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Strategies Used by Local Communities in the Management of Human-Wildlife Conflicts in Kieni-West Sub-County, Kenya

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Abstract
Human-wildlife conflicts (HWC) are a common phenomenon worldwide, particularly in areas where humans and wild animal's requirements overlap. This stud y focused on strategies used by the local communities in the management of HWC in Kieni West S ub -Count y, Kenya. In order to accomplish this stud y, the stud y objective was: To assess the mitigation strategies employed by the local community to reduce human-wildlife conflicts . The rationale for the stud y was informed by the fact that human-wildlife conflicts have been common in Kieni West Sub-County causing negative social, economic and environmental impacts. This stud y used a descriptive survey design. Three locations were purposively selected for the stud y. The y included Amboni, Bondeni and Njeng'u. The target population of the study was 2340 households drawn from the three locations. Data was collected using questionnaires, interview schedules for key informants, participant observations and focus group discussions. These instruments were piloted for reliability and validity. Collected data was later analyzed with the aid of Statistical Package for Social Scientist (SPSS). Chi- squared test was used to compare different variables while Spearman rank correlation coefficient was used to establish the relationship between variables. Information given by key informants and opinions by local leaders was analyzed thematically. The data was presented in frequency tables, figures, percentages and texts in a descriptive way. The finding of this stud y indicated that the local communities in the area used different management strategies to mitigate the human -wildlife conflicts. 16% of the local communities used lethal control, 42 % used deterrents, 46% used physical barriers, 22% used guard animals, 61% used human vigilance while 39% used deceptive planting. Observed differences were highly significant ($X2=65.5$, $df=5$, $P\geq0.001$). The stud y concluded that different mitigation strategies worked differently to diverse wild animal species that were targeted as the y behaved and responded differently. The major recommendation was for the local community to come up with alternative and modern methods of mitigating human-wildlife conflicts in the area. Areas of further research were identified.
Keywords: Deterrents, Human-wildlife conflicts, mitigation measures.

1. Introduction

Human–wildlife conflict has been in existence for as long as humans have existed and wild animals and people have shared the same landscapes and resources. Fossil records show that the first hominids fell prey to the animals with which the y shared their habitats and shelters. Forensic evidence has recently shown that the "Taung skull", perhaps the most famous hominid fossil which was discovered in South Africa in 1924, came from a child killed by an eagle two million years ago (Berger & Clarke, 1995; Berger, 2006).

Studies around the world show that HWC is more intense in the developing countries where livestock holdings and agriculture are an important part of rural livelihoods. In these regions, competition between local communities and wild animals, for the use of natural resources, is particularly intense and direct and resident human populations are very vulnerable (Distefano, 2010). However, human-wildlife conflicts occur everywhere around the world in one form or another. In North America, for example, bears raid dustbins in the national parks and even at the edge of towns, waking up residents and creating disorder in the streets. Deer collisions with auto mobiles in the United States injure an average of 29000 people annually and cause more than US $ 1 billion in damages (USDA, 2006).

In Asia, large feline predators (tigers, leopards, lions and snow leopards) and elephants are the principal sources of conflict. In India, in the state of Himachal Pradesh, near the Kibber wildlife Sanctuary, wild carnivores- mainly snow leopards-killed 18 percent of the total livestock holdings in 1995 (Mishra, 1997). In China, the rural inhabitants of the mountain area of Simao near the Xishuang Banna Nature Reserve, claimed that elephant damage reduced the community's annual income in 2000 by 28 to 48 percent and that the total economic losses between 1996 between 1999 amounted to US $ 314 600 (Zang & Wang, 2003).

In Africa, human wildlife conflicts are also prevalent in many countries. In Namibia, 157 crocodile attacks on human and cattle were recorded in 2005 b y community rangers in registered conservations in the Caprivi region (Murphy, 2007). In the United Republic of Tanzania home to the largest world's lion population, lion's attacks are widespread. Between 1990 and 2004, lions killed at least 563 people and injured more than 308. The problem has increased dramatically over the past 15 years with the majority of cases occurring in Southern part of the country (Parker *et al.,* 2005).

In Kenya, more than 200 people were killed over the last seven years by elephants alone (WWF, 2007).

Kenya's unique landscape supports abundant and varied wildlife of scientific intrinsic and economic value and has a considerable extent of wildlife habitat (Government of Kenya, 2008, 2009; KWS, 2008; Western, 2008). With a significant population of wildlife living outside protected areas on a seasonal or permanent basis, the country's wildlife resource has suffered from the effects of human economic activities poaching, human wildlife conflict, demand for wildlife products in the illegal market, and weak legislation, among other factors (Kamande, 2008; KWS, 2009).

2. Materials And Methods

2.1 Location of study area

The study was carried out in Kieni West Sub-County. Purposive sampling was used to select Kieni West Sub-County as the study site since it had incidences of human-wildlife conflicts. In Kieni West Sub-County,

Amboni, Bondeni and Njeng'u villages were purposively selected as the study locations. Administratively Kieni

West Sub-County has Mweiga, Endarasha, Gatarakwa, Labura, Mwiyogo and Mugunda locations covering a total of 1,230Km^2. The population is mainly comprised of low-income families sparsely dispersed throughout the area. Kieni West Sub-County land has fertile ridges that are on the slopes of Aberdares Mountain. The transport infrastructure in most of Kieni West Sub-County is underdeveloped. The populated areas are mainly connected by dirt roads (Figure 1).

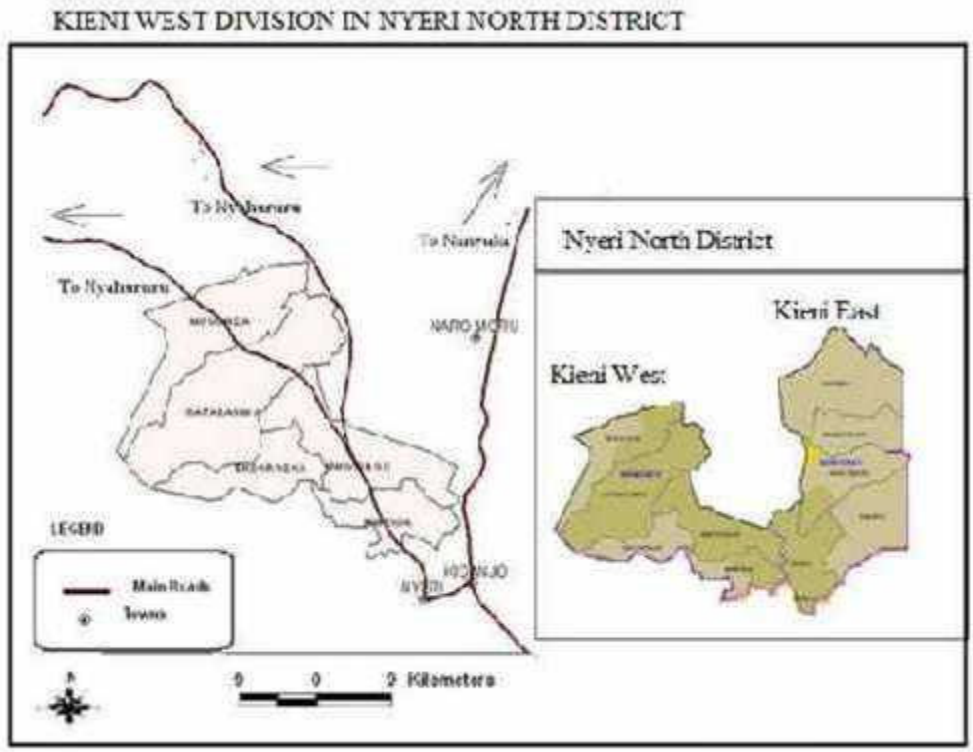

Figure 1: Map of Kieni West Sub-County showing the research site
Source: Survey of Kenya (2009)

2.2 Sample size and sampling procedure

Kieni West Sub - County comprises of 6 locations with an estimated population of 79,312 people. The target population of this stud y was drawn from three sub-locations namely Amboni, Bondeni, Njeng'u of Mweiga location, Kieni West Sub-Count y. Target population comprised of a total of 2345 households (Amboni has 1194, Bondeni 365 and Njeng'u 784 households) (Table 1). The respondents included farmers, Kenya Wildlife Service (KWS) officers, Agricultural officers, Veterinary officers and local opinion leaders. The sample size (n) was determined using the following formula given by Colton (1963) cited in Dongol (2007) at 95% confidence level.

Sample size (n) =

$$\frac{N*z2*P\ (1-P)}{N*d2+z2*P\ (1-P)}$$

Where,

N=total number of households

Z=value of standard variant at 95% confidence level (1.96) P=estimated population (0.05)
d=error limit of 5% (0.05)

Table 1: Total number of households and sampled households

Villages	Total households (N)	Sampled Households
Amboni	1194	69
Bondeni	367	61
Njeng'u	784	67
Total	**2345**	**197**

Source: KNBS (2009)

2.3 Data Collection

Data was collected using structured questionnaires, FGDs, interviews with key informants and field observations. The researcher randomly administered structured questionnaires to the affected households in the three sampled village. Three FGDs were involved; each from the three villages comprising of 8 members of the local community. Interviews with key informants were conducted with agricultural officers, veterinary officers, Kenya Wildlife Service officer and local leaders. Field observations in the form of visits to the affected fields in order to have an appreciation of the nature of the conflicts between humans and wildlife were conducted on both affected and non-affected fields. Both primary data and secondary data were used.

2.4 Data analysis

The study yielded both qualitative and quantitative data which was analyzed based on objectives of the study. Qualitative data was derived from open-ended questions in the questionnaires, Key Informant Interviews (KIIs) and FGDs. Analysis of quantitative data was done with the aid of Statistical Package for Social Scientist (SPSS) where descriptive statistics in form of frequencies, percentages, chi-square and spearman rank correlation coefficient was computed. The data collected was then presented by frequency tables, figures, percentages and texts in a descriptive way.

3. Results and discussion

3.1 Strategies used by the local communities

Different mitigation measures were employed by the local communities to reduce human- wildlife conflicts (Table 2). Findings show that 61% of farmers in the local communities used human vigilance as a measure to protect their farms and homesteads from wild animals' attacks, 16% used lethal control measures, 42% used deterrents or non-lethal controls, 46% used physical barriers, 22% used guard animals while 39% used deceptive planting strategies. Observed differences were highly significant ($X2$=65.5, df=5, P 0.001) with 61% of farmers using human vigilance/herding as a mitigation measure. The finding implies that most of the farmers used much of their time in their farms protecting their crops and livestock and hence did not have much time for other productive activities.

Table 2.: Strategies used by the local communities

Mitigation Measure	Frequency	Percentage
Lethal	29	16
Non-Lethal/Deterrent	76	42
Physical barriers	84	46
Guard Animals	40	22
Human Vigilance/Herding	111	61
Deceptive planting	71	39
Totals	**100**	**29**

Source: Field Survey (2015)

3.1.1 Lethal control

50% of farmers laid traps especially for porcupines and squirrels, 19% of farmers attacked and killed animals that reached their farms or homesteads while 31% of farmers used poison which was primarily directed at birds but also targeted porcupines and baboons (Table 3). The observed difference however was not statistically significant ($X2$=3.4, df=2, P=0.200) in terms of the lethal control measure used among farmers.

Table 3: Lethal control measures

Lethal control	Frequency	Percentage
Killing	6	19
Trapping	14	50
Poisoning	9	31
Totals	**100**	**29**

Source: Field Survey (2015)

3.1.2 Non-lethal/Deterrents

51% of farmers used visual deterrents, 38% used auditory deterrents while 11% used contact deterrents to keep away wild animal species and birds (Table 4). However, the observed differences between the deterrents used was not statistically significant ($X2$=5.8, df=6, P=0.050).

Table 4: Deterrents used by farmers

Deterrents	Frequency	Percentage
Visual Deterrents		
Scare crows	9	12
Burning fires	7	9
Sheathing	13	17
Cutting stems	10	13
Auditory Deterrents		
Beating objects	13	17
Guard animals	16	21
Contact Deterrent		
Throwing objects	8	11
N=76		

Source: Field Survey (2015)

Visual deterrents

Scare crows

12% of farmers erected scare crows on the cultivated farms and mounted polythene papers of diverse colors on wooden sticks and tree branches to scare away birds and antelopes from raiding crops. The scarecrows and mounted plastic papers served to frighten wildlife but were not in themselves dangerous.

Burning fires

9% of farmers burned fires at night to scare away crop-raiding animal species. Burning of elephants dung and chili pepper was done at the edge of fields and at the elephant entry point to the field. This was mainly used to deter elephants that raided the farms at night. The light of the fire, smoke and the smell produced by burning materials was intended to keep wild animals away from farms. Farmers reported that wildlife has an aversion to smoke and to the smoke associated with fire and the night was thought to catalyze these effects as darkness and stillness triggered the aversion. Many types of materials for example old clothes, plastics, rubber, dry cow or sheep dung and sacks were burnt to scare away wild animals. Sometimes, diesel fuel was used to fuel the fire, darken the smoke and intensify the odor.

Sheathing

17% of farmers where farmers sheathed maize with socks, plastic bottles cut in small pieces and plastic papers to protect them from wild animals' attacks (Plate 1). In some farms, maize was not attacked by the wild animals but it rotted. This was done primarily to protect maize from birds attack. Bunches of bananas were also covered with old clothes to prevent monkey raids.

Plate 1: Sheathed maize in a farm

Cutting stems

13% of farmers indicated that they cut the stems of the potatoes so t h a t the monkeys could be deceived and therefore unable to attack the potatoes (Plate 2). This was because they could not trace the potatoes under the soil. By so doing, farmers were able to protect the potatoes from monkeys and this made them grow until maturity.

Plate 2: Cut potatoes stems

Auditory deterrents

Beating objects

17% of farmers were beating drums, tins and trees or cracking whips close to the fields at night in addition to shouting, yelling and whistling which emitted an unexpected loud noise or specific sounds to scare away wildlife (while making bodily movements).This was intended to scare away mainly elephants especially during the night.

Use of guard animals

21% of respondents reported that barking dogs kept the wild animals away from their crops and homesteads and also alerted the farmers on approaching wild animal species. Donkeys also were reported to produce a sound that warded off wild animals especially the antelopes.

Contact deterrents

Throwing objects

11% of farmers threw objects towards the wild animals to drive them away from their farms. Stones were the main objects thrown at the animals but also burning sticks were used. The wild animals were either hit by the subjects or the objects simply fell on the ground, creating a sound that scared the animals away. When the animals were hit, the pain and the fear of another sound caused them to leave. In some cases farmers stockpiled the stones that they threw at night to scare the wild animals away from their farms. Animals that were targeted by this measure included elephants and porcupines.

3.1.3 Physical barriers

52% of respondents used fencing to protect their crops and livestock from wild animals' attacks especially at night while 48% of respondents used enclosures like cow sheds and calf pens to protect their livestock from

wild animals attack (Table 5). However there no significant different between different physical barriers used ($X2$=0.2, df=1, P=0.050) that is fences and enclosures.

Table 5: Physical barriers

Physical barrier	Frequency	Percentage
Fences	44	52
Enclosures	40	48
Totals	**84**	**100**

Source: Field Survey (2015)

Types of fences used

4 8 % of farmers used traditional thorns branches, 30% used thorn branches and barbed wire while 22% used wire mesh (Figure 2). However, the observed difference between different types of fences used was not significant ($X2$=5.8, df=2, P=0.050).

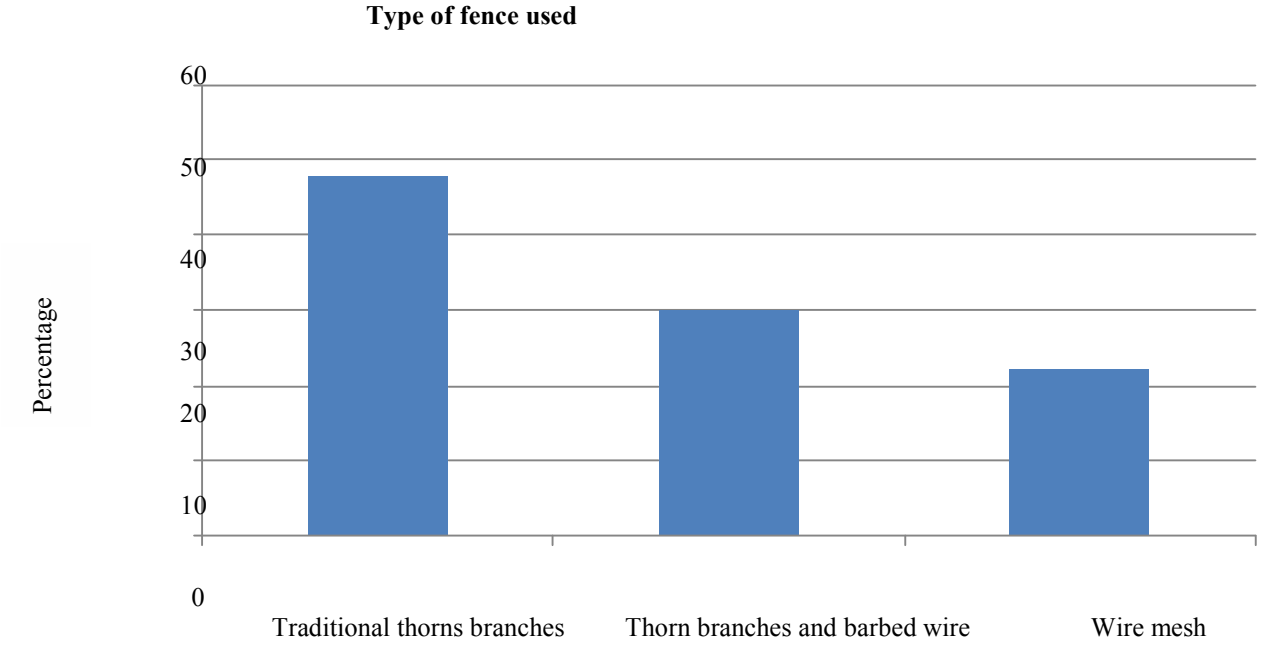

Figure 2: Types of fences used
Source: Field survey (2015)

3.1.4 Use of guard animals

21% of farmers used guard animals to protect their crops and livestock. Domestic dogs were chained or left unchained on farms to guard crops, homesteads and livestock attacks from predators as they barked when they sighted wild animals approaching. Some wild animals like monkeys avoided farms that had guard animals especially dogs which were not chained. However, baboons could notice the chained dogs and would not be scared by the barking dogs and went ahead to attack the crops. In some instances, when the number of baboons were many (around 20 and above) attacked and even killed the guarding dogs.

Dogs also played another important role in that their barking served as the primary signal of the approach of wild animals. Irrespective of whether they were chained on farms, dogs were an invaluable asset to the farmers as they have a good sense of smell and could detect animals before they entered the farm. When dogs barked at night, farmers awakened and used torches to search for wild animals on their farms. In addition to barking unchained dogs also chased other species off the farm such as antelope.

Woodroffe *et al.* (2006) reported that having domestic dogs accompanying a herd reduces the risk of attack by 63 percent. In the Nothern Kenya, the presence of shepherd, dogs and humans has been linked with lower rates of livestock attacks by large predators. However, the presence of dogs was only linked with reduced rates of lion raids on cattle, but not on sheep and goats (Ogada *et al.,* 2003). Dogs and donkeys have been used to accompany livestock in Namibia and Botswana with some success in reducing human conflict with cheetah and spotted hyena. This has been reasonably successful in reducing incidences of human -wildlife conflicts, especially where cheetahs and spotted hyenas are concerned (WWF SAPRO, 2005).

3.1.5 Human Vigilance / Herding

61% of farmers guarded their cropland and livestock from attacks by the wild animals. They mostly guarded their farms from the monkeys and baboons which were reported to be the most problematic animals in the area.

The fear of the human beings dissuaded the wild animals from committing damage. Farmers guarded their farms from the animals' attacks from 6am to 6pm and in turns so as not to leave a gap where the animals could attack the crops. For example, birds were reported to be on the fields early in the morning and again late in the afternoon or early evening. Baboons and monkeys were considered to be unpredictable.

Thouless (1994) noted that farmers can cooperate by means of a rotating system of guard duty whereby only a few of them patrol during the night. If an elephant is sighted, other farmers are woken to chase them away. Guarding was done both by adult people and also children. Adults could guard animals in the early hours of the day and late hours of the day while children guarded during the day after the school hours. Men and women were both involved in guarding their farms from the animals. However, some species such as baboons were reported to be far less fearful of women than they are of men. Determined troops of baboon could intimidate guardians, particularly women, who were often chased away.

The findings are similar to a study conducted by Barnes *et al.* (2003) who noted that in Kibale National Park in Uganda, elephants waited at the forest edge until farmers left the fields before they would enter suggesting an aversion to the presence of humans. Elephants in the area around the Kakum Conservation Area in Ghana appear to avoid farms where people are p re se n t (Naughton-Treves, 1998). Lamarque *e t al.* (2009) observes that the fear of man normally prevents wild animals from committing damage.

Farmers also herded their animals during the day to protect and reduce the exposure of livestock to depredation through vigilance. Herding was done in open fields so as to have advantage of sighting an approaching predator. Animals were herded in groups including all animals like cattle, sheep and goats. However, young boys going to school are no longer available for herding. In East Africa, where human herders are effective and fearless in warding off predators, herders are reported to challenge and scare away dangerous carnivores such as lions, hyenas, and cheetahs with nothing more than simple weapons such as spears, knifes or firearms (Patterson *et al.,* 2004).

Other similar studies indicate that effective livestock husbandry can reduce predation and mitigate the impact of predators on human livelihoods (Ogada *et al.,* 2003; Breitenmoser *et al.,* 2005; Woodroffe *et al.,* 2006). Livestock herds that are herded by day and kept in *bomas* at night with guard dogs had a high level of human activity are less likely to be killed by predators (Ogada *et al.,* 2003).

3.1.6 Deceptive planting

48% of farmers spread soil after sowing seeds, 28% sowed several seeds in one hole while 24% of farmers smeared maize seeds with the black substance contained in used zinc chloride dry cell before planting (Table 6). The observed differences were significant ($X2$=2.06, df=2, P 0.050) with most of the farmers spreading soil after sowing. The findings suggest that the farmers expected some of the seeds to be eaten by wild animals.

The findings are similar to Hill (2000) who noted that farmers around Budongo Forest Reserve, Uganda who, on average have small land holdings, tend to plant more than one stand of important staple crops in any one growing season (reasons given for this are that it reduces the risk of suffering high loses through wildlife, insects, diseases and variable soil fertility.

Table 6: Deceptive planting

Method	Frequency	Percentage
Planting several seeds	20	28
Spreading soil after sowing	34	48
Use of carbon-zinc dry cell	17	24
Totals	**71**	**100**

Source: Field Survey (2015)

3.2 Number of strategies per household

46% of respondents used two strategies simultaneously, 40% used one strategy, 37% used three strategies, 2 3 % used four strategies, 16% used five strategies while 20% used six strategies simultaneously (Table 7).

According to the survey results, there was a strong negative correlation between the number of strategies employed by individual households and their distance from the Aberdare National Park fence (Spearman's rs=0.890, p 0.05, n=6). Thus close to Aberdare National Park fence employed more strategies than did households farther away from the ANP fence. This indicates that farms close to the ANP fence were vulnerable to wildlife raids.

Table 7: Number of strategies employed per household

Number of strategies	Frequency
1	40
2	46
3	37
4	23
5	16
6	20
N=182	

Source: Field Survey (2015)

3.3 Effectiveness of mitigation strategies a) Lethal control

38% of respondents said that effectiveness of lethal control was good, 7% very good, 31% fair, and 17% low while 7% said it was very low.

b) Non-lethal/Deterrents

41% of respondents indicated that effectiveness of deterrents were good, 13% very good, 25% of respondents good, 16% low while 5% said it was very low. Muruthi (2005) noted that while deterrent techniques are widely used, they are not effective in the long term. Animals soon learn that they pose no real threat and then ignore them. Both modern and traditional methods face this problem and become less effective over time.

c) Physical barriers

33% of respondents said that effectiveness of physical barriers which included fences and enclosures was considered good, 9% very good, 29% fair, 18% low while 11% considered it very low. The findings implies that some predators could still attack livestock while small animals like squirrels and porcupines could still attack crops and cause substantive damage. This implied that physical barriers did not deal with the root cause of the problem. This finding is similar to a similar study by Hoare (1992) who observed that failure of the mitigation strategies was as a result of the behavior of different animal species. Burrowing animals for instance, will breach barriers and allow access to other species. Lions for example can use holes that have been dug by warthogs. In Zimbabwe, in the area neighboring the Sengwa Wildlife Research Area, livestock are still attacked even though the reserve is fenced and livestock are penned in fortified enclosures at night. This is because baboons, lions and leopards can pass through the reserve fence and jump into the enclosures. Improving fences with addition of a roof (chain link ceilings for instance) would sustainably reduce economic losses (Butler, 2000).

The results also indicate that livestock were not regularly enclosed at night and in strong structures while fences were not well maintained. It also indicates that effective barriers were expensive to erect and maintain and hence many did not afford. A study was made of the effectiveness of different enclosure types in defending livestock from predator attacks; the depredation rates for domestic animals was lower when the they were penned in corals overnight, and the type of pen was a significant factor in accounting for a lower loss of sheep and goats, whether they were kept in wire, acacia, wicker or solid enclosures (listed in order of effectiveness) (Ogada *et al.,* 2003).

d) Guard animals

45% of respondents felt that the use of guard animals was good, 10% very good, 22% fair, 18% low and 5% very low. The results suggest that presence of a guard animal was able to drive away wild animals or alert farmers on the wild animals came to the crop lands and homesteads. This finding is similar to a study carried out by Marker *et al.* (2005) between January 1994 and November 2001 of domestic dogs accompanying herds in 117 Namibian farms, which showed that guard dogs were successful in terms of reducing livestock losses, with 73 percent of responding farmers reporting a significant decline in losses since the y acquired a dog.

e) Human vigilance

19% indicated that effectiveness of human vigilance/ herding was very good, 31% good, 24% fair, 16% low and 10% very low. The findings indicates that some species especially monkeys and baboons shown less fear to human beings and hence less effective while others adapted rapidly to measures taken against them and were remarkably quick to find weaknesses in the guarding of crops. The finding also suggests that most of the predators such as wild dogs and monkeys avoided attacking crops and livestock in the presence of a herder. It also implies that not all the time livestock and crops were guarded since guarding is labor-intensive and hence required more manpower, time consuming and costly. It was also difficult to predict when the wild animals would appear which could be very dangerous and was also difficult to cover a large area when guarding.

f) Deceptive planting

21% of respondents said that deceptive planting effectiveness was very good, 35% said was good, 20% fair, 17% low while 7% said it was very low. The findings indicate that most of the seeds germinated after sowing by the farmers. The findings also imply that some animals especially the rodents would still trace where the seeds

were sowed by the farmers.

3.4 Frequency of use of mitigation strategies

30% of respondents used the mitigation measures often, 20% very often, 26% moderately while 24% of farmers used the mitigation measures rarely (Figure 3). However, the observed differences on hoe often farmers used mitigation measures was not statistically significant ($X2$=4.0, df=3, P=0.050).

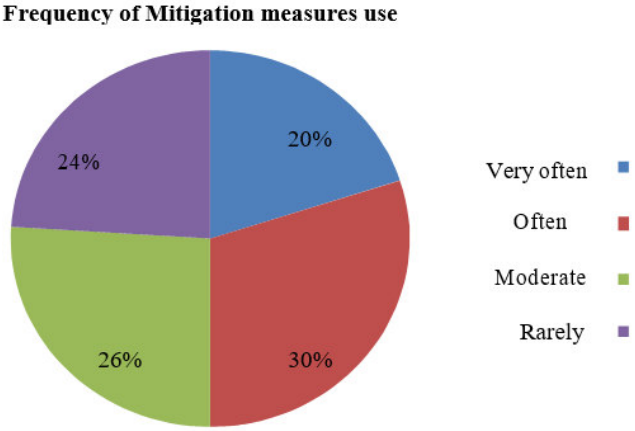

Figure 3: Frequency of mitigation measures used
Source: Field survey (2015)

Conclusion

Different strategies worked differently to diverse wild animal species that were targeted. Different wild animal species behaved and responded differently to various strategies employed by farmers in the local communities. Households close to Aberdare National Park (ANP) fence were more vulnerable to wild animal attacks than households farther away from the ANP fence and hence significant social and economic impact. Further, the strategies used were not 100 percent effective and hence left a gap for the wild animals to still attack their crops and livestock in the local communities.

Recommendations

The local communities should come up with alternative and modern methods of mitigating human-wildlife conflicts since with the current strategies human-wildlife conflicts are still rampant. The local communities should be educated on different behaviors' of wild animal and reaction to different mitigation strategies so as to protect their crops and livestock effectively from negative impact of wild animals.

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