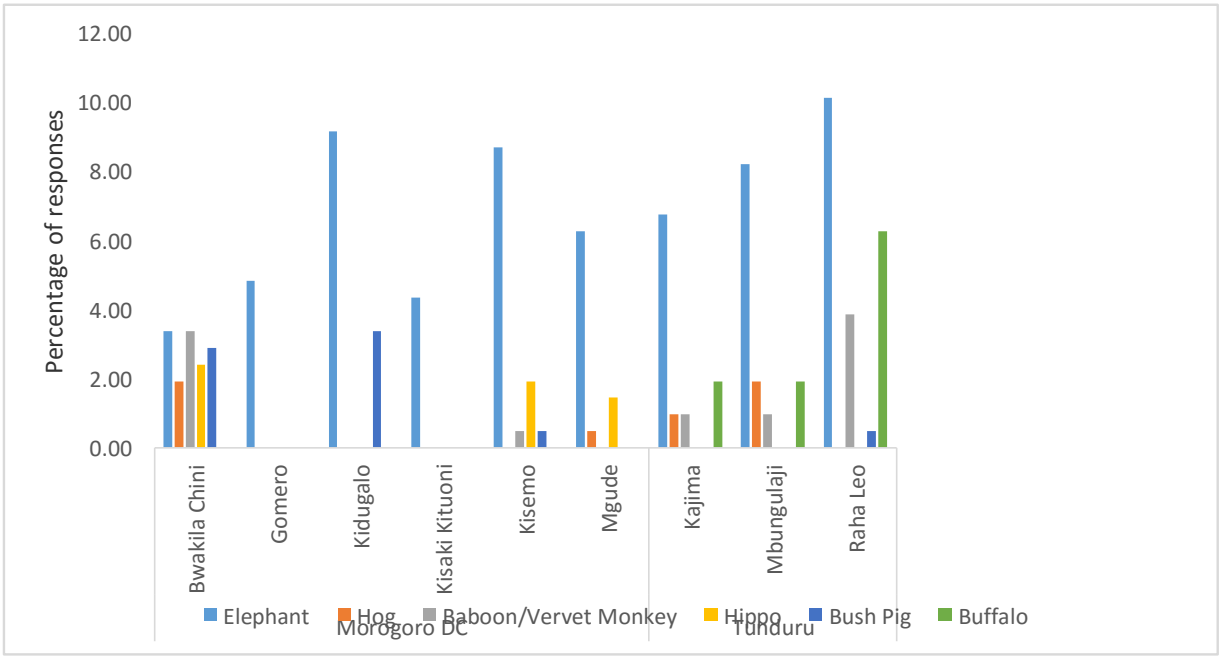

Figure 11:Wild animals threatening crops in surveyed villages around SGR/Nyerere NP. N=207

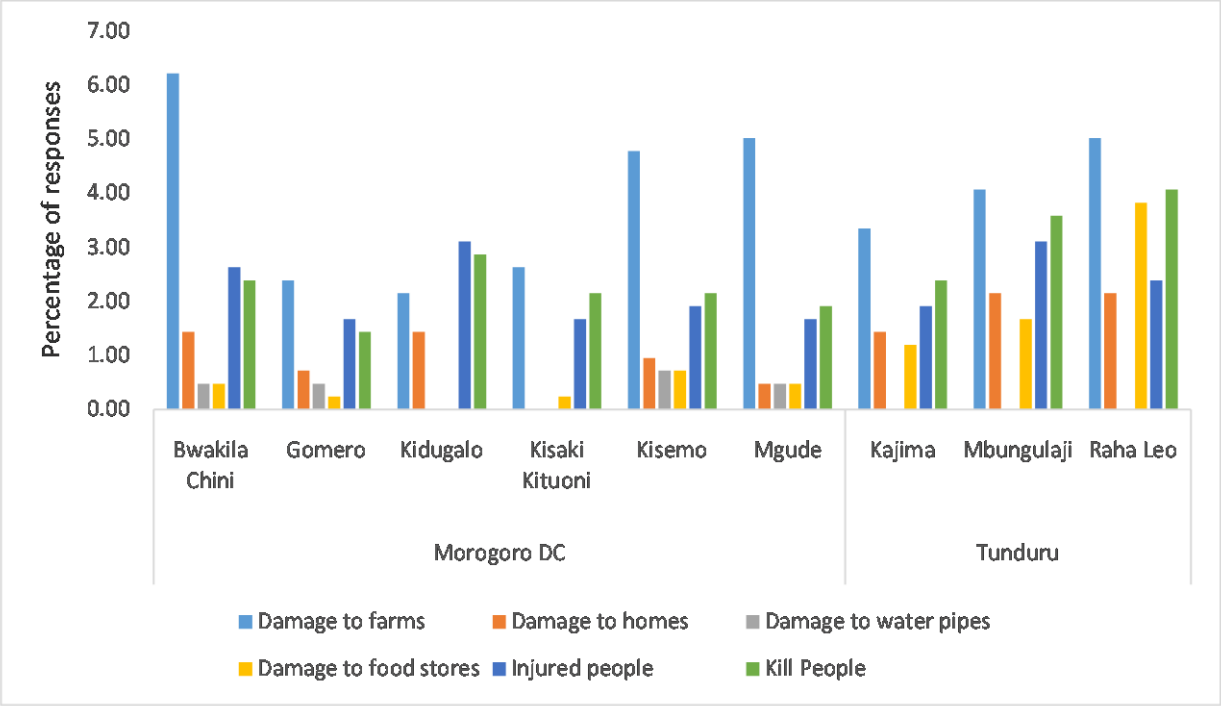

Figure 12: Threats caused by elephants in surveyed villages around MNP. N=418

Figure 13: Elephants in maize farm in Raha leo village, Tunduru district.

Figure 14: Damage caused by elephants on maize and cassava farm in Kisaki village in Morogoro DC.

Figure 15: Damage caused by elephants on banana farm in Mgude village in Morogoro DC.

Figure 16: Elephant dung in maize farm in Kisemo village in Morogoro DC.

Figure 17: Damaged Mango tree by elephants in Kisemo village in Morogoro DC.

4.1.3.2 Human injuries and fatalities

In Morogoro district, nine human deaths and nine human injuries were attributed to elephants between 2015 and 2020. In Tunduru district, four human deaths and zero human injuries were attributed to elephants between 2015 and 2019. This risk may be heightened by people's unfamiliarity with elephants (lacking enough education on elephants).

Table 2: Table 2: Human injuries and deaths. (Source: District Game Officers, Morogoro DC and Tunduru).

No.	Incidence	Year (s)	No. people involved	Village	District	Region
1.	Human deaths	2015-2019	3	Rahaleo	Tunduru	Ruvuma
2.	Human death	2015-2019	1	Kajima	Tunduru	Ruvuma
2.	Human death	2015-2019	2	Kisemo	Morogoro DC	Morogoro
3.	Human death	2016	1	Sangasanga	Morogoro DC	Morogoro
4.	Human death	2020	1	Kidugalo	Morogoro DC	Morogoro
5.	Human deaths	2015-2019	2	Bwakilachini	Morogoro DC	Morogoro
6.	Human injuries	2015-2019	3	Bwakilachini	Morogoro DC	Morogoro
7.	Human deaths	2015-2019	2	Kisakikituoni	Morogoro DC	Morogoro
8.	Human injuries	2015-2019	4	Kisakikituoni	Morogoro DC	Morogoro
9.	Human death	2015-2019	1	Gomero	Morogoro DC	Morogoro
10.	Human injuries	2015-2019	2	Gomero	Morogoro DC	Morogoro

4.1.4:Temporal trends and seasonality of crop-raiding in villages around SGR/Nyerere NP

The communities have reported that crop-raiding incidents started a long time ago; however the severity increased within the past five years. Communities in the study areas recalled that crop-raiding events occur in both seasons of the year (wet and dry), peaking near the harvesting season. Furthermore, communities have reported that most crop-raiding events occur during the evening and night. However, in Tunduru district the crop-raiding events and elephant movements occurs all throughout the day.Reported trends in the frequency of crop-raiding incidents over the past five years is increasing.

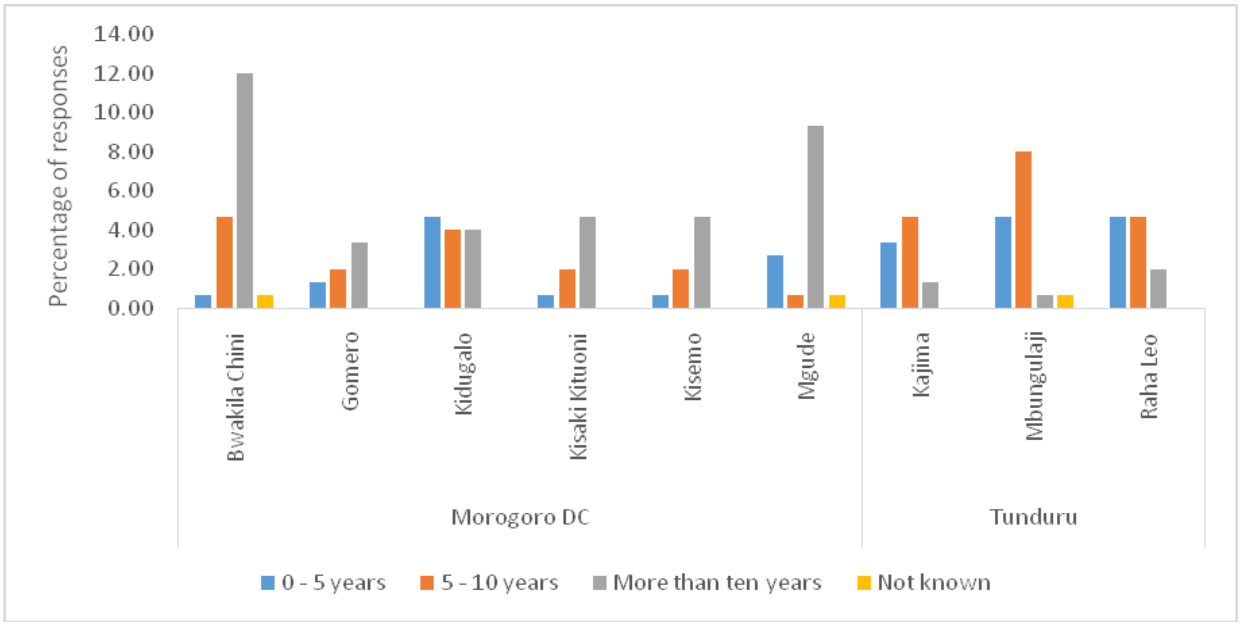

Figure 18: Onset of farmer's experience crop-raiding by elephants in surveyed villages around SGR/Nyerere NP. N=150

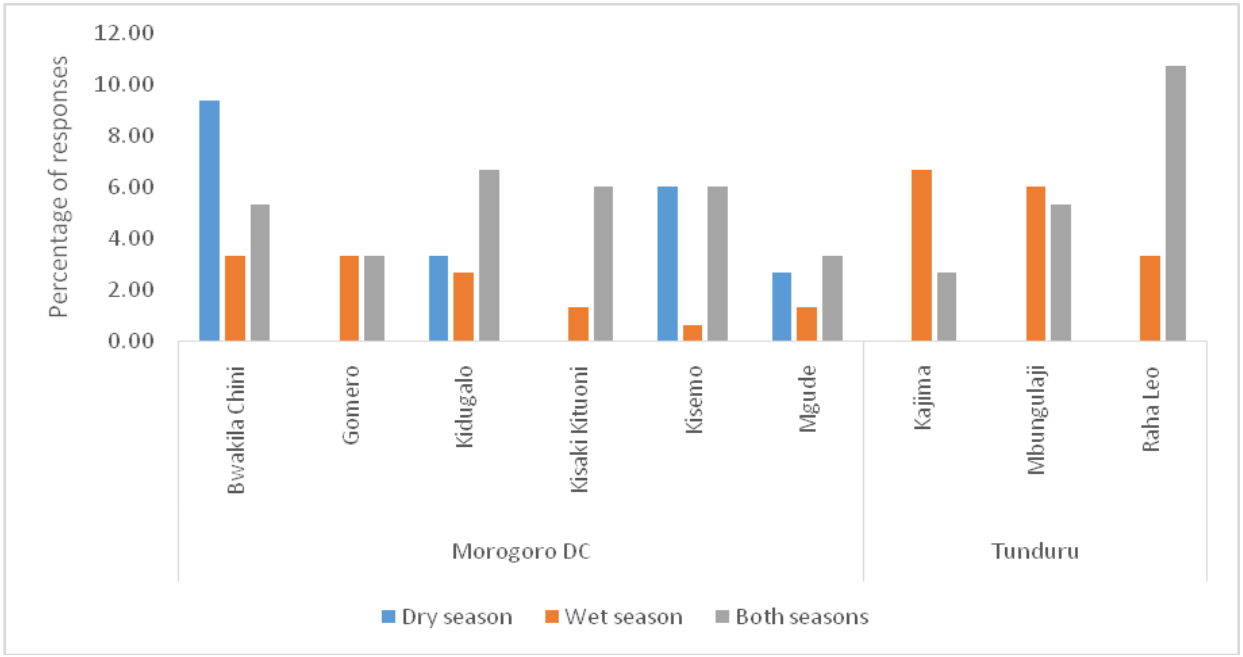

Figure 19: Seasonality of elephant crop-raiding by elephants in surveyed villages around SGR/ Nyerere NP. N=149

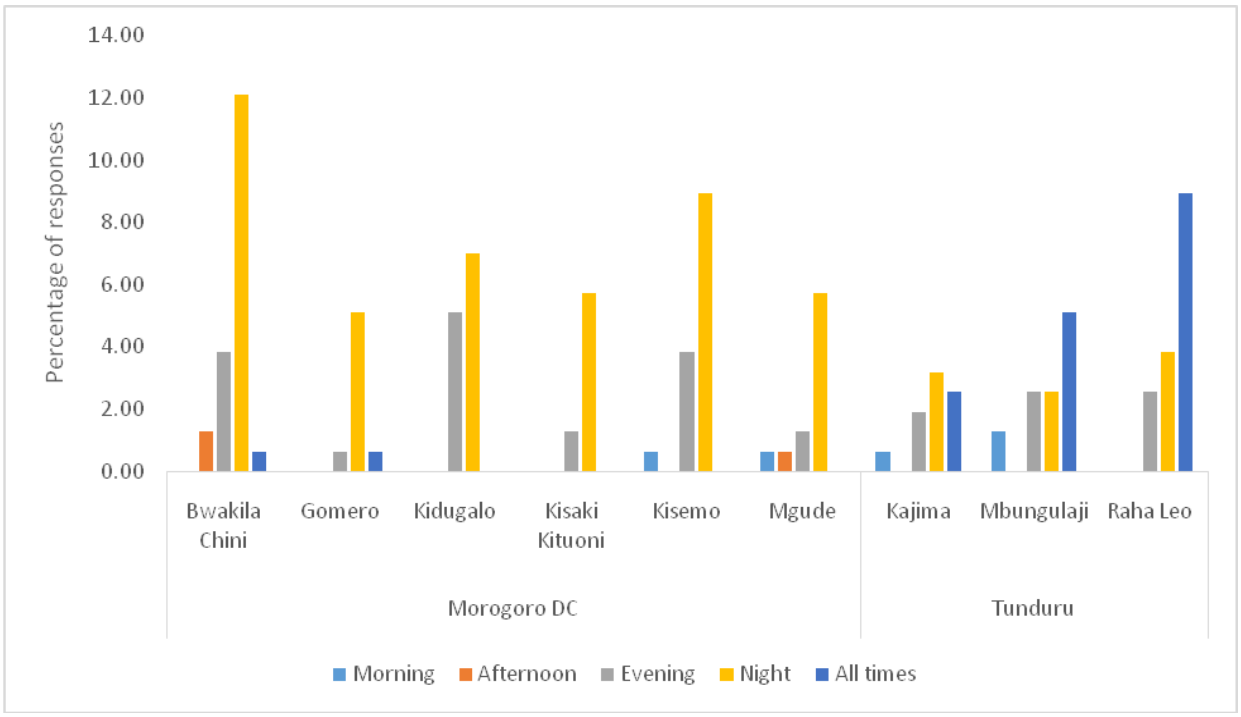

Figure 20: Time of a day elephant entering the farms. N=157

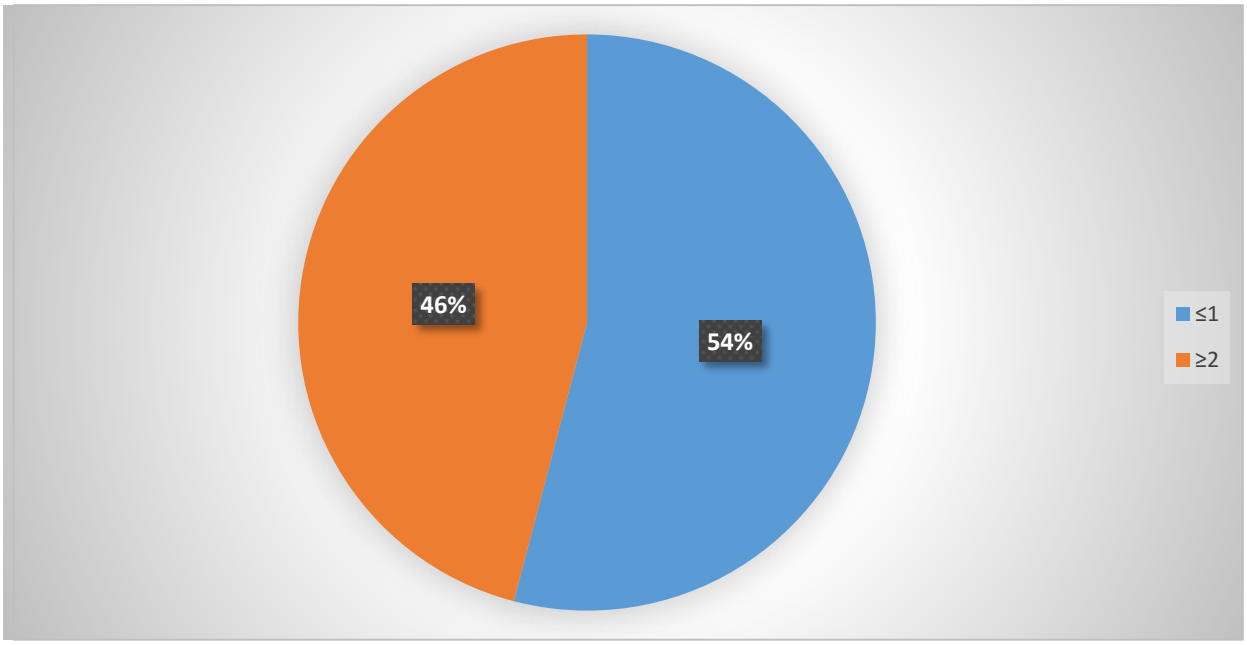

Figure 21: Frequency of elephant crop-raiding reported by farmers in Morogoro DC for 2018.

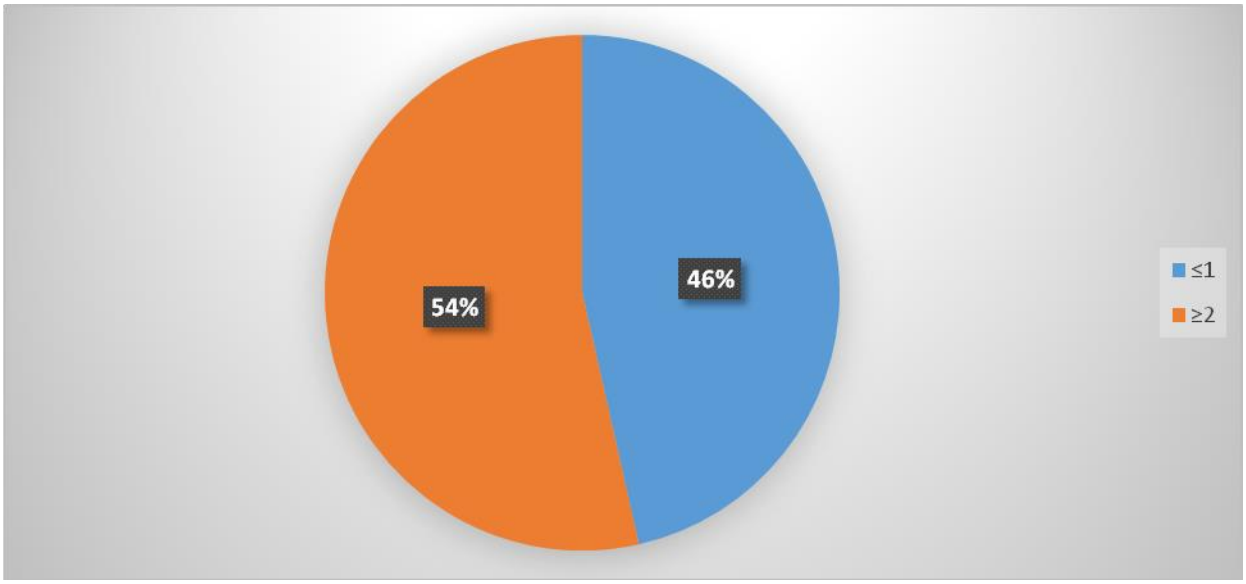

Figure 22: Frequency of elephant crop-raiding reported by farmers in Morogoro DC for 2019.

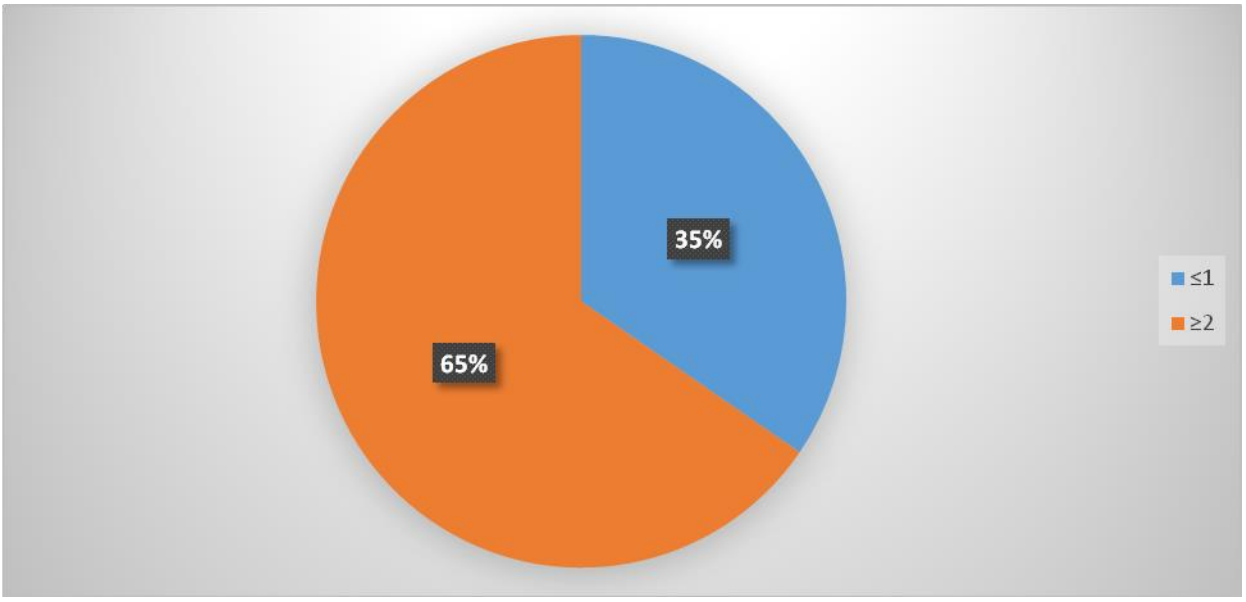

Figure 23: Frequency of elephant crop-raiding reported by farmers in Tunduru for 2018.

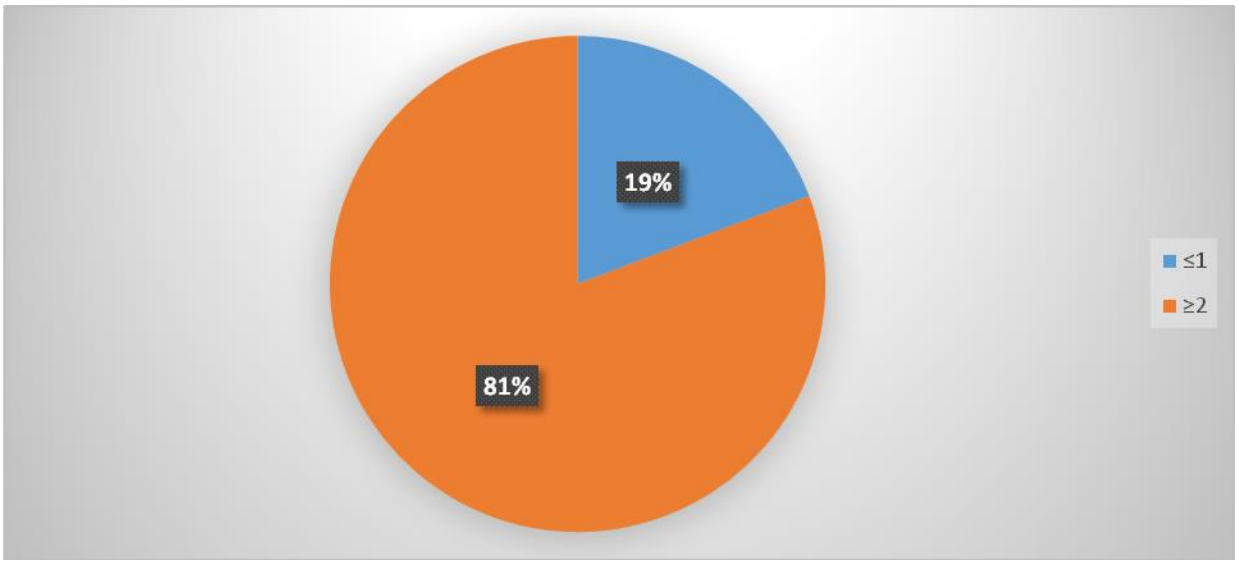

Figure 24: Frequency of elephant crop-raiding reported by farmers in Tunduru for 2019.

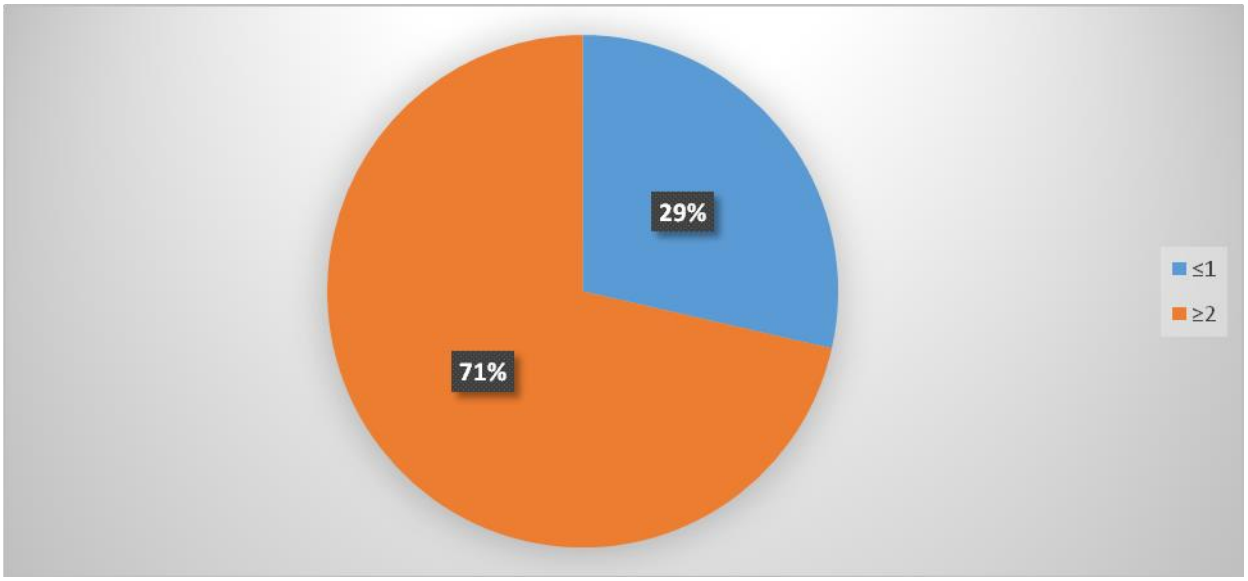

Figure 25: Frequency of elephant crop-raiding reported by village leaders in Morogoro for 2018.

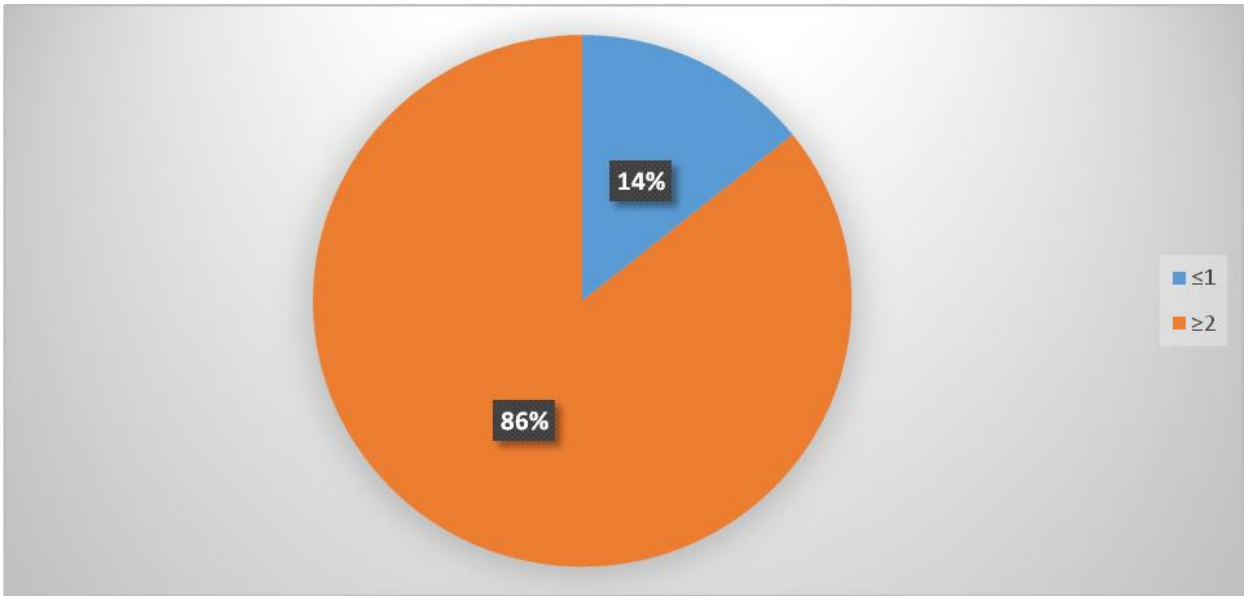

Figure 26: Frequency of elephant crop-raiding reported by village leaders in Morogoro for 2019.

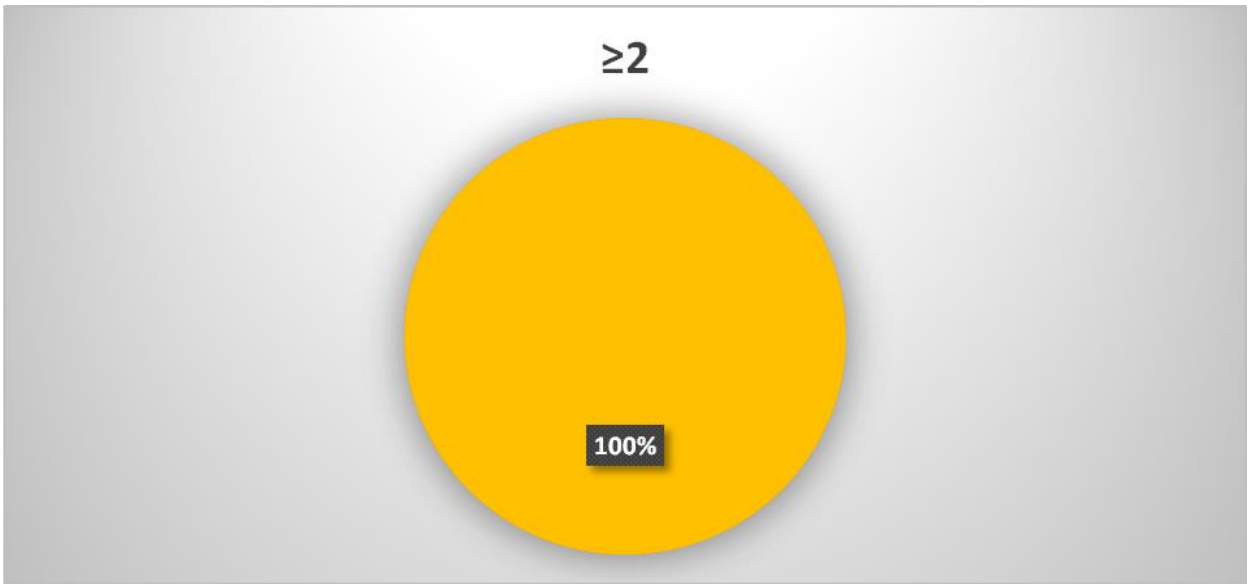

Figure 27: Frequency of elephant crop-raiding greater than 2 times reported by village leaders in Tunduru for 2018.

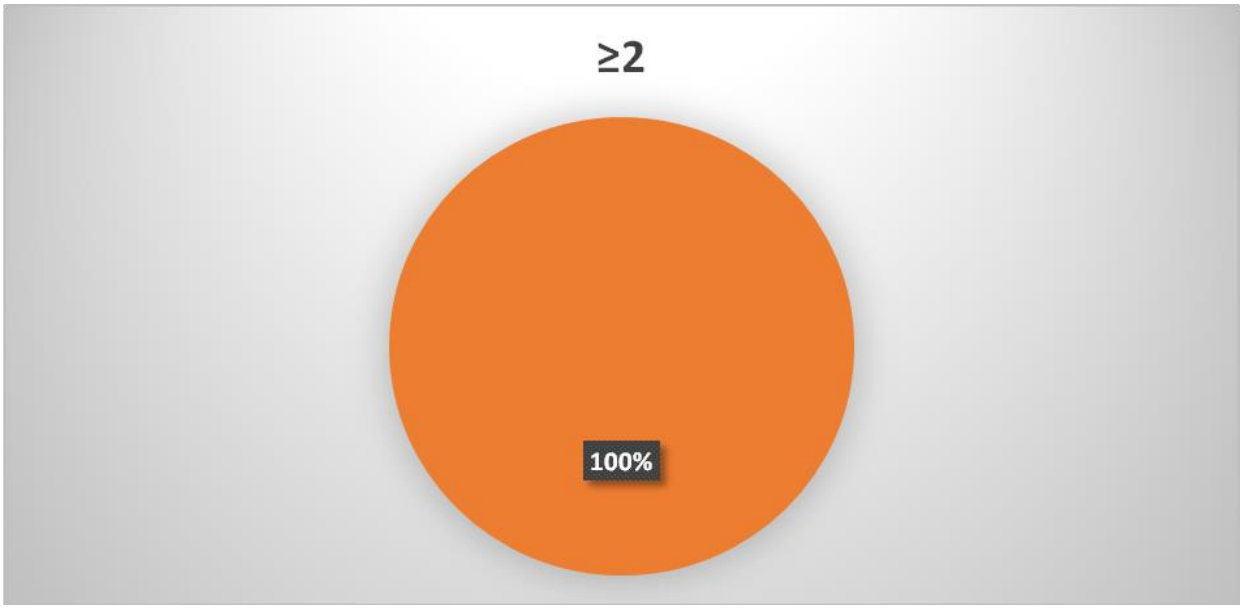

Figure 28:Frequency of elephant crop-raiding greater than 2 times reported by village leaders in Tunduru for 2019.

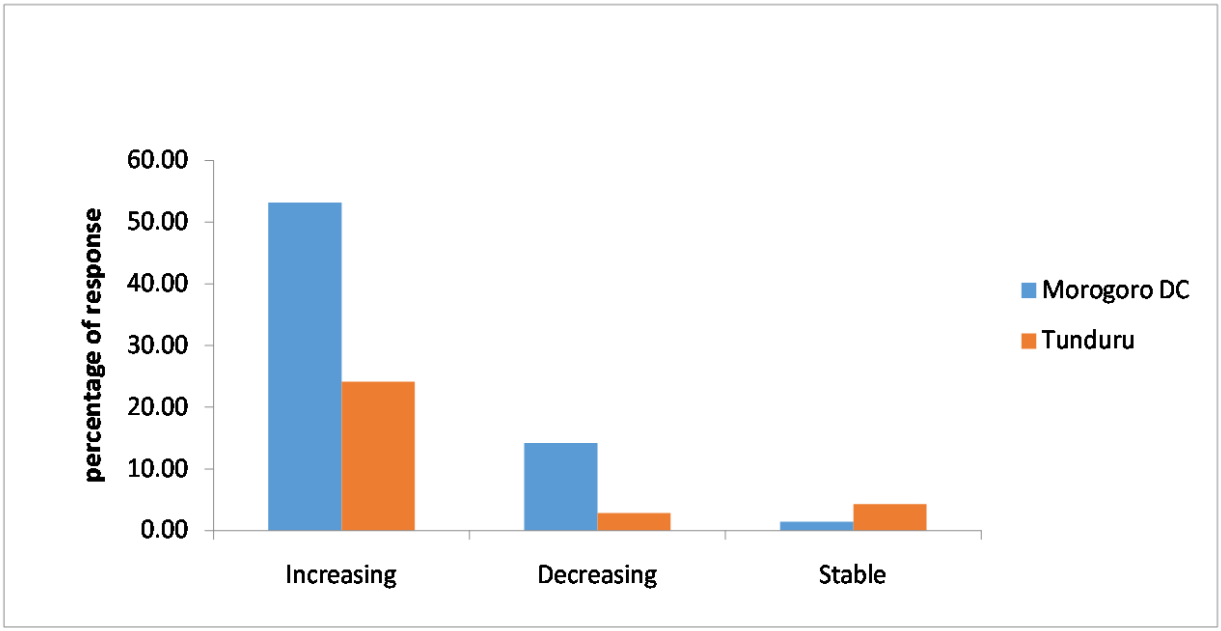

Figure 29: Trends in elephant crop-raiding reported by farmers in surveyed districts around SGR/Nyerere NP. N=141

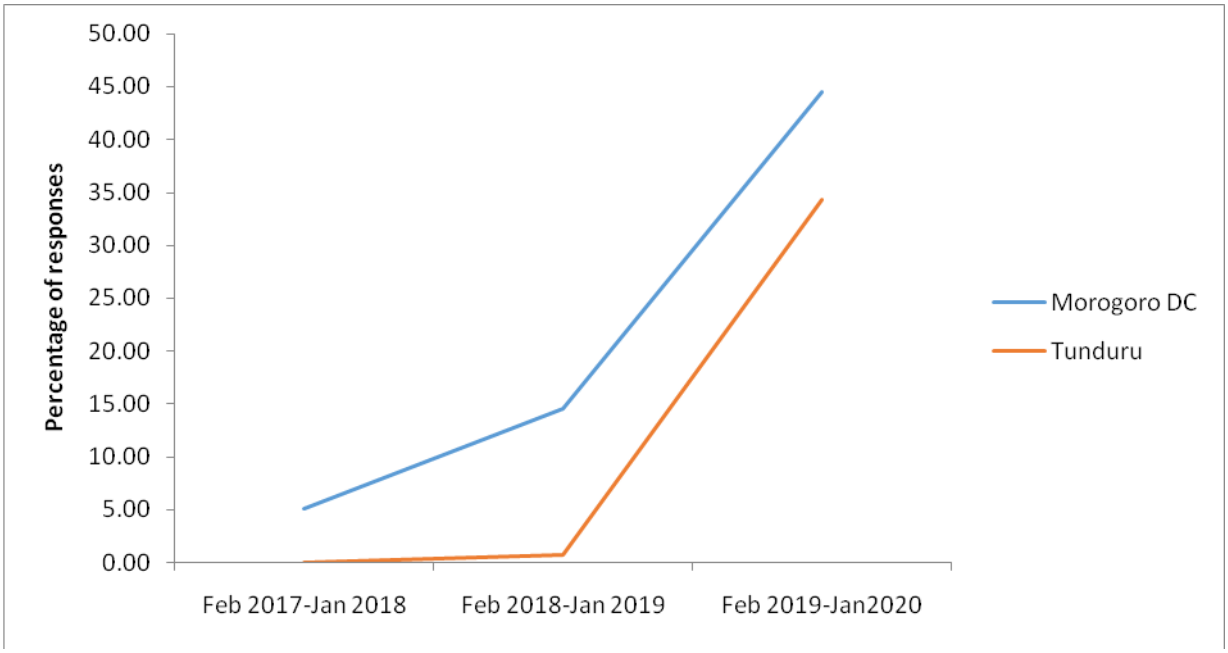

Figure 30: Last time of elephant crop-raiding reported in districts around SGR/Nyerere NP.N=137

4.2. Elephant movements and historical range (buffer zones and dispersal areas)

The majority of respondents reported that elephants are coming to their village land from SGR/Nyerere NP (this was reported by Kisaki kituoni, Gomero, Raha leo, Mbungulaji and Kajima villages). Others said that elephants are approaching from Mikumi National Park (Kisaki kituoni and Nyarutanga villages), from Military forest (Mgude, Kesemo and Kidugalo villages) and from NALIKA WMA (Raha leo, Mbungulaji and Kajima villages).

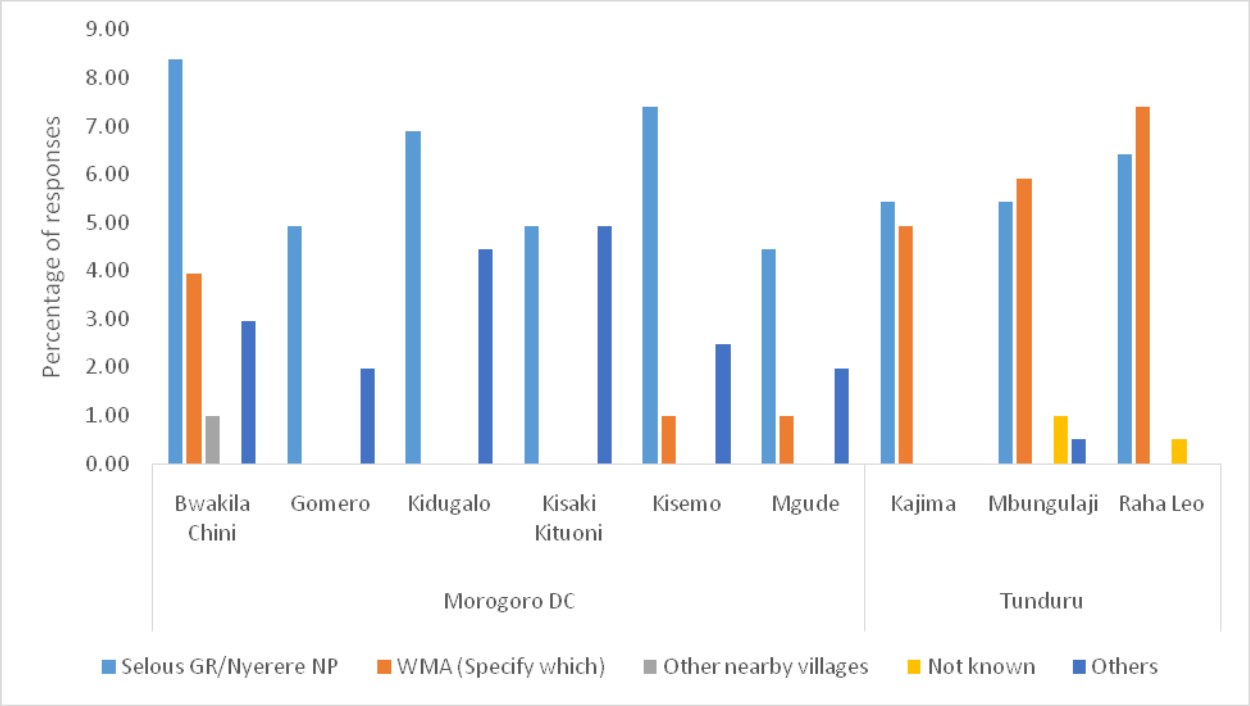

Figure 31: Response by farmers on where problem elephants are coming from. N=203

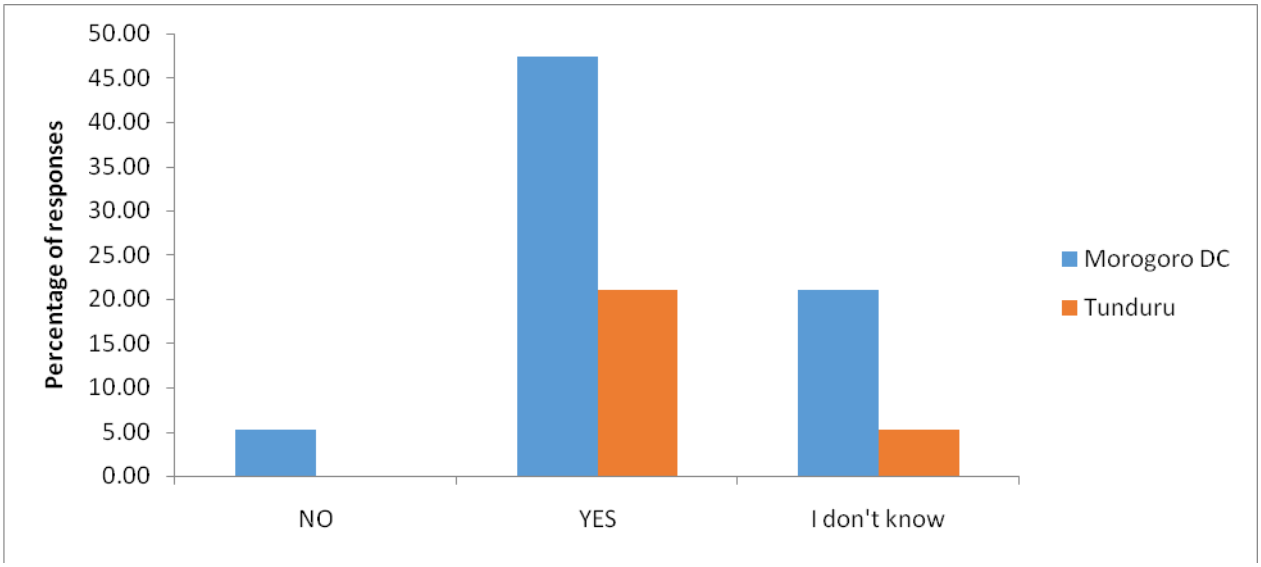

Figure 32: Response by village leaders to whether they know if elephants have been using specific routes/pathways in the past and present to move from one area to another. N=19

4.3 Attitudes towards elephants and PA's

4.3.1 Attitudes towards elephants

In response to the question, "What are your feelings about elephants?", the majority of farmers responded negatively with, few expressing positive or neutral (both positive and negative) feelings on elephants The negative response of farmers towards elephants was 31% in Tunduru district and 40% in Morogoro DC. While the positive response of farmers towards elephants was 2% in Tunduru district and 13% in Morogoro DC. The neutral response of farmers towards elephants was 1% in Tunduru district and 13% in Morogoro DC. Although the majority of village leaders had positive feelings on elephants,almost as many had negative and neutral responses, with 26% in Morogoro DC and 74% in Tunduru district.

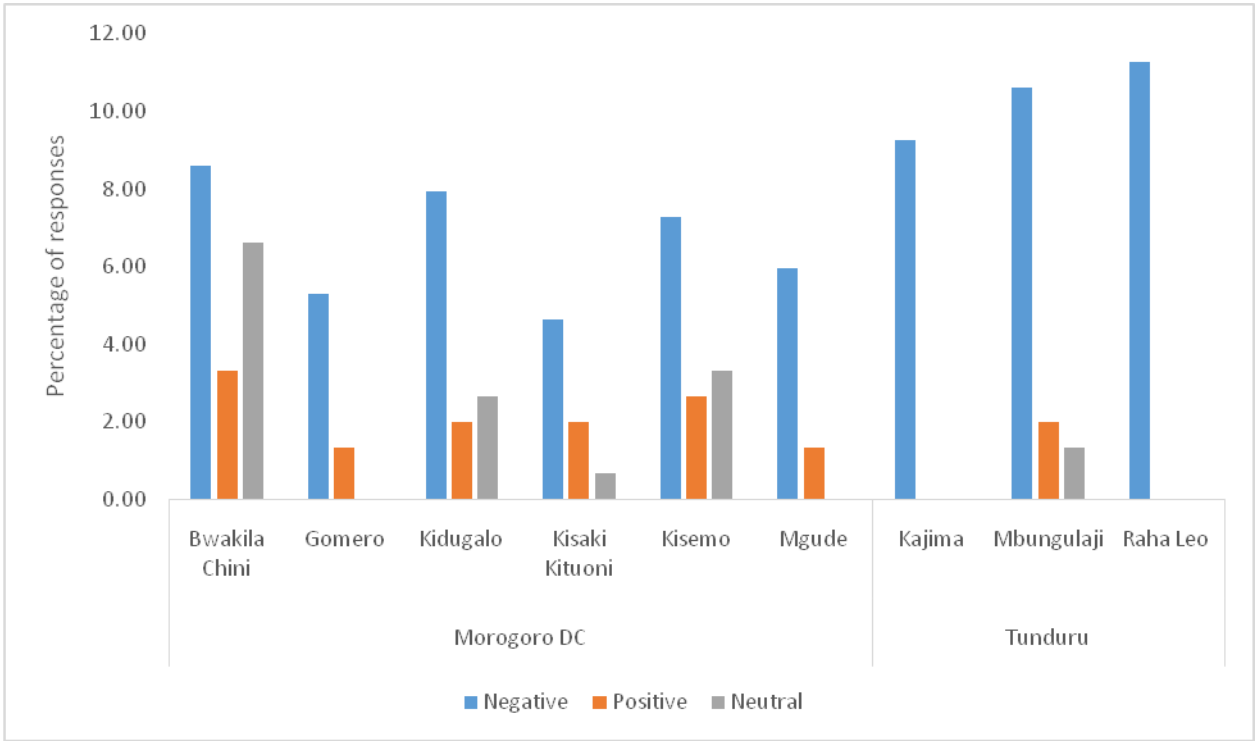

Figure 33: Attitude of farmers towards elephants in surveyed villages around SGR/Nyerere NP. N=151

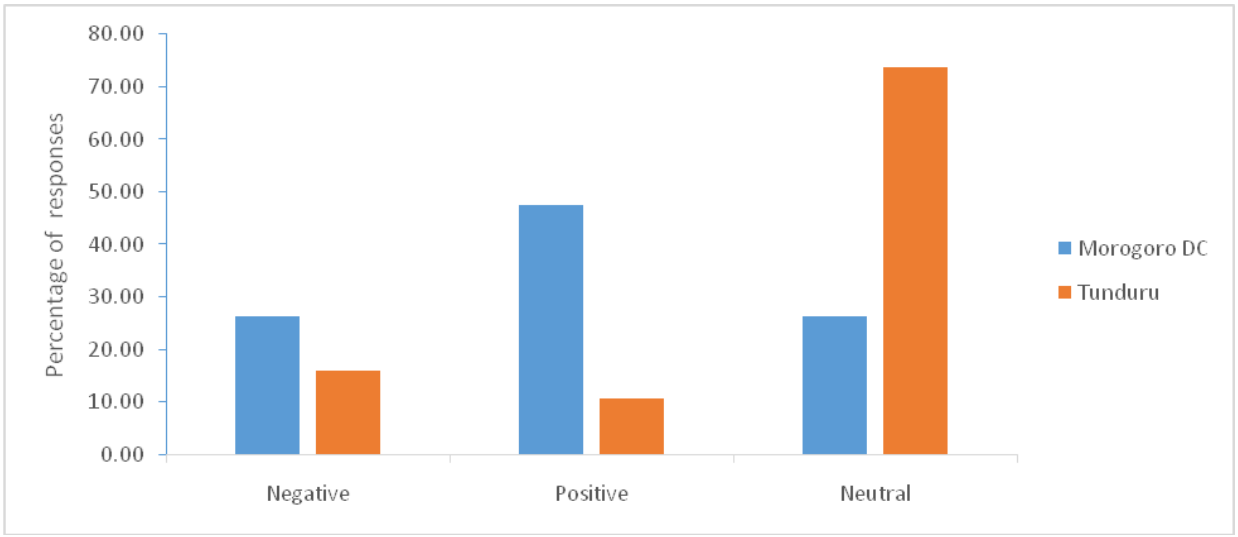

Figure 34: Attitude of village leaders towards elephants in surveyed villages around SGR/ Nyerere NP. N=19

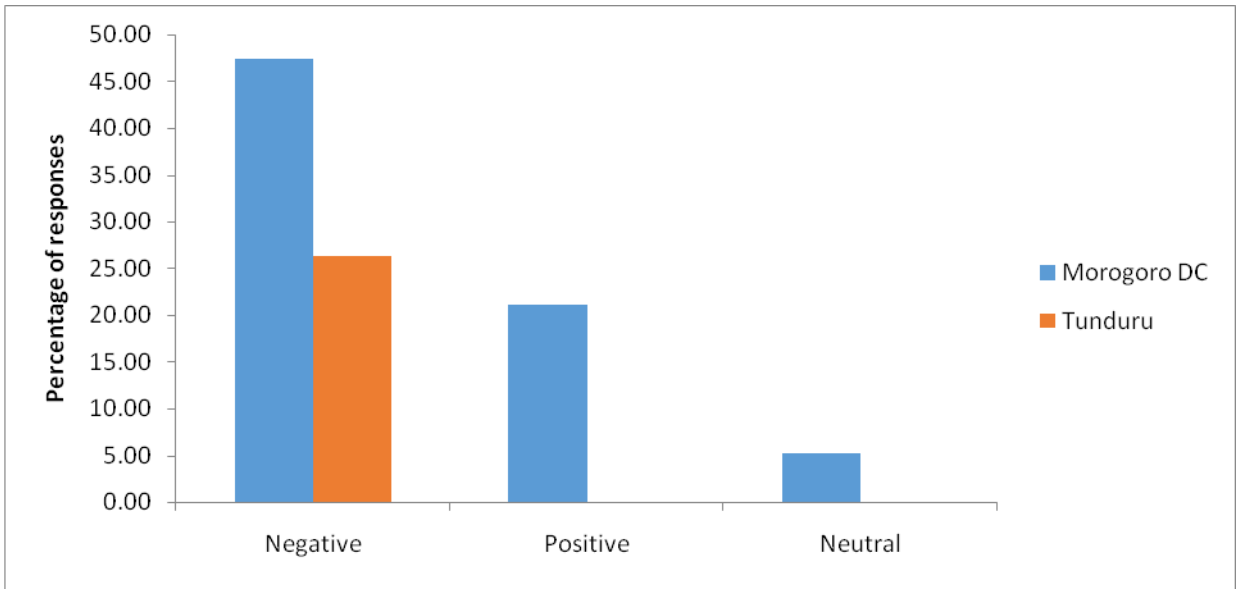

Figure 35: Response by village leaders on what feelings do the villagers have towards elephants. N=19

4.3.2 Attitudes towards PA's

In response to the question, "What are your feelings towards PA's?'' most of the farmers in the surveyed villages had positive feelings on PA's. However, others had negative feelings on PA's. Few of them had a neutral response, while several others offered no response.The

negative response of farmers towards PA's was 18% in Tunduru district and 20% in Morogoro DC. While the positive response of farmers towards PA's was 7% in Tunduru district and 37% in Morogoro DC. The neutral response of farmers towards PA's was 5% in Tunduru district and 7% in Morogoro DC. The majority of village leaders had positive response on PA's while few of them had negative reponses.

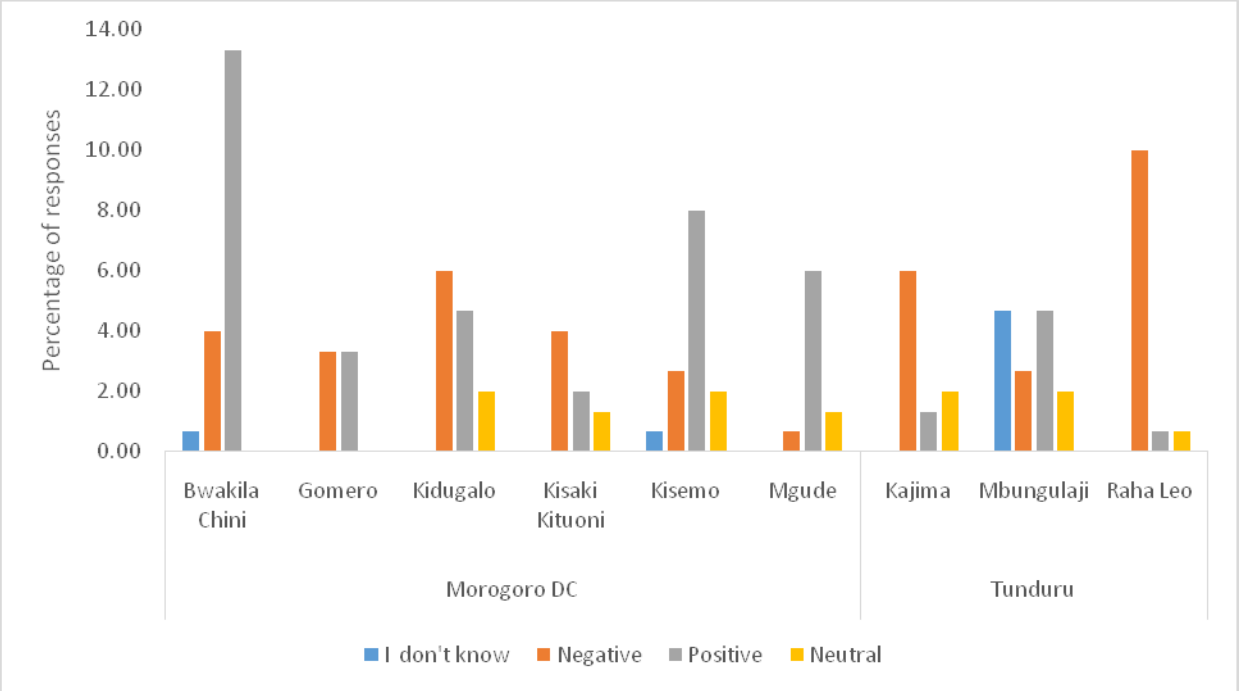

Figure 36: Attitude of farmers towards PA's in surveyed villages around SGR/Nyerere NP. N=151

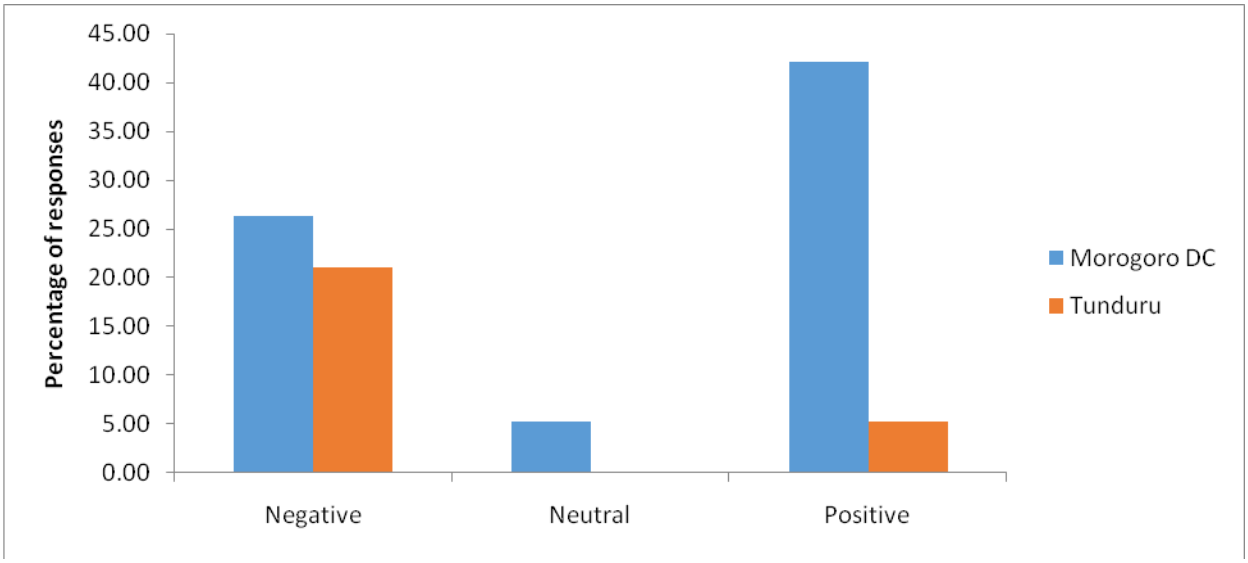

Figure 37: Response by village leaders on what feelings do the villagers have towards PA's. N=19

4.4 How village government and farmers currently manage HEC in the surveyed villages around SGR/Nyerere NP.

Across the study areas, village leaders and farmers were asked about current HEC management strategies. Common mitigation efforts reported include; guarding farms, fire, making noise, and reporting to local governments and district wildlife authority for more assistance. We also investigated beekeeping practices as a part of questionnaires to village leaders, as previous experience with beehive fence projects in Kenya showed that these projects are more successful (lower rates of HEC) when participants have prior beekeeping experience and knowledge.

In our questionnaire survey, we also included the question to village leaders on how the village land has been distributed for various purposes. In all surveyed districts, the village leaders reported that there is local land use planning practices carried out by the village governments, and the village land is planned for settlements, farms areas, grazing areas, wildlife/protected areas, public areas, and for future development.

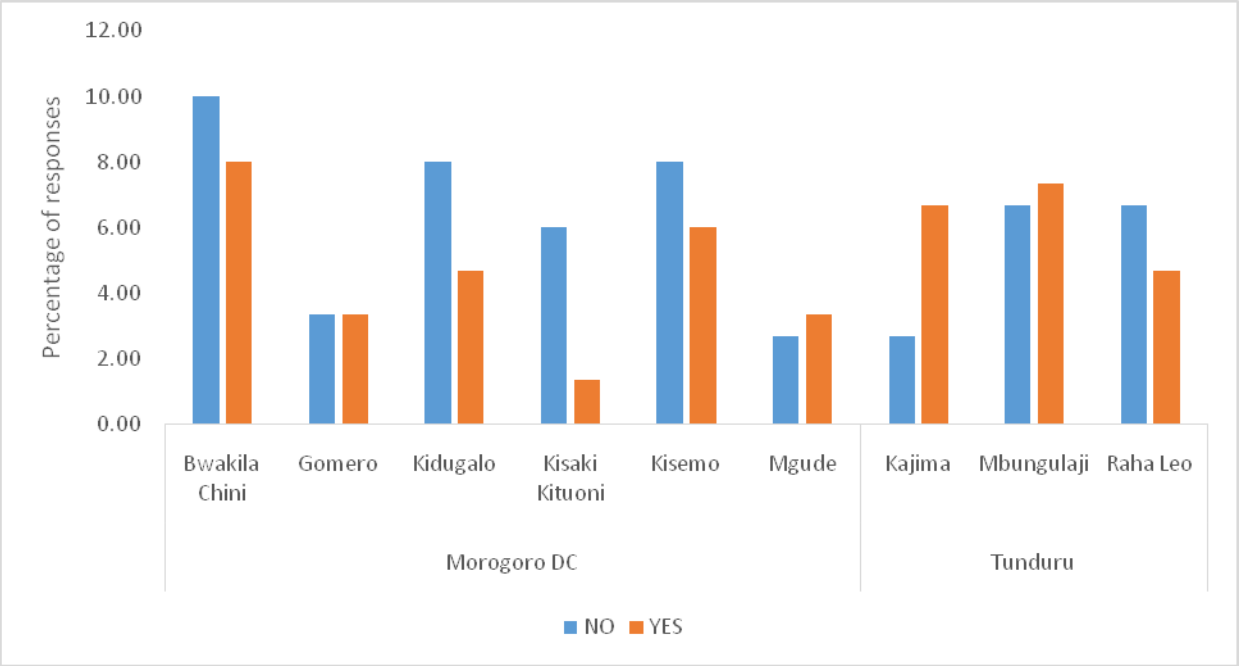

Figure 38: Response by farmers to whether there are any actions they are doing to prevent elephants from raiding farms. N=151

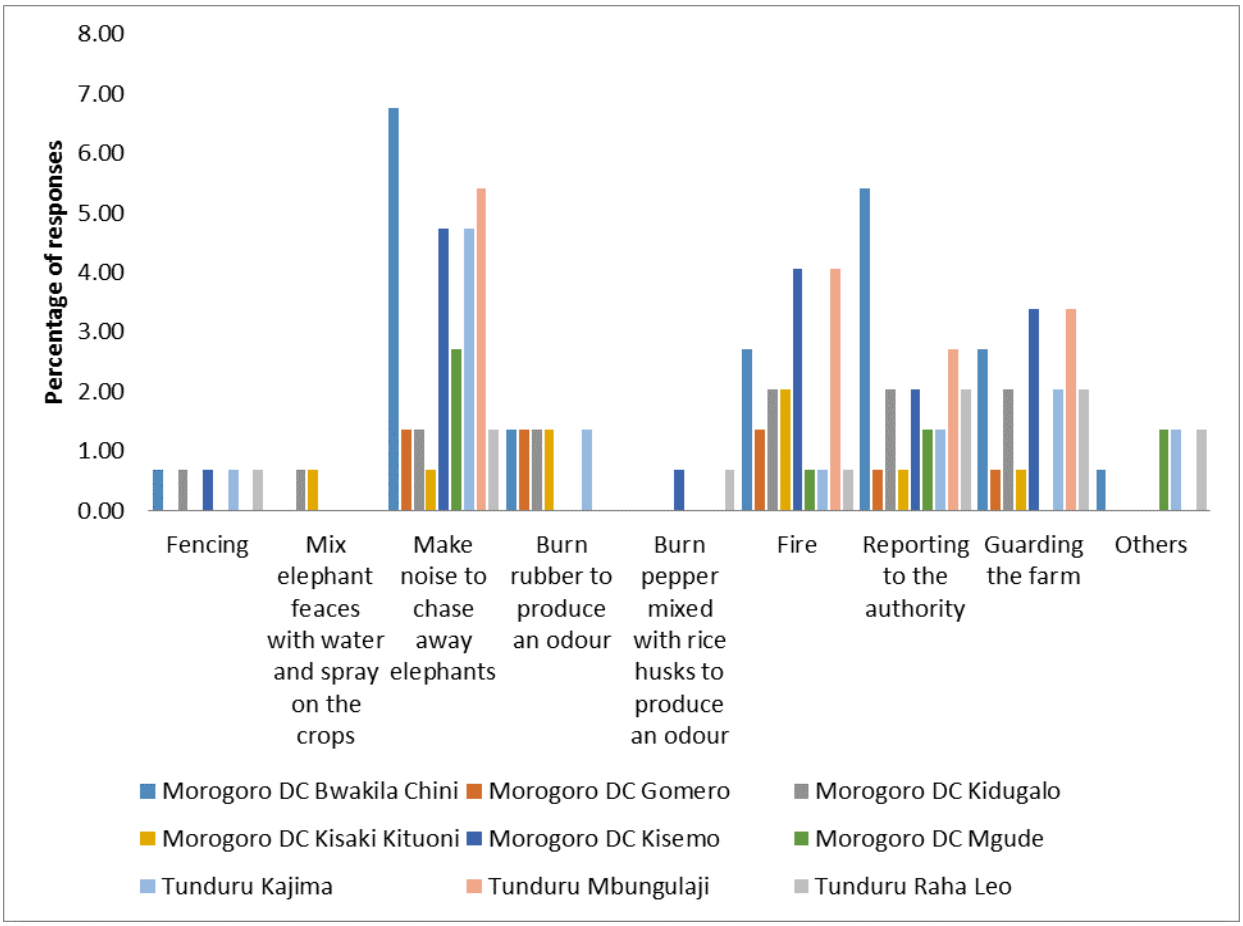

Figure 39: Response by farmers on the methods that they have been using to prevent elephant crop-raiding. N=267

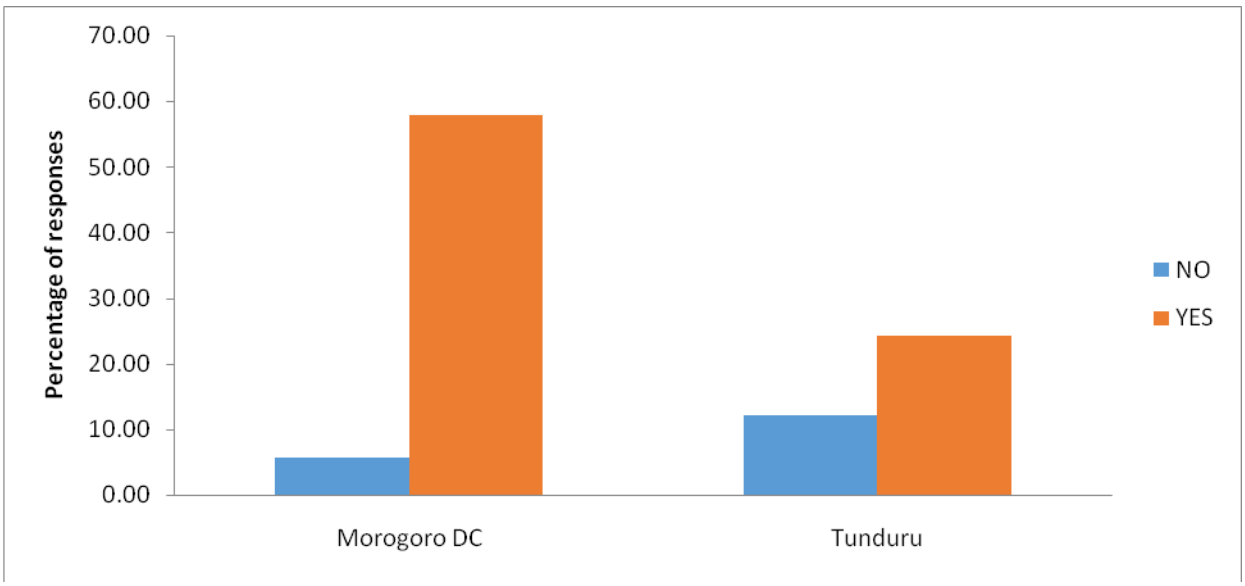

Figure 40: Response by farmers whether they have been reporting HEC incidences. N=140

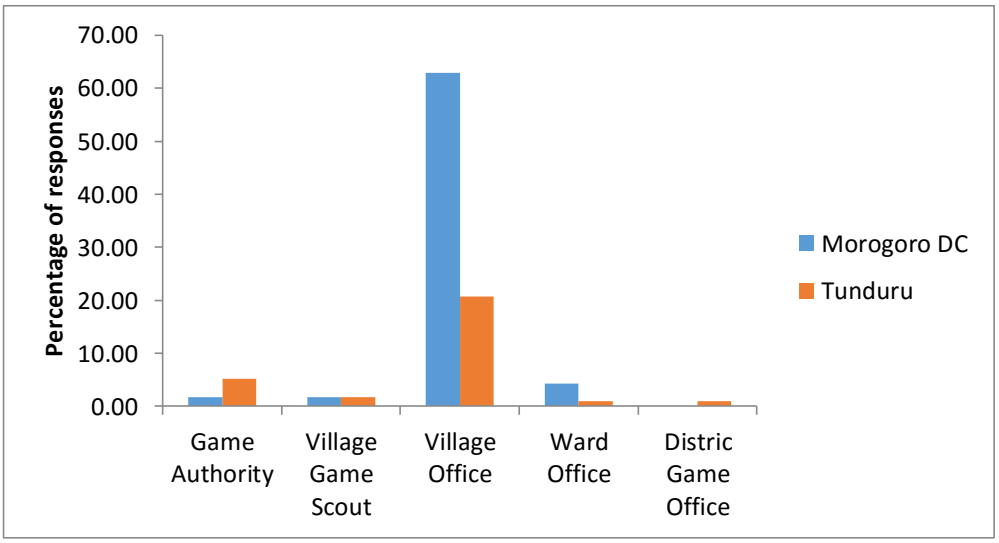

Figure 41: Response by farmers to where they report elephant crop-raiding. N=116

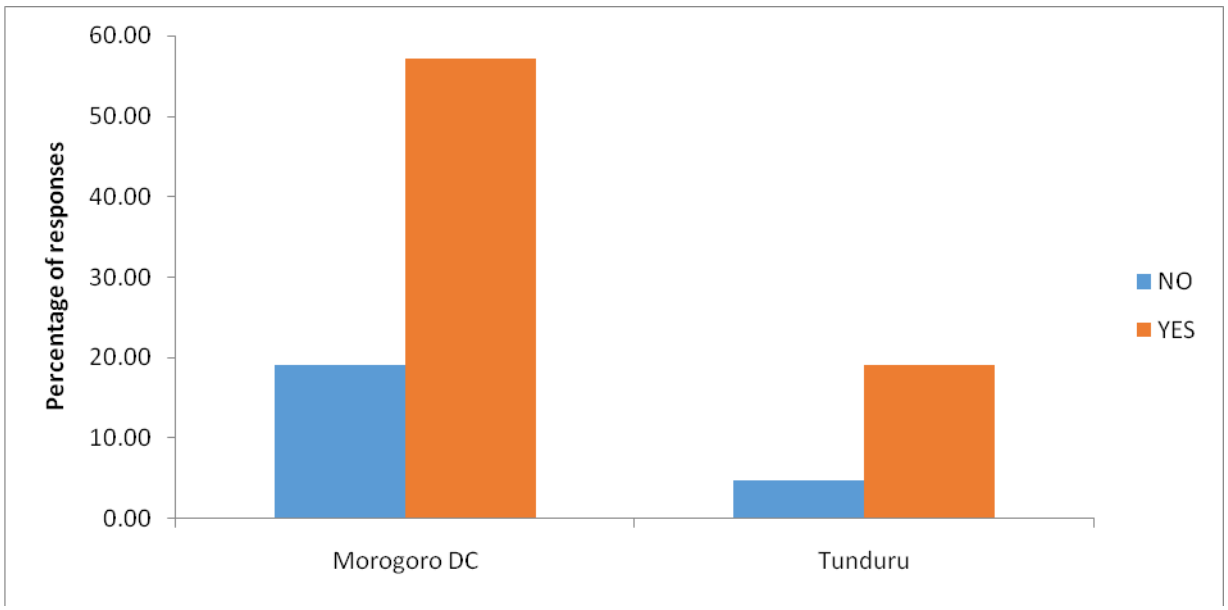

Figure 42: Response by village leaders to whether they are receiving any information from farmers about HEC. N=21

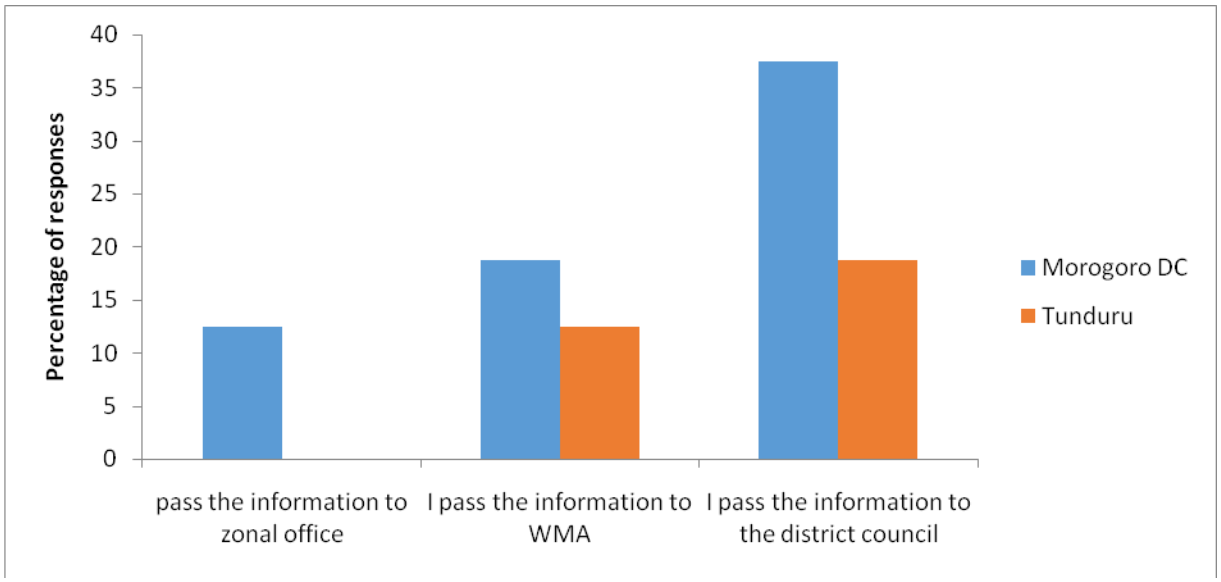

Figure 43: Response by village leaders to what actions they take with the given information on HEC.

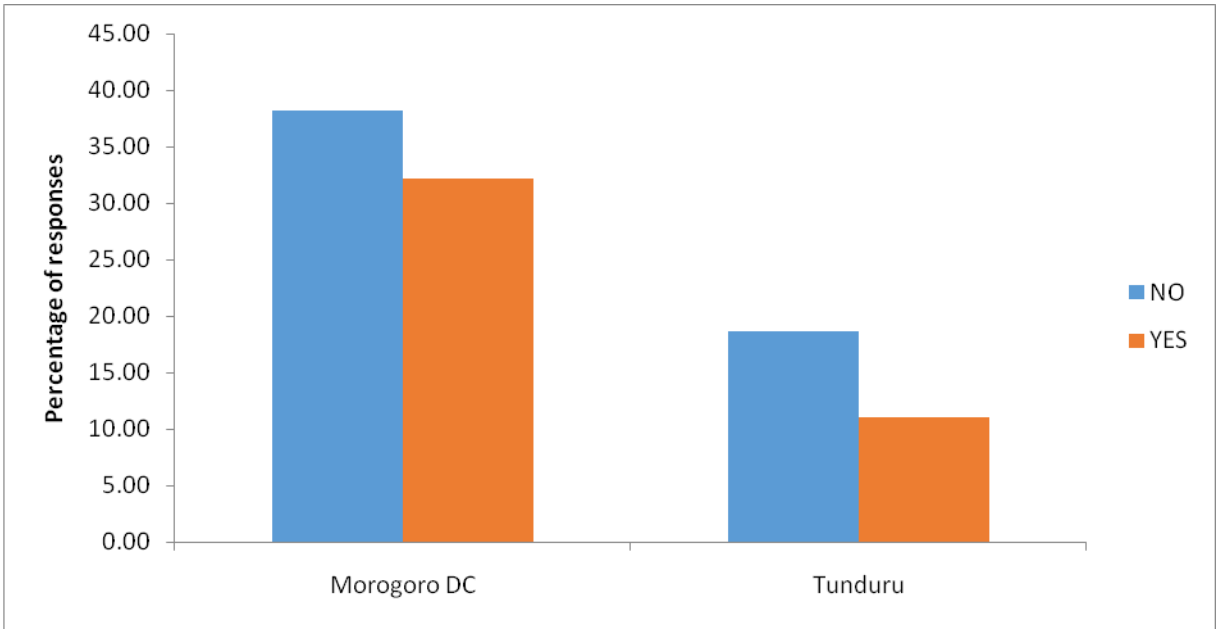

Figure 44: Response by farmers if they have received any assistance. N=118

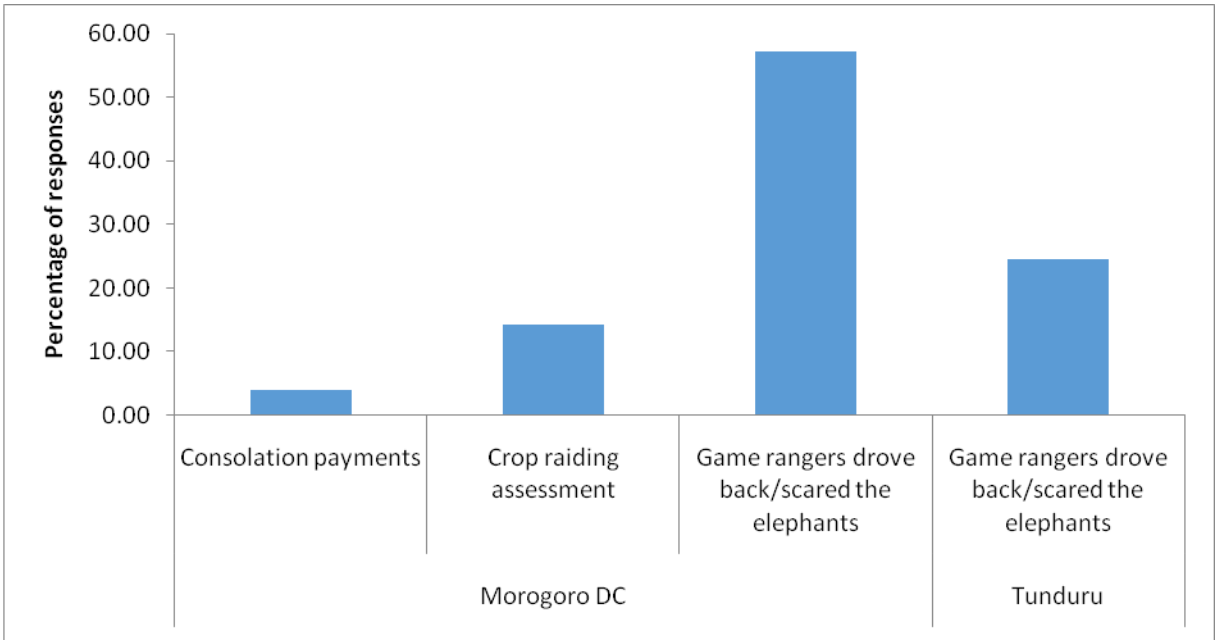

Figure 45: Response by farmers to what types of assistance they have been receiving. N=49

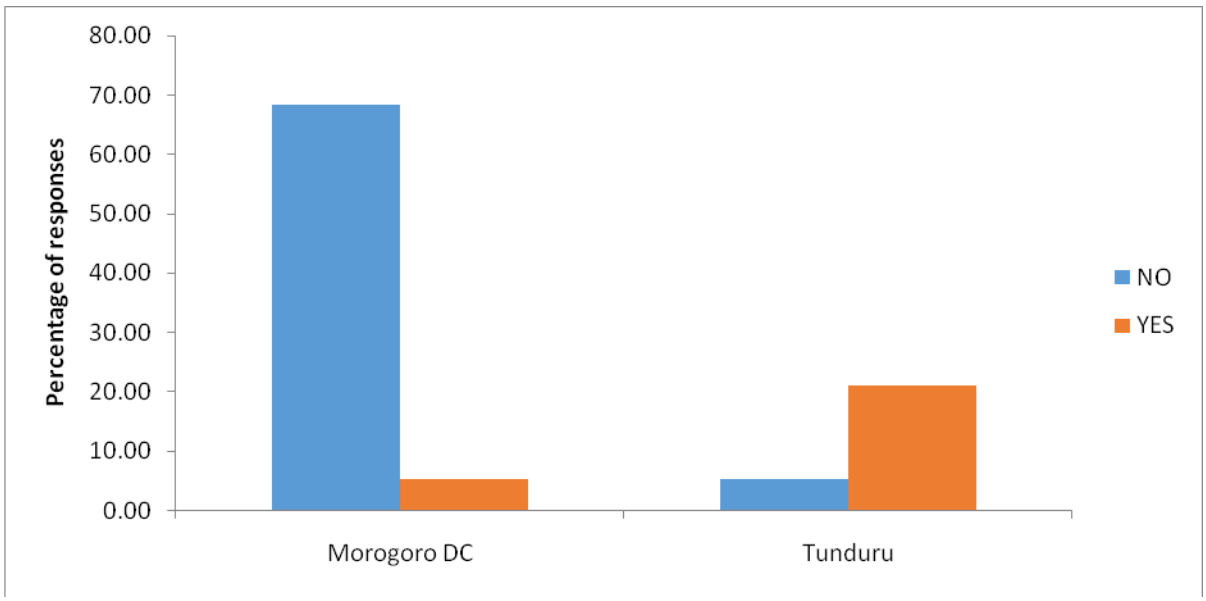

Figure 46: Response by village leaders whether they keep any records about HEC. N=19

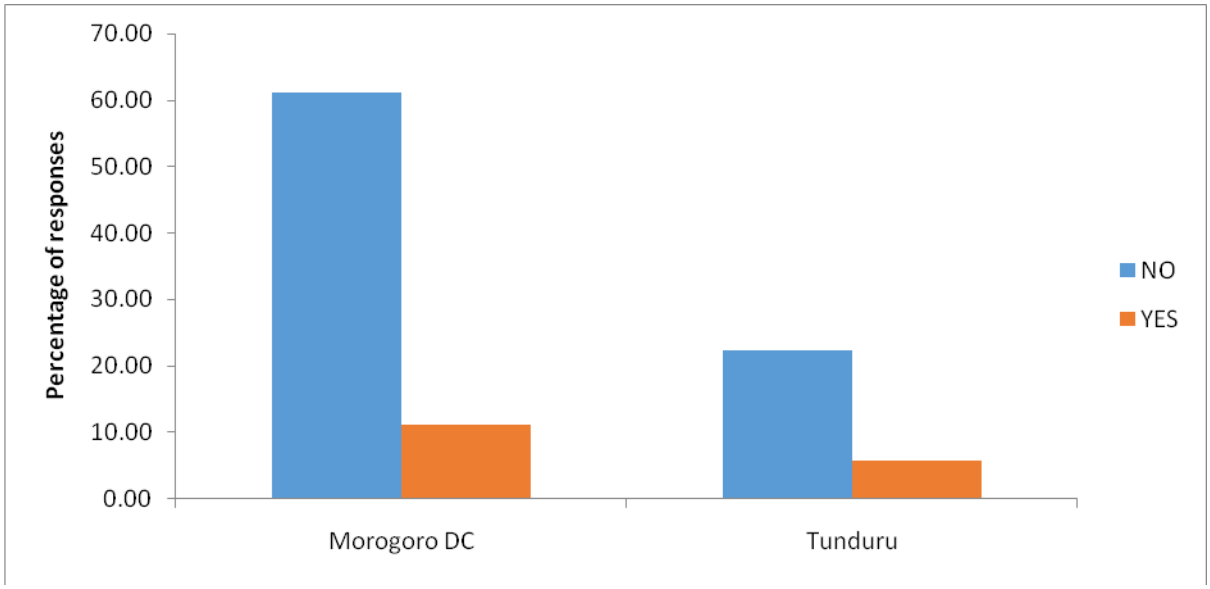

Figure 47: Response by village leaders whether there is any beekeeping activities in their villages. N= 19

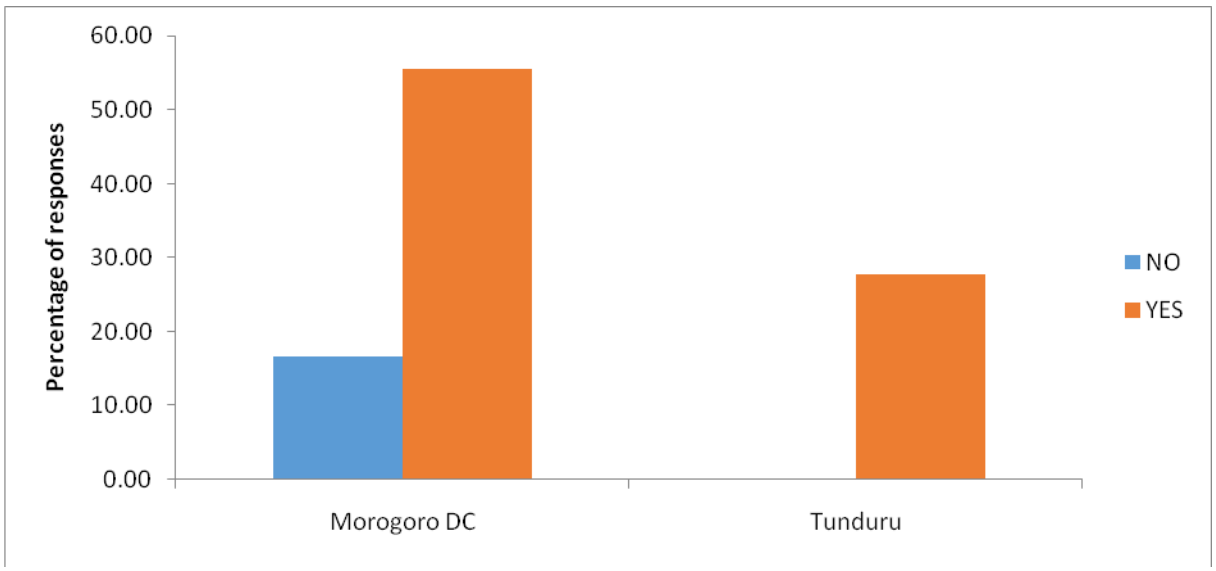

Figure 48: Responses by village leaders if there any forms of land-use planning in their villages. N=19

4.5 Needs for conservation education and outreach programs

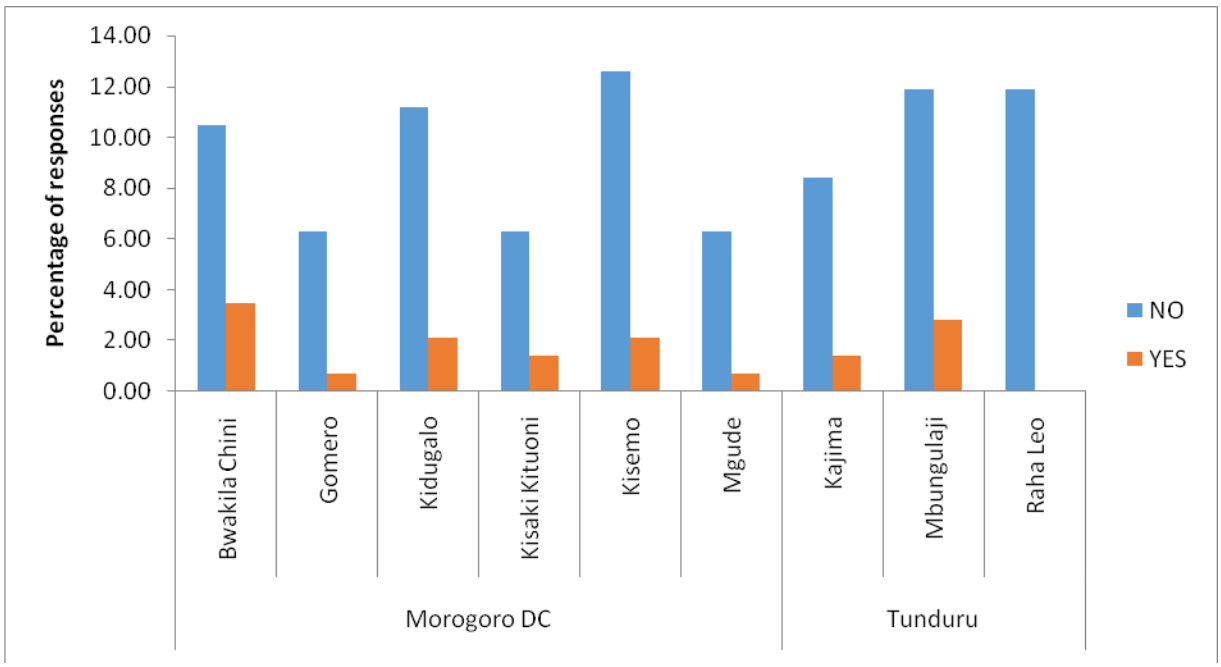

Figure 49: Response by farmers whether they have enough knowledge on wildlife and conservation. N=140

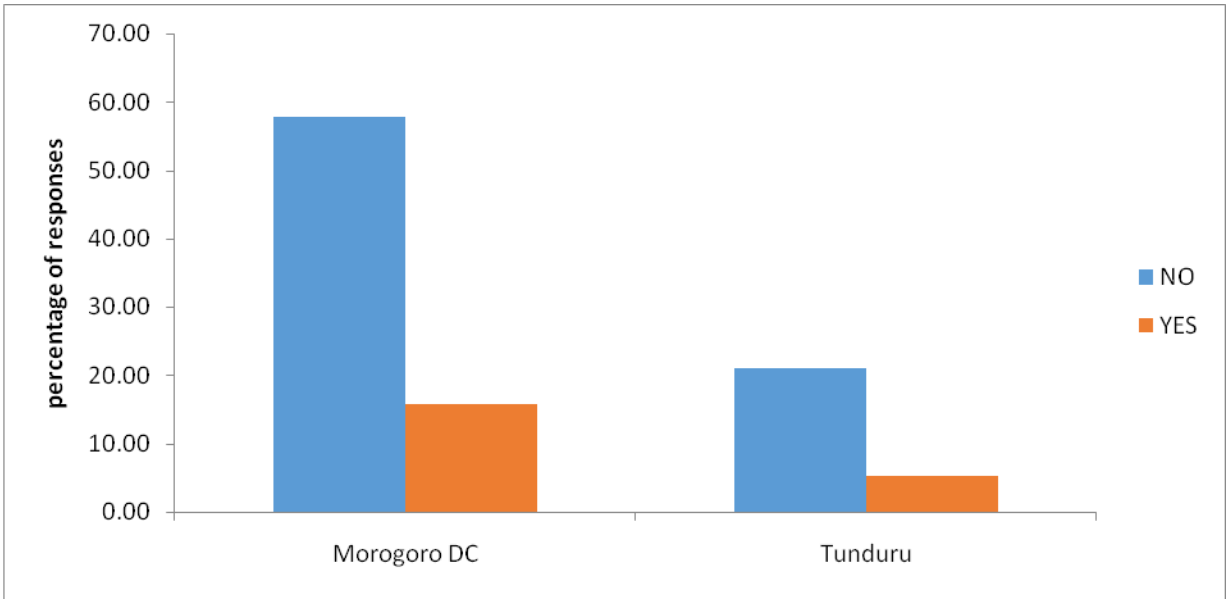

Figure 50: Response by village leaders whether their villagers have enough knowledge on wildlife and conservation. N=19

4.6: Other sources of income generating activities to buffer financial losses from elephant crop raiding.

During our questionnaire surveys, we asked the question to the village leaders whether farmers have sources of income generating activities other than crop production to buffer the financial losses from elephant crop-raiding. The majority of village leaders' responses revealed that most farmers have no other sources of income, being completely dependent on agriculture to sustain their lives. All respondents from Tunduru district revealed that there farmers have no other source of income. The mentioned sources of income generating activities in the study area includes small scale business (small shops, food vending, and employment to small industries, small scale mining, poultry, livestock keeping, and village community banks)and beekeeping.

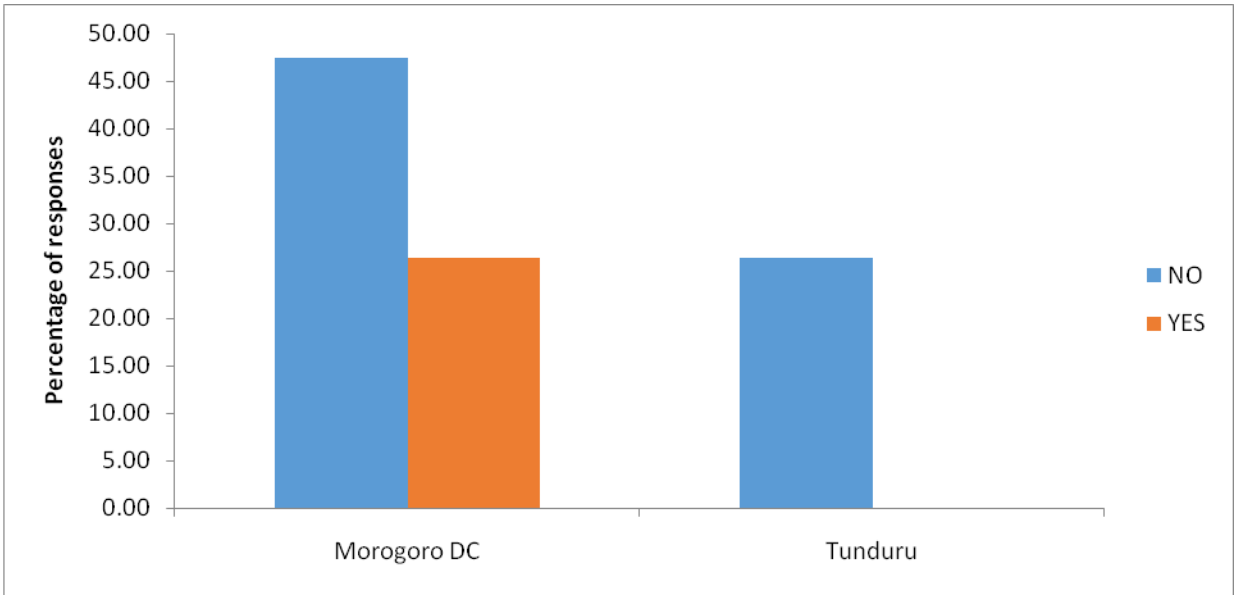

Figure 51: Response by village leaders on other sources of income generating activities by farmers in surveyed districts around SGR/Nyerere NP

5.0: Other forms of conflicts available in villages around SGR/Nyerere NP

We investigated other forms of conflicts as part of this questionnaire survey by asking the village leaders and pastoralists to mention the conflicts and its source. Two types of conflicts were identified: conflict between farmers and pastoralists, occurring when pastoralists graze their livestock on farmer's crops. Another form of conflict reported is between pastoralists and park management, seen when pastoralists graze their livestock in park boundaries, and incur high financial penalties.

6.0: Threats facing elephants in the surveyed districts around SGR/Nyerere NP

We gauged the threats facing elephant conservation around the study area by asking village leaders whether they have received any information about killing of elephants by the villagers. Majority of respondents reported that they have not received any information about killing of elephants by the villagers, except a few respondents who reported incidences of elephant killing by poachers between 2010-2015. Village leaders were also asked to provide their opinion on what might happen to elephants if HEC will not be controlled. The majority of respondents said that elephants might be killed in retaliation.

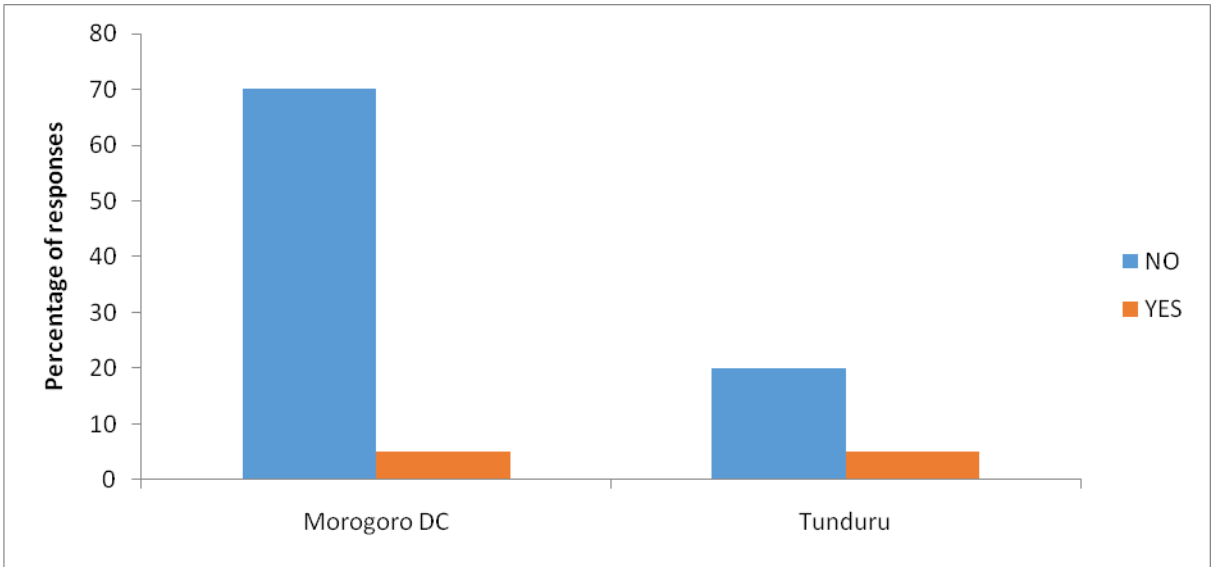

Figure 52: Response by village leaders whether they have any information about elephant being killed by the community. N=19

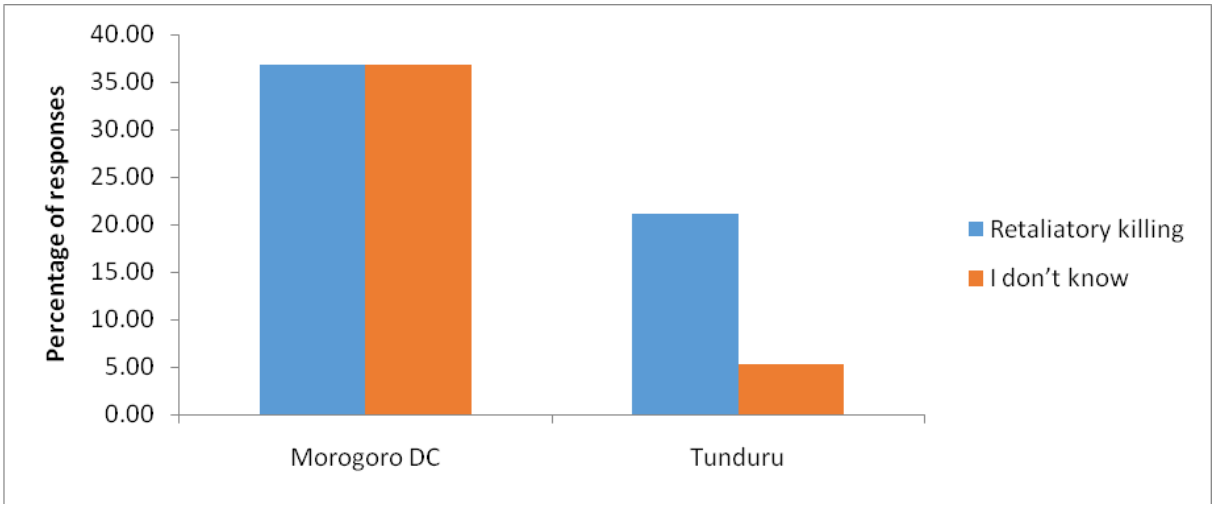

Figure 53: Responses by village leaders on what might happen to elephants if HEC will not be controlled. N=19

7.0 Recommendation

In this section, we outline options for mitigating human-elephant conflicts, and identify priority areas for HEC mitigation in villages around SGR/Nyerere NP.

7.1 Mitigation of HEC

We recommend farm-based crop-raiding reduction methods such as beehive fencing and chili fencing that have found to be socially and economically suitable in a range of contexts (Table 3). In addition, we believe that coexistence in the long-term will involve conservation education and outreach, and possibly the identification of wildlife corridors, buffer zones and dispersal areas to accommodate elephant movements outside of PAs.

Traditional farmer-managed deterrents such as fire, vuvuzela, stone throwing, shouting, and drums, become ineffective over time as elephants usually become habituated to these methods (Graham and Ochieng, 2008; Hoare 2012), and involve risks for people and elephants alike. Barriers such as electric fences suffer from high outlay and maintenance costs, are prone to vandalism, and can be breached by elephants (Hoare 2012). Compensation schemes and legal killing of elephants under Problem Animal Control are not recommended because they do not reduce the likelihood of crop-raiding, and are problematic to implement (Hoare 2012).

Table 3. Review of HEC mitigation options

Method	Description	Pros	Cons
Beehive fencing	Barrier fence around farms constructed from beehives linked by wire, in order to deter elephants from crop-raiding	Effective elephant deterrent when beehive occupancy is high Additional income from honey linked to elephant conservation	High outlay and beekeeping training costs require external/donor funding Labor-intensive to set up and maintain
Chilli fencing	Cloth and string dipped in oil and chilli mix and hung from fence structure around farms, in order to deter	Low initial payout, reasonably cheap to maintain Additional income from chilli cash crop if farmers grow the	Labor-intensive to set up and maintain Requires reliable supply of engine oil

	elephants from crop-raiding	crop themselves	Chilli-oil mixture can be unpleasant to handle
Education and outreach activities	Conservation education; such as Park visitation, workshops, films, village meeting discussions and school curricula	Provide education and knowledge to increase interest and motivation for mitigation techniques, and increase awareness about wildlife	Activities may be high cost to maintain, require constant intervention to maintain standards
Wildlife corridors assessment (Collaring) and gazettement	Obtain information on the seasonal movement of elephants within Selous ecosystem that will contribute to establishment of landscape conservation corridors, dispersal areas and habitat use for better elephant protection.	Corridors can reduce human-wildlife conflict including crop-raiding, and thus increase agricultural yield over the long-term	High costs and challenging to implement
Monetary compensation	Monetary compensation for crop losses, property damage, injuries/fatalities		Compensation for crop-losses has never been successfully implemented:

			cumbersome to administer; does not reduce crop-raiding incidents; high costs (Hoare 2012)
Problem Animal Control (PAC)	Legal killing of elephants for "Problem Animal Control" (Wildlife Conservation Act, CAP 283 RE 2002)		Futile as it does not reduce crop-raiding (Hoare 2001) Can be used as a pre-text for poaching (Malima et al. 2005)

7.1.2 Beehive fencing

Research has found that elephants avoid bees (King et al. 2002), and fences constructed with beehives successfully deter elephants from crop raiding (King 2010). A beehive fence consists of a series of beehives hung between posts, linked by wire between one beehive to the next. This design ensures that if an elephant tries to breach the fence through the wire linking two hives, the hives will swing and disturb the bees. Beehive fences have the added advantage of honey to harvest and sell, allowing farmers to benefit from additional income generated from honey.

Resources on beehive fencing:
King, L. Beehive Fence Construction Manual.
www.elephantsandbees.com

7.1.3 Chilli fencing

Another farm-based method is chilli fencing, which builds on research that elephants are deterred by capsaicin, a chemical in chilli that acts as an olfactory irritant (Osborn, 2002). Chilli fences are constructed from squares of fabric (mutton cloth) dipped in a mixture of crushed chilli peppers and used engine oil (Osborn & Parker, 2002a-b). The fabric is then hung from sisal rope hung in a fence structure around the farm. The fabric should have the mixture re-applied every 21 days or within a week after rain to ensure effectiveness.

Resources on chilli fencing:
HEC Chilli Fence Manual World Animal Protection 2015.

7.1.4 Education and outreach activities

It is recommended that in combination with mitigation techniques, education and outreach play a role in enhancing human-elephant coexistence. In general, very few rural people living adjacent to PAs have the opportunity to visit PAs and experience elephants and other wildlife, and many have a negative view of wildlife. Hence, park visitation programs are encouraged.

7.1.5 Managing elephant movements through wildlife corridors (collaring project)

In the long-term, human-elephant conflict requires landscape-scale solutions to maintain connectivity between elephant populations and reduce economic losses incurred by farmers from elephant crop-raiding (Jones et al. 2012). Where elephants spend significant amount of time outside Protected Areas, conservation planning can be improved by catering for elephant space needs. Keeping open crucial corridors would allow elephants to spread impact over their range (not to become isolated in core areas, or along the edges of protected areas) and maintain connectivity between populations (Douglas-Hamilton et al. 2005).

7.2 Priority Areas for HEC mitigation

7.2.1 Villages experiencing high HEC events in Morogoro DC

Mgude
Kisemo
Kidugalo
Kisaki kituoni
Gomero

7.2.2 Villages experiencing high HEC events in Tunduru district

Rahaleo
Mbungulaji
Kajima/Jaribuni

7.2.3 Plan for mitigation

Enhancing human-elephant coexistence through community-led livelihood projects around SGR/Nyerere NP that increase and diversify incomes, reduce crop losses from wildlife, and conserve biodiversity. This includes trialling elephant deterrent methods with registered farmers' groups and constructing beehive fences and provision of conservation education later this year depending on match funding.

7.2.4 Other villages reported with HEC events around the study area

No.	Village Name	District	Region
1.	Kichangani	Morogoro DC	Morogoro
2.	Midulu	Morogoro DC	Morogoro
3.	Bonye	Morogoro DC	Morogoro
4.	Mbwade	Morogoro DC	Morogoro
5.	Fatemi	Morogoro DC	Morogoro
6.	Kitengwe	Morogoro DC	Morogoro
7.	Sinyaulime	Morogoro DC	Morogoro
8.	Kisunyoli	Morogoro DC	Morogoro
9.	Matuli	Morogoro DC	Morogoro
10.	Singiri	Morogoro DC	Morogoro
11.	Kipera	Morogoro DC	Morogoro
12.	Vikulukulu	Morogoro DC	Morogoro
13.	Ubena	Morogoro DC	Morogoro
14.	Mdokonyole	Morogoro DC	Morogoro
15.	Kizuka	Morogoro DC	Morogoro
16.	Mikobola	Morogoro DC	Morogoro
17.	Twendembele	Tunduru	Ruvuma
18.	Kindamba	Tunduru	Ruvuma
19.	Matemanga	Tunduru	Ruvuma
20.	Uria	Tunduru	Ruvuma
21.	Muhuwesi	Tunduru	Ruvuma
22.	Nampingu	Tunduru	Ruvuma
23.	Darajambili	Tunduru	Ruvuma
24.	Namwinyu	Tunduru	Ruvuma
25.	Ndenyende	Tunduru	Ruvuma
26.	Fundimbanga	Tunduru	Ruvuma
27.	Kilimasela	Tunduru	Ruvuma
28.	Majimaji	Tunduru	Ruvuma

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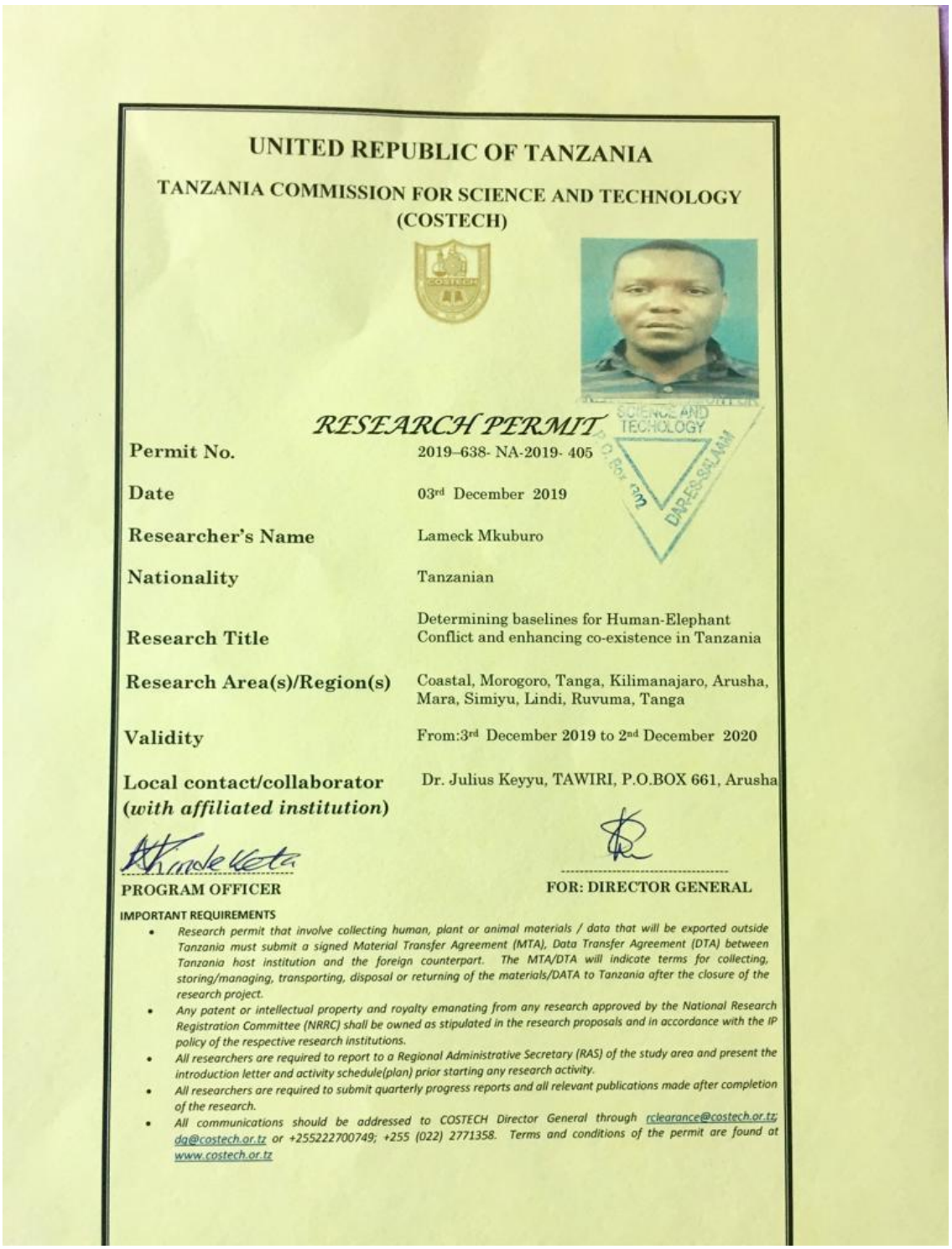
9.0 Other materials

9.1 Research permit



UNITED REPUBLIC OF TANZANIA

TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY
(COSTECH)

RESEARCH PERMIT

Permit No.	2019–638- NA-2019- 405
Date	03rd December 2019
Researcher's Name	Lameck Mkuburo
Nationality	Tanzanian
Research Title	Determining baselines for Human-Elephant Conflict and enhancing co-existence in Tanzania
Research Area(s)/Region(s)	Coastal, Morogoro, Tanga, Kilimanajaro, Arusha, Mara, Simiyu, Lindi, Ruvuma, Tanga
Validity	From:3rd December 2019 to 2nd December 2020
Local contact/collaborator *(with affiliated institution)*	Dr. Julius Keyyu, TAWIRI, P.O.BOX 661, Arusha

SCIENCE AND TECHOLOGY
P. O. Box 4302 DAR-ES-SALAAM

PROGRAM OFFICER

FOR: DIRECTOR GENERAL

IMPORTANT REQUIREMENTS

- *Research permit that involve collecting human, plant or animal materials / data that will be exported outside Tanzania must submit a signed Material Transfer Agreement (MTA), Data Transfer Agreement (DTA) between Tanzania host institution and the foreign counterpart. The MTA/DTA will indicate terms for collecting, storing/managing, transporting, disposal or returning of the materials/DATA to Tanzania after the closure of the research project.*
- *Any patent or intellectual property and royalty emanating from any research approved by the National Research Registration Committee (NRRC) shall be owned as stipulated in the research proposals and in accordance with the IP policy of the respective research institutions.*
- *All researchers are required to report to a Regional Administrative Secretary (RAS) of the study area and present the introduction letter and activity schedule(plan) prior starting any research activity.*
- *All researchers are required to submit quarterly progress reports and all relevant publications made after completion of the research.*
- *All communications should be addressed to COSTECH Director General through rclearance@costech.or.tz; dg@costech.or.tz or +255222700749; +255 (022) 2771358. Terms and conditions of the permit are found at www.costech.or.tz*