HUMAN-ELEPHANT CONFLICTS AND MANAGEMENT STRATEGIES IN MBUVORI SUB LOCATION, EMBU DISTRICT, KENYA

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A THESIS SUBMITTED TO GRADUATE SCHOOL IN PARTIAL FULFILLMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN NATURAL RESOURCES MANAGEMENT OF EGERTON UNIVERSITY

DEPARTMENT OF NATURAL RESOURCES MANAGEMENT

JUNE 2006

Eger242950

DECLARATION

This thesis is my original work and has not been presented for award of a degree or diploma in any other university.

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APPROVAL

This thesis has been submitted with our approval as university supervisors.

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DEDICATION

To my dear parents and all other parents, organizations and individuals who invest in education especially for girls.

ACKNOWLEDGEMENT

Completion of this thesis was by no means single handed. I wish to acknowledge the inspiration and scholarly criticism from my supervisors, Dr. M. Karachi and Dr. Maina-Gichaba who patiently and dedicatedly guided me through this thesis. I also thank the Germany Academic Exchange Services (DAAD) for awarding me the scholarship for the Masters degree. Egerton University is greatly acknowledged for granting me study leave. I also thank Mr. Ndegwa the assistant warden, KWS Embu and the staff for facilitating my research through providing transport and rangers who took me to the field.

My heart felt gratitude goes to my dear family members for their support while I was pursuing the study. Finally, I wish to express my sincere gratitude to all who contributed to the research but have not been mentioned individually.

ABSTRACT

Human–elephant conflicts are a result of effects of elephant activities that adversely affect human welfare. This research was prompted by the frequent public demonstrations by farmers in the Mt Kenya region demanding solutions from the government to problems associated with crop damage by elephants. The study was carried out in Mbuvori sub-location in Embu District, where human-elephant conflicts are a frequent occurrence. Mbuvori sub location is adjacent to Mt Kenya forest and its economy is based on small-scale agriculture. The broad objective was to evaluate the human-elephant conflicts and management strategies in Mbuvori Sub location, Embu district. The specific objectives were to investigate the types and extent of elephant damages on farms as influenced by proximity to the forest reserve; assess the effectiveness of conflict management strategies in minimizing elephant damages in farms and to evaluate local people's attitudes towards elephants. Two hundred households were randomly selected and the household heads interviewed using a semi-structured questionnaire to obtain the primary data in addition to a group discussion, observations and key informants interviews. Secondary data from relevant sources was collected through out the study period. The primary data was analyzed using Statistical Package for Social Science version 11.5. Spearman's rho correlation coefficient was used to test hypotheses. Farmers were adversely affected by elephant's activities through destruction and damage to crops, grain storage facilities and fencing. Indirect losses included loss of sleep while protecting crops and harvesting crops before maturity. There was a significant ($P< 0.05$) decline in damage with distance from Mt. Kenya forest reserve. The methods farmers used to deter elephants were not effective ($P > 0.05$). The farmers attitude towards elephants did not significantly ($P> 0.05$) influence the methods they used to deter elephants. This was partly due to prohibition by wildlife authorities to injure elephants. The output of this study will be useful to policy makers in that it has pointed out that other effective methods to deter elephants should be sought rather than the methods farmers are allowed to use. Failure to prevent entry of elephants into farms will lead to continued farmer-elephants conflicts in Mbuvori sub-location and in other areas that experience similar conflicts.

ACRONYMS/ ABBREVIATIONS

AfESG	African Elephant Specialist Group
FAO	Food and Agriculture Organization
HEC	Human-Elephant Conflict
IUCN	International Union for Conservation of Nature
KWS	Kenya Wildlife Service
UNEP	United Nations Environmental Programme
WWF	World Wide Fund for Nature

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CHAPTER ONE

INTRODUCTION

Wildlife is unique among natural resources. The public owns it, government administers it, private landowners help produce it, business benefit from it, recreational minded people use it and many misunderstand its place, uses and values (Aboud 1989; Berryman, 1961). Demand for land has forced a large number of farmers from both the high potential and low potential regions to migrate into semi-arid regions, originally used for raising wildlife thus initiating competition and conflicts with wildlife interests (Rocheleau and Lelo, 1994).

Similarly, the colonial wildlife management policies did not consider the livelihoods of the local populations on whose lands national parks were incorporated as important (Yeager and Miller; 1986; Lusigi, 1978; Graham, 1973). As a result, many wildlife species face increasing competition with people for space and resources (Balmford *et al.*, 2001; Pimm, *et al.*, 1995). Large herbivores, such as black rhinoceros, elephants and large carnivores are most affected by this conflict and are either critically endangered or are declining rapidly in numbers (Emslie and Brooks, 1999; Woodroffe and Ginsberg, 1998).

Human-elephant conflicts refer to a range of direct and indirect negative interactions between humans and elephants that potentially harm both (Ngure, 1995). Although the harmful effects are many in some areas, the most publicized are crop damage and injury or death to people. There are also many negative impacts on elephants from people which come into focus when they lead to a reduction in elephant numbers (Douglas-Hamilton, 1988). Whereas human interests in elephants extend beyond their home range, the negative effects of elephants on humans are usually confined within their home range. Elephants, for example injure and kill livestock, damage property, and disrupt social and economic activities.

Indirectly, elephants lead to unwarranted clearing of natural vegetation through increased demand for fuel wood for lighting fire by people while guarding their crops at night (Ngure, 1995). Elephants are constantly interacting with human beings due to

reduction in home range size, interference with the migratory routes and land fragmentation (Rerimoi, 2002). When illegal hunting of elephants was widespread in the 1970s and 1980s, many elephants sought refuge in protected areas and dense forests. However, when hunting was banned, they appear to be recolonising areas which had been settled by people during their absence (Kangwana, 1995). As a result humans are adversely affected by elephant's activities through destruction and damage to property. This is evident in Mbuvori sub- location of Embu district.

Elephants enter into conflict situations with humans primarily as a result of their being displaced by human populations. In addition to losing their habitat, they are subjected to injury through use of homemade weapons. The current approaches used for dealing with the conflict situations usually involve government agencies who attempt to provide solutions without involving the affected communities. Extended use of these methods that are also technically demanding is likely to lead to a culture of dependency within the local communities who may expect outsiders or governments to solve problems.

As a result, the search for effective measures to deal with human-elephant conflicts is now one of the major challenges facing elephant management (Kangwana, 1995). Several studies have been carried out on the human wildlife conflicts in Kenya but they did not isolate damage due to elephants from that caused by other wild animals (Rerimoi, 2002; Omondi, 1994). Another study (Lelo, 1994) on humanization of wildlife among the Muka Mkuu community of Oldonyo Sabuk National Park established that wild animals caused huge losses to farmers and that some animals were more notorious than others. However, the study did not assess farmers' management strategies. Given the extent of the problems, more studies that isolate elephants' damage from that of other wild animals are needed. The collection and dissemination of objective information on the severity of conflicts in different regions will also ensure rational use of available resources.

1.1 Statement of the problem

Elephants cause severe damage to crops, injuries and death to human and livestock and damage infrastructures. Consequently farmers are forced to harvest their crops prematurely. This implies that food cannot be stored for long without getting spoiled. This leads to a potential source of food insecurity. Furthermore, trampling on planted fields reduces the rate of seed germination and leaves behind large depressions during wet seasons. Such depressions make ploughing difficult in the preceding season.

Elephant impacts on farms have been reported in the press and evidenced by public demonstrations by farmers who demand that the government provides long-term solutions to the conflict.

From the occurrence books maintained in the Kenya Wildlife Service office at Mbuvori field station, an average of 116 cases of crop raiding and damage to farm installations were reported between 2000 to 2004. Besides the residents reported other indirect losses such as loss of sleep while protecting crops. Consequently, sustainable coexistence between humans and elephants is threatened as the livelihood of the people is affected by elephant activities. The KWS rangers' shoot elephants on control when death of a human occurs or if crop raiding is persistent.

1.2 Justification

Human-elephant conflicts are increasing in areas located close to wildlife habitats due to reduction in home range size, interference with the migratory routes and land fragmentation. The conflicts have resulted in huge losses in terms of damage to crops, injuries and death to human and livestock and damage to infrastructures. This research was prompted by the increasing cases of damage by elephants reported in the media and evidenced by public demonstration from farmers in the Mt Kenya region. The conflicts were ascertained through a visit to the sub location where farmers identified elephants as the major crop pest. This was also collaborated by KWS officials. There was need to assess the damage caused by elephants because the farmers are small-scale holders whose livelihood could be affected by damage from a single elephant's activity.

The farmers who were enraged by the damage responded by driving elephants away using traditional methods . Sometimes the elephants got provoked and caused more damage entailing intervention from KWS officials. Because of the incurred damage, farmers have negative attitude towards elephants. This situation made it important to evaluate human-elephant relationships with a view of understanding the impacts at farm level. Similarly, given the projected population increase in Mbuvori sub location (Republic of Kenya, 2000) and the ineffective methods used to regulate elephant densities, there is likely to be more conflicts over resources because both human and elephant populations are increasing.

In addition, inadequate policies on compensation for damage underscored the need for this study. The ability to minimize conflicts between elephants and humans depend on a clear understanding of the problem and a well-informed approach towards conflict management. This study provided information on interactions between elephants and humans as baseline information for management of the conflict in Mbuvori sub location and other areas that experience similar problems. Conflicts between elephants and humans have become more severe in recent years (Kangwana, 1995) and have attracted attention from conservation biologists and wildlife managers in Kenya.

1.3 Broad objective

Evaluate the human-elephant conflicts and management strategies in Mbuvori Sub location, Embu district.

1.3.1 Specific objectives

(i) Determine the type and extent of damage caused by elephants.

(ii) Determine how distance from Mt Kenya Forest Reserve influences the extent of damage caused by elephants.

(iii) Evaluate management strategies and their effectiveness in minimizing damage caused by elephant.

(iv) Evaluate how people's attitudes towards the elephants influence their management strategies.

1.4 Hypotheses

Ho_1: There is no relationship between distance from Mt Kenya Forest and the extent of damage caused by elephants.

H_{O2}: The management strategies used are not effective in minimizing damage caused by elephant.

H_{O3}: There is no relationship between people's attitude towards elephants and their management strategies.

1.5 Definition of Operational terms

1.5.1 Human-elephant conflict

Conflicts arise due to struggle for resources between elephants and humans. Elephants come from the forest reserve and cause damage to crops and thereby undermining people's livelihoods. It is usually manifested in destruction of crops, life or property. It was assessed through:

1.5.1.1 Type

This refers to the form the damage takes. It ranges from crop raiding, death and injury to both people and livestock and damage to infrastructure.

1.5.1.2 Extent

This refers to the amount of damage caused by elephants to livestock and human life, crops or property. This was determined in terms of area (Ha), volume (bags) and weight (kg) which were later converted into monetary terms for standardization of the values.

1.5.2 Management control strategies

These are the methods and techniques used to dissuade elephants from getting into farms. These methods include the use of bows and arrows, fire, making noise or any assistance sought from relevant authorities.

1.5.3 Peoples' attitude towards elephants

This reflects the way people behave towards elephants. This was obtained from farmers' response to the question of whether elephants are of any value to them and their feelings towards removal of elephants from the forest. The methods they use to scare elephants or dissuade them from getting into their farms were also be used.

1.5.4 Proximity to the forest

This refers to the relative location of farms from Mt Kenya forest reserve. It was determined by the furthest distance from the forest reserve the elephant have ever gone into the farms.

1.5.5 Sustainable coexistence

Sustainable coexistence is harmonious interaction between humans and elephants that will ensure benefits for both with out degrading the environment in which they live.

1.5.6 Forest reserve

This is a large forest area where a given degree of human activities that are consistent with conservation of catchment, forest biota and wildlife is observed.

1.5.7 Land use

Land use refers to all the human activities that take place on particular land-system. They include human settlement, farming, and forestry among others.

1.5.8 Drumming

Drumming was used to mean banging metallic objects together and beating empty barrels to provide deterrence to elephants.

1.5.9 Noise

It was used to mean screaming, singing and shouting to deter elephants from raiding or getting into the farms.

1.5.10 Repellents

It was used to mean burning of animal dung, nylon bags and any waste materials to provide gaseous deterrence.

CHAPTER TWO

LITERATURE REVIEW

Human-elephant conflicts occur throughout the elephant ranges in Africa, from the forest ecosystems in west and central Africa to savanna ecosystems in east and southern Africa (Thouless, 1994; Barnes, 1996; O'Connell-Rodwell *et al.*, 2000). The root cause of the human-elephant conflicts is human population growth and the resultant pressure on elephant's habitats as well as change in land use patterns. Many wildlife species especially large mammals face increasing competition from people for space and resources (Pimm *et al.*, 1995; Balmford *et al.*, 2001). Large herbivores, such as the black rhinoceros (*Diceros bicornis*), elephants and large carnivores are either endangered or their populations are declining rapidly (Woodroffe and Ginsberg, 1998; Emslie and Brooks, 1999).

In 1981, the elephant population had declined dramatically through effects of a century or more of vigorous hunting. According to research done by the African Elephant Conservation Coordinating Group a continent wide elephant population of approximately 1.2 million had declined to around 610 000 by 1989. According to the African elephant specialist Group, elephant population in Kenya has been declining from 140 000 in 1970 to 35 000 in 1987 and is currently estimated at 24 000.

2.1 Human related causes of conflicts

2.1.1 Human population

Elephants can be a source of food, crop pest, and of considerable economic returns through tourism if they are well nurtured (Delany and Hapold, 1979), but are also an endangered species (IUCN, 2000). For example, Kenya had lost over 48 % of her original wildlife habitat by 1994 (Lelo, 1994). Food and Agricultural Organization (FAO) estimated that the rate of deforestation in Africa between 1998 –2000 was 0.78 % of the total forest cover per year, equivalent to a loss of about 5.2 million hectares. As forest areas become more fragmented and degraded or are converted to

agricultural land, elephants foraging habitats and migratory patterns are disrupted (Nigaram, 2002; Rerimoi, 2002)

2.1.2 Land use and land legislation

Land ownership and land use is administered and regulated by the constitution (Trust lands) and other statutes that include the Government Lands Act (Cap 280), the Trust Land Act (Cap 288), the Agriculture Act (Cap 318) and the Crop production and Livestock Act (321). Despite these legal instruments, there has not been proper land use. Demand for land is on the increase and has resulted in uncoordinated and unsuitable land uses, conflicts, environmental degradation and encroachment of wildlife habitats.

As the majority of wild animals are found outside the protected areas and Kenya's economy is mainly based on agriculture, conflicts between the farming communities and wildlife interests will always occur since returns from wildlife utilization cannot compete effectively with returns from agriculture (UNEP and Acts, 2001). Furthermore, animals that enter into conflict situations with humans such as elephants are either migratory or resident.

2.1.3 Dissatisfaction

Conflicts are also exacerbated by dissatisfaction about the amounts of benefits derived from wildlife that is extended to the local communities. The monies generated from national parks are taken to treasury while the local people whose land is incorporated into parks are not considered. As a result, the people feel cheated and are becoming resentful to tourists and conservation programs (Aboud, 1989). The elephant negative impacts on people's welfare have serious implications on the management and conservation because it creates and escalates hostility. Lelo (1994) opposed isolationist and authoritative management systems as they made the local community become indifferent to the use of resources by outsiders.

Currently, no compensation is paid for the damage to property by wildlife. Bell (1984) argued that the benefits of natural prestige are enjoyed mainly by national governments. The situation is made worse by politicians who incite people who live

close to wildlife habitats that the government does little to solve their problems (Leakey, 1991; KWS, 1991). The negative effects on people have persisted for the past four decades (Kangwana, 1995) necessitating search for lasting solutions.

2.1.4 Poaching /Hunting

Hunting is interaction between humans and nature and it takes many forms. The situation was made worse by a belief that outwitting a big strong mature animal was a credit to the hunter (Teague 1979). Poaching on the other hand is the pursuit of animals with lethal weapons for trophies (Teague, 1979). Teague (1979) argued that in the past, taxidermy did not exist and trophies had a different meaning. Trophies were things such as bear-claw necklaces, eagle-feather headdresses and human scalps. They were things to be worn and not to be hung on walls.

The main factor responsible for the low number of elephants and other large mammals in West Africa was poaching (Happold, 1973). Edroma (1973) examined the poaching situation in Ruwenzori National Park between 1972 and 1973 and drew attention to its increasing trend as a result of population growth. In Zimbabwe, records of annual exports of ivory and that of the number of elephants killed each year led Spinage (1973) to conclude that at the turn of the century, few animals were killed and little ivory exported because there were few elephants

2.1.5 Conservation policy

Traditionally, sustainable utilization of wildlife in east Africa was ensured by use of low level of technology as well as the cultural norms and customs. The traditional African societies were conservationists and managed the resources in a manner consistent with ecological principles (Lelo, 1994). With the increasing demand for agricultural land and widespread use of firearms for hunting, there was a marked reduction in the number of wild animals and disintegration of culturally and ecologically sound methods. This immense loss stimulated conservation movements.

Today, the overall authority in ensuring conservation, management and utilization of wildlife resources in national parks, national reserves and non-gazetted areas is entrusted to the KWS under the wildlife conservation and management Act of 1989

(Republic of Kenya, 1989). However, a KWS report in 1994 (KWS,1994) acknowledged the need to change with time and that protected areas were not a solution to human-elephant conflicts as more than 75 % of wild animals resided outside protected areas.

Leakey (1991) and Lelo (1994) supported an integrated management approach for wildlife in order to improve sustainability and inter-generational equity of the resources because local communities were willing to conserve wildlife as long as they were included in conservation programmes and benefited from such activities. It has also been observed that in the absence of a comprehensive policy, farmers killed wildlife because they did not gain by protecting them (KWS, 1991). Similarly, a study on resolving resource use conflicts in Chyulu Hills National Park and its environs indicated that conflicts with the park management could not be resolved because the community did not know that all human activities are not allowed in the park (Mosse, 2003)

2.2 Elephant related causes of conflicts

Human-elephant conflicts may take many forms ranging from crop raiding and damage to infrastructure to disturbances of normal activities such as travel and injury or death of people and elephants (Hoare, 2000). Causes of human-elephant conflicts can be put into human related and elephant related causes.

2.2.1 Crop raiding

The human-elephant conflicts become increasingly significant as human populations encroach upon elephant habitats (Dublin McShane and Newby 1997; Hoare and du Toit, 1999) particularly where people practice cultivation. Although elephants are not the only crop pest in Africa, they may cause severe localized damage within the affected areas (Barnes, 1995; Lahm, 1996; Naughton-Treves, 1998). Elephants greatly affect the structure and dynamics of vegetation and could cause habitat degradation (Cott, 1975; Western, 1989). Elephant activities are generally highest in close proximity to protected areas that act as elephant refuges (Bhima, 1998; Parker and Osborn, 2001).

Elephant's movements are determined by food supply and as food supply declines their home range sizes increase. However, few systematic studies of human-elephant conflicts distribution have been conducted. The study by Hoare (1999) failed to identify any strong spatial correlation. The studies by Sukumar (1989, 1991) suggested that human-elephant conflicts were much a feature of unpredictable behavior by male elephants that were responsible for the majority of crop raiding.

However, Smith and Kasiki (1988) indicated that spatial associations relate to human and elephant density. In this study female-led family groups, which may be more predictable than male elephants, were mostly involved in crop raiding.

Recent reviews of human-elephant conflicts by Hoare (1999, 2000,) identified some trends on elephant activities. Crop raiding usually took place between dusk and dawn and were strongly seasonal. However, food preferences may differ between areas (Barnes *et al.*, 1995) and may be a severe local problem in that farmers can lose an entire year's crop overnight, as well as risk their lives in defense of their crops. A more accurate measure of their effect would come from a comparison of the damage inflicted by elephants with that of other species (Deodatus and Lipiya, 1991).

Elephants may raid crops because they prefer them to natural food or because of a shortage of natural food (Thouless, 1994). They are also likely to raid crops if the favored natural vegetation is growing in the vicinity of crops or because human activities have created secondary growth which is often a preferred habitat (Lahm, 1994; Barnes *et al.*, 1995).

2.2.2 Injury to people and livestock

African elephants are dangerous to people and livestock and are among the most feared wildlife species and are generally less easily tolerated. (Naughton-Treves and Rose, 2001). Human mortality attributed to elephants has been reported in Asia (Prasad and Reddy, 2002; Nigram, 2002) and Africa (Kiiru, 1995; Meitamei, 2002). However, injury or deaths of farmers defending their crops are uncommon (Thuoless, 1994), except when people are not used to dealing with elephants (Tchamba, 1995). The most common circumstances in which people are killed by elephants are

accidental (Thouless, 1994) although "rogue" elephants appear to go out of their way to attack people. These may be bulls or injured individuals.

2.2.3 Damage to water /infrastructure

Elephants do not stay far away from water for long (Sikes, 1971; Walker, 1982; Oliver, 1983). Although men scare away elephants from watering points, elephants in most cases prevail by maintaining their ground and forcing people and livestock go thirsty (Maitamei, 2002). Conflict is likely to be intense where agricultural or other human developments are blocking the access of elephants to key resources such as food, water or salt (Rerimoi, 2002). They also cause serious damage to installations and restrict water availability to livestock by drinking the contents of troughs (Thouless, 1994).

2.3 Management strategies

There are presently two approaches that are used by wildlife managers and farmers to limit elephant damages to property: a) non-interventionist approach - elephant populations are let to regulate themselves which exposes habitats to degradation. b) interventionist approach- involves active regulation of elephant' population densities. Four methods are used, namely culling, translocation, contraception and expansion of the range. However, such strategies are constrained in attaining the desired effects as means of conflict resolution measures (WWF, 1997).

For example culling traumatizes the affected family units while translocation requires specialized equipment and skills. This method also causes stress during transport and after release traumatic effects. It is therefore unacceptable to management in conservation of wildlife (WWF, 1997). Contraception is a relatively new method under study in Kenya and South Africa. It involves immuno and hormonal means of population control, but although effective, there have been behavioral changes in the initial months after implantation (Whyte and Grobler, 1998). Range expansion is difficult to realize because of lack of land.

2.3.1 Disturbance

This is the most commonly used technique whereby attempts are made to drive elephants by shouting, banging drums, lighting fires, olfactory engines, and throwing missiles. In extreme cases, people may fire shotguns at the elephants. These techniques however, are seldom effective when used in isolation as elephants eventually ignore the disturbances (Ngure, 1995; Rerimoi 2002). Although not fatal to elephants, missiles and short guns may wound elephants and induce aggression in them (Ngure, 1995).

2.3.2 Controlled shooting

Controlled shooting involves shooting individual elephants, either as a deterrent or to remove particular problem animals. It is usually carried out by game scouts or licensed personnel. Bulls are the main targets as they are often implicated in raiding crops but often, non-culprits are also killed (Lahm, 1994). A study by Bell and McShane-caluzi, (1984) suggested that shooting elephants had little or no effect on the number of elephants visiting fields in subsequent nights.

Similar sentiments were also expressed by Nicholson, (1968). However, it has been reported that shooting members of a breeding herd in the vicinity of crop-raiding bulls was a more effective technique as family groups were forced to move away which enticed the bulls to follow (Nicholson, 1968). The usefulness of this method will however depend upon the availability of alternative areas into which elephants migrate. The traditional methods that are used include use of bows, arrows and spears.

2.3.3 Physical removal

Driving elephants away from areas of conflicts using lines of men or helicopters has been used in Asia and Africa but elephants soon move back (Jenkins and Hamilton, 1982; Jayewardene, 1984). Extermination of an entire population of "pocketed" animals has also been applied (Haigh *et al.*, 1979), but this operation created negative publicity.

2.3.4 Barriers

A variety of barriers have been used but the most successful ones have been solar-powered electrified fences (Hoare, 1995; Thuoless and Sakwa, 1995). The most commonly used are cheap to construct and require little maintenance although materials may not be easily available and they have limited effects towards elephants. For example construction of ditches or moats has social and ecological costs such as disruption of natural drainage, obstruction of road and river crossings, acceleration of soil erosion and yet the elephants can refill them. The use of unpalatable vegetation as barrier is slow and there may be uneven establishment. The most efficient barrier method is electric fence. The design can easily be changed but requires high initial cost and intensive maintenance (Ngure, 1995)

2.3.5 Knowledge gap

From the literature reviewed, most of the studies on human-elephants have focused mainly on the causes, forms and management strategies of the resulting conflicts in parks and wildlife dispersal areas. However, none of these studies has been conducted in areas of small scale agriculture where elephant raid farms such as Mbuvori sub location and its environs. This underscores the need for data on crops consumed, quantities and patterns of raiding, characteristics of the raiding elephants and what induces raiding. This study will assess the above aspects in Mbuvori sub location with the aim of documenting impacts of elephant damages to small scale holding.

2.4 Conceptual framework

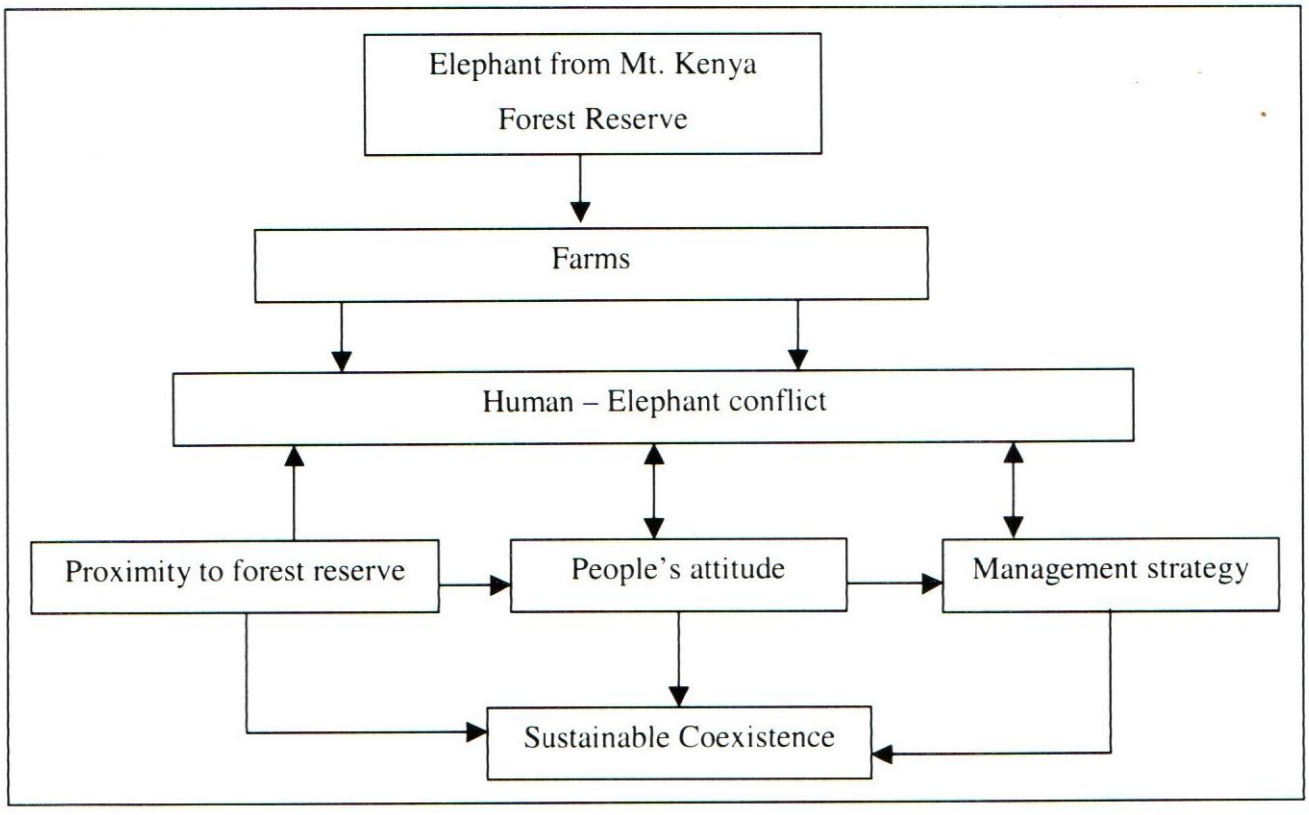


Figure 1. Conceptual framework

Source: Modified from Michael (1986)

The conceptual framework (Figure 1) shows the relationship between elephants, forest and humans. For sustainable coexistence to be realized, conservationists must maintain a balance between use of forest for elephant conservation and extraction of resources by humans. They should consider the interests of the communities that live close to wildlife habitats. When elephants come into the farms or humans encroach upon their habitat, conflicts result. Conflicts are intense in areas close to the forest reserve. The people's attitudes influence the management strategies. The distance from the forest also influences people's attitude, as elephant impacts are more severe in farms closest to the forest.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study area

The study area was identified through the KWS district office, Embu. The office considered the area as hard hit by the human-elephant conflicts. This was followed by a reconnaissance survey collaborated by KWS that ascertained the claim.

3.1.1 Geographical location

Mbuvori sub location is in Manyatta division in Embu district of Eastern Province. It is adjacent to the Mt Kenya Forest Reserve (Figure 2) with only a stretch of 100 m of Nyayo Tea Zone separating the farms from the forest. Mbuvori sub location occupies an area of approximately 39 km^2. (Republic of Kenya, 2000)

3.1.2 Demography

According to the 1999-population census Mbuvori sub location had a population of 8,812 people, which was growing at an annual growth rate of 1.7 %. Using this growth rate, it is projected that this population will increase to 9,716 people in the year 2006. (Republic of Kenya, 2000)

3.1.3 Topography and climate

Highlands and midlands characterize the landscape. Other topographical features include hills and valleys. The rainfall pattern is bimodal with two distinct seasons. The long rains fall between March and June and the short rains are experienced from October to December.

The amount of rainfall received varies with altitude, but averages 1495 mm per year. The rainfall pattern changes to a trimodal pattern with a peak in July/August above 1700 m attitude. The temperature ranges from a minimum of 12^0 C in July to a maximum of 27.1^0 C in March (Republic of Kenya, 2000)

3.1.4 Geomorphology and geology

The geomorphology of Mbuvori sub location is a peneplain, moderately dissected. The geology is mostly the Basements belonging to the Archean Period. Others are groups of Pleistocene belonging to Mt. Kenya Series. Rocks are not exposed within the Basement System of rocks. The geological conditions allow abstraction of water from the forest to the households through gravity as most of the farmers rely solely on surface water (Republic of Kenya, 2000).

3.1.5 Soils

The sub location has an agro-ecological profile that is typical of the windward side of Mt. Kenya. The soils are imperfectly drained, shallow to moderately deep and dark reddish brown in colour. They are classified as loam to clay or loam with rock outcrops (Republic of Kenya, 2000)

3.1.6 Land use practices

Agriculture is the mainstay of economy of the sub location and has enormous potential for supporting viable agro-based industrial activities. The agricultural activities involve growing high value crops such as tea, coffee and macadamia. Other crops grown are cereals such as maize and legumes such as beans and horticultural crops such as French beans, cabbages, kales, tomatoes, avocados and oranges. Livestock production activities are a significant supplementary source of income.

The most important types of livestock kept are cattle and goats and the livestock products include milk, meat, skins and hides. Honey production is also practiced in the forest and most of it is marketed informally. Agroforestly is also common with Grevillia as dominant tree on farms (Republic of Kenya, 2000)

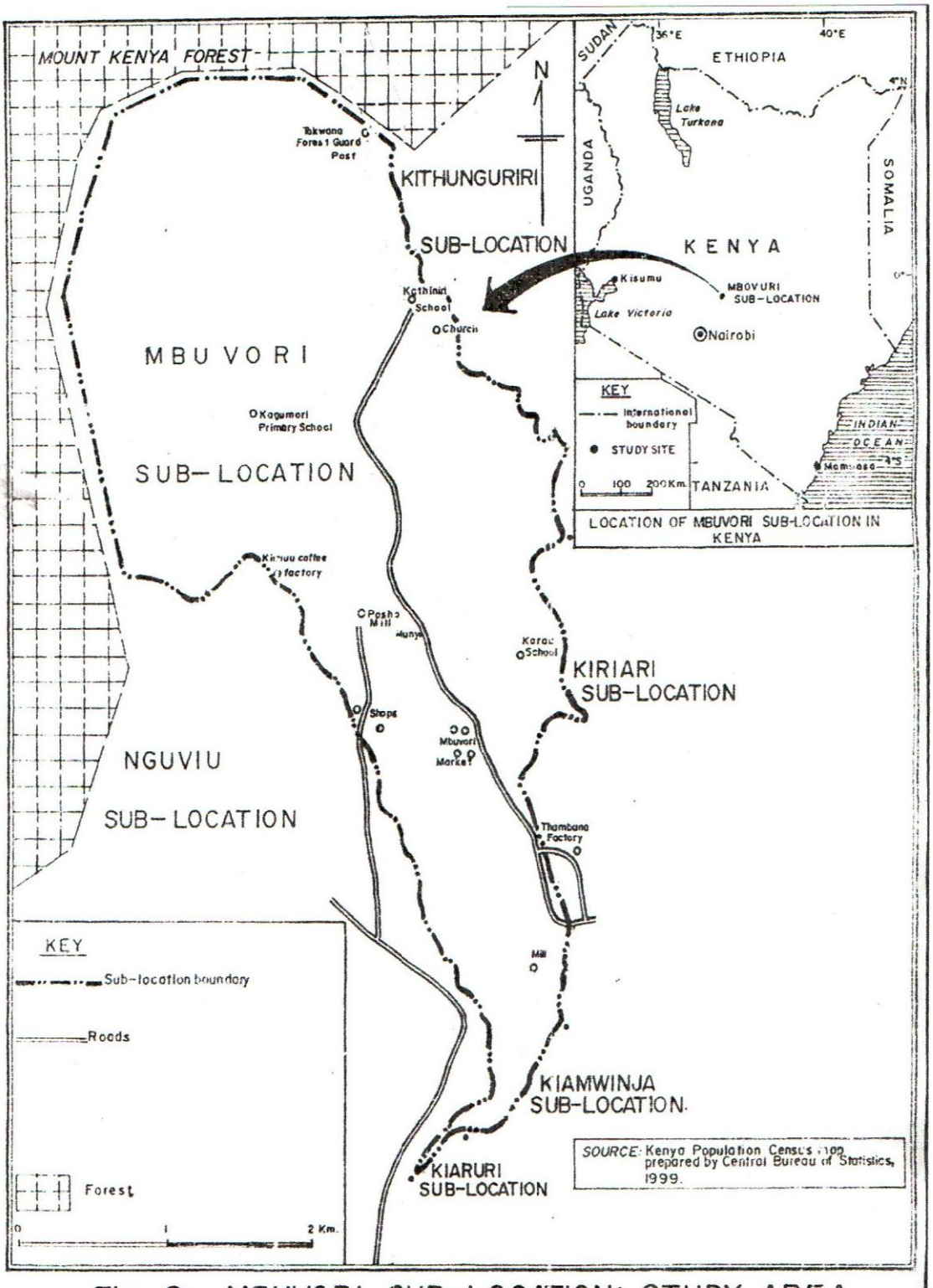


Fig. 2: MBUVORI SUB-LOCATION: STUDY AREA.

3.2 Research design

The study was a sociological inquiry that included both qualitative and quantitative approaches to gather data. Quantitative approach involved the use of questionnaire while qualitative approach involved gathering information from focus group discussions and key informants interviews. Included in this section is reconnaissance, type of data, sources of data, sampling frame and sample size, sampling procedure, instrument for data collection and data analysis.

3.2.1 Reconnaissance

A reconnaissance visit to the study area for the purpose of familiarization and pre-testing of the questionnaire was made. This facilitated making the necessary adjustments to the questionnaire and thereby increasing the reliability of the data. In addition, it promoted the co-operation and support from the community during the study period.

The reconnaissance survey also showed that the intensity of elephant activities into farms decreased with increasing distance from the edge of forest and that the furthest distance visited was 3 km. This enabled easy sampling as it defined the distance from the forest edge to be covered (3km belt).

3.2.2 Data collection

Data was collected on the following variables: kind of conflict (crop damage, livestock/human injuries and deaths and damage to infrastructure), extent of conflict, (standardized into monetary terms}, occurrence of conflicts (season of the year and time of day), management control strategies (items used such as drumming, fires, KWS personnel), and people's attitude (community feelings towards elimination of elephants).

3.2.3 Sources of data

Two parallel and supplementary methods were used to obtain the required information namely primary and secondary data.

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3.2.4 Primary data

Semi-structured questionnaires were administered to randomly selected respondents. The local community administrators introduced the researcher to the community prior to selection of respondents. The heads of households were the key interviewees. Before commencement of any interview, the interviewees were explained the purpose of the study and assured that the interview was only for research. This dispelled likely tendencies by interviewees to exaggerate the extent of crop damage in hope of higher compensation for damage. To effectively obtain primary data, questionnaires, interview schedule, focus group discussions and personal observation were used.

3.2.4.1 Questionnaires

A semi-structured questionnaire (Appendix 1) was used to collect data from the households. The questionnaire consisted of both open and closed ended questions based on research objectives. The administration of questionnaires enhanced personal contact with respondents thus enhancing more insight to the problem. The output from the questionnaires provided data on:

- Types and extent of human-elephant conflicts on farms.
- Types of management strategies used to curtail damage and their effectiveness.
- People's attitude towards elephants.

3.2.4.2 Key informants

The key informants comprised of four KWS officials: the district game warden and three game rangers. The information obtained was on local and national wildlife status, threats to wildlife as a resource, KWS policy and the challenges facing KWS. Another set of questionnaire (Appendix II) was administered to obtain data. The KWS officials were selected on non-probability sampling because the information needed was obtained from specific officials.

Five local leaders were selected on the basis of the duration they have resided in the study area (more than 10 years) and their influence in the community. They included 2 outstanding farmers other than those interviewed, a church elder and 2 leaders of a community conservation project. They provided information on the use of forest resources (plant and wild animal species), their awareness of wildlife policy, impacts

of elephants on the welfare of the local community and suggested solutions to the conflicts. Local leaders were identified through consultation with heads of local institutions. The interviews were guided by interview schedules (Appendix III). The questions were open-ended to provide insight and in-depth information to the study objectives.

3.2.4.3 Group discussion

One group discussion was conducted at one of the KWS outposts at Thambana towards the end of the field study. The group comprised twenty residents other than those interviewed and institution leaders. The discussion was guided by researcher to create a free environment for discussion and focused on the human-elephant conflicts in the area.

3.2.4.4 Personal observation

Throughout the study period, personal observation on the extent of damage to crops, vegetation and infrastructure was made to supplement the data obtained through interviews as well as focus group discussion with community elders and opinion leaders. These observations were recorded on camera with some of the photographs taken forming the plates included in the thesis.

3.2.5 Secondary data

Secondary data was collected throughout the research period. This included data from government sources, KWS occurrence books and annual reports, journals, books and any other relevant literature. Data from KWS occurrence books was on type of damage, number of reported cases, date of occurrence, animals involved and action taken to contain the conflicts.

3.2.6 Sampling frame and sample size

The total number of households in the sub-location (N) constituted the sampling frame and the units of sampling were individual households. The sample size was determined using Ress (1995) formular

$$S = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 p(1-p)}$$

Where,

S = required sample

N= population of household in the study area

P= sample proportion which is favored in the population to give 95 % confidence level

d = degree of accuracy which is reflected by the amount of error that can be tolerated in the fluctuation of sample proportion p

X^2 =chi-square value corresponding to one degree of freedom relative to desired confidence

As already noted the sub location has a population of 8,812 people with an average household size of 7 persons (Republic of Kenya 2000). If the required degree of accuracy is 0.002, a sample proportion of 20 % and a chi-square value of 0.016 at 0.01 or 99 % confidence level, according to Rees (1995),

$$\text{Sample size} = \frac{0.016 \times 8812/7 \times 20\% \times (1-20\%)}{0.002^2 (8812/7 - 1) \div 0.016(20\%)(1-20\%)} = 426.3$$

However, only 200 households were interviewed because this sample size gives reliable results when Statistical Package for Social Scientist is used in data analysis (Bryman *et al* 1997).

3.2.7 Sampling procedures

Both probability and non-probability sampling procedures were used to obtain sample respondents.

3.2.7.1 Probability sampling

Probability sampling was used to select the 200 households. This procedure was used to ensure that each household had equal chance of being sampled. The sample area was stratified into three one-kilometer strata from the edge of the forest. Eighty, 70 and 50 farmers were interviewed in the stratum adjacent to the forest, the middle and furthest stratum respectively. The first respondent was selected at random. The next

interviewee was the 10th household head along the north-south direction. It ensured that the total length and width of the affected area in the sub-location was covered. This procedure was followed through out the sampling.

3.2.7.2 Non-probability sampling

Non-probability sampling was carried out to select key informants who included local leaders, KWS officials and other residents who attended the focus group discussion. This procedure does not give equal chance of being sampled and is suitable for selecting a small sample or where the researcher may have bias such as selection of respondents with more insight to the research problem.

3.3 Data analysis

Data was organized and edited to remove outliers. The responses to each question were coded and processed using Statistical Package for Social Science (SPSS) version 11.5. Since all respondents provided data on damage to crops in terms of volume (bags of maize, beans, potatoes, bunches of bananas), all the values were standardized in monetary terms of Kenya shillings (Ksh) by use of market prices at the time of study. Descriptive analysis was used to show summary and distribution of the data.

This included use of frequency tables, charts and cross-tabulations. To generate frequency tables and figures Microsoft Excel software was used. The analytical procedures were used to determine the relationships among variables to enable easy interpretation of data. Correlation analysis was used to test the hypotheses. Spearman's rho correlation coefficient (r) was used to test the relationship between variables. The correlation tables were generated using the SPSS program.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

In order to ensure that the respondents gave a true reflection of the conflict in the study area, it was important to establish their time of settlement, their land sizes, crops grown and the losses they incur due to damages caused elephant. According to the respondents the earliest settlement in the area was in 1950 but the majority (96 %) occupied land in 1962 when land demarcation took place; the latest settlement was in 1980 (Table 1).

Table 1. Year of settlement in Mbuvori sub location

Year of Settlement	No. of respondents	Percent
1950	1	.5
1952	1	.5
1961	1	.5
1962	192	96.0
1963	1	.5
1965	1	.5
1971	1	.5
1974	1	.5
1980	1	.5
Total	200	100.0

n = 200

However, land transfer to children without official documents on land ownership is continuing. Farm sizes (Table 2) are small due to the continued sub-division through inheritance. Most of the farmers cannot purchase extra land due to shortage of money. The mainstay of the people of Mbuvori sub location is small-scale rainfed agriculture. All the respondents practiced mixed farming. Field data showed that water for household use was obtained from streams originating from Mt Kenya forest but was not sufficient for irrigation purposes.

Table 2. Area (ha) of land under crop production

Farm size (Hectares)	Percent
<0.2	40.0
0.2-0 4	29.5
0.4-0.6	20.5
>0.6	10.0

n = 200

All (100 %) respondents grew maize, 81 % grew bananas but only 19 % grew beans (Table 3). Observation showed that they also raised livestock and poultry for household purposes.

Table 3. Proportion (%) of farmers growing various crops

Crop	Percent of respondents
Maize	100
Bananas	81
Potatoes	34
Sugar cane	67
Cabbage	27
Beans	19

n = 200

Observations showed that all farmers grew tea and some few farmers grew coffee as the main cash crops. The focus group discussion revealed that these two crops provide income for paying school fees and purchase of other goods and services that are not produced within the farms. The discussion also revealed that the cash crops were never raided by elephants.

4.1 Damage caused by elephants

Mbuvori sub location was not a migratory corridor for elephants between Mt. Kenya and northern / southern grazing areas. Therefore, the farms did not form part of elephant dispersal route from Mt. Kenya forest. The human-elephant conflicts could

be explained by the fact that the sub location is an intensive agricultural area adjacent to the forest reserve; elephants probably preferred crops than forage on offer in the forest or may be there was a deficiency of food on offer in the forest.

Seventy nine percent of the farmers indicated they experienced crop raiding, 6 % indicated breaking of trees and 4 % indicated soil compaction (Table 4). Most damage was caused by browsing, uprooting crops and trampling upon when elephants were foraging or were being chased away from fields by farmers.

Table 4. Types of damage caused by elephants

Damage	Percent of respondent
Crop raiding	79
Damage to infrastructure	11
Breaking trees	6
Soil compaction	4

n = 200

Elephants foraged upon or trampled on a variety of crops including maize (*Zea mays*); banana (*Musa domestica*); sugarcane (*Saccherum officinarum*); sweet potatoes (*Ipomea potatas*); beans (*Phaseolus vulgaris*); pumpkins (*Curcabita maxima*) and napier grass (*Pennisetum perpurium*). The extent of crop damage varied but the respondents ranked maize as the frequently raided (Table 5). Seventy three percent of respondents ranked bananas second followed by sweet potatoes but beans was ranked last. A similar report was made by Bell and Mcshane-Caluzi, (1984) Deodatus and Sefu, (1992) and Tchamba, (1995) that maize and millet are the main crops damaged in eastern/southern Africa and the Sahelian region respectively.

Table 5: Frequency (%) of damage on various crops

Crop	Percent of respondent
Maize	100
Bananas	73
Sweet Potatoes	34
Sugar cane	51
Cabbage	27
Beans	19

n = 200

The cash income that farmers would have obtained from sale of farm produce if damage by elephants did not occur is shown in Table 6.

Table 6. Estimated value of farm Produce without damage by elephants

Total damage Ksh	Description of damage	Percent response
< 7000	Low	10
7000- 14000	Moderate	27
>14000	High	63

n = 200

Sixty three percent of the respondents would have made an income of more than Ksh 14000 while 10 % would have made an income of less than Ksh 7000 annually

4.1.1 Value of damaged farm produce in relation to distance from the forest

The cost of damaged produce was greater near the edge of the forest and decreased with distance from the edge of forest (Table 7). Forty percent of the damage occurred within the 1km stratum and decreased to 25 % within the 2-3 km stratum. The observation concurs with Bhima (1998) and Parker and Osborn (2001) in that elephant activities are highest in areas close to elephant refuges.

Table 7. Value of damaged farm produce in relation to the distance from edge of forest

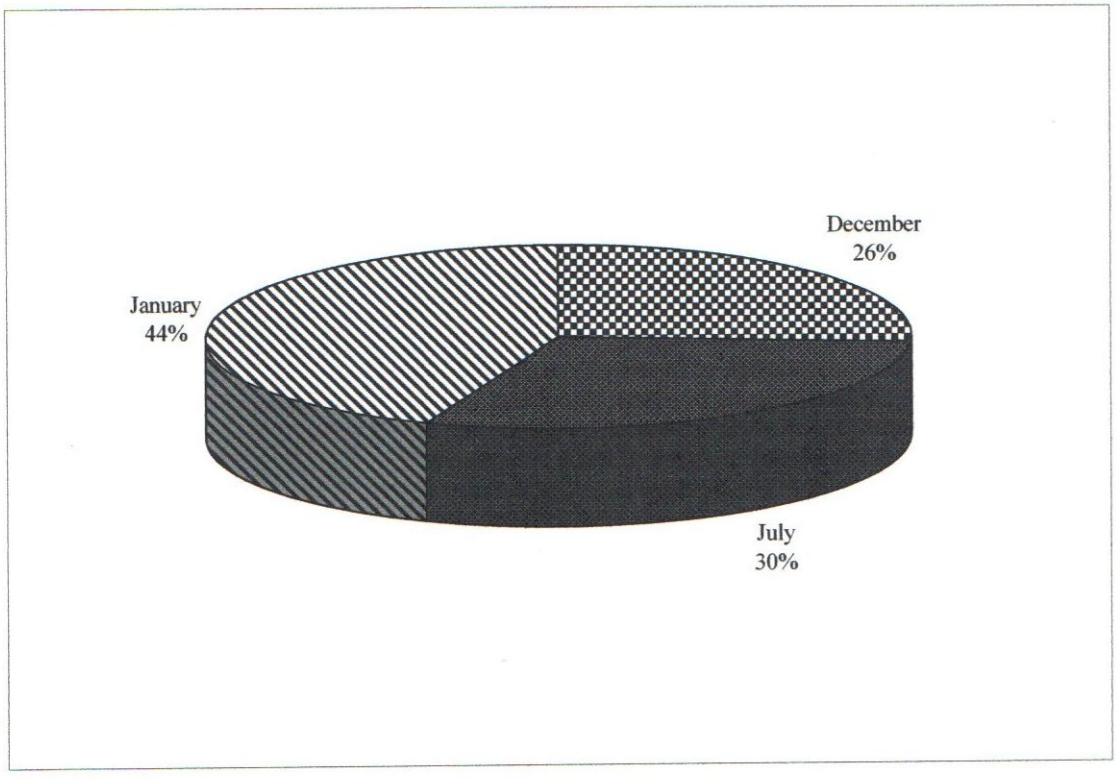
Total damage (Ksh)	Distance from edge of the forest (km)		
	<1	1-2	2-3
< 5000	5.1 [a]	3.0	2.0
5000-10000	9.6	9.1	7.1
>10000	27.8	22.7	13.6
Total	42.5	34.8	22.7

n = 200

[a] Percent number of respondents

4.1.2 Time of raiding

All respondents indicated that crop raiding occurred during the night. The forest provides refuge during the day from where they come out to raid at night in addition to causing other damages. This observation concurs with Kangwana (1993) who reported that elephants avoid human settlement during the day to minimize contact with humans.



n = 200

Figure 3: Periods of peak damage to crops by elephants

Forty four percent of respondents reported that their farms were raided in January, 26 % in December and 30 % in July (Figure 3). The raids in of January correspond to the period when crops are mature. This observation is in agreement with Hillman, (1995) who reported that peak damage periods occurred during pre-harvest and harvest periods. Raids in July correspond to the wet seasons when the forest environment was muddy and very cold. This concurs with Osborn (2004) that elephant's raid in wet season because the crops provide a food resource higher in quality than wild foods.

Elephants raid the farms in December because some of the crops sown during the short rains (October to December) have grown and can be foraged upon. Barnes *et al.* (1995) who reported that crop raiding was strongly seasonal made a similar observation. Plate 1 shows the leftovers in a crop field originally under mixed cropping after an elephant raid.

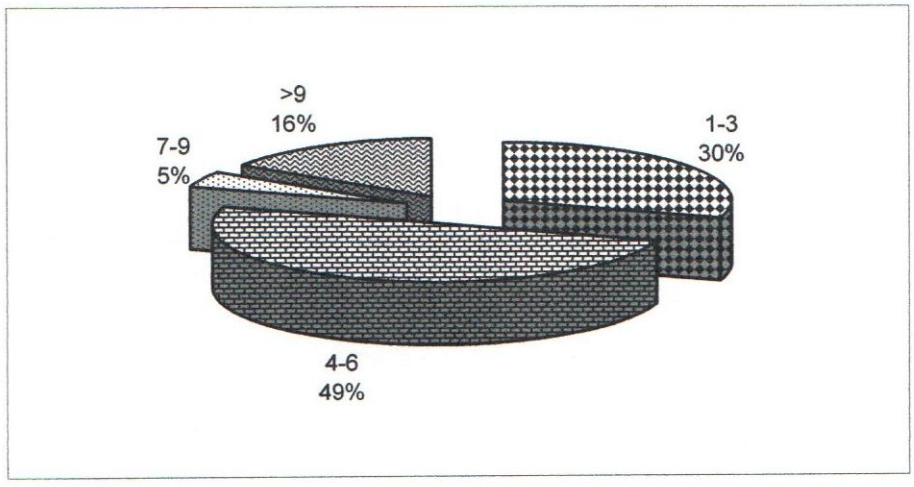


Plate 1. Farmers on a crop field after a raid by elephants

4.1.3 Number of raiding elephants

Raiding elephants ranged in number from 1 to more than 9. Forty nine percent of respondents indicated that elephants raided in groups of 4 to 6, 30 % in groups of 1 to 3, and 16 % in groups greater than 9 (Figure 4).

The group discussion revealed that the composition was usually a single male, females and calves although groups of males only were also common. This is in agreement with report by Malima *et al*, (2005). The groups comprising of males were usually associated with greater damage, which tallies with a report by Kioko (2005).



n = 200

Figure 4 . Number of raiding elephants

KWS officials stated that groups of 1 to 9 were usually resident whereas herds of greater than 9 included migratory elephants. The group discussion also indicated that it was easier to drive away a big herd than one or two elephants and that a herd of males was more difficult to drive away than that comprised of females and calves. A study in Zimbabwe (Sukumar, 1991) also indicated that human-elephant conflicts were much a feature of the unpredictable behaviour by male elephants, which were also responsible for the majority of crop raiding events.

The group discussion revealed that there has been increase in elephant population in the Mt. Kenya region over years due to enforcement of conservation rules by KWS officials. Pouching was reduced in addition to the ban on ivory trade. Most of the elephants responsible for raiding crops were resident and used paths within the Nyayo Tea Zone plantations (Plate 2) that are used by people to get into their farms when harvesting tea.

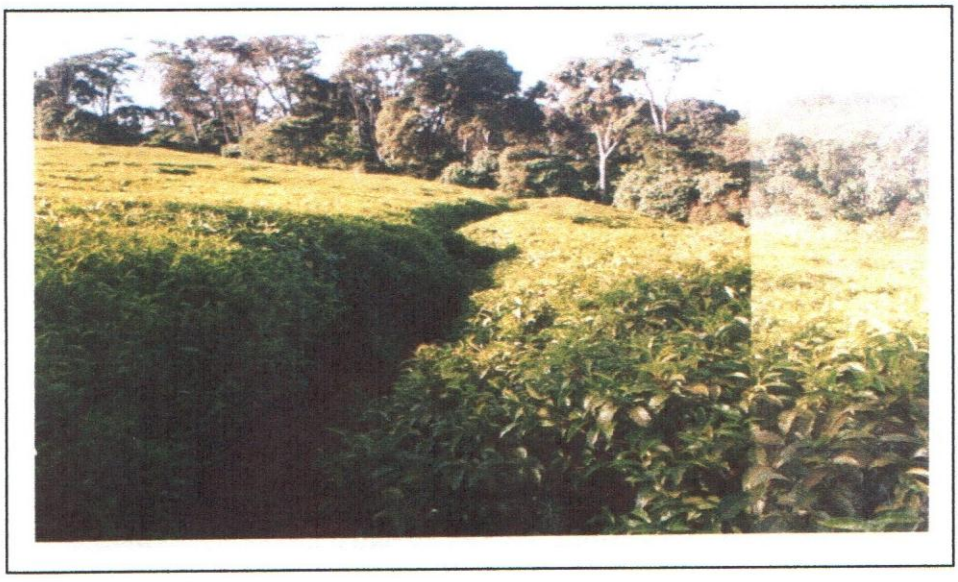


Plate 2: Paths within tea plantation used by elephants during raids

The group discussion revealed that elephants forage on maize at all stages of growth but with preference for cobs that are fully developed. This concurs with Thouless, (1994) who reported that elephants may raid crops because they prefer them to natural foods. They also caused post harvest damage to stored maize cobs (Plate 3) which is in agreement with IUCN (1987), Rerimoi (2002) and Kioko (2005).

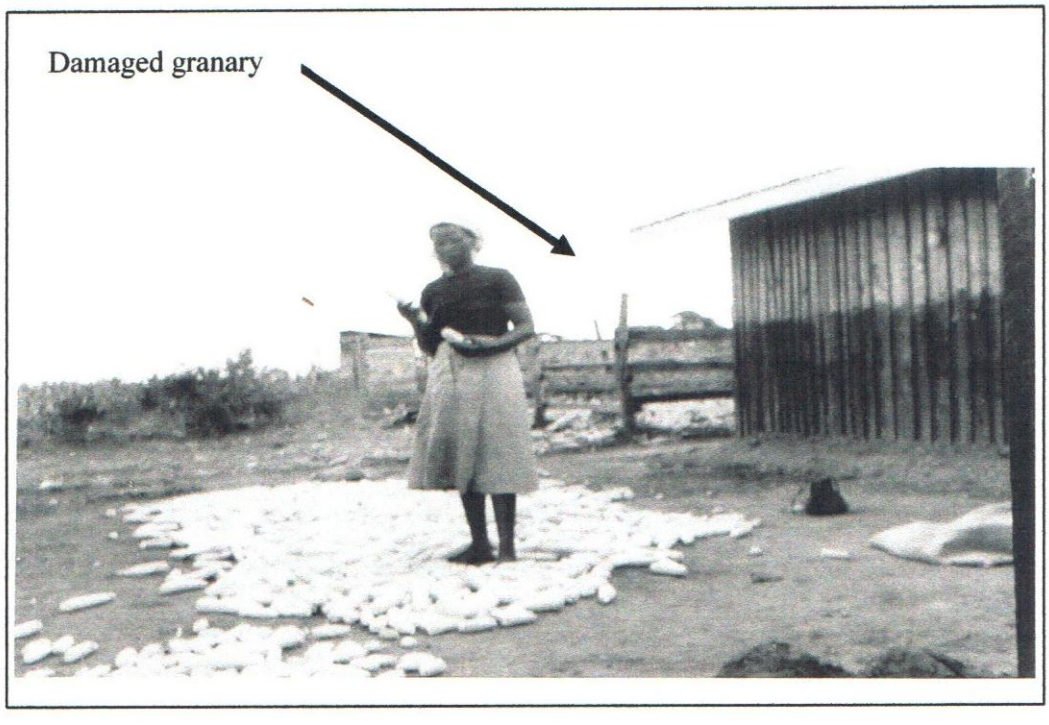


Plate 3: Damaged granary and maize leftovers

Since ninety percent of the farmers own < 0.2 to 0.6 ha of land (Table 2), a single elephant raid can cause substantial damage on these smallholdings. This situation escalates hostility because farmers are left with little to take care of their household needs. The respondents indicated that interference with forest food resources during the period of illegal logging and harsh climatic conditions contributed significantly to the human-elephants conflicts.

The elephants appear to visit farms when crops are mature and probably are more nutritious and palatable than feed on offer in the forest. A similar observation was made by Sukumar, (1994). High energy foodstuffs also appear as preference. Osborn (2004) reported that elephants appear to select highly nutritious foods available as opposed to selecting the most available foods. It was also observed that when elephants foraged on bananas, they preferred the pith probably because it is rich in minerals. Raiding may therefore be associated with the need for quantity and nutrient supplementation that may be lacking in vegetation on offer in the forest.

It also emerged from the group discussion that farmers harvested crops prematurely to avoid damage and as a desperate measure to reduce food insecurity. This was common as regards potatoes and beans. Food insecurity in the study area is inevitable because the harvested food can not be stored for long. Similarly, it also emerged that some farmers had stopped planting some of the crops preferred by elephants as a remedy to reduce vulnerability of other crops to damage by elephants.

This has cultural costs as arrowroot and pumpkin leaves were used for mashing "githeri" and are served as vegetables. The arrowroots and pumpkins are also traditionally used for meals. The locals therefore, forego the nutritional benefits associated with these crops. As part of precaution, bananas and sugarcanes were often planted around the houses because the noise produced when elephants were raiding alerted the farmers. Farmers also planted bananas and sugarcanes surrounding maize crops so that when raiding occurred, these crops would be eaten first before getting to the maize crop which is the staple food.

The group discussion also revealed that trampling on seedlings reduced the percentage of crop stand and thereby reducing final yields. In addition, trampling also caused soil compaction and made it difficult to till and plough especially when the raids were made during the wet season. This was also associated with soil erosion due to reduced infiltration and consequently lowering the quality of soil.

Testing hypothesis

Ho_1: There is no relationship between distance from Mt Kenya Forest and the extent of damages caused by elephants

Table 8. Relationship between total damage (Ksh) and distance (km) from the edge of the forest

			Distance from the natural forest to farms (km)	Total damage (Ksh)
Spearman's rho	Distance from the natural forest to farms (km)	Correlation Coefficient	1.000	
		Sig. (2-tailed)	.	.017
		N	150	150
	Total damage (Ksh)	Correlation Coefficient	.196	1.000
		Sig. (2-tailed)	.017	.
		N	150	150

n = 150

The value of damaged crops from fifty respondents from each stratum was used in analysis.

The cost of damaged produce decreased ($P<0.05$) with increase in distance from the edge of Mt Kenya forest (Table 7). The statistical analysis confirms a relationship between the distance from the edge of Mt Kenya forest and extent of damages caused by elephants. Similar to this study, Deodatus and Lipiya (1991) and Kioko (2005) also did establish that crop raiding by elephants was often a severe local problem.

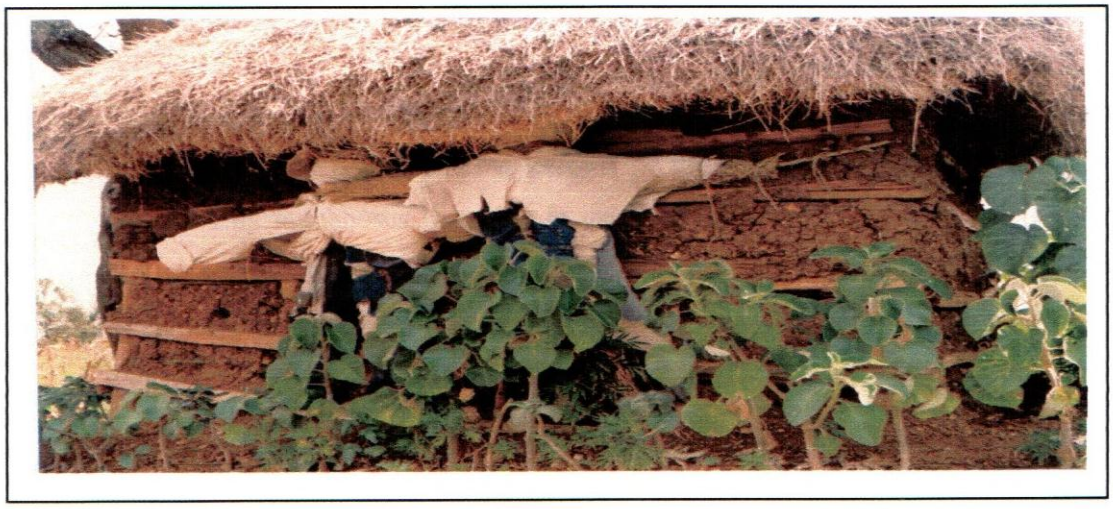


Plate 1: Scarecrows in shape of a male statue

4.1.5 Human Injury

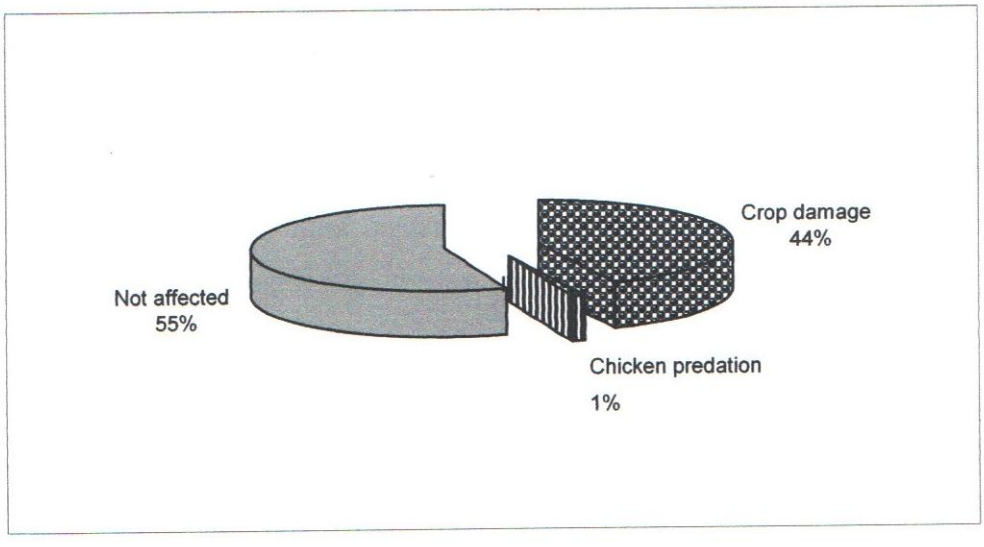
The group discussion indicated that elephants were generally not aggressive unless they were nursing or were provoked. Records in KWS Occurrence Books showed that two male farmers' sustained injuries between 2000-2004. However, the injuries were not from direct attacks by elephants but were caused by objects while they were running away for safety. This is in agreement with Thouless (1994) who reported that the common circumstances under which people were injured were accidental by rogue animals.

Elephants showed biased reactions to gender by never harming women and children but charging at men. This was attributed to the fact that in most encounters with men, they were either chasing them out of the farms or hunting them for meat or ivory, which induced aggression in the elephants. Sukumar (1994) also reported that elephant antagonistic behaviours towards humans were a result of harassment by men and that direct injuries occurred when elephants were provoked by hitting with stones or sharp objects that caused pain or when nursing elephants considered calves threatened.

However, the report by Sukumar (1994) and my results disagree with the reports from Oloitoktok and Laikipia, Narok, Taita-Taveta, and Kwale districts where deaths and injuries due to elephants have been reported without prior provocation (Thouless,

4.1.4 Damage caused by other wild animals

Forty five percent of farmers within the 1 km range from the forest reported damage from other wild animals. One percent of the respondents reported predation on chickens by mongooses that hide in the bush at the edge of the forest (Figure 5). Forty four percent of the respondents reported that crop damage by monkeys, bush pigs, and baboons occurred throughout the year. However, the damage was considered insignificant compared to that caused by elephants.



n = 200

Figure 5. Damage caused by other wild animals

Monkeys and baboons targeted maize cobs, fruits and ripe bananas while bush pigs dug sown seeds as well as fed on mature crops. Baboons and monkeys disregarded women as a deterrent. The respondents attributed this to the fact that during the illegal hunting and logging periods, only men were involved and that animals could recognize them from their dressing and scent. This explanation however, differs from that of Rerimoi (2002) who reported that it was sheer disregard for women that they showed open aggression. Field observations also showed that scarecrows that were used to scare wild animals took the shape of male statue made of old clothes and sticks (Plate 4).

1994; Kiiru, 1995; Meitamei, 2002; Rerimoi, 2002; Kioko, 2005). This is probably because Mbuvori sub location is neither a migratory corridor nor a dispersal area like in areas the above studies were carried out. No incidences of teachers and students missing school, failure to go to markets or work as a result of elephants blocking travel routes were reported. However, it also emerged that many cases were not reported due to the frustrating procedures followed in pursuing compensation and inadequate compensation for damage.

4.1.6 Benefits obtained by farmers living close to the forest

During the interview with the local leaders, it emerged that they were aware of human-elephant conflicts which they attributed to increased number of elephants in the forest reserve and the consequent protection by wildlife authorities. The local leaders said that important benefits acquired by farmers' living close to the forest were access to firewood, wild vegetables, honey and forage.

The individual respondents did not admit that they obtained game meat for fear of being associated with criminal activities but in situations where children were present during the interviews they alluded it occurred frequently. Similarly, during the group discussion the respondents admitted they obtained game meat without the knowledge of KWS officials. In addition, parts of wild animals were also used for making drums and other artifacts values. Traditional healers are important in the area, and the forest is the source of all medicinal extracts they use.

4.2 Management strategies

The farmers employed several methods to deter elephants from getting into and driving the elephants out of farms (Table 9). The majority used combination of the traditional methods and a few used the KWS officials to deter animals from their farms

Table 9. Various methods used by farmers to deter elephants

Method	Percent
Fire	34
Drumming	26
Repellents	14
KWS	12
Noise	10
Fencing	4

n = 200

Majority of the farmers (34 %) used fire and the least used (4 %) method was fencing (Table 9). Lighting bonfires and drumming were the most common methods used to scare elephants. Farmers indicated that the methods used lost effectiveness with time as the elephants got habituated to them. A similar observation was made by Kiiru, (1995) and Rerimoi, (2002).

The results also showed that the farmers used the methods in combination to boost their effects. One hundred and nineteen farmers used a combination of fires and drumming, 34 used fires and repellents and the least (one) used repellents and fencing or KWS officials (Table 10).

Table 10. The combination of methods used to deter elephants

	Drumming	Fires	Noise	KWS	Repellents	Fencing
Drumming						
Fires	119[a]					
Noise	22	29				
KWS personnel	17	18	6			
Repellents	28	34	3	8		
Fencing	3	4	3	1	1	

n = 200

[a] Percent of the respondents using the methods in combination

4.3 Effectiveness of methods

The number of respondents using each method of deterrence is shown in Table 9. Respondents were asked to indicate the effectiveness of the method. The degree of effectiveness of each method is shown in Table 11.

Table 11. Effectiveness of individual methods as deterrents

Method	Effectiveness of the methods used			
	Very effective	Effective	Ineffective	Very ineffective
Fire	0 [a]	24	76	0
Drumming	3	32	62	3
Repellents	0	62	32	0
KWS personnel	0	36	57	7
Noise	0	55	45	0
Fencing	0	14	86	0
Total percent	1	35	62	2

n = 200

[a] Percent of the respondents

4.3.1 Fires

Seventy six percent of the farmers indicated that fires were ineffective in distracting elephants from raiding (Table 11). The farmers used banana fibre and maize stalks which burnt rapidly because there was scarcity of fuel wood. The method also included throwing glowing missiles towards elephants. The ineffectiveness of fire as a deterrent could be explained by the fact that during the illegal logging, the loggers used fires for various activities and the elephants became accustomed.

4.3.2 Drumming and making noise

Thirty two percent and 55 % of the respondents indicated that drumming and noise were effective respectively (Table 11). However, they stated that the success of these methods depended on the size of herd, its composition and the elephant's state of hunger. Often, the elephants ignored the disturbances and continued raiding.

4.3.3 Repellents

Fourteen percent of the farmers used repellents. Smoke from burnt animal dung, plastics, nylon bags and old clothes were used to produce some gaseous deterrence (Table 9). Sixty two percent of the respondents indicated that the method was generally effective (Table 11).

4.3.4 KWS personnel

The KWS was formed in 1989 with a mandate to deal with the poaching menace and ensure management of wildlife resources. In addition, the KWS is also expected to manage wildlife that stray into people's farms. Interviews with the KWS officials revealed that KWS was aware of human-elephant conflicts in the study area that started less than 10 years ago.

The assistant warden estimated the number of elephants in the area as less than 1000. Use of the KWS rangers to drive away the elephants was a more effective method of dealing with problem elephants because the rangers were allowed to kill stubborn elephants that were dangerous to the residents. The use of thunder flushes and ammunitions were effective in driving elephants back to the forest. However, the rangers were rarely available when needed. The operation act made the exercise a public relations operation similar to what Kangwana (1993) reported.

The KWS officials stated that they were hindered from effectively carrying out their operations by shortage of human and material resources. They indicated that there was need for compensation and fencing off the forest reserve with an effective restricting means such as electric fencing. This was potential option to reduce human-elephant conflicts.

4.3.5 Fencing

Only 4 % of the farmers fenced their farms (Table 9) but it was an ineffective method as deterrence (86 %, Table 11). This was partly because elephants damaged all fences. Fencing was only able to prevent domestic and smaller wild animals from going into the farms. The observation contradicts the recommendation by the republic of Kenya (1997) that encouraged fencing as efficient method in management

of wildlife. Furthermore, elephants are capable of going through electrified fences (Kangwana, 1995). Most farmers used wood to fence and few strands of barbed wires because it was expensive.

Overall, 64 % of the respondents stated that the methods were not effective. However, 36 % of the respondents stated that the methods were effective as a means of deterring elephants (Table 11). Respondents who indicated that the methods were effective also qualified that the effectiveness was dependent on the distance from the forest reserve where raids occurred. The group discussion indicated that the further away from the forest the easier it was to drive elephants out of farms. The respondents revealed that neighbours combined efforts as elephants were driven from one farm to another towards the forest.

Table 12. Time spent (h) on driving elephants out of the farms

Time spent (h)	Percent response
1-3	46.0
4-5	26.0
6-7	18.5
8-9	9.5

n = 200

Forty six percent of the respondents indicated that they spent 1- 3 hours to drive elephants out of the farms whereas 26 % spent 4-5 hours and 10 % spent 8-9 hours (Table 12).

Testing the hypothesis

H_{O2}: The management strategies used are not effective in minimizing damage caused by elephants.

More farmers (64 %) indicated that the methods were ineffective. This is confirmed by the statistical analysis of the data (Table 13)

Table 13. Effectiveness of management strategies used to minimize human-elephant conflicts

			Effectiveness	Method
Spearman's rho	Effectiveness	Correlation Coefficient	1.000	.123
		Sig. (2-tailed)	.	.082
		N	200	200
	Method	Correlation Coefficient	.123	1.000
		Sig. (2-tailed)	.082	.
		N	200	200

The methods were not effective (P>0.05) in deterring elephants (Table 13). The null hypothesis is therefore accepted suggesting that elephants moved freely irrespective of the farmers' efforts to deter them.

4.4 Farmers attitude towards elephants

The farmers responses on how they would react towards removal of elephants from the forest were dependent on value of damages incurred and benefits associated with the presence of elephants. Fifty three percent of farmers, 34 % and 13 % of farmers who associated presence of elephant negatively were from 1 km, 1-2 km and 2-3 km strata respectively (Table 14). This closely followed the trends in the magnitude of economic losses associated to elephant's activity (Table 7).

Table 14. Farmers negative regard to elephants in relation to distance from the edge of forest

Stratum	Percent
1 km	53
1 to 2 km	34
2 to 3 km	13
n = 200	

From the group discussion, it emerged that peoples attitude towards elephants varied with age and the cultural attachment to elephants. The presumed young generation viewed elephants in monetary terms while the more mature viewed them in terms of cultural heritage.

The group discussion also revealed that women disliked elephants more than men. Kangwana (1993) attributed women's negative attitude towards elephants to their inability to use weapons for personal defence and not their being as aggressive as men. The attitudes of the local community towards elephants were generally negative because they lacked benefits associated with their presence (Figure 6).

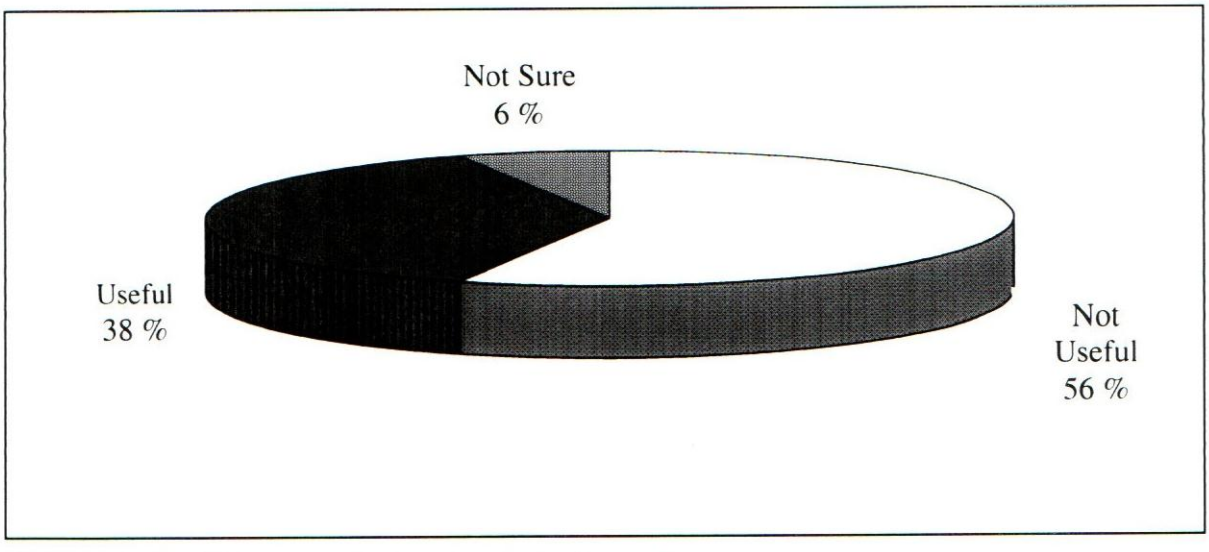
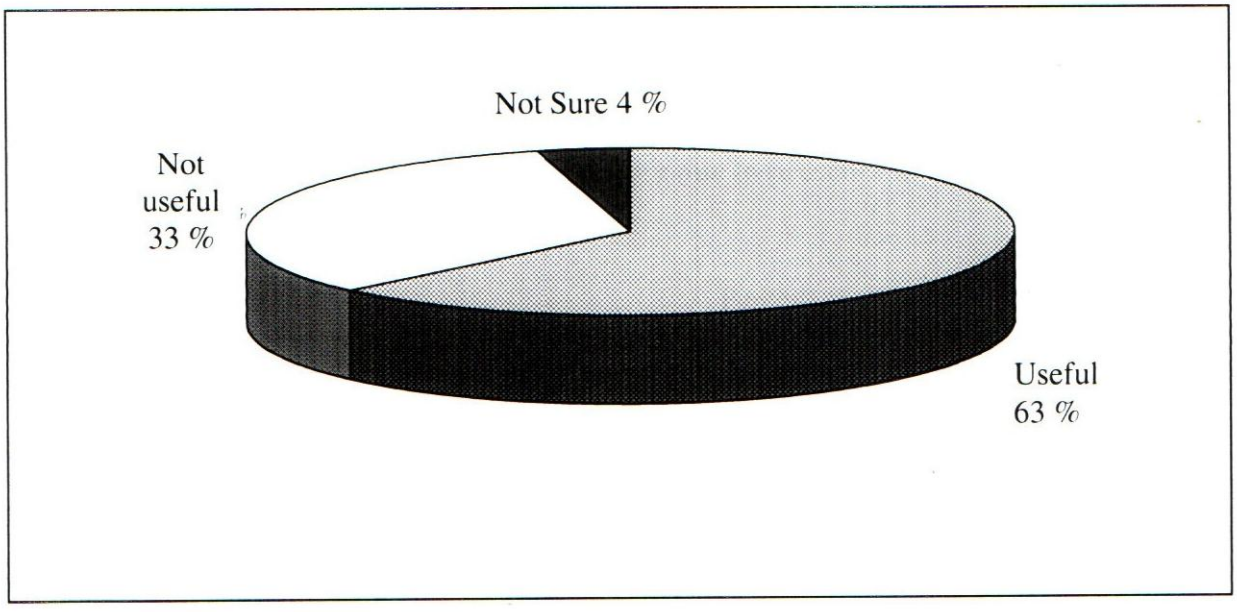


Figure 6: Usefulness of elephants to individual farmers

Fifty six percent of the farmers indicated that elephants were of no value to them as local community, while 38 % indicated they were of some use and 6 % of the respondents were not decided. This concurs with Hoare (2000) and Hill (1998) who reported that people's attitude varied depending on individual values and situations and community value of wildlife. The values of elephants were indicated as aesthetic values for future generations and ecological reasons in that they were part of our natural heritage.



n= 200

Figure 7: Farmers opinion on elephant usefulness to people outside Mbuvori

Sixty three percent of the farmers were of the opinion that people outside Mbuvori benefited more from elephant related activities, 33 % did not respond while 4 % were not sure (Figure 7).

The group discussion indicated that elephants were instrumental in opening up forest canopy, which enabled locals' access to the forest for firewood, forage, wild vegetables and fruits as well as putting beehives. The reasons cited as contributing to dislike of elephants are shown in Table 15.

Table 15. Factors contributing to negative attitudes towards elephants

Factor	Percent response
Crop destruction	43
Loss of sleep	18
Soil compaction	4
Breaking trees	3

n = 200

The group discussion also indicated that losses occurred to the local community whereas gains were obtained by other people. The benefits other people gained attributed to presence of elephants are shown in Table 16.

Table 16. Benefits obtained by other people due to presence of elephants

Benefits	Percent of response
Tourism	42
Aesthetic	27
Employment	22
Game meat	9

n = 200

The group discussion revealed that farming activities could not coexist peacefully with elephants because of the damage they caused. They indicated that the animosity could be lessened if the benefits accrued by the other people were shared with them including improved measures to control elephants. The farmers' attitudes on the removal of elephants from the forest are shown in Table 17.

Table 17. Farmers' reactions towards removal of the elephants from the forest reserve

Method	Peoples attitude towards elephant elimination			
	Very Sad	Sad	Happy	Very happy
Drumming	1[a]	11	12	2
Fires	5	13	7	9
Noise	1	5	3	1
Repellents	4	4	4	2
KWS	4	5	2	1
Fencing	0	2	1	1
Total	15	40	29	16

n = 200

[a] Percent of the respondents

Fifty five percent of the farmers were unhappy with the activities of elephants. The reasons cited for unwillingness to remove elephants from the forest included the loss of aesthetic values, potential ecological disturbances and loss of economic benefits associated with elephants. The willingness to remove elephants was mainly associated with damage caused to crops.

Testing the hypothesis

H_{O3}: There is no relationship between people's attitude towards elephants and their management strategies.

Table 18. Relationship between people's attitude towards elephants and their management strategies

			Management strategies	Attitude
Spearman's rho	Management strategies	Correlation Coefficient	1.000	.066
		Sig. (2-tailed)	.	.355
		N	200	200
	Attitude	Correlation Coefficient	.066	1.000
		Sig. (2-tailed)	.355	.
		N	200	200

The peoples attitude did not influence ($P > 0.05$) their management strategies (Table 18). The null hypothesis is therefore accepted. The assumption was that people would use hostile methods which would cause injury to elephants. However, none of such methods of deterrence were used. Hostile methods would include the use of bows and poisoned arrows and any method that would injure the elephants. This was partly because of the wildlife act and its enforcement by the KWS officials.

4.5 Farmers Suggestions on minimizing human-elephant conflicts in Mbuvori sub location

Thirty two percent of the farmers were of the opinion that electric fencing would confine the animals in the reserve. However, provision to access forest resources would be a pre-requisite if this method was used (Table 19).

Table 19. Farmers' suggestions on minimizing human-elephant conflicts in Mbuvori sub location

Suggestion	Percentage of respondents
Electric fencing	32
Improve KWS capability	20
Compensation	16
Construction of game moats	14
Culling	10
Community involvement	5
Killing problem animal	3

Twenty percent of the farmers were of the opinion that increasing the number of KWS personnel and outposts to affect patrols would aid in reducing the conflicts while16 % suggested compensation for damaged crops and property. Culling rogue animals and maintaining manageable numbers (10 %), construction of game moats (14 %), incorporating the community in management and decision-making (5 %) and shooting stray elephants (3 %) were also suggested as the way forward towards managing the human-elephant conflicts in the sub location.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study was carried to test three hypotheses:

Ho_1: There is no relationship between distance from Mt Kenya Forest and the extent of damage caused by elephants.

H_{O2}: The management strategies used were not effective in minimizing human-elephant conflicts.

H_{O3}: There is no relationship between people's attitude towards elephants and their management strategies.

The result from testing hypothesis one showed that the value of damaged produce decreased ($P < 0.05$) with increase in distance from the Mt Kenya forest reserve. The conclusion is that poverty and food insecurity will continue as elephants damage all kinds of crops and farmers are forced to harvest their crops before full maturity. The change of diet will also persist because of the omission of some crops that are preferred more by elephants as a remedy to raids.

The Results from testing hypothesis two showed that the management strategies are not effective ($P > 0.05$) in deterring elephants from farms. The conclusion based on this test is that elephants move freely and will continue causing damage to crops and infrastructure unless the current methods in use are replaced with effective ones.

The results from testing hypothesis three showed that the people's attitude did not ($P> 0.05$) influence their management strategies. This is because farmers did not have the freedom to use any method they wanted because of the wildlife act and the strict enforcement by KWS officials

5.2 Recommendations

The human-elephant conflicts in Mbuvori sub location presents a situation which might escalate in the future given the notable increase in intensity of land use and elephant numbers in Kenya. Any solution will have to take into account the interests of the local people and the goals of sustainable elephant conservation. The government and its international conservation partners can probably manage the challenge through the following:

- Effective methods to deter elephants. This could include installing effective fencing and increasing the KWS capacity to perform their duties. Since areas such as Mbuvori sub location will remain agricultural for a long time in future, communal guarding should be enhanced during the periods of conflict to ensure proper response to raiding elephants.
- Reducing the elephant population by culling and translocation. In this regard the KWS should introduce a legislation on sustainable wildlife utilizations that supercedes the current bans on hunting and prohibition of trade in wildlife and wildlife products. This will enhance integration of wildlife and land uses in areas adjacent to conservation areas or outside protected areas. The legislation will decentralize rights of ownership by giving land owners right and authority to utilize wildlife for economic benefits. It will also ensure that they take on certain costs of conservation while maintaining the states prerogative to own all wildlife and intervene when the situation demands.
- Habitat rehabilitation to ensure supply of elephant feed. This would include reducing degradation of the habitat which is the natural source of food for elephants.

5.3 Future research

The discussion with farmers showed that elephants preferred some crops to others and in some cases preferred specific parts of crops. Farmers often do not plant these crops to avoid raids. Therefore studies are recommended to:

- To establish the reasons for preference which would be of value in determining the cropping sequencing/patterns.
- Establish the impacts of avoiding the preferred crops by elephants on the poverty status and food insecurity.

5.4 Significance of the study

The study provides the baseline information on impacts of elephants on crop production in small scale farming systems in Mbuvori sub location. The study also established that the methods used by the community to deter elephants were not effective. The information will be useful to planners and policy makers for areas that are adjacent to conservation areas in designing more effective methods of controlling the raiding elephants. The need to share benefits arising from wildlife with the neighbouring communities is also implied.

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APPENDIX I: HOUSEHOLD QUESTIONNAIRE

The questions in this questionnaire are for research purposes only. The information you provide will be treated with utmost confidentiality. Your assistance in answering the questions truthfully and accurately will be highly appreciated.

1. What are the main sources of water for domestic consumption?

   (a) Rainwater ☐

   (b) River/stream ☐

   (c) Boreholes ☐

   (d) Dam ☐

   (e) Well ☐

2. How adequate is the supply?

   a) Adequate ☐

   b) Inadequate ☐

   c) Very adequate ☐

   d) Very inadequate ☐

3. When did you settle in this area? _____

4. What is the size of your farm? _____Acres

5. What are your sources of income?

   a) Livestock keeping

   b) Mixed farming

   c) Crop farming

   d) Others (specify) _____

   _____

   _____

   _____

6. If farming please list the crops grown.

i) _____

ii) _____

iii) _____

iv) _____

7. What is the yield per year in bags per ha for each crop mentioned?

i) _____

ii) _____

iii) _____

iv) _____

v) _____

8. Do elephants come to your land? Yes ☐ No ☐

9. If yes, what type of damage did the elephant cause?

a) Human injury/death ☐

b) Livestock injury/death ☐

c) Crop damage ☐

Any other damage (specify) _____

_____

_____

10. Please show an estimate amount of loss they caused.

(a) Crop damage

Crop damaged	**Estimated area in ha.**	**Estimated loss in bags**	**Estimated loss in Shillings (KShs.)**
a)			
b)			
c)			
d)			
e)			
f)			

(b) Number of people injured or killed by elephant._____

(c) Number of livestock killed or injured by elephants _____

11. State the last time an elephant was seen in this area. _____

12. Have elephants stopped coming to your farm? Yes ☐ No ☐

13. If yes what caused the problem to stop?_____

_____

14. How far is the natural forest from your farm? (in Km)_____

15. What seasons do elephants come to your land? _____

16. What time of the day? _____

17. What is the number of elephants that normally come to your land? _____

18. Where do the elephants come from? _____

19. Are elephants of any use to you as an individual? Yes ☐ No ☐ Not sure ☐

20. Please explain your answer_____

21. Are elephants of any use to other people? Yes ☐ No ☐ Not sure ☐

22. Please explain your answer _____

23. How would you feel if all elephants in the reserve and the forest adjacent were eliminated? Very sad ☐ Sad ☐ Happy ☐ Very happy ☐

24. Do you protect your farms from elephants? Yes ☐ No ☐

25. How do you do it? _____

26. Who does it?_____

---

27. How much time do you spend when protecting your farm when elephants come?_____

28. How effective is the method you used?

Very effective ☐

Effective ☐

Ineffective ☐

Very ineffective ☐

29. Do other wild animals come to your farm? Yes ☐ No ☐

30. Please list down the names of the animals.

i) _____

ii) _____

iii) _____

iv) _____

v) _____

31. What damage do they cause?

a) Crop damage ☐

b) Infrastructural damage ☐

c) Injury or death to livestock ☐

d) Injury or death to human beings ☐

e) Others. Specify_____

_____

_____

32. Please estimate the damage they cause.

Animal	**Type of damage**	**Estimated damage**		
		KShs.	**Bags**	**Number in case of animals or humans**
i.				
ii.				
iii.				
iv.				
v.				
vi.				
vii.				
viii.				

Please list them from the most damaging to the least.

APPENDIX II: QUESTIONNAIRE FOR KWS OFFICIALS

The questions in this questionnaire are for research purposes only. The information you provide will be treated with utmost confidentiality. Your assistance in answering the questions truthfully and accurately will be highly appreciated.

1. Are you aware of human-elephant conflict in Mbuvori sub-location?

2. When did the conflict start? ☐ <5 years ago ☐ 5-10 years ago ☐ >10 years ago.

3. Where do the elephants come from?

4. What is the number of elephant population in the region?

5. What seasons is the conflict intense?

6. What is the KWS policy on damage to livestock and livestock injuries or deaths, Crop and property?

7. Do people report damage to relevant authorities?

8. Under what circumstances do the rangers kill elephants?

9. Are KWS officials effective in managing the problem? Please explain.

10. What challenges does KWS face in management of the problem?

11. Is the conflict related to land use?

12. What do you think could be a permanent solution to the problem?

APPENDIX III: QUESTIONNAIRE FOR LOCAL LEADERS

The questions in this questionnaire are for research purposes only. The information you provide will be treated with utmost confidentiality. Your assistance in answering the questions truthfully and accurately will be highly appreciated.

1. Is Mt Kenya forest reserve of any importance to you? Yes ☐ No ☐

2. If yes please mention the importance.

3. Are you aware of any wildlife policy? Please explain.

4. Are you aware of any human-elephant conflicts in Mbuvori sub location?

5. What do elephants destroy when they come in the land?

6. What are the impacts of elephant's destruction on the welfare of the community?

7. What do farmers do when elephants come into the farms?

8. What are the underlying causes of the conflict?

9. How does KWS respond to damage caused by elephants to crops, property, livestock or humans?

10. Please suggest what could be done to solve the problem.

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