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POPULATION STATUS OF GELADA BABOON AND HUMAN - WILDLIFE CONFLICT IN AND AROUND DENKORO FOREST, ETHIOPIA

BY MUSSA ADEM

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ADVISOR: PROF. AFEWORK BEKELE

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Abstract

This study was aimed at determining population status of gelada baboon and human - wildlife conflict around Denkoro Forest. The study was conducted from August 2008 to March 2009. The main objective was to find out gelada baboon population by age and sex classes. The second was to identify if there was a significant crop and livestock depredation caused by wild mammals. The methods employed for human-wildlife conflict were face-to-face questionnaire interview of 250 randomly selected local residents and direct observation on the crop damage by wild animals. The method employed for population estimation of gelada baboon was total count in the entire study area. Data were analyzed using one way ANOVA, student's t-test and chi-square test. The result of the analysis of the data collected through questionnaire survey indicated that crop losses per hectare ranged from 3% for potato to 15% for wheat. However, results of direct observations indicated that the loss ranged from 3.2% for potato to 12.6% for barley. Gelada baboon, rabbit, hamadryas baboon and bushbuck were the top four crop raiders in the study area. Leopard, common jackal and hayaena were the common predators. On the average, 0.6 livestock per household was preyed annually and the amount of monetary loss due to predation was Birr 313 per household. The present study also revealed that a total of 914 and 988 gelada populations occurred in the study area during the wet and the dry seasons, respectively. As the Denkoro 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.

Key words: Denkoro Forest, Gelada baboon, Human – wildlife conflict

1. INTRODUCTION

Human - wildlife conflicts have started since the beginning of the human era. This conflict with wild animals made man to hide in caves, and to be called “as cave man”. Slowly, with technological advancement it was man who invented weapons such as axe during stone and iron ages to frighten wild animals, initially. Later on humans hunted wild animals as food and protection. (Eltringham, 1979).

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 increase 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).

Human - wildlife conflict is a growing global problem, which is not restricted to a particular geographical region or climatic condition, but common to all areas 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 high highly (Ogada *et al*., 2003).

Human - wildlife conflict may affect human welfare, health and safety, and have economic costs. Humans also will be exposed to different negative social impacts such as missed school, and work, additional labour costs, loss of sleep, fear and restriction of travels (Hoar, 1992).

There is more human - wildlife conflict in the tropics and in the developing countries where livestock and agriculture are important parts of rural livelihoods and income. In these areas competition between resources is very high. 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).

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 of 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 of human - wildlife conflict. These can be grouped into human population growth, landuse 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 landuse 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. Some times, the solution to animal - human conflict requires change of behaviour 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’, defence 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 behaviour 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).

As the above case studies indicate, human - wildlife conflict may occur everywhere and thus studies should be conducted to identify such conflict. One of the aim of the present study is thus to identify such types of human - wildlife conflict around Denkoro Forest.

The present study also aimed at the determination of the population status of gelada baboon. Studies indicated that different sizes of gelada's population found in different northern plateau of Ethiopia and Arssi highlands (for example, Croock, 1966; Dunbar, 1977; Dunbar, 1980; Gurja Belay and Shotake, 1998). However, we currently do not have an accurate account on the number of gelada baboon living in Denkoro Forest, and we have even less knowledge about total number of geladas throughout Ethiopia. The total number of gelada baboon is estimated as slightly less than 250,000 individuals in Ethiopia (Dunbar, 1998).

2. LITERATURE REVIEW

2.1. The Gelada baboon

2. 1. 1. Background and common features

Gelada baboon (*Theropithicus gelada*) is endemic to Ethiopia and it was first discovered by a German naturalist called Rüppel in 1835 in a few areas of the northern Ethiopian highlands (Crook, 1966). Formerly, it was believed that the genus *Theropithicus* included several extinct species which were widespread and successfully found over much of Africa and across India. But, at present, the gelada is the sole survivor of the genus Theropithicus (Dunbar, 1998).

Respecting to its taxonomic group, some biologists regard gelada as a member of the genus *Papio*, some other biologists grouped it with the Asian genus *Macaca* and some even considered that its affinities lay properly with the genus *Cercopithecus* (Hill, 1999).

At present, gelada occur at a retreat habitat on the mountainous plateau of Ethiopia due to the reason that they were forced to take refuge on the inaccessible highlands as a result of competition from the more successful *Pappio* baboons. However, *Pappio* baboons and gelada differ radically in diet and as a result, competition between them was very limited (Dunbar and Dunbar, 1974). This unusual baboon is one of the most specialized of the primates in that it is exclusively graminivore. It is the only member of the Order which is a true grazer capable of competing with ungulates in the open grassland (Jolly, 1972).

Geladas are large primates with dark brown to buff coarse pelage with dark brown faces and lighter, pale eyelids. Males are larger than females and marked sexual dimorphism is characteristics of the species, with adult females around two-third the size of adult males. Adult females weigh an average around 11 kg while adult males weigh 18.5 kg. A Head and body length of the adult female and male range between 50 and 75 cm and the tail is between 30 and 50 cm. The species has highly opposable index figures. In addition its fingers are short, allowing them to be used efficiently for digging. Most characteristics of gelada are the hairless hourglass-shaped pink or red area of the skin located on the chest (Dunbar, 1978; Krentz, 1993).

2. 1. 2. Habitat and Feeding

The location where geladas are known to found lie within what is often as the Ethiopian Amhara plateau, an area of volcanic cliff lying north and west of Addis Ababa. These highlands, which slope roughly northeast to southwest from an altitude of 4,500 m down to 1,500 m, are known to be the main location of geladas (Croock, 1966). However, recent study about the location of gelada in Ethiopia show that geladas are also found in the Arssi highlands, which is east of the Rift Valley to the south of the Amhara plateau. This area is similar to the latter in altitude, climate and vegetation (Gurja Belay and Shotake, 1998).

Gelada habitat is characterized by their proximity to cliffs for sleeping and the use of several different types of relatively treeless and montane grasslands for foraging; habitats that are usually interspersed with bushes, trees and dens thickets (Iwamoto and Dunbar, 1983). Although the gelada community forages on grasslands on the plateau, they depend on ready access to the steep gorge sides both for sleeping sites and for refuge for predators. They occur only in the vicinity of cliff to which they run on even the least alarm and were they sleep (Dunbar, 1980). The geladas are ill-adapted to an arboreal way of life. Even where they occur in or near forested areas, they rarely climb up trees. Their clumsiness when climbing trees is striking compared to the more arboreal *Papio* baboon. The gelada's dependence on gorge side has not only provided a refuge from the incursion of man and protection from the more conventional predators, but also a habitat to which the species is particularly well adapted (Jolly, 1972).

Geladas occur at high altitudinal areas and in some habitats where the weather can be harsh, as hill storms occur regularly during the wet season and frosts during the dry season. Certain areas of the plateau habitat are under human cultivation and populations often are marginalized to the areas near the cliffs and sometimes they invade the intrusive crop lands to forage (Iwamoto, 1993).

The habitat of gelada is generally cooler and less arid and thus less effect of food scarcity even during the dry season. Some 90-95% of the diets of the species consists of leaves, roots and seeds of grasses; the remaining 5% is made up of the leaves, fruits, and flowers of a variety of herbs, shrubs and bushes and rarely insects (Dunbar, 1977). Their success in exploiting a habitat where grasses are the most abundant form of vegetation is indicated by the fact that they usually account for a large proportion of the herbivore biomass throughout the highlands. A typical section of a gorge side is capable of supporting three times the number of gelada compared to the more omnivorous *Papio anubis* (Dunbar and Dunbar, 1974).

Geladas are the only graminivorous primates that consume foods more than those eaten by ungulates, chewing food about as efficiently as Zebras (Iwamoto, 1979). There is a variable seasonal shift during the dry season diet in which fewer grasses are consumed and other food plants, especially herbs are substituted. Further, where grasses are in seed, proportionally more seeds are consumed and they preferentially choose grass blades when both are available (Dunbar, 1977).

2. 2. Human - wildlife conflict

3. 2.1. Human - herbivore conflict

Supply of food especially grain in the developing countries will have to rise by around 70% by the 2020 if the 6.5 billion people who are expected to be living in Africa, Asia, and Latin America by then are to be food secured. Nearly all of this increase in food supply is expected to come from the developing countries. Meeting the projected goal will require a sustained rise in crop yields of the major grains and legumes grown by millions of small-scale producers in Africa, Latin America and Asia. In spite of this, agricultural crop production has been facing problems from crop raiding wildlife such as mammals, birds and insects (Yudelman, 1998). This crop yield loss by wild animals encourages farmers to revenge on wildlife and thus it leads to conflict.

Although 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. For example, White-tailed deer (*Odocoileus virginianus*) in the USA, African elephant (*Loxodonta africana*) in Africa and Asian elephant (*Elephas maximus*) in Asia, bird species throughout the world and different arthropod species are agricultural crop pests (Silero-zubiri and Swetzer, 2001). When people think of damage to crops, they probably think chiefly of insects such as locust that devastate large areas of farm within a short time.

However, crop raiding by vertebrates such as birds and mammals is also a major issue in different parts of the world. The majority of vertebrates are potential competitors of farmers. Birds of prey consume chicken and ducks, other birds forage grains and most mammals feed on either livestock or crops (Eltirngham, 1979).

Wild animals often destroy unharvested farms, causing economic losses to farmers. Crop damage is becoming serious for many residents around protected areas. Due to this reason, in developing countries intervention in the name of conservation can generate considerable resentment and hostility in local communities. Establishment of protected areas is a major form of government intervention with local people as it leads to conflict with wildlife. Sometimes people around protected areas are forced to keep their farm fallow due to fear of crop raiders. They are also forced to change their cropping patterns to escape crop damage. Moreover, they spend additional labour, time and expenditure to protect their crop against wild herbivores (Sekhar, 1998).

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 landuses 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 behaviour. 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 animals may vary from season to season as the type of farming during wet seasons and dry seasons. The behaviour of the animal is also an other 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).

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).

Crop damage affects farmers directly through loss of their primary food and cash resources, and indirectly through a variety of social costs such as costs for school and hospital. Due to these losses, rural people express their fear, or even sabotage development projects that deal with wildlife conservation (Hill *et al*., 2000).

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).

Research has revealed that different species apparently favour different human crops, e.g. bush pigs prefer cassava and yams, elephants are recorded to damage bananas, sorghum and maize and rodents are considerable pests of rice (Hill, 1997; Naughton-Treves, 1998). Field rodents are commonly reported to be serious pests of rice throughout South East Asia. Estimates of yield reduction of approximately 20% have been recorded from Pakistan (Fulk *et al*., 1981).

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).

Surveys on crop damage by wildlife have many practical applications from agricultural and wildlife points of view. They are useful to document the extent of a suspected wildlife damage problem, the timing of the problem, and in some cases, the particular species responsible for the problem. They also can be used to compare trends among geographic regions or between time periods. Surveys on the problem of crop raiding also are useful to detect changes in tolerance to wildlife damage. Moreover, surveys on crop damage can be used to identify current methods used to control wildlife damage and to design management programs that address stakeholder needs. Results from surveys on wildlife damage are useful in developing management plans that will be acceptable to farmers and address their problems and concerns (Craven *et al*., 1992). Therefore, it is crucial to document the different wildlife that cause crop damage, the amount of losses they cause, the place where they cause the damage and the different strategies used by the local people to prevent the damage in different parts of the world.

In different States of North America, crop damage by wildlife has been studied. Survey conducted in Pennsylvania, showed that white-tailed deer were most commonly the cause of damage in all crops except soybeans. Farmers reported that the damage by white-tailed deer was heaviest from June through September. Some farmers reported that farming is no longer profitable because of deer damage. Disagreement over damage severity arises because estimates of crop losses to deer vary from year to year, with respect to adjacent landuse or habitat types, and sampling methods (Conover and Decker, 1991). In New Jersey, New York, and Virginia, human - deer conflict was high. In these areas, more than one million deer - vehicle collisions occurred annually, causing over US $ 1.1 billion in repair costs and resulting in 29,000 human injuries and 211 human fatalities. That was recognized to cause more damage to agricultural crops than any other vertebrate wildlife species costing farmers more than an estimated US $ 100 million each year (Conover *et al*., 1995; Conover, 1998).

Studies of human - wildlife conflicts around protected areas elsewhere in Sub-Saharan Africa have shown 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. 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 vervet monkeys, birds and bushbuck also being sited as frequent visitors to farmers (Kagoro-Rugunda, 2004).

At the prriphery of Gashaka Gumti National Park, in Nigeria, a total of 229 damage events reported by the local people between May 2001 and March 2002. The majority of these damage events (97 %) were carried out by four species namely, tantalus monkey, baboons, Warthogs and cows. Of the total expected yields of field crops, 2.3 % was lost to animals in the wet season and 42.2 % in the dry season in the study area (Warreny, 2007).

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*), vervet monkey (*Cercopithecus aethiops*) and black and white colobus (*Colobus guereza*) were reported as problematic species. In addition, bushpigs, rodents, porcupines, elephants, bushbuck (*Tragelaphus scriptus*), duiker (*Cephalophus* spp) and striped ground squirrel (*Xerus erythropus*) 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 (*Syncerus caffer*), Zebra (*Equus burchelli*), Hippopotamus (*Hippopotamus amphibious*) and elephant (*Loxodonta africana*) were among the most cited crop raiders. Of these mammals, telephant was mentioned as the most frequent crop raider, mostly during the dry season (Okello, 2005).

The case studies in Zanzibar revealed that the red colobus (*Procolobus kirkii*) was one of the major crop pests. On this island, farmers consider the red colobus as the third most serious crop raiding vertebrates. This case deserves particular attention because the red colobus is one of the most endangered primates in Africa and in Zanzibar they number only about 2000 individuals (Siex *et al*., 1999).

Human - wildlife conflict is also 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 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 (*Sus scrofa*), 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). In Indonesia, elephants raided crop at a rate of 0.53 elephant per day. The frequency of crop raiding was related to the vegetation type along the park border and the distance of farmlands from the park border. Wild elephants damage at least 450,000 m^2 of maize, rice, cassava, beans and other annual crops, and around 900 coconuts, banana and other perennial trees in the area surveyed. Villagers try to reduce elephant damage by guarding fields, digging trenches, and modifying their cropping pattern (Nyhus, 2008).

Crop raiding by wildlife was also a common phenomenon in different countries of South America (Naughton-Treves *et al*., 2003). For example, in Peru, in the Amazon province of Tambopata, around 3,200 people live inside northern border of the 1.5 million hectare protected area of the Tambopara-Candamo Reserve, and thus experience a certain level of conflict with wildlife. Among the principal herbivores responsible for the damage in this area were the Brazilian tapir (*Tapirus terrestris*), Collared peccary (*Tayassu tajacu*), Paca (*Agouti paca*) and Tyra (*Era Barbara*) (Naughton-Treves, *et al*., 2003).

2. 2. 2. Human - carnivore Conflict

The members of the mammalian Order Carnivore number about 226 species, almost all are predators. As a group, carnivores exert a profound influence on biological communities via predation and interspecific competition. Carnivores often regulate or limit the number of their prey, thereby, altering the structure and function of the entire ecosystems (Ester *et al*., 1998). They can function not only as flagship species, which conserve a raft of other species along with them, but some are keystone species. Their extirpation or rarity can result in a change in the communities of the habitat (Berger *et al*., 2001).

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 landuse 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 greater majority of cases of human - carnivore conflict through depredation of domestic animals reflect some type of imbalance in the local ecosystem. If the habitat in which they live consists of areas large enough to support them, with sufficient food resources and if the influence of human on their habitat decreases, these animals tend to avoid man and his domestic animals. The absence or depletion of natural prey animals due to hunting or disease transmission from domestic animals can provoke the onset of attack by large carnivores on domestic animals (Karanth and Sunquist, 1995; Treves and Karanth, 2003).

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. Specially 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).

The human - carnivore conflict was serious in the areas around Waza National Park, in Cameroon, as there are different predators such as lion, hyaena (*Crocuta crocuta* and *Hyaena hyaena*) 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. Hyaenas attack small stock in or near the settlements at night time. They enter the enclosures and even houses, but are easily chased away. Hyaenas 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).

Conflict between human and wild carnivores was common around Tsavo National Park, in Kenya. In this study area, lions, cheetah and spotted hyena were responsible for attacks on domestic animals. Lions and spotted hyenas targeted large domestic animals such as cows, bulls and steers while cheetahs take only smaller adult stock and young cattle. In a four-year study, the ranches have lost an average of 2.4 % of the total herd per annum, which represented 2.6 % of their economic value and amounted to US $ 8,749. The numbers of attacks and stock killed showed significant seasonal differences (Patterson *et al*., 2004).

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). Another survey conducted in India around Bhadra Tiger Riserve, 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).

Direct effects of predation were results in significant economic losses to livestock producers in USA. Livestock losses attributed to predators, predominantly coyotes (*Canis latranus*), reached about US $ 71 million annually. In 2000, cattle and calf losses to predators was 147,000, which valued US $ 51.6 million while sheep losses to predators reached 273,000 in 1999 which valued US $ 16.5 million. The three goat producing States, Arizona, New Mexico and Texas lost 61, 000 goats in 1999 which valued to US $ 3.4 million (Larry *et al*., 2004). Other survey around the Western Great Lake States of USA (Minnesota, Michigan and Wisconsin) revealed that wolves (*Canis lupus*) caused considerable livestock depredation. Wolf population in these area has grown from time to time, and thus with the growth of this wolf population, there has been major increase in depredation on livestock. The majority of the livestock losses have been calves with over a half a million dollars paid to livestock owners (Mech, 1998; Ruid *et al*, 2005).

In Latin America, the problem of depredation of domestic animals, especially cattle, was caused by the two large American cats namely the Jaguar (*Panthera onca*) 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 palace when the livestock were grazing in proximity with shrub or woodland cover (Cozza *et al*., 1996).

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).

3. OBJECTIVES

3.1. General objective

3.2.

To determine human-wildlife conflicts and to assess the population status of Gelada baboon in and around Denkoro Forest.

3.2. Specific objectives

- To find out the agricultural crop losses caused by large wild mammals
- To determine the extent of livestock depredation by wild carnivores
- To determine the population structure of Gelada baboon
- To recommend solutions regarding to human-wildlife conflict and the population status of gelada baboon in the study area.

4. THE STUDY AREA

4.1. Location

Denkoro Forest (10^o 47’-10^o 50 N latitude and 38^o 35’-38^o 42’ E longitude) lies in the Debresina Woreda, South Wollo Zone, Amhara Regional State of Ethiopia. The physical distance of the Forest from Addis Ababa is about 600 km to the North and the total area of the forest is about 5,500 ha (PaDPA, 1999**, as** cited by Eshetu Moges, 2008) (Fig. 1).

4.2. Geology and Topography

The geological background of the Ethiopian highland massifs, in which the study area is a part, lie on Tertiary volcanic deposits, which become extremely thick in the Simen Mountains. The highland massifs were assumed to be formed over 75 million years ago by volcanic action. The soils developed over these rocks are principally nitosol and in some are lithosol (McGinley, 2007). The topographic features of Denkoro Forest are mainly characterized by mountains, deeply incised valleys, escarpments and plateaus.

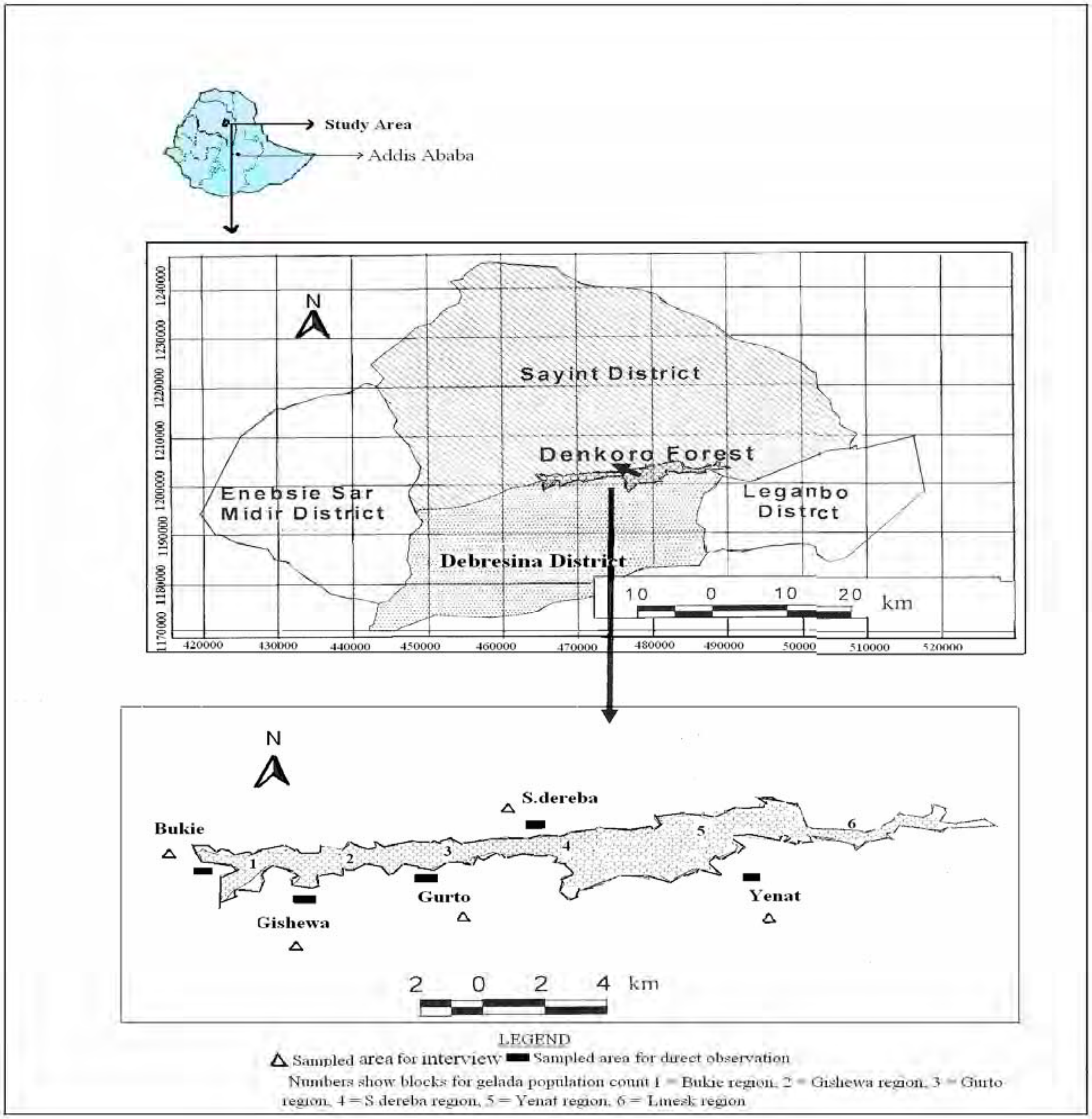

Figure 1. Map of the study area.

4. 3. Climate

As Denkoro forest has a relatively broad range of altitude (2,300-3,800 m above sea level), it has relatively broad ranges of annual. The rainfall in the study area is bimodal. The first wet season mostly occurs from June to the end of September, while the second short rainy season occurs between January and April. According to Mekaneselam Meteorological Station (the town of the study area), the annual rainfall ranges between 600-1,000 mm, while the annual maximum temperature ranges from 20° C to 25° C during the dry season and the minimum temperature ranges from 10° C to 15° C during the wet season (Fig. 2).

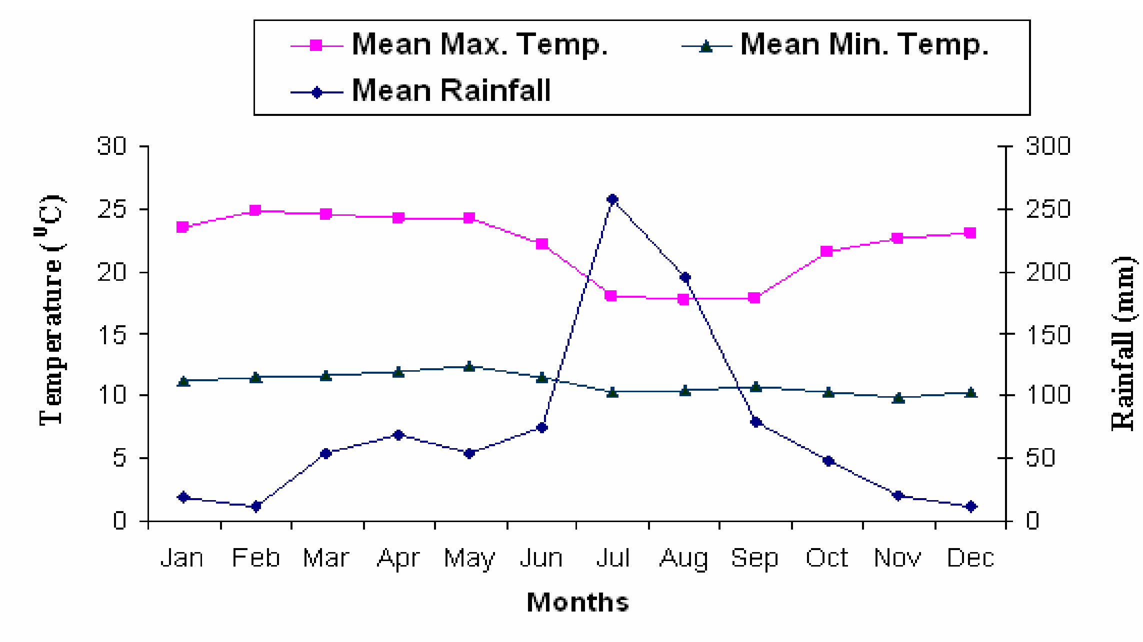

Figure 2. Rainfall and temperature recorded from 1995-2007 in Mekane Selam

(Source: Ethiopian National Meteorological Service Agency, 1995-2007)

4.4. Flora and Fauna

According to Abate Ayalew *et al.* (2006), the vegetation of the study area shows similarity to the dry evergreen montane forests of the central plateau. The forest consists of about 175 species of vascular plants of which some are endemic to Ethiopia. Some of the vascular plants include *Erica arborea, Hypericum revolutum, Dombeya torrida, Myrsine Africana, Maesa lanceolata, Prunus africana, Olinia rochetiana, Olea europea, Allophylus abyssinicus* and *Lobelia rhynchopetallum* (Abate ayalew *et al.*, 2006). The vegetation pattern varies depending on altitude. In general, thick forest is a feature of lower altitude of the study area, while the higher altitude of the study area is characterized by *Erica* woodlands and open but in some area *Lobelia* mixed grassland. The forest also harbours different species of mammals, birds, reptiles and arthropods. According to the South Wollo Zone Department of Agriculture (2008), around 44 species of mammals are found in this forest including two large endemic mammals, the gelada baboon (*Theropithecus gelada*) and the Ethiopian wolf (*Canis siminsis)*.

5. METHODS

5. 1. Data collection

Data collection was conducted during August, 2008 - March, 2009. A total of four field trips (two sessions during wet season and two sessions during the dry season) were conducted. The wet season study included August to October 2008 and the dry season study included January to March, 2009.

4. 1. 1. Population estimate of Gelada baboons

Total population count can be used to estimate the population number of large sized mammals (Burham *et al*, 1980). As gelada baboons are large sized mammals, total count method was used for the present study. Counting of population was carried out by moving on foot throughout the whole habitat of the animals in and around the study area. For this purpose, the study area was divided in to six blocks in which the researcher and two scouts participated in the total counting process. Unless the Gelada baboons are not disturbed by people, they keep on foraging throughout the day. This behavior made the counting process easy as they are available on grassland habitat. A total of two counts were conducted in each of the wet and dry seasons and thus their population number was documented. Their population was categorized into four age groups namely adult male, adult female, sub adult male, sub adult female, young and infant (see 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 beginning of the mane 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.

5. 1. 2. Questionnaire survey

The questionnaire, together with interviews and discussions, were designed and conducted to determine the extent of the general loss of crops and livestock due to human-wildlife conflict and other related issues around the study area. Two hundred and fifty randomly selected respondents participated from five selected sites namely Bukie, Gishewa, Gurto, Sekadereba (S.dereba) and Yenat. Before the questionnaire survey was commenced, the aim was explained by the researchers. The questions are both open and close ended and that include issues such as the damage caused by wild animals on crops, carnivores that prey on domestic animals, wildlife that caused the most loss and socio-economic situation of the local residents (see Appendix I).

5. 1. 3. Direct observation on crop damage by wildlife

For the purpose of direct observation on crop damage by wildlife, five study sites (listed above) were selected randomly. For each site, five corresponding cultivated land covering an area of 40,000 m^2 were selected randomly. In turn, each of the five cultivated lands was divided into five grids each of which has 8,000 m^2. Crop damage by large mammals was recorded in meter directly to estimate the average losses (see Appendix II). In addition to the researcher, two forest guards have participated during the time of direct observation and thus a total of ten days (12 hours each) direct observation was conducted in each study site in each trip. Some animals do not damage crops during the day time as such. 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).

5. 2. Data analysis

Data were analyzed using SPSS version 15.0 computer software. Descriptive statistic was used and responses were compared by using one-way ANOVA, chi-square test and student's paired t-test. One-way ANOVA and chi-square test were used to analyze the extent of crop damage and livestock depredation. To compute the number of gelada baboon population between wet season and dry season, student's t-test was used. The sex ratio of gelada baboon was computed by using chi-square test.

6. RESULTS

6.1. Population estimate of gelada baboon

The result of total counts of gelada baboon for wet and dry seasons is given in Table 1 and 2, respectively.

Table 1. Numbers of gelada baboon counted in each counting blocks during the wet season.

Site	Adult males	Adult females	Sub-adult males	Sub-adult females	Young (sex undefined)	Infant (sex undefined)	Total count
Bukie	23	51	14	29	30	27	174
Gishewa	15	34	10	20	27	23	129
Gurto	19	45	11	30	21	22	148
Sekadereba	16	48	10	37	30	25	166
Yenat	8	31	5	18	20	14	96
Lmesk	26	67	13	29	32	35	202
Total	107	276	63	162	160	146	914

A total of 914 and 988 geladas were counted in the entire study area during the wet and dry season, respectively. ANOVA indicated that significant difference was found among the number of the different age groups during the wet season ($F_{5\ 30} = 15.01$, $P < 0.05$). Further analysis on the number of the different age groups by using Tukey test showed that the number of adult female and sub-adult female was significantly higher than the number of the corresponding male age groups ($p < 0.05$). ANOVA test was also showed that the number of adult and sub-adult females differed significantly from the number of adult and sub-adult males during the dry season, respectively ($F_{5\ 30} = 23.95$, $P < 0.05$).

The population of gelada in the study area showed an increase during the dry season. A two-tailed paired t-test at a significant level of 0.05 indicates that the number of gelada population differed significantly during the wet and dry seasons ($P = 5.5$).

Table 2. Number of gelada baboon counted in each counting blocks during the dry season.

Site	Adult males	Adult females	Sub-adult males	Sub-adult females	Young (sex undefined)	Infant (sex undefined)	Total count
Bukie	20	60	14	31	30	27	182
Gishewa	11	38	10	29	28	27	143
Gurto	14	44	13	24	25	28	148
Sekadereba	16	51	16	40	35	34	192
Yenat	12	39	10	21	24	20	126
Lmesk	24	60	11	29	30	43	197
Total	97	292	74	174	172	179	988

A total of 72 and 83 groups were counted in the wet and dry seasons, respectively. On the average, group size ranged from 5 to 18. Both all-male and one-male groups were found in the ratio of 1:12. Thus, during in the wet season, out of the 72 groups, 6 groups were of all-males and during the dry season, 7 groups were of all-males.

With respect to the age structure and sex ratio, 276 adult females (30.2%), 107 adult males (11.7 %), 162 sub-adult females (17.7%) and 63 sub-adult males (6.9%) were recorded during the wet season. The number of females was significantly higher than the number of males (χ^2 =59.06, df =1, P < 0.05). During the dry season count, there was 292 adult females (29.6%), 97 adult males (9.8%), 174 sub-adult females (17.6 %) and 74 sub-adult males (7.5%). The number of female was significantly higher than the number of male (χ^2 = 68.31, df = 1, P < 0.05). The number of young and infants during the wet season was 160 and 146, which was 17.5% and 16% of the total population, respectively. There were also 274 young and 172 infants during the dry season (Fig. 3). The adult male to adult female ratio was 1:2.6 and 1:3, whereas the sub-adult male to su adultfemale ratio was 1:2.6 and 1:2.4 during the wet and dry seasons, respectively.

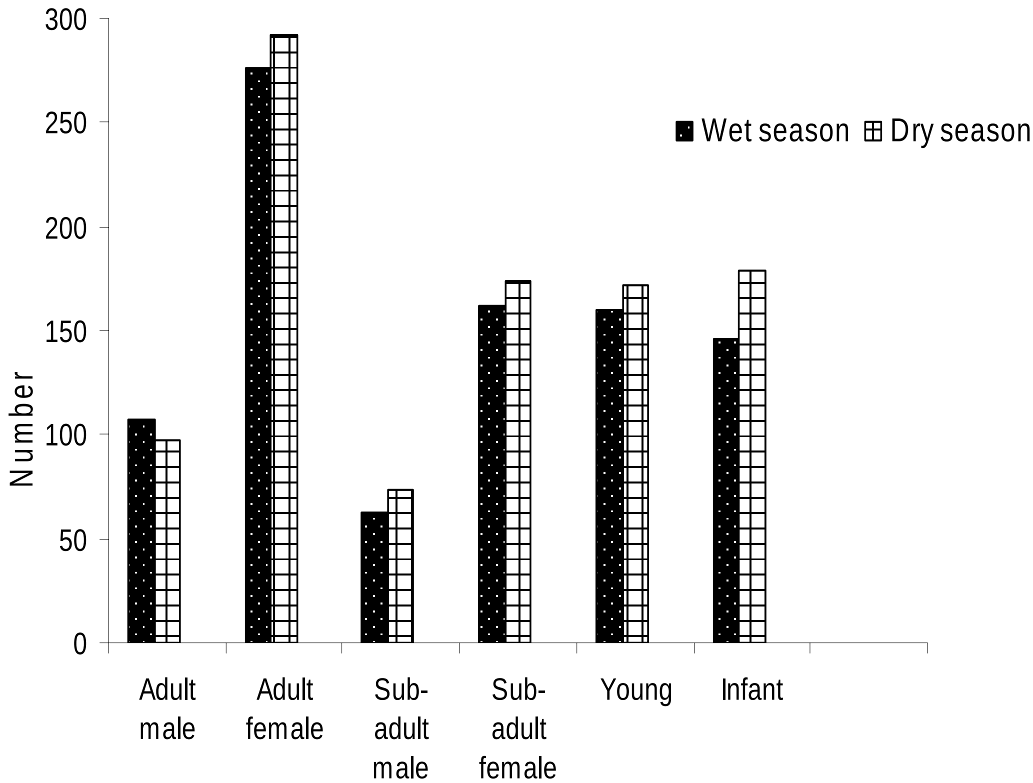

Figure 3. Age structure of gelada baboon during the wet and dry season.

6.2. Questionnaire survey

6.2.1. Background of the respondents

The community around the study area consists of the Amhara Ethnic group. A total of 250 respondents were involved in the questionnaire survey of which 127 were males and 123 were females There was no significant difference in the number of male and female respondents ($\chi^2 = 0.064$, df=1, P> 0.05). The vast majority of respondents were literate and few were illiterate (Table 3).

Table 3. Background of the respondents who were involved in questionnaire survey of human - wildlife conflict around Denkoro Forest.

Age class	No. of individuals		Educational background, %	
	Male	Female	Literate	Illiterate
11-20	25	30	00	0
21-30	27	23	100	0
31-40	22	25	100	0
41-50	23	20	72	28
51-60	18	17	40	60
61-70	12	8	15	85
Total	127	123	80	20

The respondents listed 13 wild mammals that occur in the study area (Table 4).Mammals such as gelada baboon and bushbuck were known to all respondents, but the Ethiopian wolf was known only too few respondents. Mammals that were known by more respondents were common around the study area, but those were known only too few respondents were rare.

Table 4. List of wild mammals occur in Denkoro Forest as revealed by respondents.

Common name	Scientific name	No. of responses
Gelada baboon	*Theropithicus gelada*	250
Hamadryas baboon	*Papio hamadryas*	250
Leopard	*Panthera pardus*	250
Common jackal	*Canis aureus*	250
Spotted hyaena	*Crocuta crocuta*	250
Rock hyrax	*Procavia capensis*	250
Rabbit	*Lepus starcki*	250
Klipspringer	*Oreotragus oreotragus*	220
Bush duiker	*Sylvicapra grimmia*	247
Ethiopian wolf	*Canis simensis*	120
Guereza	*Colobus guereza*	250
Common bushbuck	*Tragelapus scrpitus*	250
Porcupine	*Hystrix cristata*	238

6. 2. 2. Economic activity and resource utilization

Agriculture was the main activity of the people around the study area. The main crop growing months were July to December. In the five surveyed villages, wheat was the major crop. It was the most important crop cultivated by most farmers in the year 2008. However, farmers also cultivated barley, pea, lentil, and potato to some extent (Table 5).

Table 5. A survey conducted on 62 family heads about the type of crops they cultivated in the year 2008.

Crop type	No. of family heads	Percentage
Wheat	45	71.4
Barley	18	28.6
Pea	13	20.6
Lentil	8	12.6
Potato	5	7.9

Most of the people were subsistence farmers without any other source of income. However, agricultural activity includes different patterns such as animal rearing, crop farming, or a mixture of both. A few of the family heads stated that they have other sources of income such as guarding the forest and income from sales of local hand crafts. Most (59.7%) of the family heads generated their income from mixed agriculture (crop farming and animal rearing) and few (25.8%) depended on crop farming for their income sources. Only 14.5% of the family heads had other income sources besides farming (Table 6).

Table 6. Income sources of respondents on 62 family heads.

Income sources	No. of family heads	Percentage
Crop farming alone	16	25.8
Crop farming and animal rearing	37	59.7
Crop farming, animal rearing and Other income sources	9	14.5
Total	62	100

The amount of farmlands owned by family heads ranged from 1.5 to 2.5 ha with an over all mean of 1.7 ha (Table 7). Out of the 62 family heads, 10 (16%) and 20 (32%) possessed 2.5 and 2 ha of farmland each, respectively. But 18 (29 %) and 14 (22%) of the family heads processed 1.5 and 1 ha of farmland, respectively. There was significant difference in the number of family heads that processed the four different sizes of land (χ^2 = 3.2, df = 3, $P < 0.05$).

Table 7. Extent of farmlands possessed by 62 family heads.

Size, in ha	No. of family heads in each study site				
	Bukie	Gishewa	Gurto	S.dereba	Yenat
1.0	3	3	4	1	3
1.5	4	5	2	3	4
2.0	3	2	6	4	5
2.5	2	3	1	2	2
Mean	1.7	1.7	1.6	2.0	1.7

There was scarcity of grazing land around the study area. However, most respondents in the study area reared livestock such as cattle, goat, sheep, and pack animals. Sheep were the predominant livestock in each site followed by cattle and goat. The overall mean number of sheep and cattle holding per household was 12 ± 1.3 and 5 ± 0.6, respectively whereas that of goat was 4 ± 0.4. The lowest number of livestock per household was recorded for horse and donkey (Fig. 4).

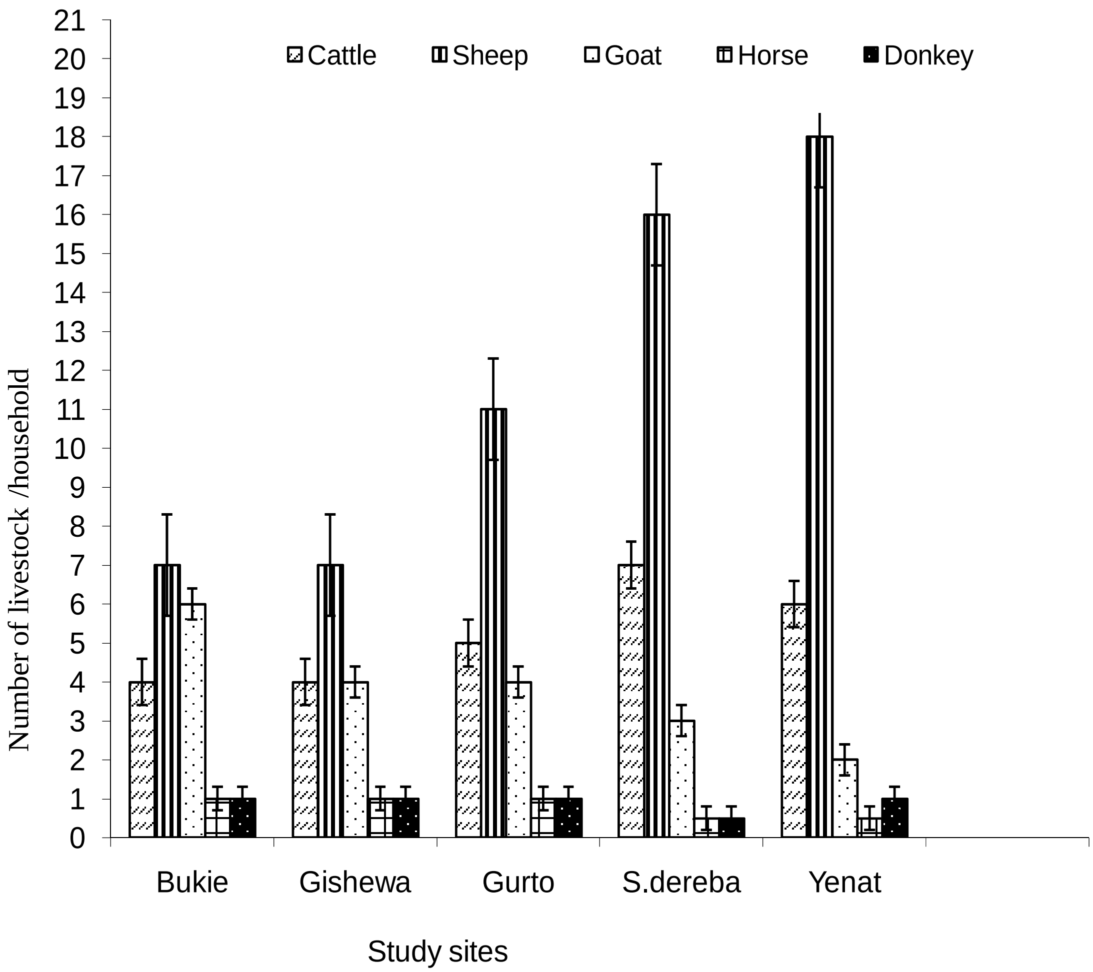

Figure 4. Livestock per household among respondents of each site (mean ± SE).

Livestock were not allowed to enter the forest area, but sometimes residents entered the forest area to collect fodder, firewood and even they cut branches from trees. In all study sites, more than half of the respondents stated that they collected fodder from the forest. About, 68% and 60% of the respondents at Sekadereba and Gishewa used the forest to collect fodder, respectively. Respondents at Yenat and Bukie also used the forest to collect fodder. No respondent used the forest to hunt wild animals. Fuel wood was the second important resource next to fodder that respondents collected from the forest. Among the respondents, 53% at

Sekadereba and 48% at Gishewa used the forest to collect fuel wood. At Gurto and Yenat 30%, and 40% of respondents stated that they collected fuel wood from the forest, respectively (Fig. 5). There was significant difference in the number of respondents who utilized the four resources (grazing land, fuel wood, fodder and wood for house construction) from the forest ($F_{3\ 16}$ = 35.43 P < 0.05). On an average, respondents in all sampled villages utilized resources from the forest more or less in the same extent and thus there was no significant difference on resource utilization from village to village ($F_{4\ 15}$ = 0.38 P > 0.05).

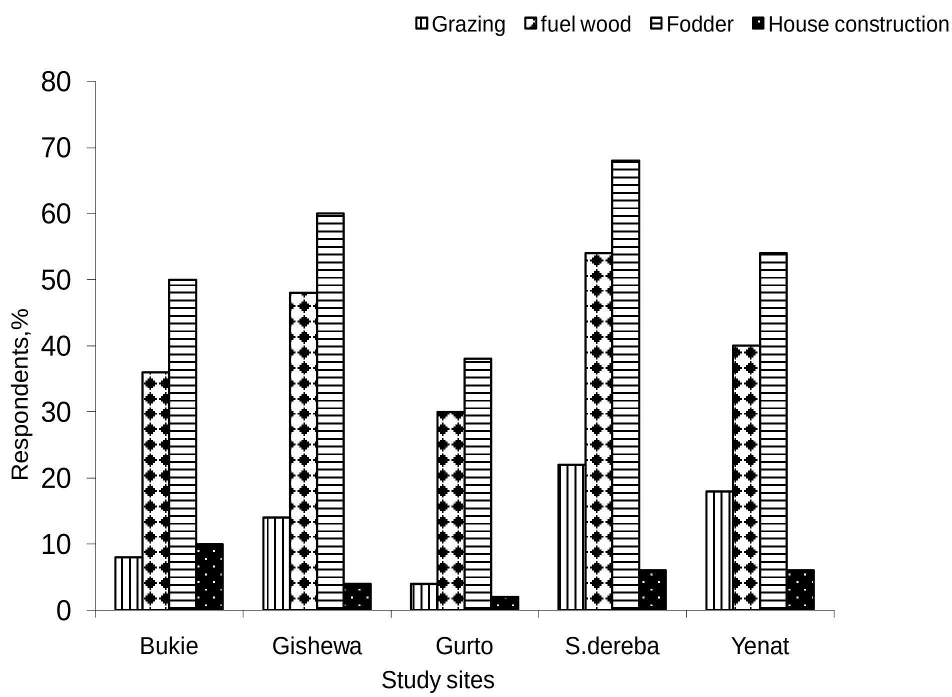

Figure 5. Percentage of respondents utilized resources from the forest.

6. 2. 3. Crop damage

According to the responses of the respondents, various of animals were involved in different degree of crop raiding. Most of the respondents reported some degree of crop losses as a result of damage by wildlife, and a total of seven wild mammal species were reported to raid crops around the study area. Farmers ranked pest animals from the one causing most damage to that causing the least damage (Table 8).

Table 8. Crop damage by wild mammals and ranking of animal species with respect to the extent of damage they caused on farm.

Animals	No. of farmers reported damage (n = 250)	Rank according to the extent of damage
Gelada	250	1
Rabbit	243	2
Hamadryas	239	3
Bushbuck	231	4
Porcupine	160	5
Duiker	89	6
Klispringer	52	7

According to the respondents, gelada baboon was the most commonly reported crop raider on the farmlands causing much damage. Gelada baboons were found around farmlands throughout the day. Respondents also stated that hamadryas baboons were also notorious crop raiders, but do not approach humans if some body is found around the farmland. Sometimes, hamadryas visit farmlands during the night time specially when there was moon light. They damage crops early in the morning and late in the evening when people are absent near farmlands. Respondents claimed that wild mammals around the study area were the major source of crop losses. Farmers lost considerable amount of crop yield in all study sites (Table 9).

Table 9. Crop production and Crop loss in kg/ha in five types of crops as estimated by farmers (mean ± SE).

Crops	Expected yield (kg/ha)	Loss (kg/ha)	Actual yield (kg/ha)	χ^2	Probability
Wheat	1590 ± 4.5	245 ± 2.2	1545	37.8	**p < 0.05
Barley	1404 ± 2.5	204 ± 2.4	1200	29.6	**p < 0.05
Pea	1292 ± 2.0	152 ± 1.2	1140	17.9	**p < 0.05
Lentil	1297 ± 1.2	147 ± 1.3	1150	16.7	**p < 0.05
Potato	1798 ± 1.9	59 ± 1.9	1739	1.94	p > 0.05

Source questionnaire survey **significant at 0.05

On the average, the losses ranged from 245 kg/ha for wheat to 59 kg/ha for potato. Barley occupied the second position in loss ranking. The loss for all crops was significant except potato (Table 9). The Loss on potato was not significant (χ^2 =1.94, df =1, p > 0.05). Respondents lost 15% and 14.5% of wheat and barley yields, respectively, annually from their one hectare farmland. Likewise, the percentage loss of pea and lentil was about 12% and 11% per hectare respectively. Percentage loss on potato was about 3.3%. Based on the local market rate, the amount of monetary loss was shown in Table 10.

Table 10. Annual mean loss, market value and annual monetary loss of five crop types as estimated by farmers.

Crops	Yield loss (kg/ha)	Market value (Birr/kg)	Annual monetary loss (Birr/ha)
Wheat	245	4.50	1102
Barley	204	4.50	918
Pea	152	4.50	684
Lentil	147	7.50	1102
Potato	59	6.00	354

Source questionnaire survey

According to respondents, on the average, wild animals around the study area caused 208 Birr economic losses per hectare on five types of crops.

6. 2. 4. Traditional methods used by the local people to prevent crop damage.

Respondents used methods such as guarding, chasing, strange scents, fencing and trapping to control their crop damage Guarding was the most familiar methods. Most of the respondents reported that they guarded their crops especially during the harvest season. Chasing and fencing were also the second and the third important methods, respectively. Yelling and throwing stones were the other methods used to chase wild animals away the farmland. Respondents scatter faecal droppings of sheep and goat over the cultivated crop to prevent it from wild animals such as bushbuck and duiker. The scent of sheep and goat droppings keeps bushbuck and duiker away the farmland. Trapping was also used in limited extent. Few of the respondents reported that they killed small size animals such as rabbit and porcupine by trapping (Fig. 6).

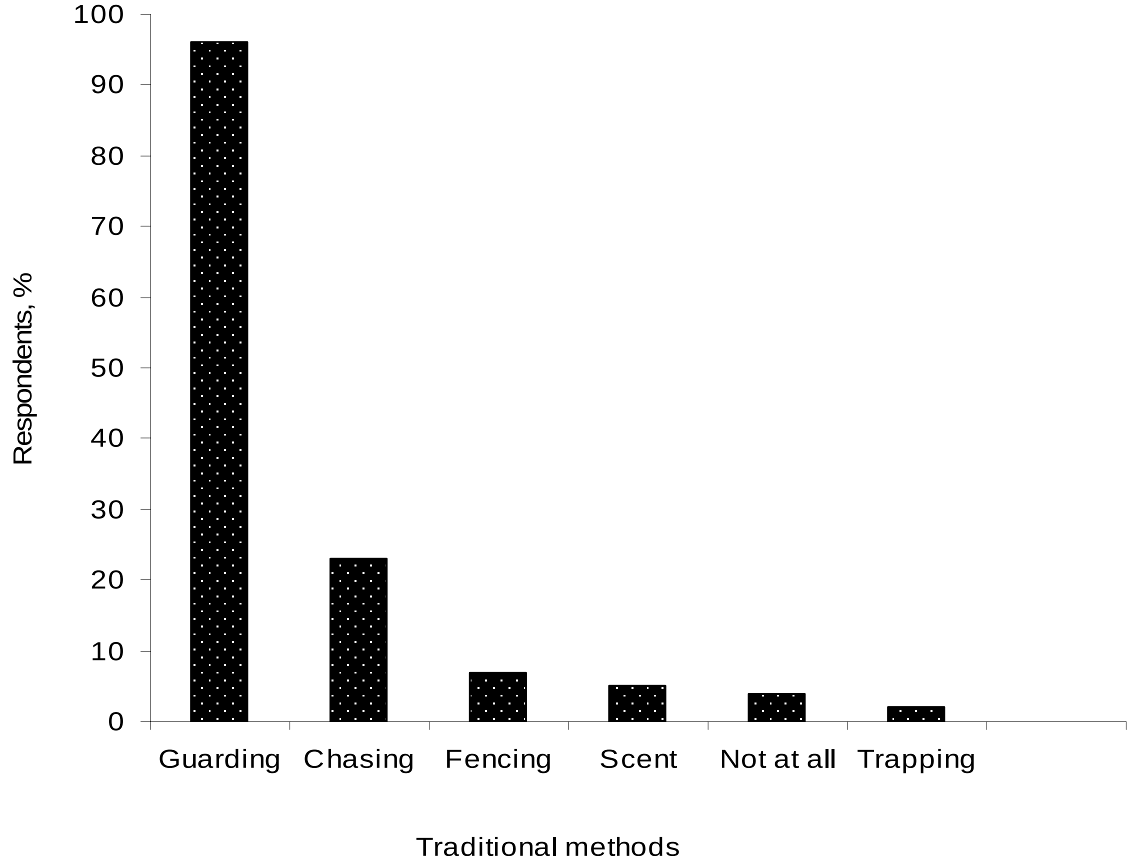

Figure 6. Percentage of respondents that used different traditional methods to prevent crop damage by wild animals.

6. 2. 5. Livestock depredation

Farmers reared different types of livestock such as cattle, sheep, goat and pack animals. During the time of the present study, no livestock was seen entering the forest area, but farmers grazed their livestock near forest edges. Goats and sheep were grazing near the forest edges and often they entered the forest.

Respondents claimed that wild animals came out from the forest and attacked their domestic animals even though their livestock did not enter the forest. Leopard, common jackal, hyaena and hamadryas baboon were the common predators on domestic animals (Table 11).

Table 11. Number of livestock and pack animals killed by predators in and around the Denkoro forest from September 2005 to January 2009 on five selected sites.

Predators	Number of livestock and pack animals predated					
	Cattle	Sheep	Goat	Horse	Donkey	Total
Leopard	2	9	33	0	0	44
Common jackal	0	22	12	0	0	34
Hyaena	7	8	3	7	13	38
Hamadryas	0	5	12	0	0	17
Total	9	44	60	7	13	133

Source: questionnaire survey

Leopard killed about 44 livestock during the stated period, of which 33 were goats, 9 were sheep and 2 were cattle. Hyaena and common jackals were the second and the third important predators around the study area, which killed 38 and 34 individuals, respectively. Hamadryas baboon preyed on12 goats and five sheep. Pack animals were frequentely killed by hyaena. Of the total kills, 33.1 % was killed by leopard and 28.1% was by hyaena. Common jackal and hamadryas baboon contributed to 25.6% and 12.9 % of the kill. The annual kill of livestock was about 39 and, on the average, the annual monetary loss was Birr 19,400 in the study area.

Individual households lost 0.6% of their livestock, which in monetary value, birr 313 annually. The number of kills caused by predators in the study area was significant (χ^2 =9.3, P < 0.05).

Market value of livestock varied based on species, age, and sex of the animals (Table 12). According to the local market, adult males and adult females differed in the market value, but young males and females of each species of livestock did not differ in market value.

The economic loss due to wild predators amounted to birr 66,180 during the specified duration (Table 10). Kills on goats and sheep accounted for a loss of 16,910 birr (25.6%) and 12,720 birr (19.2%), respectively. Predation on horse and donkey accounted for a loss of 11,100 birr (16.8%) and 10,250 birr (15.4%), respectively, whereas kills on cattle accounted for 15,200 birr (23%). The highest monetary loss was caused by hyaena which was 37,840 Birr whereas the lowest monetary loss was by hamadryas baboon, which was 3,720 birr during three and half years.

Table 12. Market value of each species of livestock killed by predator during September 2005-January 2009 as determined by age and sex classes.

Livestock	Unit value (birr)	Market value of livestock killed, birr				Total (birr)
		Leopard	Common jackal	Hyena	Hamadryas Baboon	
Cattle						15,200
Adult male	2,500	0	0	5,000 (2	0	
Adult female	1,800	0	0	5,400 (3)	0	
Young	1,200	2,400 (2)	0	2,400 (2)	0	
Sheep						12,720
Adult male	450	1,350 (3)	0	1,350 (3)	0	
Adult female	300	1,500 (5)	2,400 (8)	600 (2)	0	
Young	240	240 (1)	3,360(14)	720 (3)	1200 (5)	
Goat						16,910
Adult male	600	4,200 (7)	0	600 (1)	0	
Adult female	280	392 (14)	840 (3)	0	0	
Young	210	2,520 (12)	1,890 (9)	4,20 (2)	2520 (12)	
Horse						11,100
Adult male	1,700	0	0	5,100 (3)	0	
Adult female	1,500	0	0	6,000 (4)	0	
young	960	0	0	0	0	
Donkey						10,250
Adult male	1,000	0	0	4,000 (4)	0	
Adult female	750	0	0	5,250 (7)	0	
Young	500	0	0	1,000 (2)	0	
Total (birr)		16,130	8,490	37,840	3,720	66,180

Numbers in parentheses represent numbers of individuals killed

6. 3. Determination of crop damage based on direct observation

6. 3. 1. Crops cultivated in the study sites

Five types of crops were grown in the study sites during the present study. They were wheat, barley, pea, lentil, and potato. Wheat was the predominant crop in all five sites in terms of coverage on the farmland. Wheat constituted 116,629 m^2 (58.3%) of the total cultivated land (200,000 m^2) in all the sites. Potato crop covered the smallest portion of the cultivated farmland, which was 8,291 m^2 (4%) of the total cultivated land. There was significant difference in the size of the cultivated areas of each five types of crops ($F_{4\ 20} = 72.13$, $p < 0.05$) with the highest size for wheat and the lowest for potato. Potato crop was cultivated only at Gurto and Sekadereba. Although, they were found in small proportion, pea and lentil crops were also cultivated in all the five sites (Table 13)

Table 13. Type of crops and the extent of area (m^2) observed in the five sampled sites of the study area.

Study sites	Cropped area (m^2)					Total, m^2
	Wheat	Barley	Pea	Lentil	potato	
Bukie	28,600	5,500	3,188	2,712	0	40,000
Gishewa	26,415	6,465	3,950	3,170	0	40,000
urto	21,100	5,050	4,320	5,000	4,530	40,000
Sekadereba	20,114	6 740	5,009	4,376	3,761	40,000
Yenat	20,400	9, 417	5,063	5,120	0	40,000
Total	116,629	33,172	21,530	20,378	8,291	200,000

6. 3. 2. Analyzing the observation of crop damage events

Across the sampled study sites, seven species of wildlife were involved in the crop damage. These were gelada baboon, hamadryas baboon, rabbit, bushbuck, duiker, klipspringer and porcupine. All of them were observed when they damaged crop but some of them (porcupine and bushbuck) were not seen during the day time damaging crops. However, the remains and marks such as foot print, droppings, digging and spines were used to record the damage of such nocturnal animals.

Gelada baboon, hamadryas baboon and rabbit were observed damaging crops in all stages from the time of germination to the time of harvest. Some of them were observed when they destroyed particular developmental stages of crops. For example, bushbuck, duiker, and klipspringer actively destroyed crops for a few weeks only after germination. They also destroyed pods of pea and lentil. Gelada baboon, hamadryas baboon, rabbit, bushbuck, duiker, and klipspringer were observed when they consumed wheat, barley, pea, and lentil. Porcupine was the only animal that fed on potato tubers in the study area (Table 14). A total of 963 damage events were recorded in all five study sites in two session study during the wet season and one session during the dry when the crop was available in the field (Table 15). About 30% of the damage events were recorded during the dry season. The remaining 70% of the damage events occurred during the wet season. Gelada baboons caused the greatest damage events, 375 out of 963 total damage events while porcupine caused the least, 33 out of 963. Thus, gelada baboon was the most problematic animal for farmers around the study area. Animals differed significantly in the number of damage events they caused throughout the study time ($F_{6\ 28}$ = 52.23, $p < 0.05$) with the highest and the lowest damage events by gelada baboon and porcupine, respectively.

Table 14. Animals that damaged crops, the types of crop they damage, times they often seen in the crop field and sites were they caused damage.

Animals	Types of crop	stages of crops Damaged	Times they often seen in the crop field	Sites
Gelada	Wheat, Barley Lentil, Pea	leaf, steam, seed, pod	day	in all five sites
hamadryas	Wheat, Barley Lentil, Pea	leaf, steam, seed, pod	day, occasionally night	in all five sites
Rabbit	Wheat, Barley Lentil, Pea	leaf, steam, seed, pod	day and night	in all five sites
Bushbuck	Wheat, Barley Lentil, Pea	leaf, young steam pod	night	in all five sites
Duiker	Wheat, Barley Lentil, Pea	leaf, young steam pod	day and night	in all five sites
Klipspringer-	Wheat, Barley Lentil, Pea	leaf, young steam pod	day and night	in all five sites
Porcupine	Potato	tubers	night	Gurto, Sekadereba

Damage events occurred in all five sites by all seven species except porcupine, which did not cause any damage events at Bukie, Gishewa and Yenat. Sekadereba had the highest damage events while Yenat had the lowest. However, damage events were not significantly different from site to site ($F_{4\ 30}$ = 0.21, P > 0.05).

Table15. Numbers of damage events recorded in five study sites at different seasons

Species	Numbers damage events					Total
	Bukie	Gishewa	Gurto	S.dereba	Yenat	
Gelada	87	71	77	83	57	375
Hamadryas	51	35	32	34	20	172
Rabbit	31	39	31	41	33	175
Bussbuck	26	34	26	30	22	138
Duiker	11	8	4	13	10	46
Klipspringer	9	6	2	4	3	24
Porcupine	0	0	14	19	0	33
Total	215	193	186	224	145	963

A total of 17,253 m^2 damaged farmlands was documented during the time of 963 damage events. Out of this, 4,169 m^2 was occurred at Gishewa, which was the highest of all five sites. Bukie and Sekadereba occupied the second and the third position in damage ranking, respectively. The lowest damaged area of crop field was recorded at Yenta followed by Gurto, which were 2,290 m^2 and 1, 313 m^2, respectively (Table16).

Table 16. Total damaged area (m^2) recorded in five crop types of sampled area.

Site	Wheat	Barley	Pea	Lentil	Potato	Total/40,000 m^2
	Area damaged (m^2)					
Bukie	2,526	1,009	120	279	0	3934
Gishewa	2,083	920	725	441	0	4169
Gurto	1,826	640	180	300	167	3113
Sekaderreba	1,978	1,067	340	264	98	3747
Yenat	1,378	561	205	146	0	2290
Total/200,000 m^2	9,791	4,197	1,570	1,430	265	17,253

There was no significant difference in the size of damaged crop fields among those five sites ANOVA ($F_{4\ 20} = 0.185$, $P > 0.05$).

When compared the size of damaged area of the five types of crops, the highest damage was on wheat. From 17, 253 m^2 total damaged area, wheat constituted 9,791 m^2, which was 57% of the total damaged fields, whereas barley and lentil constituted 24% and 9% of the total damaged area of crop, respectively. The lowest size of damaged area was recorded in potato followed by lentil, which was 2% and 8% of the overall damaged area. The size of the damaged area significantly differed from crop to crop ($F_{4\ 20} = 48.7$, $P < 0.05$) with the highest damaged area on wheat and the lowest on potato.

Damage analysis on crop types excluding potato by the four important crop raiders (gelada, hamadryas, rabbit and bushbuck) revealed a considerable size of crop fields was damaged on each study site. The percentage loss of each four crops in each five sites was shown in Figure

(7-10). Rabbit caused the highest percentage loss of wheat crop at Gurto and Yenat, which was 34% at each site. Gelada baboon caused 38% loss of barley at Gurto and the same percentage loss was caused by bushbuck on the same crop at Yenat. Bushbuck was, by far, the most important raiders on lentil at Gishewa, which caused a damage of 46%. Gelada was the second important raider of lentil, followed by bushbuck. Gelada caused a damage of 41% and 40% of the total crop fields of lentil at Bukie and Gurto, respectively. The percentage of wheat field damaged by hamadryas at each site was less than the percentage loss of wheat field damaged by gelada and rabbit at each corresponding sites. The lowest percentage loss of crop field was recorded on pea by gelada baboon at Gishewa and on wheat by bushbuck at Yenat, which was 5% for each.

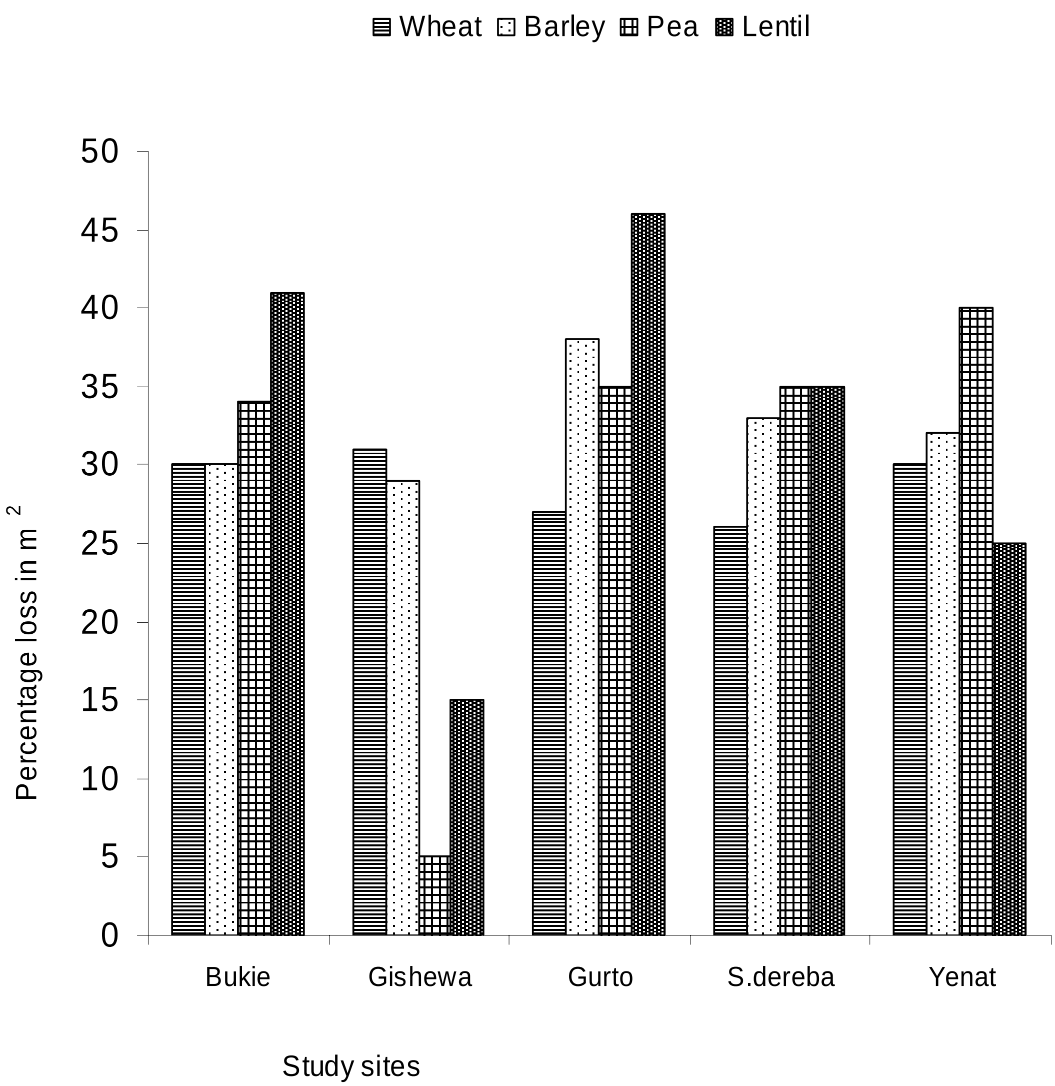

Figure 7. Proportion of losses in total damages of each crop by gelada baboons.

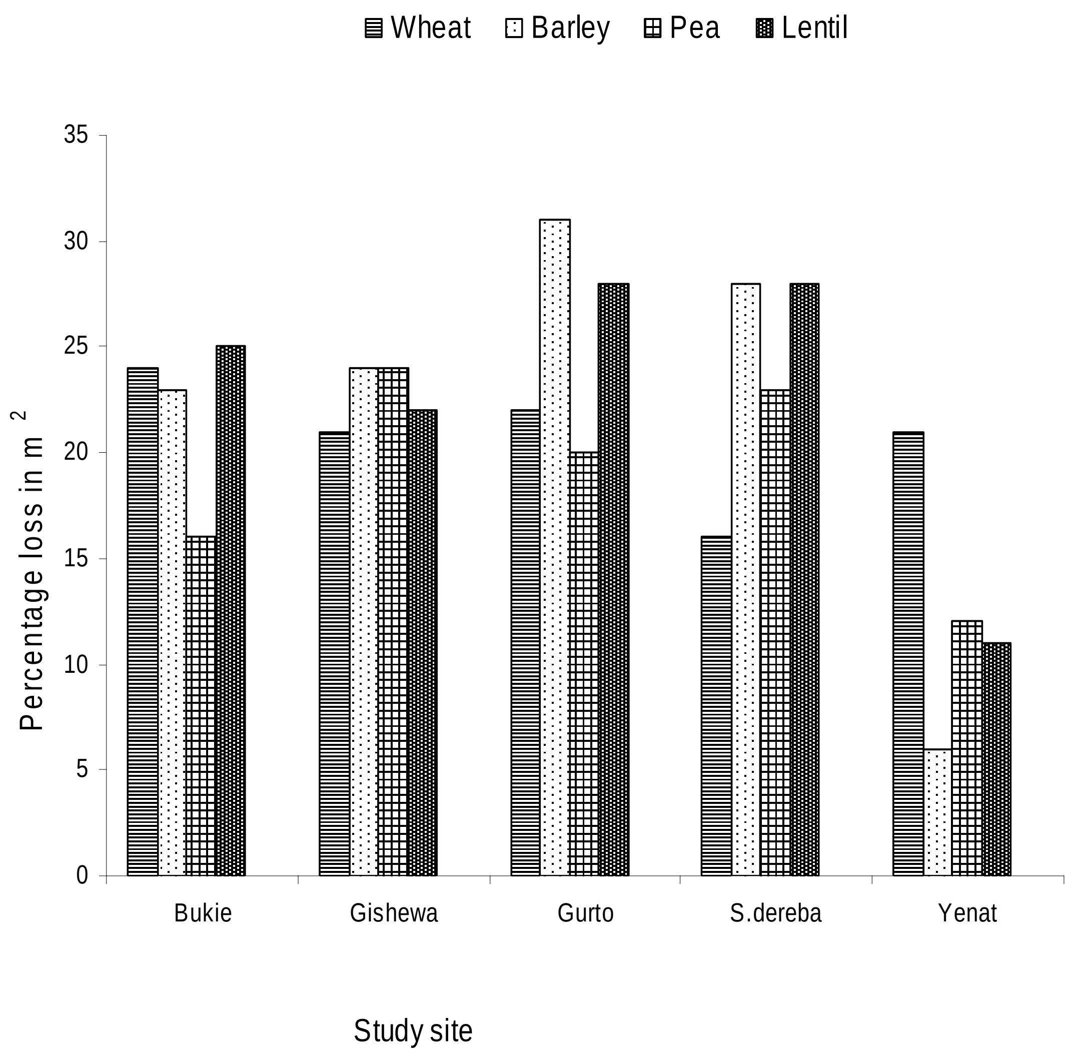

Figure 8. Proportion of losses in total damages of each crop by hamadryas baboons.

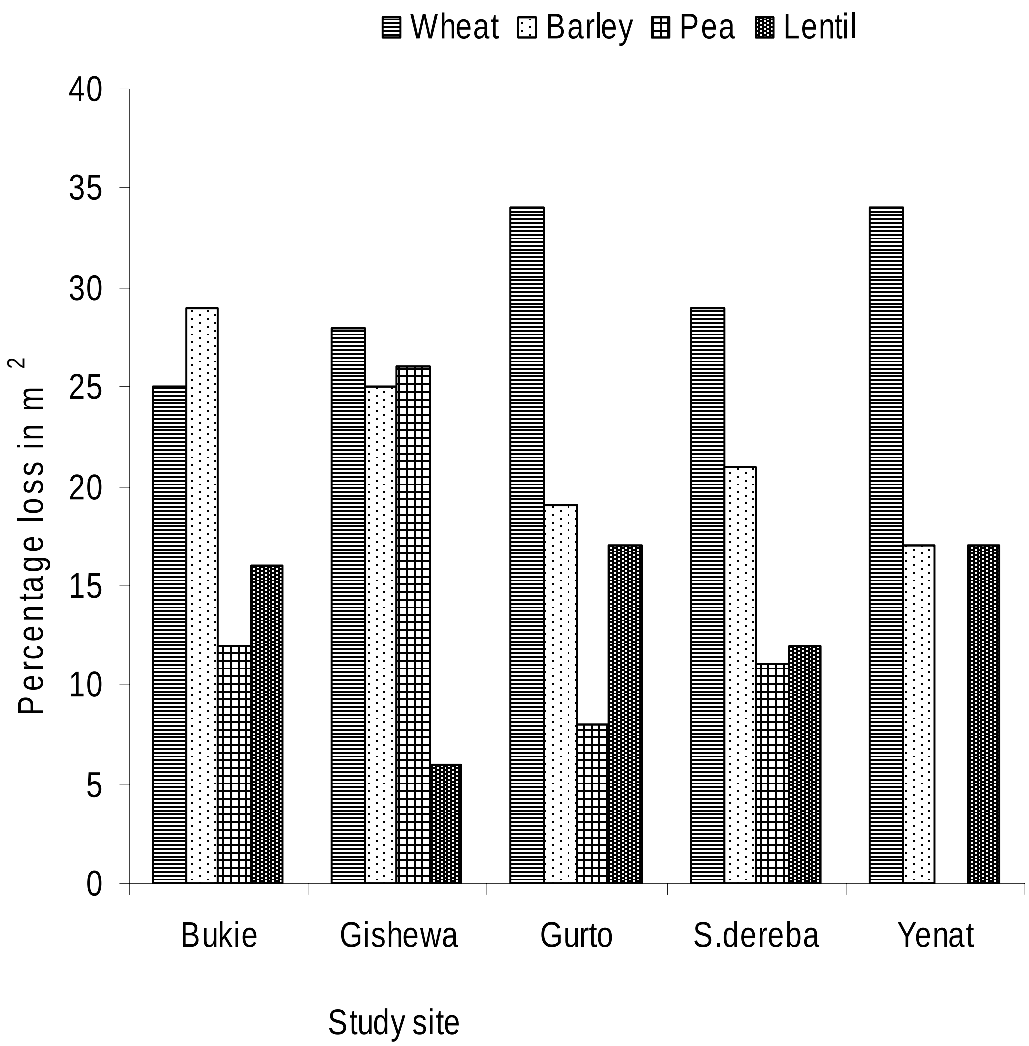

Figure 9. Proportion of losses in total damages of each crop by rabbits.

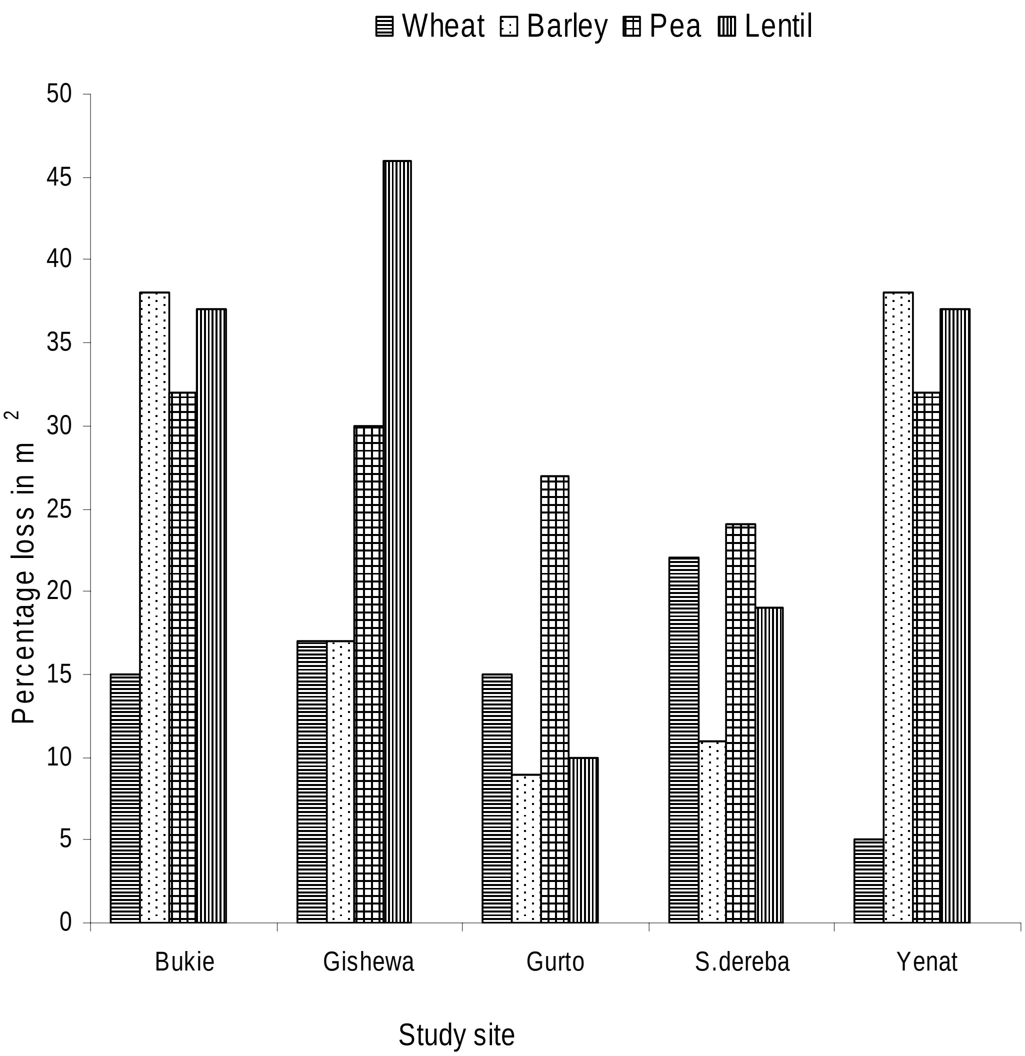

Figure 10. Proportion of losses in total damages of each crop by bushbucks.

Even though, the extent of loss was not high as those of the above four mentioned animals, duiker and klipspringer also caused damaged in all five sites. The two animals together caused 16% and 15% of the total damage on pea at Yenat and Bukie, respectively. At Gishewa and Gurto, these two animals constituted 15% and 10% of the total damage of pea. The least damage recorded by these two animals was at Gurto on wheat and barley, which was 2% and 3% of the total loss.

Duiker, klipspringer and bushbuck were more often seen in pea and lentil fields than in wheat and barley fields. Porcupine was seen only at two study sites namely Gurto and Sekadereba. At these two sites, porcupine caused a damage of 167 m^2 and 98 m^2 potato farmland, respectively.

6. 3. 3. Yield loss estimation

Animals in varying degree caused yield losses at all five sites (Table 17). A total of 749 and 771 kg of yields was lost at Bukie and Gishewa, which was 9.8% and 10% of the total expected yield, respectively. In both cases, the highest loss occurred on wheat yields, which constituted 67% of the loss at Bukie and 54% at Gishewa. Wheat received the highest loss as it covered the largest portion of the cropped land. From a total expected barley yield, which was 990 kg at Bukie and 1263 km at Gishewa, about 181 kg and 166 kg (18.3% and 14.2% of the expected yield) were lost, respectively. Potato was not cultivated in those two sites. The amount of pea lost was 3.7% and 7% of the expected yield and that of lentil was 6.5% and 5.8% at Bukie and Gishewa, respectively. The amount of wheat and barley lost in kg at Gurto was 365 and 115 which was 8.6% and 12.5% of the expected yields, respectively, whereas at Sekadereba 394 kg of wheat and 192 kg of barley yield were lost. Unlike others, at Gurto and Sekadereba, potato crop was lost. At Gurto 167 kg and at Sekadereba 98 kg of potato yield (3.7% and 2.6% of the total expected yield) were lost, respectively. From a total expected yield of pea and lentil, 4.2% and 6% was lost at Gurto, respectively. At Sekadereba 6.7% and 6.5% of the total expected pea and lentil yield was lost, respectively. When crops in kg were pooled for all sites, a significant difference was found in the amount of yield losses between wheat and other four crops ($F_{4\ 20} = 39.92$, $P < 0.05$).

Table 17. Amount of crop loss in kg as estimated through quadrate sampling in fields of five randomly selected sites.

	Loss per site, kg					
Crop	Bulkie	Gishewa	Gurto	Sekadereba	Yenat	Total
Wheat	505	418	365	394	276	1958
Barley	181	166	115	192	102	756
Pea	19	116	29	54	32	250
Lentil	44	71	48	43	24	230
Potato	0	0	167	98	0	265
Total	749	771	724	781	434	3,459

Based on quadrate sampling, about 23,326 kg wheat, 5,970 kg barley, 3,444 kg pea, 3,260 kg lentil and 8,291 kg potato yields were expected (Table18).The highest yield recorded was in wheat while the lowest was on potato.

Of all total expected yield, 3,459 kg was lost by wild animals during the present study (August 2008 to March 2009), which was 7.8% of the total annual production of the sampled area. In monetary term, the overall loss to farmers in the sampled area was estimated at birr 16,653 per 20 ha, which was 9.4% of the monetary value of the annual production. The extent of damage done was significant when tested using chi-square at 5% significant level (Table 18).

Table18. The amount expected and actual yield in kg to show the extent of damage in the study area.

Crop	Expected yield	Observed yield	Yield difference	χ^2	P-value
Wheat	23,326	21,368	1,958	164.4	< 0.05**
Barley	5,970	5,214	756	95.7	<0.05**
Pea	3,444	3,194	250	18.2	< 0.05**
Lentil	3,260	3,030	230	16.2	<0.05**
Potato	8,291	8,026	265	8.5	<0.05**

** Significant at 5%

On the average, the highest loss per hectare occurred on barley while the lowest was on potato, which was 12.6% and 3%, respectively. Loss per hectare for pea and lentil was almost the same (about 7%) and that of wheat was about 8.4%.

7. DISCUSSION

Data collected through the questionnaire survey pointed out that wild animals found around the study area often destroyed standing crops and preyed on livestock, causing economic loss to farmers in the study area. Similar studies in different parts of Africa revealed that wild animals posed major threats on crops and livestock (Hill, 1997; Kagoro-rugunda, 2004; Okello, 2005). Gelada baboon, hamadryas baboon and rabbit were the most feared wild crop pests in the study area. Farmers ranked that gelada baboon is the leading crop raider followed by hamadryas baboon. Respondents in all the study sites stated that, on the average, about 15% and 14% yield of wheat and barley were lost from one ha. Studies conducted in Uganda also revealed that wild animals near protected area destroyed 85% of the crop grown (Kagoro-Rugunda, 2004). Likewise, a survey conducted in India showed that wild animals were responsible for the loss of 19% of the yield expected from one hectare farmland (Sekhar, 1998), whereas a loss of 32% per ha was recorded in Nepal (Limbu, 2003).

Annual loss in monetary term per hectare was highest for wheat when compared to all crops except lentil. Because wheat crop constituted the highest portion of the crop field in each site, it received the highest damage and thus the greatest monetary loss in each site. A farmer around the study area lost birr 1,102 income from one hectare of wheat field due to crop raiding animals. This monetary loss was about 15% of the monetary income that the farmer expected from one hectare wheat field. The second more available crop in the study area was barley next to wheat. The monetary loss due to wildlife damage on one hectare barley field was estimated as Br 918, which was 14% of the income that a farmer would get. Pea received the lowest monetary loss per hectare of all grain crops. A farmer who had one hectare of pea field around the study area would loss about 12% of his monetary income due to wild animal damage. The amount of loss in kilogram per hectare for lentil yield was the lowest of all grain crops but its monetary loss per hectare was greater than pea and barley and equal to wheat. This is because the market value of lentil per km was the greatest of all crops in the local market during the study period. Pea and lentil were rare during the dry season as they were harvested or even if they were present at the beginning of the dry season, guarding on these two crops was high. This was one of the reasons why their damage per hectare was lower than wheat and barley. A study conducted in Uganda, revealed that crops such as pea, bean and lentil harvested in relatively shorter periods of time than crops such as wheat and sorghum and thus they received relatively lower damage (Kagoro-Rugunda, 2004). The loss on potato was the lowest of all crops. Potato was damaged by porcupine only in the study area and grown near villages and thus easily looked after by humans or dog. In addition, during the dry season, the land was very hard to dig and thus the animal could not find the potato tuber. A survey conducted in Tanzania also showed that tuber crops such as potato was not damaged much by wild animals during the dry season as the land become hard and thus animals could not dig that easily (Hill, 1997).

The analysis of data collected through direct observation also has shown more or less the same result with that of questionnaire survey. Species observed damaging crops were the same as those species listed under questionnaire survey. But in the case of direct observation, rabbit was the second most important crop raiders next to gelada baboon, rather than hamadryas baboon. The result of direct observation has shown that all types of crops cultivated in the study area were damaged by all species except that rabbit did not cause damage on pea at Yenat. Porcupine was observed damaging crop only at Gurto and Sekadereba where potato crop was found.

During the time of direct observation, gelada, hamadryas and rabbit were seen damaging all types of crops except potato in all developmental stages. However, bushbuck, duiker and klipspringer damaged crop actively few weeks after germination. But they also caused damage on pods of pea and lentil while the pod was emerging. Studies conducted in Uganda and Nigeria revealed that bushbuck and duiker mostly caused damage on pods of bean, pea and lentil (Warren, 2007; Kagoro-Rugunda, 2004).

A total of 963 damage incidents were recorded in all five study sites during both the wet and dry seasons. Damage incidents recorded at Bukie was the highest of all sites but Yenat received the lowest damage events. More damage events were recorded during the wet season than the dry season. The possible reasons was that farmers did not guard crops during the young stage and bushbuck, duiker and klipspringer were actively involved while the crops were young and pea and lentil crops were harvested at the end of the wet season. In Tanzania, it was found that crop damage by wild animals decreased during the harvest season as farmers highly guarded their crops (Sillero-zubiri and swetzer, 2001).

Gelada baboon, hamadryas baboon, rabbit and bushbuck were the top four crop raiders in the study area. Baboons such as hamadryas, and antelopes such as bushbuck and duiker caused significant crop damage in Tanzania and Uganda (Hill, 1997; Kagoro-Rugunda, 2004). In the present study, the above four mentioned animals caused significant yield loss at varying degrees.

Farmers in the study area have developed different strategies to prevent their crop against wild animal crop damage. Guarding was one of the most common strategies farmers employed in the study area. Guarding was a popular method in different parts of Africa (Sillero-Zubiri and Swetzer, 2001). More than 90% of respondents stated that they guarded crops against wildlife damage. Guarding was common specially during the harvest season. During this time, farmers guard crops even during the night time. Crops which had high market values, for example, lentil was guarded highly. Farmers, who had no children to guard their crops, chase wild animals away from the nearby area of the farm at certain time interval. Fencing was also used specially near villages. Fence was made of local materials such as thorny bush, wooden pole and stones but farmers claimed that animals easily cross the fence through it. In some areas, farmers scatter dung of sheep and goat over farmland as they assumed that bushbuck and duiker dislike the scent of the dung. About 2% of the respondents stated that they used trapping to kill rabbit.

Hyaena preyed on all types of livestock but leopard and common jackal preyed on sheep and goat. Respondents stated that leopard attacked cattle specially calves and adult cows. During the period of three years and five months, respondents lost 60 goats and 44 sheep. Of the 60 goats, leopards preyed on 33 individuals, 55% of the total kills. Study conducted in India also revealed that leopard mostly preyed on goats and sheep but sometimes, it preyed on cattle (Sekahar, 1998). Common jackal caused half of the total sheep predation. Respondents stated that leopard did not come out of the forest to prey, rather it preyed when the livestock entered the forest. In contrast to leopard, common jackal caused most kills outside the forest. Predation by hyaena took place either inside the forest during the day time and near villages during the night time. Respondents stated that most kills were occurred during the dry season when livestock was freely released with out guard. Total number of livestock killed by leopard was greater than that of hyaena; however, amount of monetary loss caused by leopard was less than hyaena. This is due to the fact that hyaena preyed on larger animals, which had greater monetary value.

Previously it was stated that gelada baboon was found in different northern high lands of Ethiopia even though complete assessment was not conducted in different high land areas (Croock, 1966; Dunbar, 1977).The present study re-enforced this suggestion as it provide additional gelada population, which was not determined before the present study. In the present study, 951 geladas were recorded in the entire study area of a total area of 55 km^2. Thus, a density of 17 geladas per km^2 was found in the study area. According to Duinbar (1980), the density of gelada baboon around Simien Mountains National Park ranged from 15-70 individuals.

With respect to the structure of the reproductive unit, one breeding male and 2-5 sexually matured females were a common organization among the population of gelada baboon in the present study area, whereas the number of total recorded individuals in the group ranged from 5-18. Study conducted in Simien Mountains National Park revealed that the size of reproductive unit ranged from 3-23 and, on the average, four adult females were found in each reproductive unit (Dunbar, 1983). Sex ratio of adult and sub-adult male geladas to that of adult and sub-adult female geladas was 1:2.64. The ratio did not deviate much as such from that of the ratio determined in Simien Mountains National Park (dunbar, 1983), which was of 1:83 male to female.

In the present study, the number of gelada population was increased during the dry season by 74 individuals when compared with that of the wet season. During the wet season, farmers cultivated their farmland all round the forest and thus they chased baboons from the edge of the forest. In response to this chasing, some of the gelada population might temporarily migrate to the nearby semi-arid rangeland, where no more human interferences occur.

8. CONCLUSION AND RECOMMENDATIONS

Farming system around the study area was traditional seasonal type and mixed agriculture. Most of the villagers grew wheat crop but barley, pea, lentil and. Villagers in the study area rear livestock mainly sheep, cattle and goat. However, there was scarcity of grazing land. They utilize resources such as fodder and fuel wood from the forest.

The data presented provide evidence that most of the villagers experienced crop damage by wild herbivores and livestock depredation by carnivores. Gelada baboon, hamadryas baboon, rabbit and bushbuck were the main crop raiders in the study area, while leopard, common jackal and hyaena were the main predators of livestock and pack animals. Therefore, based upon the present study, the following suggestions are recommended to mitigate the human-wildlife conflict in the study area.

- The local people depended on the forest for different resources such as fodder, grazing land and fuel wood. Such human activities that lead to the degradation of the natural habitat may encourage wild animals to destroy crops. Therefore, to decrease the dependency of the local people on the forest, it needs to encourage the local people to plant trees for their different utilization and make them to have grazing land.
- Locals should be encouraged to reduce the number of livestock and to plant different vegetations for the purpose of fuel wood, fodder and other house use.
- Crop damage depends on the taste of the crop plant. For example, in the study area, porcupine totally feeds on potato crop while bushbuck and rabbit frequently use legumes and

wheat crops, respectively. Therefore, the food habit of wildlife should be thoroughly studied and villagers should be encouraged to grow less preferable and unpalatable crop to wildlife.

● Some residents claimed that poaching of bushbucks and lumbering of trees is still a problem. So such illegal activities should be strictly controlled.

● Effective conservation of the forest can not be imagined without the help of the local people. Effort should be made to create awareness among the local people to develop the knowledge about the issue of environmental degradation and its overall impact. Education on the importance of conservation of natural resources should be given frequently for the residents.

● The topography of Denkoro Forest and the surrounding areas is very attractive and interesting and thus they have great potential for tourism. But facilities such as roads, experienced wildlife experts for that area and field guides are lacking. If such and other facilities are fulfilled, tourists can visit the area and the local people will improve their economic status by different means such as hotels, lodges, restaurants, selling local products and hiring horses. This in turn will develop positive attitude among the local people towards the forest.

● At the periphery of the forest, farmers keep on expanding their cultivation and livestock grazing. The periphery of the forest is the area where gelada baboons frequently graze. In this area, it is common to see the gelada population grazing with livestock. So in the long run, the gelada population will be affected unless farming and grazing at the periphery of the forest curtailed.

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10. APPENDICES

APPENDIX I

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

1. Respondents’

    Name…………………………………………………………..

    Age………………Sex………………

    Educational background

    Able to read and write………………………….

    Unable to read and write……………………….

2. In which group you are a member?

    Head of household…………………………………..

    Members of household………………………………

3. What is the size of your farmland? ……..................................

4. What type of crop do you grow in this year?

    ……………………… ………………………. ………………………..

    ………………………. ……………………….. ……………………….

5. How many kilogram (quintal) yields did you get last year?

Crop type	size of the field	yields obtained
……………………..	………………..	………………………..
………………………	…………………	………………………..

……………………... ………………… ………………………..

……………………... ………………… ……………………….

…………………….. ………………… ………………………

6. If you have livestock, list their names and number as follow.

Name of the livestock number

…………………………………… ………………

………………………………….. ……………….

…………………………………… ……………….

…………………………………… ……………...

………………………………….... ……………….

………………………………….... ……………….

7. Which of the following resources do you use from the forest?

Grazing land Fire wood

Fodder Wood for house construction.

All of them

8. List the type of wild animals that you know in and around Denkoro Forest

………………………… ………………………. ……………………….

………………………… ………………………... ..……………………….

………………………... ……………………….. ………………………

……………………….. ………………….......... ………………………

. ……………………….. ………………………… ……………………….

.. ……………………... …………………………... ……………………….

9. Do wild animals cause crop damage? Give answers for the following table.

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

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

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

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

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

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

Wheat------------- barley-------------- pea------------ lentil------------- potato-----------

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

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………..

……………………………………………………………………………………………..

13. Are there wild animals which prey your domestic animals? If you say yes, fill the following table for the specified years (September, 2005-January, 2009).

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 gelada baboon.

Date______________________
Species____________________
Season___________________
Place ____________________
Site______________________
Altitude__________________
Name of data collector________________________________

S.No.	Group type	Age structure					
		AM	AF	SAM	SAF	Young	Infant
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
Total							

AM = adult male, AF, adult female, SAM = sub-adult male, SAF = sub-adult female

I, the under signed, declare that this thesis is my original work; it has not been presented in other university, college or institutions, seeking for similar degree or other purposes. All sources of the materials used in the thesis have been dully acknowledged.

Name: Mussa Adem Feleke

ID. No.: GSR/1149/00

Date: July 06, 2009

Signature………………….

Place: Addis Ababa University

This thesis has been presented with my approval as supervisor

Prof. Afework Bekele

Date: July 06, 2009

Signature…………………..