Jimma University

College of Natural Sciences

Department of Biology (Ecological and Systematic Zoology)

An Assessment of human-wildlife conflict with reference to Olive baboon (*Papio anubis*) in and around Chato forest, Western Ethiopia

By

Dagne Asefa

A thesis submitted to the Department of Biology, Collage of Natural Sciences, Jimma University, in partial fulfillment of the requirement for the degree of Master of Science in Biology (Ecological and systematic zoology)

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An Assessment of human-wildlife conflict with reference to Olive baboon (*Papio anubis*) in and around Chato forest, Oromia Regional State, Western Ethiopia.

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Approved by Examining Board

Name	**Signature**
Eba Alemayehu (MSc.)	
Chairman,Head Department	_____
Research Advisors	
Tariku Mekonnen Gutema (PhD candidate)	_____
Tsegaye Gadisa (PhD)	_____
External Examiner	
Habte Jabessa (PhD.)	_____
Internal Examiner	
Tadesse Habtamu (PhD.)	_____

DECLARATION

I hereby declare that this thesis entitled an assessment of human-wild life conflict with reference to Olive baboon in and around Chato forest, Western Ethiopia is my own work except wherever acknowledged, no part of this thesis has been submitted to any other university.

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Table of contents

Contents page

List of tables

Lists of figures

List of appendices

Acronyms

CSA	Central Statistical Authority
DA	Development Agents
EFAP	Ethiopia Forestry Action Plan
EMA	Ethiopia Mapping Agency
EMSA	Ethiopia Meteorological Services Agency
HH	House Hold
HWARDO	Horo Woreda Agricultural and Rural development office
NBSAP	National Biodiversity Strategy and Action Plan
NFPA	National Forest Priority Areas
SPSS	Statistical Package for Social Science

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Abstract

This study was conducted in and around Chato forest to assess human-wildlife conflict with emphasis on olive baboon. The main objectives of the study were to identify the agricultural crop losses caused by different large wild mammals and to determine the extent of livestock depredation by wild predators. As a source of human wild-life conflict Samples were collected from five selected sites in Chato forest area namely Hula Chulu, Burka Gemeda, Welda, Gaba Hamusi and Gerardo. The methods that used were face-to-face questionnaire interview of 250 randomly selected local residents and direct observation on the crop damage by wild animals. Total count method was used to estimate population abundance of olive baboon on the entire study area. Data was analyzed by using SPSS software analysis package. Student's t-test and chi-square test was used. The result collected through questionnaire survey indicated that crop losses per hectare ranged from 193Kg for potato to 328Kg for wheat. The four top crop raiders were olive baboon 247 (98.8%), grivet monkey 223 (89.2%), porcupine 148 (59.2%) and hare 89(35.6%).Regarding livestock predation, olive baboon 140(36.94%), leopard 65 (17.15%), common jackal 76(20.05%) and hyena 98 (25.86%) were the common predators.508 and 569 olive baboon populations were counted in dry and wet season in the study area respectively. There was no significant difference between number of olive baboon counted in dry and wet season (x^2>0.05). A total of 15 and 17 groups were counted in the wet and dry seasons, respectively. In this study the most serious crop raider's wild animals were olive baboon. As the Chato forest was surrounded by extensive farmlands, the area needs a close follow up and detailed studies to identify current human-wildlife conflict in the area to mitigate the problem. Based on the current study of human-wildlife guarding, chasing and trapping recommended as mitigation strategies.

Key words: *Chato, Forest, Olive baboon, Human- wildlife conflict*

1. Introduction

1.1 Back ground of the study

Human-wildlife conflict is a growing global problem, in where wildlife and human population coexist and share limited resources. Dense human population in close vicinity to nature reserve seems to pose the greatest challenge in many countries. Conflict becomes more intense where livestock holdings and agriculture are important parts of livelihoods. Competition between rural communities and wild animals over natural resources is more in developing countries where local human population tends to suffer highly (Ogada *et al*., 2003).

Human-wildlife conflict may affect human welfare, health and safety, and have economic costs (Hoar, 1992). The degree of conflicts between man and wildlife has increased in the last few decades with increasing human population, which resulted pressure on land under cultivation. As human population increase, encroachment into natural habitat also increases resulting in several forms of human-wildlife conflicts. Pastoralists and their livestock share habitat with predators, who routinely hunt domestic animals. Farmers find their fields invaded and crops raided by herbivore primates. The economic cost can be quite substantial from merely significant at the national or regional scale to outright disastrous scale at the level of affected households (Hill, 1997).

The relative impact of wildlife damages on farm production and household income varies greatly according to the extent of land owned and the economic dependence on rural activities. Indigenous people with low standard of living are particularly at risk, as their income exclusively depends on the land (Messmer, 2000).

In a 1987-1989 survey around several national parks and game reserves in Tanzania, primates such as pata's monkey (*Cercopithecus patas*), chimpanzee (*Pan froglodytes*) olive baboon (*Papio anubis*), yellow baboon (*Papio cynocephalus*), grivet monkey (*Cercopithecus aethiops*) and black and white colobus (*Colobus guereza*) were reported as problematic species. In addition, bush pigs (*Potamochoerus larvatus*), rodents, porcupines (*Hystrix cristata)*, elephants

(*Loxodonta africana*), bushbuck (*Tragelaphus scriptus*), duiker (*Cephalophus* spp.) striped ground squirrel (*Xerusery thropus*) were common crop raiders in Tanzania and western Uganda (Hill, 1997).

The olive baboon (*Papio anubis*), also called the anubis baboon, is a member of the family Cercopithecidae(Phillips-Conroy and Jolly, 1986). The species is the most widely ranging of all baboons. It is found in 25 countries throughout Africa, extending from Mali eastward to Ethiopia and Tanzania (Phillips-Conroy and Jolly, 1986).They are large primates with a greenish-grey coat covering their bodies. The individual hairs are green-grey with rings of black and yellowish-brown, giving the coat a multi-color appearance from up-close (Rowe, 1996; Groves, 2001).

Males and females are sexually dimorphic, with the males being about twice as large as females. The average height for captive and wild males is about 700 mm (2.30 ft) and females measure about 600 mm (1.97 ft) (Coelho, 1985; Eley *et al*., 1989). Wild male olive baboons weigh 24 kg on average and wild females weigh 14.7kg on average (Strum, 1991). Where they live close to agricultural production and can raid crops, supplementing their natural diets with fruits, vegetables, and grains grown by local people, the average weights are slightly higher. Crop-raiding males weigh around 27.4 kg) and females weigh 15.6 kg (strum, 1991). Captive olive baboons weigh more than their wild counterparts, with the weight of captive males averaging 29 kg and females averaging 17 kg (Coelho, 1985).

Olive baboons live in groups or "troops" as they are often called, ranging in size from 15 to 150 individuals (Rowel, 1966; Dunbar and Dunbar, 1974; Ray and Sapolsky, 1992). Within the troop, there are several adult males, numerous adult females and their offspring of various ages. Females almost always remain in their natal group for their entire lives whereas males disperse in order to mate (Smuts, 1985; Barton and Whiten, 1993; Barton *et al*., 1996). Females also interact with one or two male members of the group and form long-lasting, social relationships that have been characterized as friendships" (Smuts, 1985). These friendships between male and female baboons include frequent, relaxed grooming sessions, traveling and foraging together throughout the day, sleeping near each other at the sleeping site, defense from aggressive conspecifics, and support in caring for infants (Aldrich-Blake *et al*., 1971; Smuts, 1985).

1.2 statement of the problem

In many areas of their range where human populations are increasing, olive baboons raid agricultural crops for food and feed on garbage and human refuse (Forthman Quick, 1986; Eley *et al*., 1989; Naughton-Treves *et al*., 1998). Feeding close to human populations influences group behavior among olive baboons and may also influence social structure (Forthman Quick, 1986).

At Gilgil in Kenya, the conflict between farmers and baboons became so intense that by 1984, more than 130 baboons were trapped and translocated in an attempt to appease farmers and save the baboons from persecution (Strum, 1987). In Ethiopia, the existence of olive baboon was well known. The population appraisal indicates that there is crop damage and predation on livestock, causing economic losses to farmers around Chato forest (personal observation).

Nevertheless, in Ethiopia only few studies were carried out on human-wildlife conflict in some specific regions of the country (Tewodros Kumssa and Afework Bekele, 2008). There was no study carried out about human -wild life conflict around Chato forest, southwestern Ethiopia.

Thus, studies should be conducted to identify such types of human-wildlife conflict around Chato forest. The study also aimed at the determination of the abundance of olive baboons. Studies indicated that different sizes of olive baboon's population found in different part of Ethiopia. Therefore, this study was conducted in view of bridging this gap and come up with recommendations for future research and policy intervention to reduce human-wildlife conflict. So, during this study the following questions were considered for sake of guiding this study. These were:

1. What is the cause and effect of human-wildlife conflict in and around Chato forest?
2. What is the population status of olive baboon in and around Chato forest?
3. What are human-wild life conflict management strategies in the area?
4. What are the possible solutions regarding human-wild life conflict?

1.3. Objectives

1.3.1. General objective

- To assess human-wildlife conflicts within and around Chato forest.

1.3.2. Specific objectives

- To identify and estimate the agricultural crop losses caused by different large wild animals around Chato forest.
- To determine the extent of livestock depredation by wild predators around the study area.
- To estimate the population status of olive baboon around Chato forest.
- To identify human-wildlife conflict management strategies on olive baboon and others in the study area.

1.4 Significance of the study.

The present study was intended to assess human-wildlife conflict in and around Chato forest, Horo Guduru Wollega, western Ethiopia. Information obtained at the end of this research regarding the human-wild life conflict is important to evaluate the extent of losses and degree of severity in contributing the mitigation measure of the conflict. Therefore, the outcome of this research will provide input to plan for the lowering of human-wildlife conflict in the study area. The local community got awareness creation about wildlife use during the study and different countries experience how to manage human-wildlife conflict management. It is also source of information for the government to implement the policy.

2. Literature review

2.1. Human-wildlife conflict

Human-wildlife conflict is a serious threat for subsistence farmers in different countries of Asia (Madhusudan, 2003). In India, wild animals often destroy crops and prey on livestock, causing economic losses to farmers around protected areas. In spite of damage to crop and livestock, the local people in some countries still had a positive attitude towards the wildlife and protected areas because of cultural and religious purposes (Skehar, 1998). Crop raiding animals in India include wild boar (*Susscrofa*), nilgai (*Boselaphus tragocamelus*), Indian porcupine(*Histrix indica*), blackbuck (*Antelope cervicapra*) and Indian elephant. Losses of crops were serious in those villages inside or on the border of the reserve. Vulnerability of crop was high beginning from mid-harvest to harvest stage as wildlife attack is increasing during this time. Despite intensive guarding, fencing and other measures, which people practice to protect their crops, losses continued (Sekhar, 1998).

Human wildlife conflict is more intense in developing countries where livelihoods holding and agriculture is important parts of rural people's livelihoods and income (Boer and Baquete, 1998).Competition between local communities and wild animals, for the use of natural resource, is particularly intense and direct. As a result human and wildlife population is vulnerable (Messmer, 2000).

Human-wildlife conflict is particularly severe in reserve areas, where species that rely on extensive territories come into contact with human settlements. Therefore, boarder zones of protected areas may be considered as critical zones in which conflict is the major cause of mortality. Conflict is most acute in zones in which wide ranges of species coexist with high density of human population. Nature reserves that encompass densely populated human settlements seem to pose the greatest challenge (Woodroffe and Ginsberg, 1998). For example, in India, where 69% of the reserves support an estimated local population of more than three million people, who engage in agriculture, livestock grazing and extraction forest products, conflict was high (Madhusudan, 2003). The same is true in Kenya, where the largest park zone supports 250,000 people (Paterson *et al*., 2004).

Various factors contribute to the increase human-wildlife conflict. These can be grouped into human population growth, land use transformation, species habitat loss, habitat degradation and fragmentation, growing interest in ecotourism and increasing access to nature reserves, increasing livestock populations and competitive exclusion of wild herbivores, abundance and distribution of wild prey, increasing wildlife population as a result of conservation programs and climatic factors (Siex and Struhsuker, 1999).

Demographic and social changes place more people in direct contact with wildlife. As human population increases, demand for land, food production, energy and other raw materials become high. To satisfy these human needs the rate of transformation of forests, savannah and other ecosystems into agrarian or urban areas increases. In Africa, human population growth has led to encroachment into wildlife habitats, constriction of species into small areas and direct competition with local communities (Siex and Struhsaker, 1999).

Factors such as habitat loss, habitat degradation and fragmentation, which are directly related to human population growth and land use transformation play important role for the increase of human-wildlife conflicts. As wilderness is converted to agricultural uses, protected areas such as parks, reserves and hunting blocks, rapidly become “islands” in an area of farmland. This will result in interruption of a continuous population. In such cases the edge effect increases resulting in more Human-wildlife conflicts (Sillero-Zubiri and Swetzer, 2001).

Case studies have illustrated that, governments, wildlife managers, local communities, ecologists, and other scholars need to recognize the problem and adopt measures to resolve issues of human- wildlife conflicts in the interest of human and wildlife. The resolution seeks to balance the needs of human activities with the needs of wild animals and to the mutual enhancement of both. Sometimes, the solution to animal human conflict requires change of behavior or attitude (Limbu, 2003).

A wide range of solutions should be developed worldwide to address human-wildlife conflict. It is essential to understand that, although the solutions that should be used have similar goals, they are embedded in different ecological, social, cultural and economical realities. Therefore, the solution should take into consideration these realities. Local communities should be involved, which is one of the important requirements to conserve wildlife and to minimize human-wildlife

conflicts. Local opinions can influence conservation effort and conflict tolerance. Monitoring the concern of locals related to conservation around wildlife resources can provide a foundation for effective decision making that mitigates wildlife impact. Local people participation is now widely advocated in the development and conservation. The most sustainable approach should ensure the development of a local economy based on wildlife and revenue collection from nature reserves, as well as a reduction in the dependence of rural communities in agriculture which plays a major role in conflict resolution (Beresfored and Phillipins, 2000).

The different approaches to reduce conflict between local communities and wild herbivores across Africa are documented in different studies (Osborn, 1998; Hoar, 1992). The approaches can be divided into two groups, namely passive and active. Passive systems attempt to limit the movement of 'target species' into areas of agriculture. Barriers such as thorns, wooden or stone fences, trenches and electric fencing are among passive crop protective methods in many countries. Active systems are typically utilized in fields and some of these include 'drive them away', defense used by farmers (e.g. chasing animals by banging different objects like drums, or tin, shouting and throwing objects), and in some areas shots are fired into the air to scare animals. The most common solution is to kill the pest in order to deter other animals from returning and to compensate farmers with the meat obtained **(**Osborn and Parket, 2003).

The success of passive systems such as fencing depends on the material and design of fences and the behavior of the target species. Fencing is extremely expensive to install and maintain and thus inappropriate for large areas (Balakrishnan and Ndhlovu, 1992).

Animals such as elephants, eventually find a way to break the fence through time. Active system also has its own difficulty. For example, farmers do not regularly defend many of their fields during the night and even sometimes during the day. Therefore, what so ever farmers use various crop protection methods, there is always crop raiding in some extent. The extent of crop loss by wild herbivores is correlated with the effectiveness of the methods that farmers use and the strength of the farmer in their defense (Sekhar, 1998).

2. 1.1 Human - herbivore conflict

Wildlife damage varies considerably from site to site and farmers have unequal capacity for preventing losses. Farmers themselves are sometimes, the causes for crop loss because they continuously change the vegetation structure of the land closer to the protected areas. This changed vegetation probably becomes attractive to wild herbivores. Growing densities in livestock population can create an overlap of diets and forage competition with wild herbivores. This results in overgrazing and decline or local extinction in wild herbivore populations (Mishra *et al.*, 2003).

Crop raiding by wild herbivores has been claimed from all angles of the world. From grey kangaroos in Australia, to nilgai in India, mole-rats in Israel and white-lipped peccaries in Panama, wild animals are involving in crop raiding. There are extensive variations throughout the world in the type and pattern of damage to crops that animals cause (Warreny *et al.*, 2007).

The conflicts between human and wild herbivores are different types, such as livestock depredation and disease transmission, crop raiding is becoming one of the most common conflicts antagonizing human - wildlife relationships. Crop raiding by wildlife varies in different parts of the world (Silero-zubiri and Swetzer, 2001).

Conflicts between wildlife and local people are major concerns for wildlife management and rural development initiatives across Africa. Typically, the main conflict involves crop damage by wild herbivores, and thus solutions should set within a policy and legislative framework that attempt to address both wildlife management issues and rural development objectives. Many initiatives have been designed to address crop loss because this can undermine the success of other programs related to agriculture or wild land conservation (Tylor, 1982).

In Africa, conflicts between agriculturalists and wild herbivores have always existed. At the periphery of protected area, large wild animals wander in close proximity to human settlements. This poses serious problem in terms of crop damage. In such areas, the integration of conservation with other land uses has become difficult. However, the intensity of crop raiding around protected areas is different depending on factors such as human population density, distance of the farmland from protected area boundary and season of the year and the animal's behavior. Various animals are featured in varying degrees of crop raiding. Not all crop raiding

animals come from protected areas only; some are resident outside protected areas. They live in suitable habitats in different gardens within the community. Crop damage by wild males may vary from season to season as the type of farming during wet seasons and dry seasons. The behavior of the animal is also another factor, which has an influence on the extent of crop raiding. Information from wildlife managers and field observations in Zimbabwe have suggested that crop raiding may be learned by young elephants from older bulls. The bulls show younger males how and where to raid (Kagoro-Rugnda, 2004).

Mammals and birds are potentially destructive of food crops and that farming households may have to invest considerable time and energy in protecting their crops from depredation by these animals (Newmark *et al*., 1993). It is generally accepted that, in parts of West and East Africa, and Asia, elephants are reported to cause considerable amount of crops of both subsistence farmers and commercial grower (Blair *et al*., 1979). Yet, very little is known worldwide about the amounts and value of damage that rodents inflict annually on crops, particularly in Africa. Rodents can contribute significantly to crop losses of subsistence farmers throughout Africa (Nandua, 1973).

Studies of human-wildlife conflicts around Lake Mburo National Park in Uganda, smallholder farmers were at risk of wildlife crop damage. In addition to crop damage, sometimes human lives are affected in the process of guarding their crops each year (Naughton-Treves, 1996). In this study area, a variety of crops being grown by subsistence farmers were destroyed at different extents. In some cases, the extent of damage reaches about 85% baboons and pigs were by far the most common species, with grivet monkeys, birds and bushbuck also being cited as frequent visitors to farmers (Kagoro-Rugunda, 2004).

Human-wildlife conflict was serious in Tanzania as 22 % of its land is almost allocated to protected areas and wildlife conservation included 12 national parks, 13 game reserves and 38 game controlled areas (Sillero-Zubiri and Swetzer, 2001). In a 1987-1989 survey around several national parks and game reserves in Tanzania, primates such as pata's monkey (*Cercopithecus patas*), chimpanzee (*Pan froglodytes*) olive baboon (*Papio anubis*), yellow baboon (*Papio cynocephalus*), grivet monkey (*Cercopithecus aethiops*) and black and white colobus (*Colobus guereza*) were reported as problematic species. In addition, bush pigs, rodents, porcupines,

elephants, bushbuck (*Tragelaphus scriptus*), duiker (*Cephalophus* spp.) and striped ground squirrel (*Xerusery thropus*) were common crop raiders in Tanzania and Western Uganda (Hill, 1997).

Around protected areas in Kenya, conflict between local people and wildlife is increasing. In this country, human-wildlife conflicts not only affect rural and vulnerable communities, but also commercial cattle ranches (Patterson *et al*., 2004). Around Aboseli area, buffalo (*Synceruscaffer*), Zebra (*Equus burchelli*), Hippopotamus (*Hippopotamus amphibious*) and elephant (*Loxodonta africana*) were among the most cited crop raiders. Of these mammals, elephant was mentioned as the most frequent crop raider, mostly during the dry season (Okello, 2005).

Almost all countries in Africa including Ethiopia reported problems with herbivores crop raiding (Yirmed Demeke, 1997). Subsistence agriculture is the sector more exposed to damage than other crop pests. According to Kimega (2003), food items such as maize, cassava, beans, potatoes, and fruit trees are the target for the hungry such as, baboons, zebra, buffalo and wild pigs. Among those common agricultural pests (primates, rodents, birds or insects), the damage caused is often far greater (Hoare, 2000). Generally, it is difficult to alleviate the conflict between herbivores and human. But it is possible to minimize it using different conservation measures.

2. 1.2 Human-carnivore conflict

The human-carnivore conflict was serious in the areas around Waza National Park, in Cameroon, as there are different predators such as lion, hyena (*Crocuta crocuta)* and common jackal (*Canis aureus*) (Tchamba and Elkan, 1996). In this area, lions attack species of domestic animals on the pastures during the day time. Hyenas attack small stock in or near the settlements at night time. They enter the enclosures and even houses, but are easily chased away. Hyenas' had never been much feared, and since the introduction of the hand torchlight, the problem is entirely solved. They are easily chased off with light. Jackals and other small predators in this study area were reported to be very opportunistic and only attack small domestic animals. Most of predation occurred often during the rainy season. Staking is made easier, when camouflaged by the noise of the rain, or when walking in the tall grass (Bauer, 1999).

Across the globe, the frequency and extent of economic cost of conflict between human and carnivores is increasing due to the expansion and growth of human populations (Karanth *et al*., 1999). Besides, their large space requirements and position at the top of the food chain results in conflict with expanding human populations and domestic livestock (Myers and Bazery, 2005). Under a variety of demographic, economic and social pressures, human alteration of carnivore habitat or expansion of carnivores has led to escalated conflicts (Naughton-Treves, 2003). Humans can also allow the recovery of carnivores. For example, changing land use practices exemplified by the regrowth of forests in many regions of the United States are providing room for potential recolonization by previously extirpated carnivores (Mladenoff *et al*., 1997).

The cases briefly described here are sorted by geographical regions to explain specific issues, dimension, or aspect of human-carnivores conflict. In Zambia, many area of traditional agro-pastoralism bordering protected areas suffer from livestock depredation. Especially near Sengwa Wildlife Reserve, villagers experience negative impact from wild carnivores, which attack domestic livestock. It was reported that between January 1993 and June 1996, in a study area of 33 km^2 241 livestock were killed by baboons, lions and leopard which contributed for 52%,34% and 12 % of the kills, respectively. Their predation techniques are different. Baboons attack by day and usually kill small-stock such as goat and sheep, while lions and leopards attack at night, with lions killing large prey such as cattle and donkeys. The average annual loss per household is equivalent to 12 % of the total income (Butler, 2000).

Survey conducted in India around Bhadra Tiger Reserve, revealed that carnivore - human conflicts were still high. In the study area, between April 1996 and March 1999, the sampled households attributed a loss of 219 livestock to large carnivore predation. Villagers claimed that nearly all kills were attributed to tigers and leopards. Of the 219 kills, 216 were cattle and 3 were goats (Madhusudan, 2003).

Around Kibber wildlife sanctuary, in India, conflict among agro-pastoralists and wildlife is increasing in relation to the growing livestock population. In 1995, wild carnivores killed 18 % of the total livestock holding with an annual loss of 12 % for families with a livestock holding. Almost all the deaths were caused by the snow leopard. However, the local people took revenge

action on wolves (*Canis lupus*) incorrectly whose pups were reported to have been captured and killed almost every year in the 1980s (Mishra, 1997).

In Israel, around Golan grassland plateau, farmers claimed to losses of an average of 1.5-1.9% of the calves born each year to golden jackal (*Canis aureus*) predation. The economic value of the total cattle losses in 1995 was estimated to be about US $ 42,000 in this area (Yom-Tom, 1995).

In Latin America, the problem of depredation of domestic animals, especially cattle, was caused by the two large American cats namely the Jaguar (*Panther aonca*) and the Puma (*Felis concolor*) (Nowell and Jackson, 1996). Jaguars prey on large sized animals such as horses, donkeys and cattle while the smaller sized puma preys on younger or smaller animals. Predation of domestic animals by the wolf (*Canis lupus*) was a problem in some parts of Italy, where the rural economy was characterized by small scale-farming and cattle, sheep, goats and horses were the main stock rearing activities. Wolves caused most of the killing (94 %). Notably the majority of the attack took place when the livestock were grazing in proximity with shrub or woodland cover (Cozza *et al*., 1996).

2. 1. 3. Habitat and feeding habit of olive baboon

Olive baboons live in a variety of habitats across their broad range. Baboons are generally characterized as savanna species, inhabiting open grassland near wooded areas (Rowell, 1966). They are also found in moist, evergreen forests and near areas of human habitation and cultivation (Naughton-Treves *et al*., 1998).

Olive baboons are ecologically flexible in that they consume a wide variety of foods and can live in a variety of habitats, but nonetheless they are selective about their diet choice and habitat usage (Whiten *et al*., 1991; Barton *et al*., 1992).

Olive baboons can be found in habitats ranging from desert to mountain forest. One reason they are able to adapt to these varying habitats could be their flexibility in foraging strategies and ability to extract food and nutrients from almost all strata of the environment (Whiten *et al*., 1991). They find food on the ground, in the trees, and underground. On the ground, they forage in the grass or in thickets of savanna woodland, they forage in trees and find food at higher levels of the canopy, and finally, they dig up subterranean foods (Whiten *et al*., 1991). Baboons are omnivores and consume a huge variety of items including roots, tubers,corms, fruits, leaves, flowers, buds, seeds, bark, exudates, cacti, grasses, insects, birds, bird eggs, and vertebrates (including other primates) up to the size of a small antelope (Rowell,1966; Dunbar & Dunbar, 1974; Harding,1976; Whiten *et al*., 1991; Hassan, 2001).

Rainfall is directly correlated with food availability in many habitats. In savanna areas, the food availability is highest near the end of the rainy season and gradually decreases in abundance as the dry season continues. During the rainy season, fruit, young leaves, and flowers are abundant and important foods for olive baboons. As the dry season progresses, these foods become scarce and baboons must switch to other resources (Barton *et al*., 1992). One way that olive baboons deal with the scarcity of food is to utilize subterranean food sources such as roots, tubers, and corms (Barton and Whiten, 1993). Olive baboons are good diggers and use their hands to unearth the roots of plants (Nagel, 1973). Seeds are also an important food resource during the dryer times of the year (Barton *et al*., 1992).

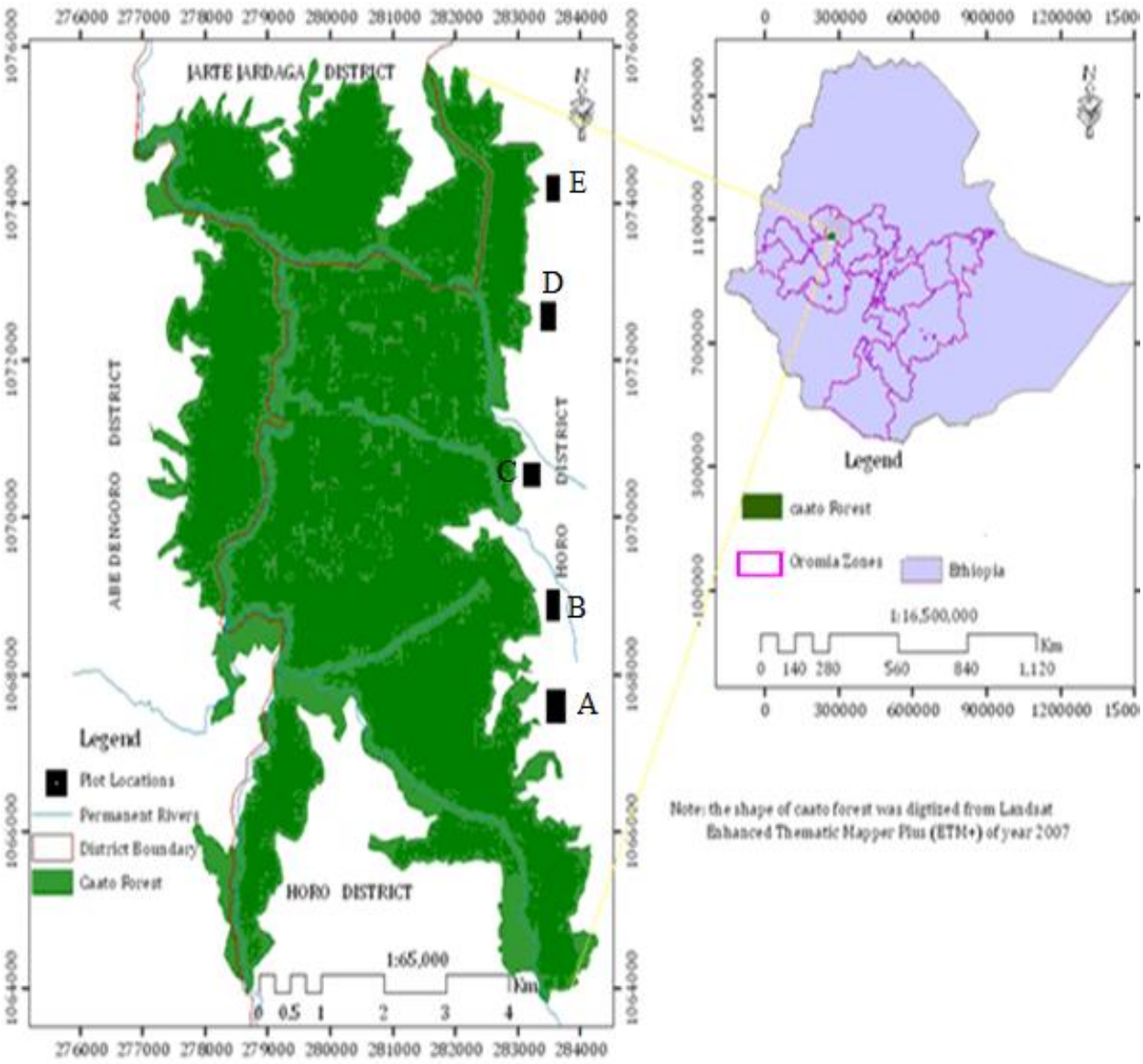
As seasonal rainfall influences food availability, it in turn affects home range size and daily ranging patterns (Nagel, 1973; Harding, 1976; Ransom, 1981; Barton *et al*., 1992). Daily activity patterns are also variable, depending on the season and climatic conditions. Departure from the sleeping site, the time spent traveling, the maximum distance traveled from the sleeping site, the number and length of resting and feeding periods, and the distance covered per day are all variable from one day to the next and from one group of baboons to the next (Nagel, 1973). The general pattern observed is a period of socializing after waking, moving from the sleeping site and feeding, resting, and then alternating feeding and resting until late afternoon at which time the group travels back to the sleeping site. Most social activities occur during the periods of rest throughout the day (Strum, 1987).

The home ranges of several groups of baboons often overlap, and when groups come into contact with one another, the larger group displaces the smaller group or the two groups largely ignore each other (Aldrich-Blake *et al*., 1971; Smuts, 1985). Olive baboons seek sleeping refuges in trees or on rocky cliffs, depending on availability (Aldrich-Blake *et al*., 1971; Nagel, 1973; Harding, 1976; Hamilton, 1982). Open cliffs, free of extensive woody vegetation and with near-vertical slopes are preferred as nighttime sleeping spots (Hamilton, 1982). When cliffs are not available, olive baboons prefer emerging trees, those that protrude from the surrounding canopy, to any other tree sleeping site such as closed canopy, where trees are close enough to each other that baboons can transverse the canopy without coming to the ground, or open woodland, where trees are separated to the degree that baboons must come to the ground to get into a neighboring tree (Hamilton, 1982). One reason they are selective about sleeping sites is to increase protection from predators. Some of the known predators of baboons include large cats, which have a difficult time scaling rocky walls because they cannot find holdings for their paws as well as baboons can for their hands and feet, explaining why cliffs and rocky ledges are preferred to trees when both are available (Hamilton, 1982).

3. Materials and methods

3.1. Description of the study area

The study was conducted in and around Chato Natural forest which is located in the Horo Guduru Wollega Zone of Oromia National Regional State, Western Ethiopia. About 314 km west of Addis Ababa and lies in Horo district 30 km north-west from the zonal town Shambu. This forest is part of National Forest Priority Areas (NFPAs) and has been known by the name Chato-Sangi-Dangab forest in the country (EFAP, 1994). (Fig. 1).This forest is located along altitudinal ranges between 1700 m and 2350 m a.s.l and covers an area of about 42,000 hectares, of these 18, 000 ha is the natural forest (HWARDO, 2013).



A=Hula Chulu, B=Burka Gemeda, C=Welda, D=Geba Hamusi
E=Gerado

Figure 1: Map of the study area (Chato Natural Forest).

Source: EMA 1988.

3.1.1 Topography

The forest is generally characterized by rough topography with undulating plain, hills, slopes and dissected plateaus. Several perennial rivers such as Yamalagi River, Badessa River, Chiracho River, Jaba River and Gabar River are flowing into Garchi River by crossing the forest, all of which emerge from the highlands. It is bounded in the north by Jaba River in the west by Garchi River, in the southeast by Bafo-Gabar River and in the east direction by plantation (Horo district). Because of topographic nature; the forest area is not easily accessible as it is surrounded by steep hill slope and escarpments. It is relatively less disturbed by human actions (HWARDO, 2013).

3.1.2 Climate

3.1.2.1 Temperature and rainfall

A 15 years rainfall and temperature data obtained from Shambu meteorological station from 1999- 20013 was used to describe the climate of the study area. According to 15 years data, the mean annual rainfall in the study area is about 1566 mm, rainfall peak period between May to October, and decreasing in November and December with little or no rainfall in January and February. The average annual temperature is 16.6^0C. The mean minimum and maximum temperature is 10.78^0C and 22.32^0C respectively. There is little temperature variation throughout the year. Horo district has three agro-climatic zones which correspond to the traditional classification systems: 43% Dega (2500-3500 m) 55.56% Woina Dega (1500 -2500 m), and 1.24% Kola (500-1500 m) (EFAP, 1994; HWARDO, 2013).

3.1.3 Soil

According to (HWARDO, 2013) the type of soil in the district is sandy-loam type. However, as visually observed the soils of the forest area are darker-reddish in color with concentrated humus as there is no strong eroding forces along vegetation cover.

3.1.4 Population and land use

The total population of Horo district was 83,194 of which 6824 were urban dwellers. The society engaged in, mixed cultivation of livestock rearing and crop production (HWARDO, 2013).Based on the data obtained from the (HWARDO, 2013), the land cover categories of the district include about 45% that account for potential arable land including land under crops and land reserved 12.29% goes to pasture land/grazing land, 11.05% accounted for forest land, 2% for swampy land and 29% for other purposes. Major crops grown in this district are cereal crops, pulses and oil crops.

3.1.5 Vegetation

The main species of plants found in this forest include broad-leaved and evergreen with important tree species such as *Poutera adolfi-friederici, Mimusops kummel, Millettia ferruginea, Teclea nobilis, Podocarpous falcatus, Celtis africana, Croton macrostachyus, Dracaena steudneri, Allophylus abyssinicum, Albiza gummifera, Prunus africana,Polyscias fulva, Cordia africana, Warburgia ugandensis, Diospyros abyssinica, Macranga capensi, Nuxia congesta, Ekebrergia capensis, Ficus* spp., *Syzygium guineense s*subsp. *afromontaum, Olea capensis subsp macrocarpa* and *Pittosporum viridiflorum* (HWARDO, 2013).

3.1.6 Wildlife

Chato Natural forest contains a variety of wildlife including mammals, birds and reptiles. Some of the common wild life include olive baboon(*Papio anubis*),grivet monkey (*Chlorocebus aethiops*),porcupine*(Hystrix cristata*),hyaena(*Crocuta crocuta*),leopard(*Panthera pardus*), colabus monkey(*Colobus guereza*), common bushbuck(*Tragelapus scrpitus*)and hare(*Lepus habyssinicus*). Thus, this forest is rich in fauna diversity (HWARDO, 2013).

3.2 Materials

Materials used for this study were digital photographic camera, meter, and geographic position system (GPS).

3.3 Sampling techniques and sample size determination.

The study was conducted in Horo district around Chato forest. The study district was selected purposively hence the area represents one of the highest case scenarios in Human-wildlife conflict. Five study sites namely Hula Chulu, Burka Gemeda, Welda,Gaba Hamusi and Gerado were selected purposively for this study which are more adjacent to the forest and has a total of 720 households(HWARDO, 2013). Using simple random sampling methods 250 households were selected for this study. By keeping the uniformity of population from the selected site about 55 households from Hula Chulu, 38 households from Burka Gemeda,60 households from Welda, 65 households from Gaba Hamusi and 32 households from Gerado site were taken. Sample size is calculated by using (Cochran, 1977) formula.

$$n = \frac{n_0}{1 + \frac{n_0}{N}} \text{ Where } \quad n_0 = \frac{Z^2_{\alpha/2} p(1-p)}{d^2}$$

n=Total sample size

$n_{o=}$Population size

d= margin of error

N=Total number of population

P = Proportion ofpopulationα = level of significance

Z = standard normal deviation (1.96 for 95% confidence level)

d= 0.05, p = 0.5 AND α= 0.0

$$n_0 = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = 384$$

Considering the population correction factor into account the sample size was:

$$n = \frac{384}{1+\frac{384}{720}} \approx 250$$

3.3.1. Data collection methods

Data was collected from August, 2013- March, 2014. A total of four field trips (two sessions during wet season and two sessions during the dry season) were conducted. The wet season study was from August to October, 2013 and the dry season study was from January, 2013 to March, 2014.

3.3. 2. Estimation of crop damage by wildlife

For the purpose of estimation of crop damage by wildlife, five study sites namely Hula Chulu, Burka Gemeda, Welda,Gaba Hamusi and Gerado were selected purposively. For each site, five corresponding cultivated land covering an area of 4ha was selected purposively. In turn, each of the five cultivated lands was divided into five grids each of which has 0.8ha. In cultivated land taken for direct observation wheat, barley, bean, maize and potato were sown in the production season 2013/2014 but potato crop was not sown in Hula chulu, Burka Gameda and Gerado site(Appendix IV). For all sites, a total of ten days (8 hours each) direct observation was conducted in each study site in each trip. Researcher, two DA , two forest guards and 10 farmers who is the owner of the farm were participated during the time of direct observation, accordingly supervision of the direct observation by researcher, DA and forest guards were under taken every three and four days respectively to ensure the correct observation of the farmer .Damage caused by large mammals on each crop land was recorded in meter square directly to estimate the average losses (Appendix II) and to get the amount of crop obtained per hectare, Woreda agriculture data were used. Independent assessment of the crop damage by the research team formed is the main direct method of data collection, but still the farmers were asked to provide their own crop loss estimates using questionnaires (Kivai, 2010).Some animals do not damage crops during the day time. Therefore, it requires using marks left by them such as dung, feeding, foot prints, diggings and other physical remains like spines (Stuart and Stuart, 1994).

3. 3. 3. Population estimate of olive baboons

To determine population of Olive Baboon preliminary survey supported by farmers' well-know Olive Baboons' habitat and their place of overnight was undertaken and identified. For this purpose five sample sites were purposively taken from forest around the farmland .The sample sites were selected by moving 1000m starting from the boundary to inside of the forest. Five site having

3ha from each site were used for present study. Counting of population was carried out by moving on foot throughout the five selected sample sites in the study area. For this purpose, the researcher and ten data collectors participated in the counting process. Counting of olive baboon population was under taken three times in all selected sample site and under taken at uniform time to minimize biasness of double counting in each of the wet and dry seasons. Finally the average of the three times count was used for the study. Unless the olive baboons are not disturbed by people, they keep on foraging throughout the day. Their population was categorized into four age groups namely adult male, adult female, sub adult male, sub adult female, young and infant (Appendix III). Body size was used in age and sex determination. Male with visible manes and overall size about twice that of adult females were considered as adult males. Males similar in size with adult females with the emerging of the manes were considered as sub-adult males. Sub-adult and adult females were identified by their body size. All other individuals were considered as young and infant based on their body size (Burham *et al*, 1980).

3.3.4. Questionnaire survey

Formal interview was designed and conducted to determine the extent of the general loss of crops and livestock due to human-wildlife conflict around the study area via open and close ended questions (Appendix I).

3.3.5 Data analysis

Data were analyzed using SPSS software. Descriptive statistic in a form of percentage, frequency and mean were used to analysis socioeconomic profile of the respondent ,farmland size, crops grown in the study area, wild animals and their damage on crops in the study area, production and loss of crops, prevention strategies of crops from wild animals' damage and wild animals that prey the domestic animals. Association of olive baboon population between season, among sample site and each age structure were analyzed using chi-square. T-test was used to analysis the difference between expected yield and actual yield crops

4. Results and discussion

This section deals with the results and discussion of the data collected through observation, questionnaires and interview consisting two parts. The first part is emphasizes on the results and discussion of the main data. The second part concerned with the description of the background of the respondents

4.1 Crops loss estimated on the basis of direct observation

During present study in five samples site taken for direct observation totally cultivated or cropped area for all crops namely wheat, barley, maize, bean, and potato was 200,000m^2 from this about, 115,229m^2 of wheat which was 57.6%, 33,933m^2 of barley which was 16.97%, 22,030m^2 of maize which was 11.02%; 20,778m^2 of bean which was 10.39%; and 8,030m^2 of potato which was 4.02%, were cultivated. Wheat was the predominant cultivated crop in all sites in terms of its coverage of the farmland followed by barley, maize, bean and potato respectively whereas potato covered the smallest portion of the cultivated farmland from all crops (Appendix IV).

4.1.1 Crop land damage and estimated size damaged

The result of direct observation showed that the existence of the damage by different wild animals on different crops in all sites. The total damage caused by all wild animals on the crops was 16,418m^2in all sites. This shows that wild animals brought a great damage crops identified in the study area.

Olive baboon damaged crops such as wheat, barley, bean, potato and maize. Olive baboon damaged 4,210m^2 of wheat; 1,123m^2 of barley, 780m^2 of bean, 660m^2 of maize and 70m^2 of potato respectively (Table 1). The total estimated size damaged by olive baboon on the crops was 6,843m^2 in all sites. A number of the large groups of olive baboon directly observed around the farm land and hence it moves in group it damages the crop land than the other wild animals. Olive baboon eats almost all parts of the cereal crops (Appendix V). Likewise, Baboons are omnivores and consume a huge variety of items including roots, tubers, corms, fruits, leaves,

flowers, buds, seeds, bark, exudates, cacti, grasses, insects, birds, bird eggs, and vertebrates (including other primates) up to the size of a small antelope (Rowell, 1966; Dunbar and Dunbar, 1974; Harding, 1976; Whiten *et al*., 1991; Hassan, 2001). This indicates that olive baboon was the dominant crop damaging wild animal in the present study area.

Grivet monkey damaged crops such as wheat, barley, bean, potato and maize. As the result of direct estimation reveals it damaged 2,830m^2 of wheat; 777m^2 of barley, , 570m^2 of bean, 405m^2 of maize and 45m^2 of the potato respectively. The total estimated size damaged by grivet monkey on the crops was 4,620m^2 in all sites. The result indicates that grivet monkey was the second dominant crop raider in the study area (Table 1). Likewise, Study conducted in sub-saharan Africa also revealed that local people were affected by crop raiding wild herbivores. Around Lake Mburo national park in Uganda, smallholder farmers were at risk of wildlife crop damage (Naughton-treves, 1996). In this study area, a variety of crops being grown by subsistence farmers were destroyed at different extents (Kagoro-rugunda, 2004).

As the result shows, Hare damaged crops such as wheat, barley and maize. Hare damaged 950m^2 of wheat whereas it damaged 380m^2 of barley and 88m^2 of maize. The total damage caused by hare on the crops was 1,426m^2 in all sites. Therefore, the result confirms that hare also caused damage to crops even though the size and parts of its damage on each crops were not serious as that of olive baboon and grivet monkey.

Porcupine caused damaged on crops such as potato, maize and bean. This result indicates that porcupine damaged 660m^2 of potato, 430m^2 of bean and 235m^2 of maize respectively. As the result shows, the total damage caused by porcupine on the stated crops was 13,25m^2 in all sites. Porcupine causes more serious damage on potato than the other crop during present study (Table 1).

Bush duiker damaged about 870m^2 of wheat, 231m^2 of barley and 123m^2 of maize on the cultivated land correspondingly. The total damage caused by Bush duiker on the crops was 1,224m^2 in all sites. Common bushbuck damaged about 675m^2 of wheat, 210m^2 of barley and 95m^2 of maize respectively on the cultivated land. The total estimated size damaged by Common bushbuck on the crops was 980m^2 in all sites. Likewise, a study conducted around several

national parks and game reserves shows that bush buck and bush duiker were common crop raiders in Tanzania and Western Uganda (Hill, 1997)

Table 1: Direct observation of the crops damaged, and the total estimated size damaged in all sites (m^2) by wild animals.

Wild animals	Crop type and area damaged in m^2					Total
	Wheat	Barely	Bean	Maize	Potato	
Olive baboon	4210	1123	780	660	70	6843
Grivet monkey	2830	770	570	405	45	4620
Hare	950	388	0	88	0	1426
Porcupine	0	0	430	235	660	1325
Bush duiker	870	231	0	123	0	1224
Common bushbuck	675	210	0	95	0	980
Grand total	9535	2722	1780	1606	775	16,418

4.1.2. The estimated amount of loss due to crop raiders.

During present study crop raiders cause considerable amount of yield loss in all selected sample site (Table 2). The result of direct observation showed that the existence of the damage by different wild animals on different crops in all sites.

Olive baboon damaged crops such as wheat, barley, bean, potato and maize. This result indicates damaged caused by olive baboon on all crops was 3.42% (1199.6kg) in all sites. Olive baboon damaged 3.65% (779.9kg) of wheat; 3.31 %(190.9kg) of barley, 3.75 %(109.2kg) of bean, 3 %(105.6kg) of maize and 0.87 %(14kg) of potato respectively (Table 2). A number of the large groups of olive baboon directly observed around the farm land and hence it moves in group it damages the crop land than the other wild animals. Olive baboon eats almost all parts of the cereal crops (Appendix V). Therefore, this reveals that olive baboon was the dominant crop damaging wild animal. The result was agree with report of (Hill, 1997), a study conducted around several national parks and game reserves that primates such as olive baboon, grivet

monkey and black and white colobus were reported as problematic species of crop raiders in Tanzania.

Grivet monkey damaged crops such as wheat, barley, bean, potato and maize. This result reveals grivet monkey damaged 2.46%(539.2 kg) of wheat; 2.27%(130.9 kg) of barley,2.75%(79.8kg) of bean, 1.84%(64.8 kg) of maize and 0.56%(9 kg) of the potato respectively. The total estimated size damaged by grivet monkey on the crops was 2.31 %(823.7) kg in all sites. The result indicates that grivet monkey was the second dominant crop damaging wild animal (Table 2).

As the result shows, hare damaged crops such as wheat, barley and maize. Hare damaged 0.82 %(180.5kg) of wheat, whereas it damaged 1.14 %(65.9kg) of barley and 0.4 %(14.1kg) of maize. The total damage caused by hare on the crops was 0.71 %(260.5 kg) in all sites. This reveals that hare was the third most dominant crop damaging wild animal.

Porcupine caused damaged on crops such as potato, bean and maize. As the result indicates porcupine damaged 8.23 %(132kg) of potato, 2.07% (60.2kg) of bean and1.07 %(37.6kg) of maize sample sites respectively. The total damage caused by porcupine on the stated crops was 0.66 %(244.2) kg in all sites (Table 2).

Bush duiker damaged about 0.76 %(165.3kg) of wheat, 0.68 %(39.3kg) of barley and 0.56 %(19.7kg) of maize on the cultivated land correspondingly. The total damage caused by Bush duiker on the crops was 0.61% (224.3kg) in all sites. Common bushbuck damaged about 0.59 %(128.2kg) of wheat, 0.62% (35.7 kg) of barley and 0.43 %(15.2kg) of maize respectively on the cultivated land. The total estimated size damaged by Common bushbuck on the crops was 0.5% (179.1 kg) in all sites (Table 2).

The total damage caused by all wild animals on the crops was 8.21 %(2917kg) in all sample sites. This result showed that amount of yield loss on the cultivated land correspondingly 8.21% per ha .This shows that wild animals brought a great damage crops identified in the study area. The result was disagree with report of (Sekhar, 1998), a survey conducted in India showed that

wild animals were responsible for the loss of 19% of the yield expected from one hectare farmland and whereas a loss of 32% per ha was recorded in Nepal (Limbu, 2003).

Table 2: Amount of crop lost to crop raiders on the base of direct observation in kg

Wild animals	Crop type and yield lost in kg					Total
	Wheat	Barely	Bean	Maize	Potato	
Olive baboon	779.9	190.9	109.2	105.6	14	1199.6
Grivet monkey	539.2	130.9	79.8	64.8	9	823.7
Hare	180.5	65.9	0	14.1	0	260.5
Porcupine	0	0	60.2	37.6	132	229.8
Bush duiker	165.3	39.3	0	19.7	0	224.3
Common bushbuck	128.2	35.7	0	15.2	0	179.1
Grand total	1793.1	462.7	249.2	257	155	2917

4.2 Prevention strategies of crops from wild animals' damage

Different prevention strategies of the crops from crop raiding wild animals' were used by respondent in present study (Table 3).

Table 3: Prevention strategies of crops from wild animals' damage

Wild animals	**Strategies of preventing the damage of crops by wild animals**											
	Guarding		Fencing		Trapping		Scenting		Chasing		Others	
	F	%	F	%	F	%	F	%	F	%	F	%
Olive baboon	240	96	0	0	178	71.3	43	17.2	250	100	87	34.8
Grivet monkey	212	84.8	0	0	159	63.35	31	12.4	247	98.8	58	23.2
Bush duiker	0	0	215	86	198	79.2	87	34.8	0	0	50	20
C. Bushbuck	0	0	237	94.8	201	80.4	73	29.2	0	0	69	27.6
Guereza	18	7.2	0	0	50	20	0	0	42	16.8	0	0
Hare	0	0	57	22.8	32	12.8	42	16.8	21	8.4	0	0
Porcupine	139	55.6	10	4	176	70.4	160	64	169	67.6	0	0

F=frequency

Of all respondent about 96% and 84.8% of them replied that they were using guarding as a prevention strategy of crops from olive baboon and grivet monkey respectively. Whereas, about 71.3% and 63.35% of them reported that they used trapping was the best prevention strategy of their crops from olive baboon and grivet monkey respectively. Whereas, 17.2% and 12.4% of the respondents replied as they used scent; 100% and 98.8% of them replied as they used chasing; and 34.8% and 23.2% of them also replied as they were using other prevention strategies of their crops from the damage of olive baboon and grivet monkey respectively. Those respondents that replied 'others' said that killing of the animals and hanging their dead on the tree; preparing a picture of a man from woods, plastics and clothes as well as perfuming it and putting on the direction of the coming of the wild animals; catching one of them, clothing, perfuming and releasing that wild animal to the large group so that the larger group of the wild animals run away from the cultivated crop; yelling and throwing stones; and providing alcoholic foods and drinks so that after it ate and drunk, farmers chase and catch in order to kill them. From this, it can be understood that chasing was the most common and widely used prevention strategy of

crops from the damage of olive baboon and grivet monkey followed by guarding and trapping. Scenting was the least prevention strategy of their crops from olive baboon and grivet monkey. Similarly, the data obtained through the interview reveals that farmers were using all preventive mechanisms discussed except fencing for both olive baboon and grivet monkey (Table 3).

As olive baboon was the most serious damage causing wild animal, farmers were looking for several options as prevention strategies. For instance, cutting of trees on which olive baboon spends at the night; deforesting the dense part of the forest and clearing the surrounding of their crops; and constructing hats for a number of trapping mechanisms were some of the prevention strategies. This indicates that olive baboon was the most crop damaging wild animal that farmers are suffering with. This result was go with the finding of Sillero-Zubiri and Switzer (2001) in Africa, Eniang *et al.* (2011) in Nigeria; Kate (2012) in Uganda and Gandiwa *et al. (*2012) in Zimbabwe who found that guarding and chasing away of animals was ranked first and second in protecting crop raiders from crops.

In preventing their crops from the damage, 86% and 94.8% of the respondents were using fencing for bush duiker and common bushbuck respectively. Additionally, 79.2% and 80.4% of them were using trapping, and 34.8% and 29.2% of them were using scent as a prevention strategy of their crops from the damage of bush duiker and common bushbuck respectively. The rest of the respondents, 20% and 27.6%, replied that they were using other prevention strategies of their crops from bush duiker and common bushbuck respectively. To them, the other strategies of prevention were yelling, throwing stones, and fecal droppings of sheep and goat over the cultivated crop. This shows that fencing was the main prevention strategy of crops from both bush duiker and common bushbuck followed by trapping. Scenting was the third prevention strategy for the crops from both bush duiker and common bushbuck. The data obtained through the interview confirms that in preventing their crops from bush duiker and common bushbuck, farmers were using fencing as their dominant prevention strategy.

About 20%, 7.2%, and 16.8% of the respondents replied that they were using trapping, guarding, and chasing as a prevention strategy of their crops from the damage caused by guereza

respectively. This result indicates that trapping was the main prevention strategy of their crops from guereza followed by chasing and guarding.

Of all respondent about 22.8% and 16.8% of the them replied that they were using fencing and scent respectively in preventing their crops from hare whereas 12.8% and 8.4% of them reported that they were using trapping and chasing respectively as prevention strategies of their crops from hare. This result indicates that fencing was the main prevention strategy of crops from hare followed by scenting and trapping even though they were not highly used by farmers. Likewise, different approaches to reduce conflict between local communities and wild herbivores across Africa are documented in different studies (Osborn, 1998; Hoar, 1992). Active systems are typically utilized in fields and some of these include 'drive them away', defense used by farmers (e.g. chasing animals by banging different objects like drums, or tin, shouting and throwing objects), and in some areas shots are fired into the air to scare animals. The most common solution is to kill the pest in order to deter other animals from returning and to compensate farmers with the meat obtained **(**Osborn and Parket, 2003).

About 55.6% and 4% of the respondents reported that they were using guarding and fencing respectively in order to prevent their crops from the damage of porcupine. In addition to this, 70.4% and 64% of the respondents replied that they were using trapping and scenting respectively as prevention strategies of their crops from porcupine whereas 67.6% of them reported that they were using chasing in order to prevent their crops from the damage caused by porcupine. The result reveals that trapping was the dominant prevention strategy of crops from the damage by the porcupine followed by chasing, scenting and guarding respectively. Fencing was the least prevention strategy of the crops from the damage caused by porcupine.

4.3 Wild animals that prey the domestic animals

On the bases of respondent response different wild animals prey domestic animals in the study area. All (100%) respondents reported that olive baboon prey both on goat and lambs. Since olive baboon was an omnivore wild animal, it damages livestock mainly goat and sheep whenever it gets the opportunity of eating them. In addition to this, 63.2%, 73.6% and 75.6% of

them replied that leopard eats cattle, goat, and sheep respectively (table 4). All respondents replied that hyena prey cattle, goat, sheep, horse, and donkey. About 86.4% and 79.6% of the respondent replied that common jackal prey both goat and sheep respectively. Even though hyena was a dominant predator according to the result as a general, olive baboon cause serious damage specifically on small ruminant (Table 4).The result was disagreeing with finding of Sekahar(1998) who reported that leopard was the most damage causing on small ruminant in India. Similarly in Zambia, near Sengwa wildlife reserve, it was reported that between January 1993 and June 1996, in a study area of 33 km^2, 241 livestock were killed by baboon, lion and Leopard which contributed for 52 %, 34 % and 12 % of the kills, respectively. Their predation techniques are different. Baboons attack by day and usually kill small-stock such as goat and sheep, while lions and leopards attack at night, with lions killing large prey such as cattle and donkeys. The average annual loss per household is equivalent to 12 % of the total income (Butler, 2000).

Table 4: Wild animals which prey domestic animals in and around Chato forest

Livestock	Predators							
	Olive baboon		Leopard		Hyena		Common jackal	
	F	%	F	%	F	%	F	%
Cattle	0	0	158	63.2	250	100	0	0
Goat	250	100	189	75.6	250	100	216	86.4
Sheep	250	100	184	73.6	250	100	199	79.6
Horse	0	0	0	0	250	100	0	0
Donkey	0	0	0	0	250	100	0	0

On the bases of respondents number of livestock predated by wild animals in and around Chato forest from September 2009 to January 2013 were a total of 57 cattle, 146 goats, and 154 sheep were predated by the wild animals or the predators which was15.04%, 38.53% and 40.63% respectively. In addition to this, 13 horses and 9 donkeys were predated by the wild animals which were 3.43% and 2.37% respectively (Table 5). Similarly survey conducted in India around Bhadra Tiger reserve, revealed that carnivore- human conflicts were high and responsible for the loss of 219 livestock between April 1996 and March 1999 (Madhusudan, 2003).

Respondents replied that olive baboon predated a total of 140 livestock which represents 36.94% of the total loss of which 45% and 55% loss were happened on goats and sheep respectively. Leopard predated a total of 65 which was 17.15% livestock of which 11, 23 and 31 were cattle, sheep and goats respectively. Likewise, a study conducted in India also revealed that leopard mostly preyed on goat and sheep but rare on cattle (sekahar1998). Hyena also predated a total of 98 which is 25.86% livestock of which 46, 13, 17, 13, and 9 were cattle, goats, sheep, horses, and donkeys respectively. Whereas, common jackal predated 76 which are 20.05% livestock of which 39 were goats and 37 were sheep (Table 5).

Larger number of sheep was the most predated domestic animal followed by goat. Since sheep is not active and powerless to escape and protect themselves from the predators mainly olive baboon there was high exposure to this danger. Goat prefer leaf to grass, so that they need to be in the forest looking for fresh leafs. This exposes them to wild animals mainly to olive baboon and common jackal. Donkey was the least predated domestic animal because they spent much of their time around the home; they are normally few in number; and they are kept in a strong fence that never be challenged by the hyena. Similar studies in different parts of Africa revealed that wild animals posed major threats on livestock (Hill, 1997; Kagoro-rugunda, 2004; Okello, 2005).

Hyena holds the second rank as livestock predator. As the data revealed from the interview, even though hyena is predating all mentioned livestock, its chance of getting alone these domestic animals for predating is very less. Since hyena is a nocturnal animal, it is only predating livestock that might be lost or forgotten outside in the night. Common jackal takes the third position as livestock predator followed by leopard. Common jackal is predating lambs and single goat and sheep lost from the group. For leopard, livestock are not a primary choice. This is because they can prey on some wild animals like common bushbuck and bush duiker.

Table 5: Number of livestock predated by wild animals in and around Chato forest from September 2009 to January 2013

Wild animals	Total number of livestock predated						
	Cattle	Goat	Sheep	Horse	Donkey	Total	Percentage
Olive baboon	0	63	77	0	0	140	36.94
Leopard	11	31	23	0	0	65	17.15
Hyena	46	13	17	13	9	98	25.86
Common jackal	0	39	37	0	0	76	20.05
Total	57	146	154	13	9	379	100
Percentage	15.04	38.53	40.63	3.43	2.37	100	

4.4. Olive baboon population estimation

A total of 508 olive baboons in 15 groups were counted during the wet season. The number of olive baboons in one group ranged from 24 and 46. On average 35 olive baboons was there in one group. The number of adult male olive baboon counted during the wet season was 50 which represent about 9.8% of the total count of the season. The number of adult female olive baboon counted during the wet season was 135 which represent about 26.6% of the count. Whereas 31 representing 6.1% sub adult male was counted during wet season. The number of sub-adult female olive baboon counted during the wet season was 77 and represent 15.2% of the total count. The number of young (sex undefined) and infant (sex undefined) olive baboon counted during the wet season was 104 and 111 respectively which represent about 20.5% and 21.8% respectively (Table 6).

Table 6: Number of olive baboon counted in each counting blocks during the wet seasons.

Age structure of Olive baboon	Study sites						Percentage
	Hula Chulu	Burka Gemeda	Welda	Geba Hamusi	Gerado	Total	
AM	23	8	10	5	4	50	9.8
AF	46	20	27	24	18	135	26.6
SAM	14	4	2	5	6	31	6.1
SAF	26	11	16	17	7	77	15.2
YSU	31	18	17	22	16	104	20.5
ISU	45	17	16	20	13	111	21.8
Total	185	78	88	93	64	508	100
Percentage	36.4	15.4	17.3	18.3	12.6	100	

AM=adult male, AF=adult female, SAM=sub-adult male, SAF=sub-adult female, YSU=young (sex undefined), ISU= infant (sex undefined)

The ratio of AM(Adult male) to AFM(Adult female) olive baboon during the present study was 1:2.7 and the ratio of (SAM)Sub-adult male to(SAF) Sub adult female 1:2.5 whereas the ratio of YSU(young sex undefined) to ISU (Infant sex undefined) was 1:1.1 during wet season.

The result indicates that more animals185 (36.4%), were recorded from Hula Chulu site followed by Geba Hamusi 93(18.3%) and least in Gerado 64(12.6%).

From the data obtained through the interview and direct observation of the sites, there was dense forest in Hula Chulu. In addition to this, it is far from the farmers' home and most of the farmlands in this site were found in the forest. These were the reasons for the presence of large number of olive baboon in the site. Small number of olive baboon was counted in Gerado because of the presence of many roads in the site so that humans were using those roads. As a result, olive baboons were not going there. The other reason was the nearness of the site to the farmers' home than other sites.

During dry season a total of 569 olive baboons in 17 groups were counted during the study area. The number of olive baboons in one group ranged from 24 and 46. On average 35 olive baboons

was there in one group. Likewise ,olive baboons live in groups or "troops" as they are often called, ranging in size from 15 to 150 individuals (Rowel 1966; Dunbar and Dunbar 1974; Ray and Sapolsky 1992).During the present study a total of 51(9%) AM, 150(26%) AF, 37(6.5%) SAM, 81(14.2%) SAF, 114(20%) YSU and 136(23.9) ISU olive baboon were counted respectively during dry season (Table 7).

Table 7: Number of olive baboon counted in each counting blocks during the dry seasons.

Age structure of olive baboon	Study sites						Percentage
	Hula Chulu	Burka Gemeda	Welda	Geba Hamusi	Gerado	Total	
AM	24	6	9	7	5	51	9.0
AF	47	23	27	29	24	150	26.4
SAM	14	5	2	7	9	37	6.5
SAF	27	13	11	18	12	81	14.2
YSU	32	19	22	26	15	114	20
ISU	47	21	20	27	21	136	23.9
Total	191	87	91	114	86	569	100
Percentage	33.6	15.3	16	20	15.1	100	

AM=adult male, AF=adult female, SAM=sub-adult male, SAF=sub-adult female, YSU=young (sex undefined), ISU= infant (sex undefined)

The ratio of AM (Adult male) to AFM (Adult female) olive baboon during present study was 1:2.9 and the ratio of (SAM) Sub-adult male to (SAF) 1:2.2 whereas the ratio of YSU (young sex undefined) to ISU (Infant sex undefined) was 1:2 during dry season.

Similar to the discussion given for olive baboon population during the wet season, large number was found in Hula Chulu 191(33.6%) due to the presence of dense forest. In addition to this, it is far from the farmers' home and most of the farmlands in this site were found in the forest. As the data reveals, small number of olive baboon was found in Gerado 86(15.1%) because of the presence of many roads which are used for traveling purposes and the nearness of the site to the farmers' home than other sites.

There was no significant different between number of olive baboon counted in the two season (X^2=3.45, df=1, p>0.05) (Table 13). There was significant different between number of olive baboon counted in each study site in count under taken (x^2=157.8, df= 4, p<0.05) in which the highest were counted in Hula chulu whereas the lowest were Gerado in both seasons. There was significant different between number of olive baboon in each age structure (x^2=201.8, df=5, p<0.05) in which AF was high in number and SAM was least (Fig.2). The number of adult female and the number of sub adult female was greater than the number of adult male during both dry and wet count. The result was agreed with report of Estes (1991) that confirmed, the female individual number of olive baboons was larger than the males.

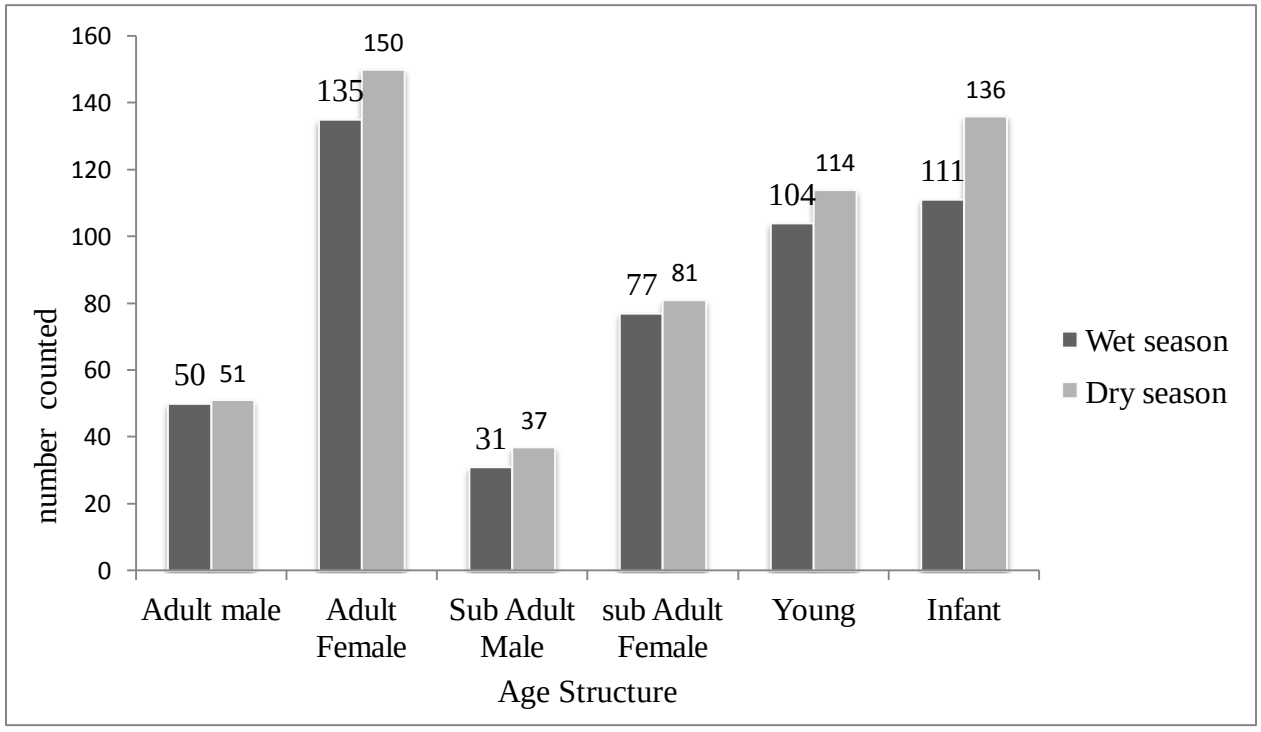


Figure 2: Age structure and number counted of olive baboon during the wet and dry season

4.5. Background of the respondents

From the total population of the study area, 250 of the respondents were included in the sample and the data was presented with frequency and percentage. Therefore,the background of the respondents is indicated in the table below as follows(Table 8).

Table 8: Background of the respondents in the study area

Variable	**Category**	**N**	**Percentage (%)**
Sex	Male	152	60.8
	Female	98	39.2
	Total	**250**	**100**
Age	<20	5	2
	21-30	59	23.6
	31-40	73	29.2
	41-50	48	19.2
	51-60	39	15.6
	61-70	26	10.4
	Total	**250**	**100**
Educational background	Able to read and write	220	88
	Unable to read and write	30	12
	Total	**250**	**100**
Position in the household	Head	155	62
	Member	95	38
	Total	**250**	**100**
Site	Hula chulu	55	22
	Burka gamada	38	15.2
	Walda	60	24
	Gaba hamusi	65	26
	Gerado	32	12.8
	Total	**250**	**100**

Table 8 reveals that 60.8% and 39.2% of the respondents were males and females respectively. Therefore, the number of male respondents is greater than that of female respondents.

Regarding the age of the respondents, 2% of the respondents were less than 20 years; 23.6% of them were between 21 and 30 years; and 29.2% of them were between 31 and 40 years. The rest of the respondents 19.2%, 15.6% and 10.4% were between 41 and 50 years; 51 and 60 years; and 61-70 years respectively. This shows that the majority of the respondents were between the age of 31 and 40 years.

With regard to the educational background of the respondents, 88% of them were able to read and write whereas 12% of them were unable to read and write. Those that were unable to read and write were included as the data collected from them is highly important for the research. Their responses were collected by the help of another person to not miss the data about the area under study. This was made because both groups of the respondents were very crucial in giving detailed information about current human-wildlife conflict in the study area.

Concerning the position of respondents in the household, 62% of them were heads whereas 38% of them were members. This indicates that the majority of the respondents in their position in the household were heads. Heads (mostly the husbands) are more concerned and usually are found around their farmland and know in detail about the consequences and the influences of human-wildlife conflict. This is not to undermine the concern of the members in the family because they have the role of facilitation and arrangements at the home and sometimes act as head when there is no head for some good or bad reasons.

Regarding the study site of the respondents, 22% of them were from Hula Chulu; 15.2% of them were from Burka gamada; 24% of them were from welda; 26% of them were from Gaba hamusi; and 12.8% of them were from Gerardo. Therefore, from this figure, it can be understood that the number of samples selected from each site is almost proportional to each other with slight differences.

Table 9: The respondents' farmland size (in ha) in the study area

Farmland size (ha)	Number of respondents (n)	Percentage (%)
1-2	28	11.2
3-4	126	50.4
5-6	59	23.6
7-8	42	16.8
>8	5	2
Total	**250**	**100**

Table 9 shows the possession of the respondents' farmland size (in ha). So, 16.8% of them have 7-8ha; 50.4% of them have 3-4 ha; 23.6% of them have 5-6 ha; 11.2% of them have 1-2 ha; and only 2% of them have more than 8 hectares. Thus, this reveals that most of the farmers in the study area have a farmland size of 3-4 hectares which is about 50.4%. Whereas, very few of them have large (>8 ha) and small (1-2ha) farmland size which is 2% and 11.2% respectively. Similarly, the data obtained from the interview indicates that the average number of hectares (3-4ha) was officially allocated for each farmer. The other numbers of hectares indicated above which were less than three and above four hectares were not officially allocated. Some farmers officially received more than eight hectares from the district for the purpose of investment (HWARDO, 2013).

4.5.1 Wild animals and their damage on crops in the study area

Table 10 shows the type of wildlife causing damages to crops and the degree of severity (Table 10)

Table 10: Wild animals and their damage to crops

Name of wild animals	Name of crops they damage											
	Wheat		Barley		Bean		Maize		Potato		Pea	
	N	%	N	%	N	%	N	%	N	%	N	%
Olive baboon	250	100	250	100	243	97.2	250	100	200	80	236	94.4
Grivet monkey	250	100	250	100	250	100	250	100	81	32.4	215	86
Leopard	0	0	0	0	0	0	0	0	0	0	0	0
Hyena	0	0	0	0	0	0	15	6	0	0	0	0
Hare	143	57.2	131	52.4	0	0	111	44.4	0	0	0	0
Bush duiker	139	55.6	97	38.8	0	0	56	22.4	0	0	0	0
Guereza	12	4.8	54	21.6	18	7.2	0	0	0	0	0	0
Common bushbuck	122	48.8	144	57.6	0	0	9	3.6	0	0	0	0
Porcupine	0	0	0	0	133	53.2	142	56.8	176	70.4	149	59.6

In Table 10, the respondents were asked to give their responses about the wild animals' damage to the crops. In the present area olive baboon damage crops such as wheat, barley, maize, bean, pea, and potatoes. This indicates that olive baboon damages all the crops with varied proportions, highest for crops including wheat, barley, maize, and bean. Similarly, Naughton-Treves (1998), also reported that Primates accounted 48% of the total damage to crops around Kibale National Park.

All (100%) of the respondents agreed that Grivet monkey are pest to wheat, barley, maize, and bean ,and lesser degeree to peas and potatoes.The result were agrees with finding of Kagoro-Rugunda (2004) who reported that baboons were by far the most common crop raider followed by grivet monkeys in Lake Mburo National Park of Uganda.

Concerning the damage of leopard and hyena to the crops, almost all the respondents replied that these wild animals do not cause damage to the crops. But out of the total interviewed respondent, about 6% of them reported that hyena damages maize.

About 57.2%, 52.4% and 44.4% of the respondents replied that Hare damages wheat, barley and maize respectively. This indicates that hare damage crops such as wheat, barley and maize. But it causes more damage to wheat and barley than maize. The data obtained from the interview reveals that since hares usually feed on grasses, they have no serious damage to crops.

With regard to the damage of bush duiker and common bushbuck to the crops, 55.6% and 48.8% of the respondents replied that bush duiker and common bushbuck respectively damages wheat. In addition to this, 38.8% and 57.6% of the respondents also replied that bush duiker and common bushbuck respectively damages barley whereas, 22.4% and 3.6% of the respondents reported that bush duiker and common bushbuck respectively damages maize. From this, it can be inferred that bush duiker and common bushbuck caused more damage to wheat and barley than maize even though their level of agreement varies. Similar to that of hare, as both bush duiker and common bushbuck feed on grasses, they cause little damage to the crops of poaceae family than legumes and other crops. The result was in agreement with finding of (Hill, 1997; Kagoro-Rugunda, 2004) who reported that bushbuck and duiker caused significant crop damage in Tanzania and Uganda.

Concerning the damage of guereza to the crops, 4.8%, 21.6%, and 7.2% of the respondents replied that guereza damages wheat, barley and bean respectively. It mainly feeds on fruits of larger forest plants like *Ficus sur*,*Ficus vista*, and others. Thus, it does not cause a serious damage even to the crops mentioned above. Similarly, the interview reveals that this wild animal does not highly damage to the crops.

With regard to the damage of porcupine to the crops, 53.2% and 56.8% of the respondents replied that porcupine causes damage to bean and maize respectively. Whereas, 70.4% and 59.6% of the respondents replied that porcupine causes damage to potato and pea respectively. But as it can be inferred from the data obtained, it highly causes damage to potato as compared to other crops. This is because porcupine is a nocturnal animal that has the ability to dig out the

ground to look for tuber crops and it also feeds on garden (Table 10). Similar to this study in Nanda Devi Biosphere Reserve (India) Showed that porcupines and monkey were major wildlife pests responsible for crop damage (Rao *et al.*, 2002).

Table 11: Rank of the wild animals based on the severity of the damage they cause to the crops

Wild animals	No of respondents (n)	Percentage (%)	Rank
Olive baboon	247	98.8	1st
Grivet monkey	223	89.2	2nd
Bush duiker	75	30	5th
Common bushbuck	69	27.6	6th
Guereza	18	7.2	7th
Hare	89	35.6	4th
Porcupine	148	59.2	3rd

Of all respondent 98.8% (247), 89.2% (223), and 59.2% (148) of them ranked olive baboon, grivet monkey and porcupine as 1st, 2nd and 3rd respectively based on the severity of the damage they cause to the crops (Table 11). Olive baboon is found everywhere around the study area. Naturally, they have large groups that are moving together in every situation (Rowel, 1966). Due to this large group, they have the ability of damaging a large square meters of the crop once they entered into the farmers' farmland. A single olive baboon can cause a serious damage if it stays a long if not guarded. Grivet monkey, which was ranked second in damaging crops and also have a large group size .But, a single grivet monkey may not cause a serious damage like a single olive baboon. This indicates that olive baboon and grivet monkey cause high damage to the crops than other wild animals. Porcupine is the sole serious damage causing nocturnal animal to crops mainly to potato. It also damages bean, pea and maize seriously next to olive baboon and grivet monkey. The data obtained through interview and direct observation also reveals that olive baboon and grivet monkey were the serious damage causing wild animals that needs continuous guarding, chasing and other preventive mechanisms. The present finding agrees with that recorded by Kate (2012) who reported that baboons were ranked number one crop raiders in Uganda. Aharikundira and Tweheyo (2011) also reported that baboons were ranked as first crop raiders in Uganda.

About 35.6%(89), 30% (75), 27.6% (69), and 7.2% (18) of the respondents ranked hare, bush duiker, common bushbuck, and guereza as 4^{th}, 5^{th}, 6^{th}, and 7^{th} respectively based on the severity of the damage they cause to the crops. Guereza cause crop damage but the degree of the damage they cause was not severe as the data indicates. Similarly, the data obtained through the interview reveals that this is because they do not use crops as their primary source of food and they do not have large group size walking together unlike olive baboon and grivet monkey.

4.5.2 Crop loss estimation on the base of respondents response

In this part, the production and loss of crops (in kg/ha) has been discussed by using mean, standard error and t-test at $\alpha = 0.05$. It is based on the expected yield (in kg/ha) and actual yield (in kg/ha) of crops.

Table 12: Production and loss of crops in kg/ha of five types of crops as estimated by farmers (mean ± se)

Crops	Expected yield (kg/ha)	Loss (kg/ha)	Actual yield (kg/ha)	T-value
Wheat	1458±21.6	328	1130±23.7	11.16
Barley	1205±34.2	167	1038±29.1	13.25
Maize	1040±33.99	262	878±22.5	6.72
Bean	956±30.59	166	790±26.7	6.08
Potato	893±29.6	193	700±27.7	12.68

In table 12, on basis of the respondents response the expected yield (kg/ha) of wheat, barley, maize, bean, and potato respectively were 1458±21.6, 1205±34.2, 1040±33.99, 956±30.59, and 893±29.6. Whereas, the loss of the above crop (kg/ha) of wheat, barley, maize, bean, and potato respectively were 328,167,262,166 and193 respectively. Actual yield (in kg/ha) of crops such as wheat, barley, maize, bean, and potato were 1130±23.7, 1038±29.1, 878±22.5, 790±26.7, and 700±27.7 respectively.

Wheat takes the first rank in loss followed by maize, respondents react the reason as wheat was the dominant crop grown in the area so that wild animals easily accessing the crop; the crop was cultivated being far from home in the study area; and even the morphology of the crop, that is because they are very short and easy to be taken than other crops. Maize was the second damaged crop followed by potato, barley and bean take 3rd, 4th, and 5th rank in crop loss respectively by wild animals. Likewise a study conducted in Uganda, revealed that crops such as bean and pea harvested in relatively shorter periods of time than crops such as wheat and sorghum and thus they received relatively lower damage (kagoro-Rugunda, 2004). There was statistically significant difference between the expected yield and the actual yield ($p < 0.05$) of crop loss in all crops. This indicates that there was a loss of crop due to crop raiding wild animals in the study area (Table 12).

5. Conclusion and recommendations

5.1. Conclusion

Based on the results, the following conclusions were drawn. Crops like wheat, barley, maize, bean, potato, pea, and teff were the crops grown around Chato forest. Among these, wheat is the dominant crop followed by barley and maize, bean and potato are also the common crops for all farmers in the study area. The commonly reared livestock in the study area include cattle, sheep, goat, horse and donkey. Sheep and goat were the dominant livestock reared by the farmers in the study area followed by cattle.

Olive baboon, grivet monkey, hyena, guereza, common bushbuck, leopards, hare, bush duiker, porcupine, and common jackal were the wild animals that are found in and around Chato forest. Some of these are crop raiding, while others are livestock predators. Among the wild animals found in and around the forest, olive baboon, grivet monkey, porcupine, common bushbuck, hare, bush duiker and gueraza, were the commonly known crop raiders. Olive baboon was a serious crop damage causing wild animal than others. Wheat and barley are highly damaged crops among the commonly grown crops were damaged by olive baboon followed by grivet monkey.

Olive baboon, hyena, leopard and common jackal are predating animals on the livestock reared in the study area. Hyena eats all the livestock as the primary food source, whereas olive baboon has the highest record on predation of sheep and goat. Olive baboon and hyena were the most damage causing wild animals on livestock than other predators.

The prevention mechanisms of wild animals from crop damage commonly used by farmers in the study area are chasing, guarding, fencing, scenting, trapping, yelling, and throwing stones. Guarding is the most commonly used prevention strategy of crops from wild animals followed by chasing. Chasing and trapping were the most commonly used strategies by the farmers in preventing olive baboon from the damage of their crops and livestock.

Olive baboons are observed at all the five sites in and around Chato forest (Hula Chulu, Geba Hamusi, Burka Gamada, Geredo and Welda). It is during the dry season that large number of olive baboon in most age structures were counted than during the wet season. From the sites, Hula Chulu comprises a large population of olive baboon followed by Geba Hamusi during both the dry and wet seasons, whereas Gerado composes the smallest number of olive baboon in different age structures.

Adult female olive baboon were observed, counted and recorded at all sites followed by the infant ones and it is found in the study area in a larger proportion than other age structure of olive baboon. In contrast to this, sub-adult male olive baboon comprises the smallest proportion in all sites during both the wet and dry seasons.

5.2. Recommendations

Based on the findings and the conclusions drawn, the following recommendations are forwarded

- The cultivated crops in the study area are highly affected by crop damaging wild animals. Therefore, the farmers have to use best preventing mechanisms by consulting the nearby Agricultural experts.
- Wheat and barley are the most seriously damaged crops mainly by olive baboon and grivet monkey. Thus, encouraging farmers as should cooperatively guard their crop farm from crop raiders to minimize yield loss.
- Sheep and goat are the most commonly predated domestic animals than others by olive baboon to a larger extent followed by hyena. Therefore, looking after has to be given a serious attention.
- The prevention mechanisms of the crops and livestock from the damage were traditional. Thus, encouraging farmers as should be designed and implemented properly in order to protect their crops and livestock from damage.
- The olive baboon population in this study was estimation but due to lack of sophisticated machines and equipments for counting and larger size of the forest reaching farther study will be needed to determine the density and exact number in the forest.
- The periphery of the forest is the area where olive baboons frequently graze.At the prephery of the forest farmers keep on expanding their cultivation, forest intercroping

and livestock grazing. In this area it is common to see the olive baboon grazing with livestock. This increases the exposure of crop and livestock to the wild animals. So in the long run, the olive baboon population and other wild animals will be affected unless farming system and grazing at the periphery of the forest is curtailed.

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7. Appendices

Jimma University

College OF Natural Sciences

Department of biology (Ecological and systematic zoology)

Appendix I

Questionnaire for the survey on crop damage, livestock predation and other related activities.

Part I: Background of respondents'

1. Sex: Male ☐ Female ☐
2. Age: <20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ 61-70 ☐
3. Educational background: Able to read and write ☐ Unable to read and write ☐
4. Position in the household: Head ☐ Member ☐
5. Site: Hula Chulu ☐ Burka Gemeda ☐ Welda ☐
   GabaHamusi ☐ Gerado ☐

Part two: Crop damage

6. Indicate the size of farm land (in ha) that you have in the study area.
   1-2 ☐ 3-4 ☐ 5-6 ☐ 7-8 ☐ >8 ☐
7. Types of crops grown in the area (you can choose more than one).
   Wheat ☐ Barley ☐ Maize ☐
   Bean ☐ Potato ☐ Others, if any ----------
8. Rank the crops listed under question number 7 in order of their commonness of growing.
   First ---------- Second ---------- Third ----------
   Fourth ---------- Fifth ---------- Sixth ----------
9. Based on question number 7, rank the crops that are highly damaged by wild animals.
   First ---------- Second ---------- Third ----------
   Fourth ---------- Fifth ---------- Sixth ----------
10. List the type of wild animals that are found in and around Chato forest.----------
    ----

11. Do these wild animals you listed under question number 10 causes damage to the crops grown there? If yes, fill the following table properly.

.

Name of the wild animals	Names of crops they damage				
	1	2	3	4	5

12. Rank animals according to the severity of the damage they cause on farm crops.

1st---------- 2nd ---------- 3rd ----------

4th----------5th----------6th----------

7th----------

13. How many kilogram (quintal) yields did you get last year per Ha?

Crop type yields obtained

…….. …….. ……..

…… …… ……..

14. In your opinion, how many kilogram (quintal) yields can be lost by wild animals from one hectare of each crop field?

Wheat---------- barley---------- bean---------- maize---------- potato----------

15. What methods do you use to prevent crop damage by wild animals?

……

……

……

……..

Part III: Domestic damage

16. Are there wild animals which prey your domestic animals? If you say yes, fill the following table for the specified years (September, 2009-January, 2013).

Name of livestock	Year	Number killed	Sex		Age		Name of predator
			M	F	Adult	Young	

Appendix-II

Data collection sheet for direct observation of crop damage by wild animals

Place_____

Site_____

Season_____

Stages of crop development_____

Distance of the field from the forest boundary_____

Name of data collector_____

S.No	Specie observed	Types of crop damaged	Parts of crop damaged	Size damaged (m^2)	Time of observation
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

Appendix III

Data collection sheet for population estimate of olive baboon

Date_____

Season_____

Place _____

Site_____

Name of data collector_____

S.No.	Age structure					
	AM	AF	SAM	SAF	Young	Infant
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
Total						

AM = Adult Male, AF= Adult Female, SAM=Sub-Adult Male, SAF=Sub-Adult Female

Appendix IV

Major crops and their respective cropped area (m^2)

Study sites	Cropped area (m^2)					Total m^2
	Wheat	Barley	Maize	Bean	Potato	
Hula chulu	28,000	5,700	3,388	2,912	0	40,000
Burka gameda	26,315	6,565	3,950	3,170	0	40,000
Welda	20,500	5,250	4,520	5,200	4,530	40,000
Gebahamusi	20,214	6,901	5,009	4,376	3,500	40,000
Gerado	20,200	9, 517	5,163	5,120	0	40,000
Total	115,229	33,933	22,030	20,778	8,030	200,000
Percentage	57.6	16.97	11.02	10.39	4.02	100

Appendix v

Parts of crop wild animals damage

Wild animals	Crops damaged observed	Parts of crop damaged
Olive baboon	Wheat	Seed, leaf, stem
	Barley	Seed, leaf, stem
	Bean	Pod, leaf
	Pea	Pod, leaf
	Potato	Tuber
	Maize	Seed, leaf, stem
Grivet monkey	Wheat	Seed, leaf
	Barley	Seed , leaf
	Bean	Pod, leaf
	Pea	Pod, leaf
	Potato	Tuber
	Maize	Seed, leaf
Hare	Wheat	Leaf, stem
	Barley	leaf ,stem
	Maize	Leaf
Porcupine	Potato	Tuber
	Maize	Stem, seed
	Bean	Pod
	Pea	Pod
Bush duiker	Wheat	Leaf, seed
	Barley	Stem, seed
	Maize	Leaf
Common bushbuck	Wheat	Leaf
	Barley	Stem
	Maize	Stem