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COLLEGE OF NATURAL SCIENCES

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DEPARTMENT OF BIOLOGY

(ECOLOGICAL AND SYTEMATIC ZOOLOGY STREAM)

DIET COMPOSITION OF SPOTTED HYENA *(CROCUTA CROCUTA)* IN AND AROUND GARBAGE DUMPING SITE IN ABI- ADI TOWN, CENTERAL TIGRAY- THE CASE OF LIVESTOCK DEPREDATION AND LOCAL PEOPLE'S ATTITUDE

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Diet Composition of Spotted Hyena *(Crocuta Crocuta)* In and Around Garbage Dumping Site in Abi- Adi Town, Cental Tigray - The Case Of Livestock Depredation And Local People's Attitude

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Declaration

I declare that the thesis entitled" Diet composition of spotted hyena *(Crocuta crocuta)* in and around garbage dumping site in abi- adi town, centeral tigray- the case of livestock depredation and local people's attitude" comprises research work done by me under the supervision of Dr. Tsegaye Gadisa and co-advisor Dr. Gidey Yirga. This work is original and has not been reported earlier by anyone else in the study areas. Part of this work, which is related to or similar to work done by other researchers, has been referred to in this thesis in appropriate places.

Name: Mihret Girmay

Signiture _____

Date   _____

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS

IUCN	International Union for Conservation of Nature
LPD	Livestock Protection Dogs
UK	United Kingdom
HWC	Human Wildlife Conflict
BMNP	Bale Mountain National Park
ETB	Ethiopian Birr
PA	Protected Area
SPSS	Statistical package for social science

ABSTRACT

The diet composition of spotted hyenas (Crocuta crocuta) in and around urban garbage dumping site of Abyi Adi town, Centeral Tigray- the case of livestock depredation and local peoples' attitude was studied from March-April, 2013. A total of 143 hyena scat samples collected from the study area and washed and hairs were extracted. Hair was analyzed based on form, length and color with the naked eye as well as by using a microscope at 10 x magnifications compared with a prey species hair reference collection. The scat analysis revealed that the diet of spotted hyena contains 96.16% prey item of livestock and 3.84% prey items of wildlife. Frequencies of prey items identified in decreasing order were; donkey, goat, and sheep in and around garbage and goat, sheep and donkeys far from the garbage area. Economic impact of livestock predation was assessed through household survey selected by systematic random sampling technique. The age, number and sex of livestock killed by spotted hyena were recorded and estimated average cost of livestock lost and the average price collected from local livestock seller. A total of 535 livestock; 175(32.7%) and 360 (67.3%) were reported to be killed by hyena over 5 years from around and far from garbage dumping areas respectively. The average annual livestock loss resulted in estimated economic loss per household were 518.8 birr and 388.6 birr from around and far from garbage area respectively. Households of the study area reported that they were protecting livestock by fence, dog and shepherd from hyena predation. However, the constructing materials and height of fence was insignificant association with livestock protection. Perception towards spotted hyena was also surveyed on a total of 355 households of urban and villages of around and far from garbage dumping areas. 48%, 26.8% and 25.2% of respondents had positive, negative and neutral perception towards hyena respectively. Education, residence, sex and age influenced the perception of respondents towards hyena. In general, hyena depredation livestock due to absence of natural preys and cause an economic value. Mitigation livestock depredation is highly recommendable either through improved animal husbandry or through ecosystem regeneration and give education and training to create awareness.

Key words: Depredation, economic impact, livestock, livestock protection, perception,

Spotted hyena

1. INTRODUCTION

1.1. Background of the study

Knowledge of feeding biology of large carnivores helps significantly to the understanding of their behavioral ecology and may have an important implication when formulating species and ecosystem management strategies (Mills, 1992). The availability and distribution of preys can influence prey selection and hunting success (Fuller *et al*., 1992). Many researchers have studied the diet of large carnivores using scat analysis (Abay *et al*., 2011). Scat analysis is the primary tool used to assess carnivore diets, especially when focusing on individual prey items (Klare *et al*., 2011). It is widely used because, costs less, relatively quick to apply and large samples can be collected (Litvaitis, 2000).

Spotted hyenas (*Crocuta crocuta*), hereafter referred to as hyenas, are the most abundant large carnivore in sub-Saharan Africa and occurring in a wide variety of habitats; outside tropical forests, alpine areas and true deserts (Frank, 1986 and Hanssen, 2009). Hyena is classified as Lower Risk and total world population size is estimated between 27,000 and 47,000 individuals (Mills and Hofer, 1998) with several subpopulations exceeding 1000 individuals and a range of well over 20,000 km^2 (Honer *et al*., 2008). Persecution, disease especially rabies and habitat loss causes the rapid decline of populations outside conservation areas (Mills and Hofer, 1998).

According to East and Hofer (2001), hyenas occur in close association with human habitations in many parts of the world. In the Horn of Africa, they are closely tied to removing garbage and carrion from most towns and cities (Gade, 2006). Hyenas feed on a wide group of preys (Cooper *et al.,* 1999) and commonly interact with other predators and scavengers at kills (Kruuk, 1972). Hyena prefers preys with medium to large body size ranging from 56–182 kg, but they have no clear preference for any particular species (Hayward, 2006).

Hyena kills domestic stocks mainly cattle, donkeys, sheep and goats and varies widely in intensity (Mill and Hofer, 1998). Accordingly, hyena predation on livestock cause significant economic damage to individual households especially subsistence farmers (Yirga and Bauer,

2010a). In addition, they have also been known to attack and kill humans, especially during human disease outbreaks (Kingdon, 1977 and Hofer, 2002).

Kraals (bomas) are a widely used method of protecting livestock from hyena predation (Yirga and Bauer, 2010b). This is an enclosure that is used to keep livestock safe. For instance, in Bale Mountain small livestock are kept in temporary wooden bomas at night (Atickem *et al*., 2010). During the day, large livestock are left to wander alone while small livestock are herded by children (Atickem *et al*., 2010). In Swahili word "boma" means enclosure and circular fence customarily made from thorn that surrounding the Maasai village as an inner fence (Muchiru *et al*., 2009). The presence of domestic dogs and the use of thorn fences are efficient in reducing attacks on domestic stock by hyenas and other predators (Yirga and Bauer, 2010 a, b). In Northern Kenya, hyena accounts for 90% of livestock losses outside the protection of thorn fences (Kruuk, 1980).

Human attitude towards a particular carnivore tend to be influenced by any behavior of that species which negatively impacts upon human activities (Shivak *et al*., 2003 and Lindsey *et al*., 2005). Attitude and perception of local people often hold negative, when carnivores prey upon livestock (Oli *et al*., 1994). Consequently, the conservation of large carnivores may fail without involving of neighboring communities (Sillero Zubiri and Lauren-son, 2001).

According to Yirga and Bauer (2010a) hyena is the leading causes of depredations on domestic livestock in southern Tigray. However, the attitudes of farmers towards the predation problem are poorly understood (Yirga and Bauer, 2012). People respond to livestock depredation by poisoning carnivores, habitat destruction and direct killing (Yirga and Bauer, 2012).

There is only little scientific literature of hyena in Ethiopia, particularly done only in some part of northern Ethiopia (Yirga and Bauer 2010a, b; Abay *et al*., 2011 and Yirga *et al.,* 2012). No research has been done about hyena in Abi-Adi, central zone of Tigray, mainly in the urban garbage dumping area. Therefore, the present study was carried out to investigate diet composition of spotted hyenas (*Crocuta crocuta*) in and around urban garbage dumping site of Abyi Adi town, Central Tigray- the case of livestock depredation and local peoples' attitude.

1.2. Statement of the problem

Hyenas are a major livestock predators and often killing more valuable livestock (Yirga and Bauer, 2010a, b). They have posed pressure to pastoral farming of camels, horses, donkeys, cattle, sheep and goats, and also kill poultry, cats and dogs (Dikobe, 1997 and Yirga and Bauer, 2010a). Losses of livestock influence the utility resulting from livestock and financial gains from direct sales (Dikobe, 1997).

According to Kolowski and Holekamp (2006), hyenas are more likely to be found near open refuse pit during times of relative prey scarcity, indicating the potential impact of human refuse at pastoral villages to increase livestock losses by hyenas. Furthermore the livestock depredation is higher where hyenas are more abundant in waste areas. In the northern region of Ethiopia, natural prey base is highly depleted, and spotted hyenas are highly dependent on anthropogenic food sources (Abay *et al*., 2011 and Yirga *et al*., 2012).

In Abi- Adi town, the main garbage dumping area is found near to the bordering of the village area (*pers. observ*.). Hyena prefers this area in order to find food residue and dead animals. For that reason it is expected that they occur in large numbers, feed on organic matter of different preys on the garbage and kill livestock around that area and cause economic impact on the stakeholders. Diet composition, economic loss caused by hyena due to livestock depredation in and around urban garbage dumping site and human attitude towards hyena is not studied in this study area. Therefore the current study was designed to investigate diet composition, quantify economic loss of the livestock depredation, investigate attitude of humans, assess techniques of livestock protection in households and evaluate effectiveness of kraals in the study areas.

Research questions

- What is the diet of hyena in the study areas?
- Is there variation in diet of hyena in garbage dumping and natural areas?
- Is there variation in terms of economic loss between areas closes to garbage dumping and locations further away?

- How stakeholders protect their livestock's from the spotted hyena predation and what is the effectiveness of kraals (enclosure)?
- What is the attitude of humans towards spotted hyena related to gender, educational status and residence (rural or urban) of the respondents?

1.3. OBJECTIVES

1.3.1. General objectives

To study the diet composition of spotted hyenas (*Crocuta crocuta*) in and around urban garbage dumping site of Abi-Adi town, Centeral Tigray- the case of livestock depredation and local peoples' attitude

1.3.2. Specific objectives

- ✓ To investigate diet of hyenas in and around the garbage dumping area and natural areas
- ✓ To assess the economic loss caused by hyena predation on livestock in study areas
- ✓ To assess method of livestock protection and evaluate the effectiveness of fence (enclosure) in protecting livestock from hyena predation
- ✓ To investigate human attitude towards hyenas related to gender, age, educational status and rural and urban residence of respondents

1.4. Significance of the Study

The study was carried out to investigate diet composition, economic loss caused by hyena due to livestock depredation and human attitude towards spotted hyena. Hyena has its own importance as a wild- life for maintaining ecosystem by predating on other predators and senatorial environments. The study would help to develop strategies of livestock management and ecosystem conservation to the future. The result of this study will also serve as baseline for further investigation of related fields.

1.5. Limitation of the study

The major limitation in this study was lack of relevant socioeconomic data on population of the study area. For example, numbers of households and livestock in study areas were differently estimated.

The problem is due to restructuring of Kebeles, reorganized (merging) two or more Kebeles under one Kebele administration or divided a Kebele into two administrations made few households registered more than one. All these together with distributions of randomly selected households, made the identification of sample households difficult.

Willingness of selected households to give reliable information and participate in the study was also another difficulty. Because some people fear due to listen to legend and believed that hyenas are evil, so getting the relevant information difficult.

In general, since no such kind of study has been conducted so far in the study area, lack of references, baseline data on hyena or any other large carnivores are not studied, so information about the study location and hyena was difficult to find.

1.6. Organization of the Study

The study is classified into eight chapters. The first chapter introduces the thesis incorporating background of the study, statement of the problem, objectives, research questions, significance of the study, and limitations of the study. The second chapter present review of literature. The general background of the study area and the research methodology are explained under the third chapter where data source of the study, sampling methods, sample size determination and method of data of analysis are explained. Chapter four and five presents the main part of the thesis which is called result and discussion. Chapter six contains conclusion and recommendation of the study. The seventh chapter present reference part and the final section is devoted to appendices.

2. LITERATURE REVIEW

2.1. Spotted Hyena

Family Hyaenidae contains only four living species and it is one of the smallest carnivore families (Smith and Holekamp, 2010). These living species are; aardwolf (*Proteles cristata*), the only surviving member of the subfamily Protelinae, brown hyena (*Parahyaena brunnea*), striped hyena *(Hyena hyena)* and spotted hyena *(Crocuta crocuta)* that belong to the sub family Hyaeninae (Smith and Holekamp, 2010).

Spotted hyena is classified under class mammalia; order Carnivora; Family Hyaenidae; Genus *Crocuta* and Species *Crocuta crocuta* (Honer *et al*., 2008). It has different names in different regions of Ethiopia; In Somali and Harari the spotted hyena is known as "woraba", in Oromia as "warabessa", in Amhara as "djibb", in Tigray as "zibbi" and in Afar (Danakil), it is "jangoula"(Gade, 2006).

Hyena has heavily built body, large head, rounded and powerful with a short and blunt muzzle, rounded ears, thick neck and short tail which is fairly thin and ends in a black, bushy tip (Mills and Hofer, 1998). It has general body color ranging between sandy, ginger to grayish brown background and blackish or dark brown spots, but may turn brown and fade with age and hair is short (Mills and Hofer, 1998). Their total body length is 1.3-1.85m and body mass ranges from 45-55 kg in the Serengeti (Mills and Hofer, 1998) but more than 70kg in southern Africa (Mills, 1990).

Spotted hyenas live in permanent complicated, female dominated societies, called clans, containing 6–90 individuals (Holekamp *et al*., 1996). Each clan is unbendingly structured by a linear dominance hierarchy and an individual's position in this hierarchy determines its priority of access to food (Kruuk, 1972; Tilson and Hamilton, 1984; Smith and Holekamp, 2010). Low ranking hyenas often must wait on the sidelines and feed only after high ranking hyenas have had their fill (Fig. 1). Sub adult individuals of both sexes maintain their maternal ranks as long as they remain in the natal clan (Smale *et al*., 1993). Females are normally philopatric and spend their life in their natal clans (Frank, 1986). Almost all natal males disperse between the ages of 2 and 5 years (East and Hofer, 2001; Van Horn *et al*., 2003).

Clans are fission–fusion societies in which all members know one another individually, rear their cubs together at a communal den and defend a common territory (Smith and Holekamp, 2010). Yet clan members spend much of their time alone or in small subgroups (Smith and Holekamp, 2010). Female hyenas breed 1-2 (rarely three) young in isolated natal dens (Holekamp *et al*., 1996). Cubs are typically transferred to a communal den at two to five weeks of age, where all cubs inhabit that are 7-8 months of age (Kruuk, 1972). According to Boydston *et al.* (2006), the juvenile hyenas are nursed by their mothers until old enough to feed, even when the mother must traverse long distances to the den due to the migration of prey herds away from a hyena clan's range.

Figure 1: Social dominance hierarchy of the clan members of hyena determines its priority of assess to food at kill sight (Smith and Holekamp, 2010)

2.2. Diet and Foraging of Hyena

Hyena has an incredible behavioral plasticity and can be nocturnal or diurnal (Van Meter *et al*., 2009). It is opportunistic predator hunting which ever species is locally most abundant and is an efficient predator in its own right (Cooper *et al*., 1999). According to Cooper *et al.,* (1999) although spotted hyenas scavenge opportunistically; they kill as much as 95% of the food they eat. It can be very opportunistic and has been recorded feeding more or less any mammal, bird, fishes or reptile, other species and digesting all parts of their prey except hair, horns and hooves (Sillero-Zubiri and Gottelli, 1992). Their greatly strong jaws can crush and chew up bone, and the acidic content found in their stomachs can digest it. Their droppings appear pale and crusty because of all the powdered bone in them (Smith and Holekamp, 2010).

Hyenas detect prey by sight, sound and smell and they find carrion by sound of other carnivores feeding (Mills and Hofer, 1998). Hunting is more important than scavenging in the feeding ecology of the hyena (Kruuk, 1972). Many succeeding workers have now replicated Kruuk's finding that hyenas are predominantly predators (Cooper, 1990; Mills, 1990). The most common and preferred prey are medium and large sized mammalian herbivores, such as various antelopes, zebra (*Equus grevyi*), cape buffalo (*Syncerus caffer*) juvenile rhinos (*Diceros bicornis*), hippos (*Hippopotamus amphibius*) and giraffes (*Giraffa camelopardalis*) (Mills and Hofer, 1998).

In contrast to the other members of the family Hyaenidae, hyena hunts either alone or with other members of the social unit (Mills, 1990; Cooper, 1990; Hofer and East, 1993). As hyenas are very flexible in their diet, species mainly hunted depend on the local abundance of prey (Cooper, 1990). Kruuk (1972) found that hunts of gazelles and wildebeest were most frequently initiated by lone hyenas, whereas zebra were hunted by groups containing an average of 11 hyenas. Group hunts of some prey types, for example wildebeest calves, are significantly more successful than hunts performed by lone hyenas (Kruuk, 1972). Only zebra were hunted by groups more often than by solitary hyenas (Holekamp *et al*., 1996). Furthermore, hyenas are quickly adapting to seasonal fluctuations of prey abundance by switch to herbivore species most frequently killed (Holekamp *et al*., 1997 and Cooper *et al*., 1999).

2.3. Hyenas Scavenging in Garbage Areas

Hyena is a scavenger that picks up leftovers at the kills of other sympatric carnivores (e.g., cheetah, leopard, or lion) or feeds on carrion (Simith and Holikomp, 2010). Hyenas have a main role in removing garbage and carrion from most towns and cities (Gade, 2006) (Fig.2). They also reduce fly and rat populations and fetid odors (Gade, 2006). It can consume a third of its weight at a single meal (Kruuk, 1972) and accepts every kind of organic substance. Meat and offal may be preferred but a hungry animal will also consume hide, hooves, hair, teeth, and bone. Hyenas also eat greedily human and animal feces and kitchen scraps of vegetable origin (Johnson, 2006).

Figure 2: Hyenas scavenging (feeding) at garbage dumping site in Harer (Photo by Dloniak, 2012)

In Ethiopia various people have frequently commented on hyenas scavenging in towns. For example, Gade (2006) relates that; in Adwa, Augustus (1901), wrote those animals were "the best municipal workers …I have been down a street in the afternoon and seen a dead mule on the

ground and passed the next morning and found only a small number of bones left". Besides, in Addis Abeba; Charles Rey (1924) found that those "four footed garbage cleaner" came up each night from the river valley below to consume left materials in alleyways. Kalab, (2001) stated that the growth of the city reached more than 1 million people by 1973 and they did not eliminate the "djibb" from city. In that period hyenas still were the most efficient means of maintaining sanitation in the town. Yirga *et al.,* (2012) has reported that hyenas clean up organic waste of Mekele town and also they are the most efficient means of maintaining sanitation of Arid, the main campus of Mekele University. They have removed waste of butchers and households from the city and are traditionally known as 'municipal workers' (Yirga *et al*., 2012)

2.4. Economic Loss caused by Hyenas

The African lion (*Panthera leo*), spotted hyena (*Crocuta crocuta*) and leopard (*Panthera pardus*) are all killed in reprisal for livestock predation, but each species endures differently from these conflict due to differences in predatory behavior and cultural attitudes of pastoralists (Kissue, 2008). Predation on domestic livestock and poultry by large carnivores are a historical and continuing problem faced on agricultural producers throughout the world (Harris and Szunders, 1993). These carnivores depended entirely on domestic prey species, partly through depredation and partly through scavenging in urban wastes (Abay *et al.,* 2011). Lion, leopard and cheetah range widely outside game reserves and national parks and are thought to do most damage on livestock (Dikobe, 1997). Moreover, hyena damage to domestic stock mainly cattle, sheep and goats varies widely in intensity (Mill and Hofer, 1998).The importance of domestic stock as a food item may depend on stock keeping practices (Kruuk, 1980), availability of alternative prey, and availability of human-associated sources of refuse and other organic material (Mill and Hofer, 1998).

Large carnivores are in clash with the interests of humans to a greater extent than do many other groups of animals (Mills, 1998 and Madden, 2004) and cause an economic damage and ill will (Hemson, 2003). Livestock predation can cause significant economic losses among pastoralists. For example, Patterson *et al*., (2004) estimated livestock predation to represent 2.6% of the herd's economic value in a Kenyan ranch which warrant a loss of $8749 per annum. Similarly, Mishra (1997) reported an economic loss of $15418 due to predation among the Indian-trans

Himalayan communities equivalent to $128 loss per family per year. Besides, Abay *et al*. (2011) reported that in Enderta sub district, Tigray, hyena depredation causing an estimated financial loss of about US$ 35,208 over 5 years and an annual mean worth US$ 7,042.

In southern Tigray, human-hyena clash showing that livestock losses caused by the hyena represent an economic concern for livestock owners (Yirga and Bauer, 2010a). However, the tolerance of predators by local communities regularly depends on the size of predation on their livestock (Woodroffe *et al*., 2005 and Kolowski and Holekamp, 2006). In south eastern Tigray the predation of hyena on livestock gives a great economic importance and cause more a problem in the village (Yirga and Bauer, 2010b). In this village it causes an estimated financial loss of about US$ 6,116.

2.5. Human- Hyena Conflict

Worldwide, population of lions (*Panthero leo*), cheetahs (*Acinonyl jubatus*), spotted hyena (*Crocuta crocuta*), tiger (*Panthera tigers*), snow Leopards (*Uncia uncia*), grey wolves, (*Canis lupus*) and other species continuous to decline primarily due to conflict with people (Nowel and Jackson, 1996; Mill and Hofor, 1998). Expanding human populations and changes in utilization of land towards more cultivation will lead to an increase in human-wildlife conflict with potential enhancement in human related mortality in hyenas (Ogutu *et al*., 2005). Human contravention into wilderness is increasing worldwide, retreating lands for wildlife. Human population growth wears away at grazing areas, increasing competition between livestock and herbivores resulting in a reduction prey base for large carnivores (Ogutu *et al*., 2005).

Increasing pressure of population growth around PAs forced the carnivores to share their geographical distribution area with humans, which resulted in a human carnivore conflict or human-wildlife conflict (Mcdonald, 2002). It has become more frequent and sever over resent decades as a result of human population growth degradation of natural habitats, extension of transport routes and expansion of agricultural and industrial activities which together have led to increased human encroachment on wild and uninhabited areas (Lamarque *et al*., 2009).

Livestock depredation in particular has been a serious challenge to conserving threatened predators outside PA (Treves and Karanth, 2003) with predators potentially adversely affecting the profitably of livestock production and people livelihoods. Conflict between human and carnivores that kill livestock is a worldwide phenomenon with significant conservation implication. Well known examples of human-carnivore conflict include hyena (*Crocuta crocuta*) and lion (*Panthera leo*) in Africa (Kolowski and Holekamp, 2006); snow leopard (*Uncia uncia*) in India and Pakistan (Hussian, 2003); wolves (*Canis lupus*) in North America (Mazzolli *et al*., 2002) Puma (*Puma concolor*) and jaguar (*Panthera onca*) in South America (Polisar, 2003) and dingoes (*Canis lupusdingo*) in Australia (Allen and Sparkes, 2001).

Hyenas are becoming extremely rare outside PA due to both direct and indirect persecution (Hanssen, 2009). The species is threatened directly when killed due to threats on human and livestock and indirectly, when get into snares set for other species. This reduction in the number and distribution of hyenas has been accelerating as human population increases (Nowell and Jackson, 1996), resulting in an increase in conflict with human development.

According to Pangle and Holekamp (2010) between 1988 and 2006, 20 of 83 hyena deaths of known causes in the Talek West of Massi Mera National Reserve clan could be attributed unambiguously to humans, mainly by spiking, snaring or poisoning. Therefore, illegal shooting, snaring, spearing and trapping are the main causes for population decline (Mills and Hofer, 1998). To reduce this conflict, knowledge about hyena behavior is needed to minimize predation on livestock and thereby reduce the conflict and retaliatory killings of hyenas (Hirsch, 2009).

2.6. Methods of livestock protection from predators

In former times livestock depredation was a serious problem, often threatening the welfare of whole families. Fencing is one preventative measure available to producers in combating livestock predation (Brien, 2002). According to Klowski (2007) fence type is the only effective in estimating the vulnerability of sheep/goat enclosures. Overall, fences made from bush and pole material are equally susceptible to predator attack. Pole fences offer certain advantages over bush fences in that they require less protection and appear to be effective deterrents against hyena attack (Klowski, 2007). Electric fences are an effective measure for reducing predation on

sheep or goats. In most cases electric sheep nets are sufficient as wolves rarely jump over fences (Reinhardt *et al*., 2012). Most effective appears to be a combination of electric fences and LPDs. However, it will be imperative to provide shepherds not only with dogs but also with expert advice on the raising and training of these dogs (Reinhardt *et al*., 2012).

In the United States, LPDs have helped to protect livestock herds from predators, but increasing large carnivores create new challenges, and the number of LPDs killed by large predators is increasing (Urbigkit and Urbigkit, 2010). Where flocks are left free grazing, shepherding is a prerequisite for confining the sheep in fenced corrals for the night or keeping them together during the day to enabling guarding dogs to function (Linnell *et al*., 2012). In some areas such as Scandinavia shepherding is uncommon and therefore not recommended (Reinhardt *et al*., 2012).

Throughout Europe, livestock husbandry practices vary with local predators, livestock type, and terrain. This has resulted in a wide range of practices, many of which changed dramatically with the decline of predators (Kaczensk, 1999). For example, in Bulgaria, Slovakia and Italy sheep are guarded by shepherds with dogs and are brought into enclosure at night. Shepherds spend the night in small cabins, but the sheep normally stay outside, with the livestock guarding dogs and in Slovakia, sheep are brought to large open pastures and shepherds sleep in cabins nearby (Kaczensk, 1999). Normally in Bulgaria one shepherd collects sheep from a whole village and moves them to the summer range (Kaczensk, 1999). In the German Alps where flocks are usually small, several herds would have to be integrated into a larger herd to make shepherding cost effective (Reinhardt *et al*., 2012). Alternatively, where feasible alpine grazing land could be fenced and sheep left with livestock guarding dogs only (Reinhardt *et al*., 2012).

2.7. Human attitude towards large carnivores

An understanding of the attitudes and actions of local communities toward large carnivores relate to human–carnivore conflict are fundamental to the conservation of large carnivores outside PA (Infield and Namara, 2001 and Sillero-Zubiri and Laurenson, 2001). Human attitudes towards carnivores tend to be shaped by understanding and knowledge of a particular species (Kellert *et al.,* 1996). In most landscapes large carnivores need to coexist with humans and this coexistence requires knowledge about people and their attitudes towards large carnivore conservation (Yirga

and Bauer, 2012). Hence, study of public opinion and knowledge becomes an important element of large carnivore conservation (Yirga and Bauer, 2012).

In general carnivores have disappeared from areas of high human density (Woodroffe, 2001), and the species most exposed to conflicts with people are the most prone to extinction. They have been perceived as a threat to human survival because of danger to human life and to livestock. People retaliate to livestock depredation by poisoning carnivores, habitat damage and direct killing which have led to extinction of many species and significant reductions in carnivore populations.

Local people often hold negative attitudes, when carnivores prey upon livestock as reported for snow leopards (*Panthera uncia*) by Oli *et al*., (1994) and wolves (*Canis lupus*) by (Lenihan, 1996). Due to such losses and sometimes due to perceived dangers, pastoralists have had a long history of intolerance against large carnivores (Sillero-Zubiri and Laurenson, 2001). For instance; Red foxes in the UK are deliberately killed by farmers due to perceived threat to livestock (Baker and Macdonald, 2000). Attitudes towards hyenas vary widely among countries (Mill and Hofer, 1998). According to Yirga and Bauer (2012) most farmers do not like the presence of hyenas in the local area.

Human attitudes toward a particular carnivore tend to be influenced by any behavior of that species which negatively impacts upon human activities, as well as by an understanding and knowledge of that species (Conforti and De Azevedo, 2003; Shivak *et al*., 2003; Lindsey *et al*., 2005). For example, in Namibia commercial farmers reported considerable losses to large carnivores and although actual losses were lower than perceived losses (Arnold, 2001; Marker *et al*., 2003b), it was the perceived losses that influenced the removal of these predators (Marker *et al.*, 2003a). Such perceptions may also vary between economic enterprises. In Namibia, more game farmers reported problems with and removed more cheetahs (*Acinonyx jubatus*) than livestock farmers (Marker *et al*., 2003a).

To understand the opposition to carnivore policy, it is necessary to gain a better understanding of the factors that influence and form attitudes (Roskaft, 2007). Studies of human perceptions of carnivores also have been used as a basis for long term conservation strategies (Conforti and de

Azevedo, 2003). However, conservation efforts can be improved by raising the tolerance of pastoralists for wild carnivores through educational and economic incentives (e.g. cheetah on sheep ranches in Namibia) (Marker *et al*., 2003a).

3. STUDY AREA AND METHODS

3.1. Study location

The study was conducted in the sub districts surrounding the Abi- Adi town within the Kola Tembien district. Abi-Adi is found in Northern part of Ethiopia, Central zone of Tigray Regional State .It is the big town of Tembien and surrounded from south to north eastern by Kola Tembien district, south eastern by Degua Tembien and south by Tanqua Abergele. It is located about 95 km North of Mekelle and 870 km North of Addis Ababa. This town has latitude and longitude of 14°20′N; 39°29′E and the elevation ranging 1400 – 2435 m.a.s.l. The town has a total population of 20,000 (annual report of Abi-Adi Administration, Finance Bureau, 2012 unpublished data).
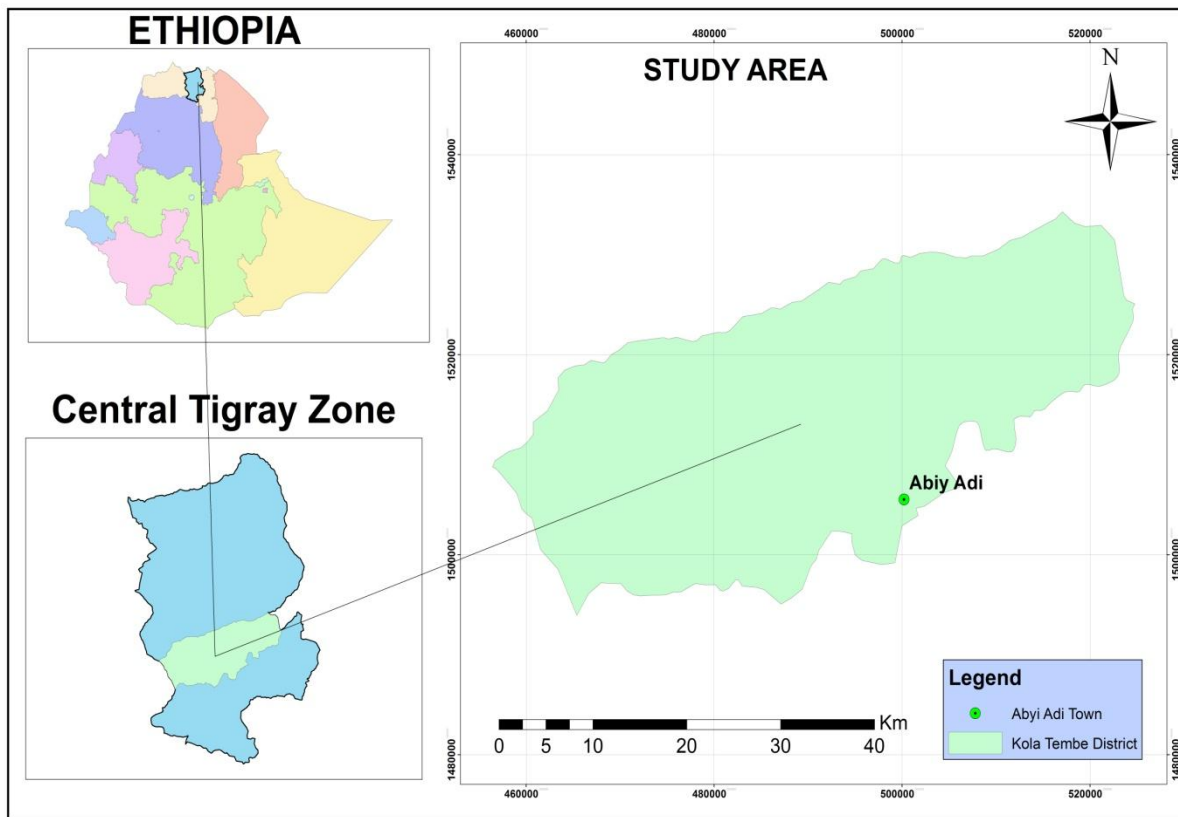
Figure 3: Map of the study area

The rain fall in the study area is characterized by one main rainy season (*keremt*) between June and September and minor rainfalls month shows between March and May. The average monthly rainfall ranges from 0-531.6mm (Fig.4).
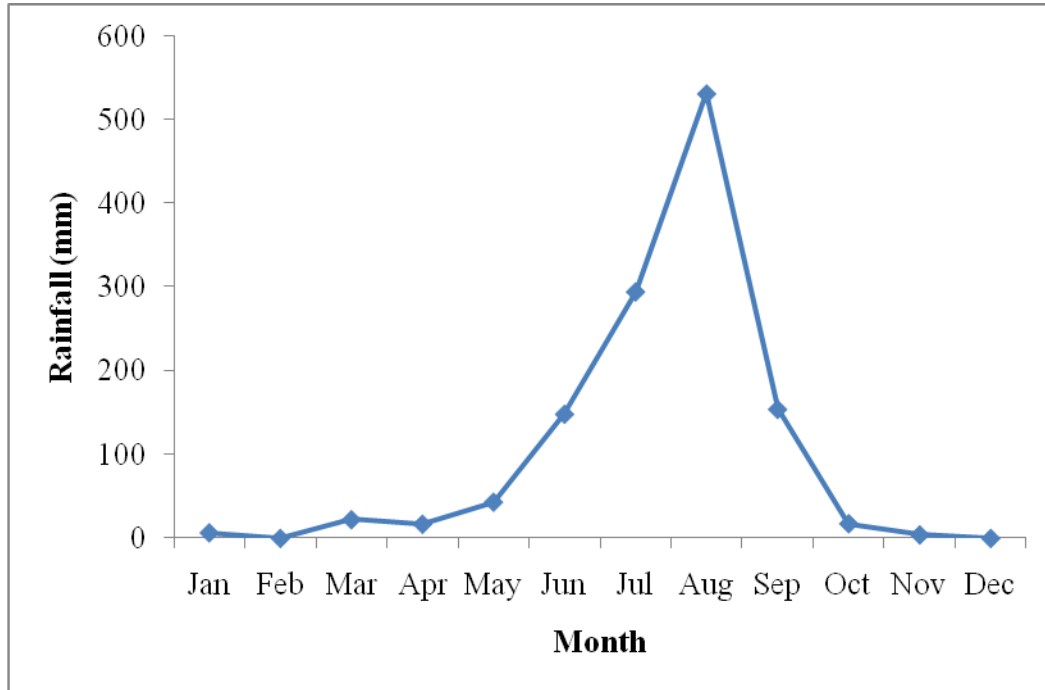
Figure 4: Monthly average rainfall in Abi-Adi (2007-2012)

According to six years temperature data (2007-2012) the mean monthly minimum temperature ranged from 12.9^0C to 14.2^0C, while the maximum ranged between 26.7^0C to 32.6^0C (Fig. 5). The mean monthly minimum temperature was 12.9^0C in August and the maximum was 32.6^0C, in April.

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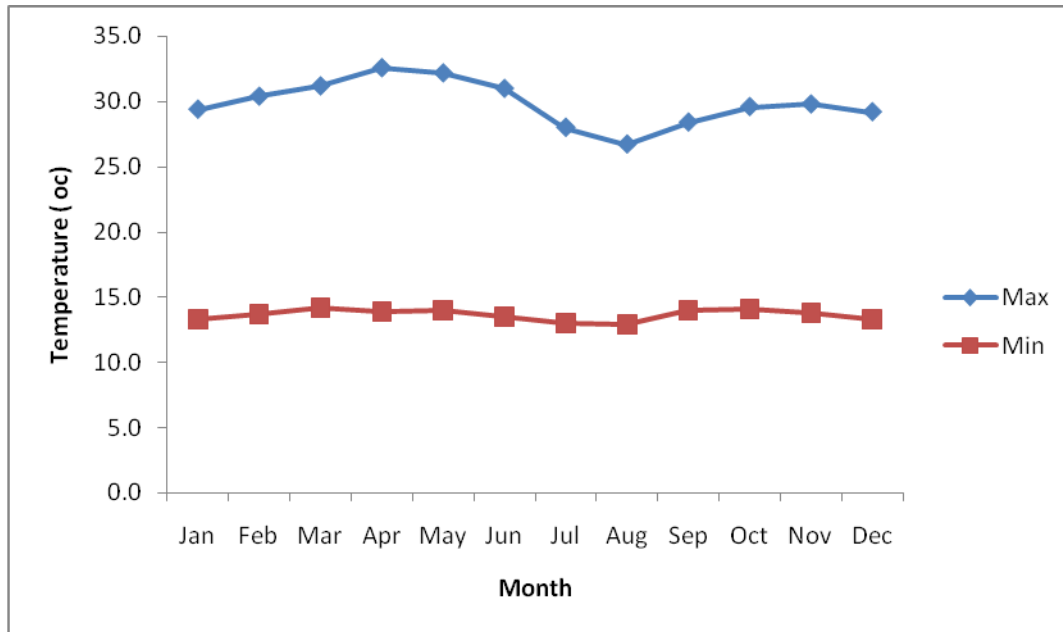
Figure 5: Monthly average minimum and maximum temperature in Abi-Adi (2007-2012)

The vegetation of the study area is dominated by *Acacia abisynica* and *Acacia etbaica* trees and the type of soil in this area is clay and sand clay (Bureau of Agricultural and Natural Resources development, 2005 unpublished data). The primary economic activity of the area is subsistence agriculture, with the main crops being sorghum (*Sorghum halepense*), teff (*Eragrostis tef*), maize (*Zea mays*), finger millet (*Eleusine coracana*), wheat (*Triticum*) and legumes (*Fabaceae*). In addition livestock farming is common especially cattle and goats. The wild life species in the study areas include; spotted hyena (*Crocuta crocuta*), leopard (*Panthera pardus*), wildcat (*Felis silvestris*), common jackal (*Canis aureus aureus*), civet (*Civettictis civetta*), dikdik (*Madoqua kirkii*), vervet monkey (*Cercopithicus aethiops*), rabbit (*Lepus starcki*), rock hyrax (*Procavia capensis*), squirrel (*Sciurus carolinensis*) and birds (Bureau of Agricultural and Natural Resources development, 2012 unpublished data).

The town has one big garbage dumping area located 1 km south west. The area of the garbage is 150m x 100m or 1.5 hectare (Bureau of Urban Development trade and Industry of Abyi-Adi, 2012 unpublished data). The remains of slaughtered animals and all redundant pack animals create an abundant food resource for hyenas in the garbage area.

For this study, four villages found around Abi-Adi town were purposively selected based on their distance (5km- 22km) from the garbage dumping area and the presence of hyena. From the town one Kebele was also selected randomly in order to assess human perception towards hyena.

The study focused in five sub districts; where four villages were found around Abi-Adi town and the remaining one Kebele from Abi-Adi town. The first was Debre-Genet, with a total households and livestock population of about 409 and 4867, respectively. It is about 6 km from Abi-Adi town located at about 1500 m.a.s.l. the second was Debre-Tsehay with a total households and livestock population of about 422 and 16561, respectively. It is about 7km from Abi-Adi town and located at about 1700 m.a.s.l. The third was Worki-Amba situated at about 1500 -1600 m.a.s.l, at 18km from Abi-Adi town with total households and livestock population of about 1907 and 13358 respectively. The fourth was Dabanow situated at about 1650 m.a.s.l at 22km from the town of Abi-Adi with total households and livestock population about 1035 and 18164 respectively. The fifth sub district was from the town of Abi-Adi town with total households of about 1070. This site was selected to study only the perception of humans towards spotted hyena.

3.2. Methods

3.2.1. Preliminary survey

Reconnaissance survey was carried out in the study site for four days prior to the actual data collection. During this time all study areas were selected which found around and far from the urban garbage dumping site with the local administration and all other available and relevant information were gathered.

3.2.2. Data collection

Data were collected from five sub districts; four villages were found around and away from the garbage dumping area and one from Abi-Adi town from February to April, 2013. The data were collected from the study area by hyena's scat collection and questionnaire survey of households.

3.2.3. Scat analysis

Hyena diet was investigated following methods of (Ramakrishnan *et al.*, 1999; Yirga and Bauer, 2010 a, b; Abay *et al*., 2011 and Yirga *et al*., 2012). Eighty five and fifty eight scats were collected from the study sites of in and around the garbage dumping area and far from the garbage areas (natural areas) respectively. The scat was identified based on visual characteristics like shape, color, size, ingested hair and location of scat (Appendix 1b). The Scat samples were put in plastic bags to avoid cross sample contamination and with detail collection time, location, and characteristics of the substrate from which the scat was collected (Appendix. 1c). The samples were sun dried, ground in a mortar, and washed by using water to separate hairs, bones, hoofs, teeth and other prey components from other organic material (Appendix 1d). Separated hairs were washed in 99.5% acetone, dehydrated in 98% ethanol and dried on filter paper. Hair was compared and analyzed with hair reference on form, length, and color with the naked eye as well as using a stereomicroscope at 10X magnifications (Appendix. 1d). The reference hairs included hairs of all domestic and wild species collected from Kola Tembien district during the study period.

3.2.4. Questionnaire survey

Questionnaire survey was conducted in all study areas. A total of 355 (214 males and 141 females) respondents participated in the study. The sample size of respondents was determined from the total stockholders (N = 4836) by using the following formula (Cochran, 1977).

$$n = \frac{n_0}{1 + \frac{n_0}{N}} \qquad \text{Where} \qquad n_0 = \frac{Z_{\alpha/2}^2 pq}{d^2}$$

Where:

n= the required sample size calculated by using single population proportion formula.

Z= standard score corresponding to 95% CL.

P= assumed proportion of population

d= the margin of error tolerable, i.e. 5 %.)

N= population size

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

$$n_0 = 384$$

$$n = \frac{n_0}{1+\frac{n_0}{N}}$$

$$n = \frac{384}{1+\frac{384}{4836}}$$

n =355

The questions were designed to determine socio-demographic characteristics of respondents, economic valuation of losses caused by hyenas, perception of humans towards hyena and method of livestock protection from hyena predation. All questions were translated in to local language (Tigrigna).

3.2.4.1. Economic valuation of losses

A total of 277 respondents (n=30 from Debre-Genet, n=31 from Debre-Tsehay, n=140 from Worki-Amba and n=76 from Dabanow) were selected from four sub districts. Systematic random sampling technique was employed (After numbers were allocated to everybody in the population frame, the first individual is picked using a random number table and then subsequent subjects were selected using fixed sampling intervals, i.e. every n^{th} person) to sort out residential households of the study areas. If the selected households were not serving or participating; the next household number was directly selected. The questions were asked in the form of an interview based questionnaire. Villages near to the garbage dumping place and villages away from the garbage dumping area were assessed in consultation with the development agents which are working in the study area. Questions related to livestock owned, livestock lost, number of livestock lost, sex, age and year of livestock predation was recorded on spot from 2009-2013. To

estimate average costs of livestock lost, average market price was collected by age and sex of livestock from local livestock sellers which are found in the market place.

Respondents were also asked different questions to assess the methods of livestock protection in study area. Effectiveness of kraals (fences) found in the households was also recorded from the respondents by preparing questions based on the height, construction tools and strengthens of the fence with livestock loss (Appendix. 3, part II)

3.2.4.2. Human attitude towards hyena

A total of 355 respondents (n=277 from all the four villages which mentioned above and n=78 from one Kebele of the town) were selected. For study of human perception towards hyena questions (measured on a 5-point scale ranging from strongly disagree to strongly agree) was designed and delivered to the respondents. The Kebele of the town was selected by simple random techniques. Questions were categorized; general demographic characteristics of respondents and different statements for human perception towards hyena. Human perception was compared based on gender, educational level and area residence (rural or urban) of all respondents.

3.3. Data analysis

Data was analyzed by using SPSS window version 16.0 soft-wares. Logistic regression was used to compare the association between techniques of livestock protection and effectiveness of fence with livestock depredation by hyena from the study areas. Attitude of human's towards hyena was created by summing the scores of all questions. The attitude score ranged from 1 to 5 where (1 for strongly disagree, 2 disagree, 3 neutral, 4 agree and 5 strongly agree). Percentage score of each construct were computed and categorized in to positive negative and neutral. If respondents scores <= 40 % she or he would be labeled as having negative attitude, 41% - 60% having neutral and if scored >= 61 % having positive attitude. Human attitude towards hyena with related to gender, educational level and residence of respondents was compared by using chi-square. Socio-demographic characteristics of respondents and diet of hyena was analyzed by using descriptive statics, frequency and percentage. Statistical significance level was compared

wherever P < 0.05 and not statistical significance level was compared P > 0.05. The results were displayed by using figures and tables by using Microsoft excel.

4. RESULTS

4.1. Hyena diet

A total of 143 hyena scats were analyzed: 85scats were from garbage dumping area and 58scats were from locations away from the garbage dumping area of Abi-Adi town. The study revealed that diet of hyena contained both domestic and wild life animals in both study areas. However, the dominant prey items of hyena (about 96.16%) were domestic prey and only 3.84% of the diet was wild animals. In and around garbage dumping area about 98.9% of hyena diet was domestic preys and only 1.1% was wild preys (Table 1). Away from the garbage dumping areas about 92.5% preys were domestic and 7.5% were wild animals (Table 2). The total scat analyzed, of which 2.98% of hairs belongs to hyena (Table 2). In decreasing order of frequency of prey occurrence in the scats: donkey, goat and sheep in and around garbage dumping area (Table 1) and goat, sheep and donkey in far away the garbage dumping areas (Table 2). In this scat analysis 5(5.6%) and 2(2.5%) of human hair and hen feather was found only in and around urban garbage dumping area, respectively. There was no significant difference ($X^2 = 2.946$; DF = 8; P = 0.938) the diet of hyena among study areas.

Of the total hair examined from the scats, only 7(7.8%) hairs from in and around urban garbage dumping areas and 2(2.98%) hairs away from garbage dumping areas were not identified. From 143 hyena's scat only 4 (2.56%) scat samples contained no hair in both study areas (Table 1 and 2). About 94.3% of scat from in and around urban garbage dumping areas and 86.2% from far away urban garbage dumping areas contained remains of single prey species, while all other scats had two or three prey species.

Table 1: Frequency and Percentage of different prey species of hyena revealed by scat analysis in and around garbage dumping area of Abi-Adi town

Number of hair identification from the scat (n=85)		
Species	Frequency	Percentage
Human	5	5.6
Hen	2	2.5
Sheep	16	18.0
Goats	20	22.4
Cattle	7	7.8
Donkey	22	24.7
Dog	6	6.7
Monkey	1	1.1
Hyena	0	0
Unidentified hair	7	7.8
No hair	3	3.4
Total	89	100

Table 2: Frequency occurrence of different prey species of hyena revealed by scat analysis in faraway garbage dumping area of Abi-Adi town

Number of hair identification from the scat (n=58)		
Species	Frequency	Percentage
Human	0	0
Hen	0	0
Sheep	18	26.87
Goats	18	26.87
Cattle	4	5.97
Donkey	16	23.88
Dog	3	4.48
Monkey	3	4.48
Hyena	2	2.98
Unidentified hair	2	2.98
No hair	1	1.49
Total	67	100

4.2. Questionnaire survey

4.2.1. Socio-demographic characteristics of sampled respondents

A total of 355 respondents participated in the study with a response rate of 100%. Of the respondents 214 (60.3%) were male and 141 (39.7%) were females. The number of males was significantly higher than females (x^2 = 15.011, DF = 1, P < 0.001). Of the respondents, 107(30.0 %) were aged from 40 – 49 and followed by 105(29.2%) of age 30 – 39. The least 6(2.0 %) were aged 70 and above (Table 3). Of the total respondents, 183(51.5 %) were illiterate (not attended school) and 54(15.2%) had a basic school education (grade 5-8). The least 25(7%) had a secondary school (grade 9-12). There was highly significant difference (x^2 = 227.521, DF = 4, P < 0.001) in educational status among respondents. Majority 244 (68.7%) of respondents participated were farmers and the least number 20 (5.6%) were housewives (Table 3).

Table 3: Socio-demographic characteristics of respondents in and around and faraway garbage dumping area of Abi-Adi town, Northern Ethiopia, 2013

Variables		Number of respondents	Percent
Age in Years	20-29	42	11.8
	30-39	105	29.2
	40-49	107	30.0
	50-59	67	19.0
	60-69	28	8.0
	>70	6	2.0
	Total	355	100
Sex	Male	214	60.3
	Female	141	39.7
	Total	355	100
Educational status	Illiteracy	183	51.5
	Grade 1-4	45	12.7
	Grade 5-8	54	15.2
	Grade 9-12	25	7.0
	Higher level	48	13.6
	Total	355	100
Occupation	Farmer	244	68.7
	House wife	20	5.6

	Governmental employee	50	14.1
	Merchant	26	7.4
	Others	15	4.2
	Total	355	100

4.2. 2. Economic losses due to livestock depredation by hyena

As per the questionnaire survey, a total of 6,560 livestock including sheep, goats, cattle, donkeys, dogs, cats and poultries were counted or recorded in villages which were found around and away from garbage dumping area of Abi-Adi town (Table 4 and 5). Of the respondents 158 (57%) in the village reported that they had faced livestock loss by hyena (Fig 6).
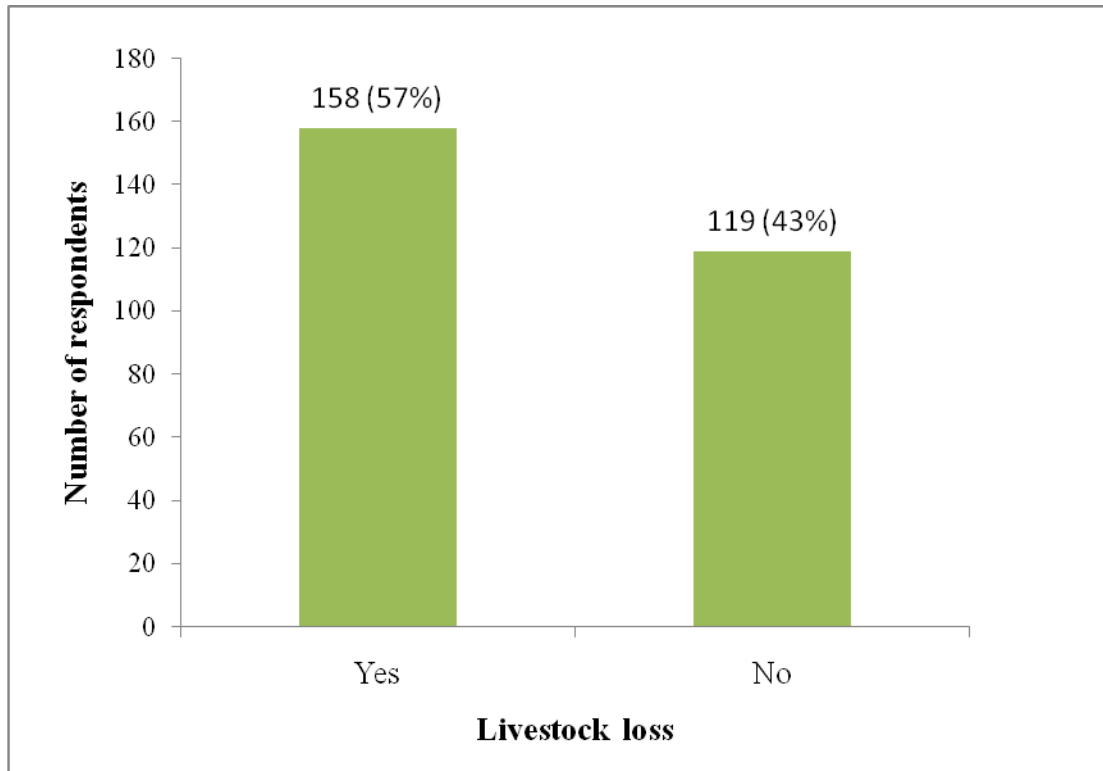
Figure 6: Respondents that faced livestock loss in villages of around and far away the garbage dumping area of Abi-Adi town (2013)

Households of the study areas reported a total of 535 livestock loss over 5 years (2009 -2013). Of those 175 (32.7%) and 360 (67.3%) livestock were lost around urban garbage dumping area and far away the garbage dumping area respectively (Table 4 and 5). The average annual livestock loss by hyena in villages of around urban garbage dumping areas and far away the urban garbage dumping areas was 35 and 72 livestock respectively. In villages of around garbage dumping area and away from garbage dumping area the average annual depredations per stock were 2.05% and

1.48% livestock respectively. Total average livestock depredation in the study area was about 8.2% livestock from their total stocks.

A total 45 livestock sellers which are found in the local market were asked; three traders were asked for each type of livestock classified by age and sex and obtained the average price of livestock. Based on this the calculations of economic loss were made based on the average local market price of each livestock in 2013; sheep (700), goat (800), cattle (3667) and donkey (1267) ETB (see appendix 2). A total estimated economic value of livestock lost in the study area was 577,880 birr; 158,145 birr in around garbage and 419,735 birr away from garbage dumping area (Table 4 and 5) and annually 115,576 birr excluding dogs, cats, and poultries. The average annual livestock loss resulted in estimated economic loss per households were 518.8 birr and 388.6 birr from around urban garbage dumping areas and far away urban garbage dumping areas respectively. Livestock lost was significantly different (X^2=8.936; DF=1, p = 0.003) among around and far away urban garbage dumping area. Livestock loss by hyena and stock number of livestock were positively correlated (R = 0.455, p < 0.001).

Table 4: Stock, loss and estimated economic value of livestock loss by spotted hyena in village of around garbage dumping area of Abi-Adi town (2009-2013)

Type of species	Stock	Depredation	Estimated economic loss
Sheep	359	54	37,800
Goat	736	80	64,000
Cattle	211	5	18,335
Donkey	68	30	38,010
Dog	55	6	0
Cat	28	0	0
Poultry	248	0	0
Total	1705	175	158,145

Table 5: Stock, loss and estimated economic value of livestock loss by spotted hyena in village of far away garbage dumping area of Abi-Adi town (2009-2013)

Type of species	Stock	Depredation	Estimated economic loss
Sheep	1258	93	65,100
Goat	2166	154	123,200
Cattle	701	41	150,347
Donkey	198	64	81,088
Dog	142	8	0
Cat	95	0	0
Poultry	298	0	0
Total	4855	360	419,735

A total of 158 respondents were asked the place of livestock lost and time. Out of respondents 106 (67.1%) indicated that the animals have been taken from their fields. In contrast 52(32.9%) of respondents indicated that the livestock has been killed inside and near fence (Fig.7).
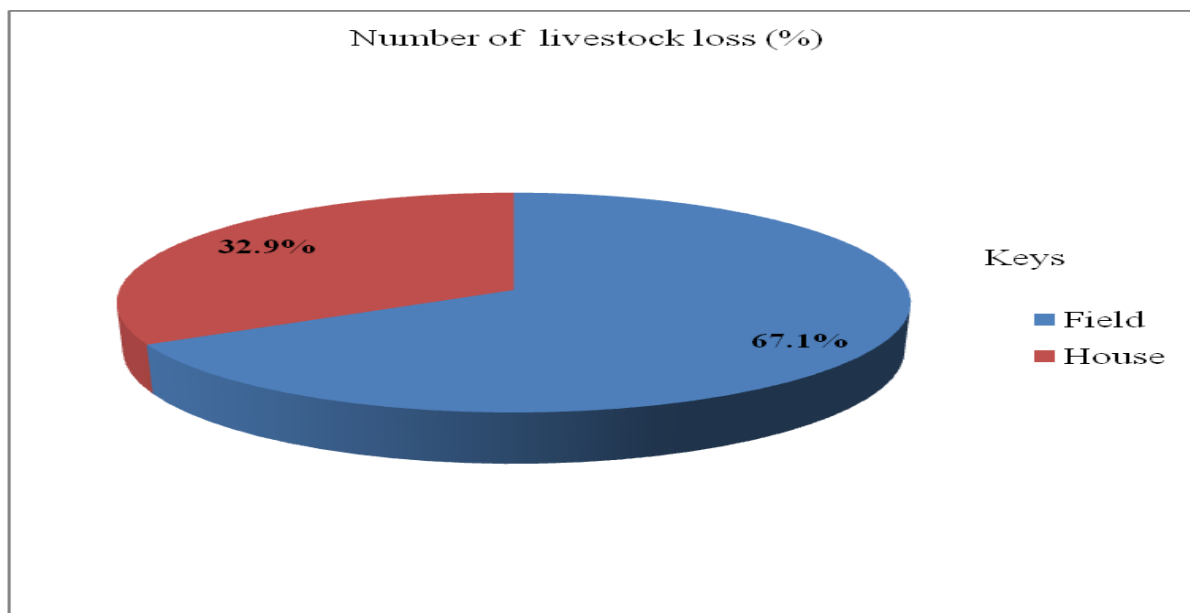
Figure 7: Principal context of livestock loss in villages which found around and away from garbage dumping areas of Abi-Adi town

Majority 134(84.5%) of households reported hyena depredation on livestock was during night time, while 24(15.2%) during a day time. There was a significant difference of livestock loss among night time and day time $X^2 = 76.582$; DF =1; p < 0.001). Of the respondents 15.2% and 51.9% thought livestock loss happened in time of grazing in the field during a day and night time respectively and 32.9% happened inside and around the fence or home during night time when livestock subsist outside fence (Fig. 8). There was a significant difference ($X^2 = 40.189$; DF =2; p < 0.001) between time and place of livestock loss.
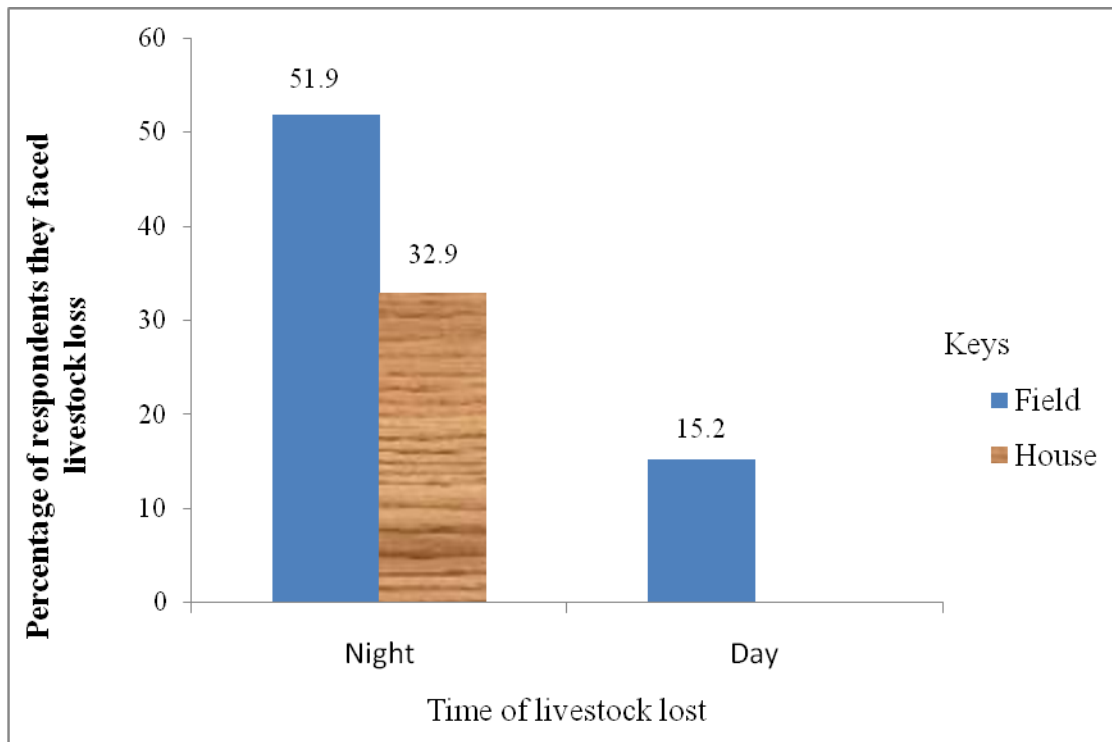
Figure 8: Time and place of livestock loss by hyena in villages of around and far away garbage dumping areas of Abi-Adi town (n=158)

4.2.3. Mitigation measure for livestock depredation and effectiveness of fence

Hyena had a characteristic method of accessing the fence (kraal) by digging and sometimes by jumping. In the study area all livestock were kept inside a fence or kraal close to their settlement and guarded by dogs at night. During the day livestock were herded by children called, shepherds. In the study, out of 277 respondents 260 respondents were asked a question of

protection measure of livestock from hyena predation but the remaining 17 households were not asked the question because they do not have any livestock. Out of respondents 87(33.5%) were keeping their livestock by all fence, shepherded and dogs followed by 73(28.1%) protect by both dog and fence. The least respondents 5(1.9%) were keeping their livestock only by dogs (Fig. 9).
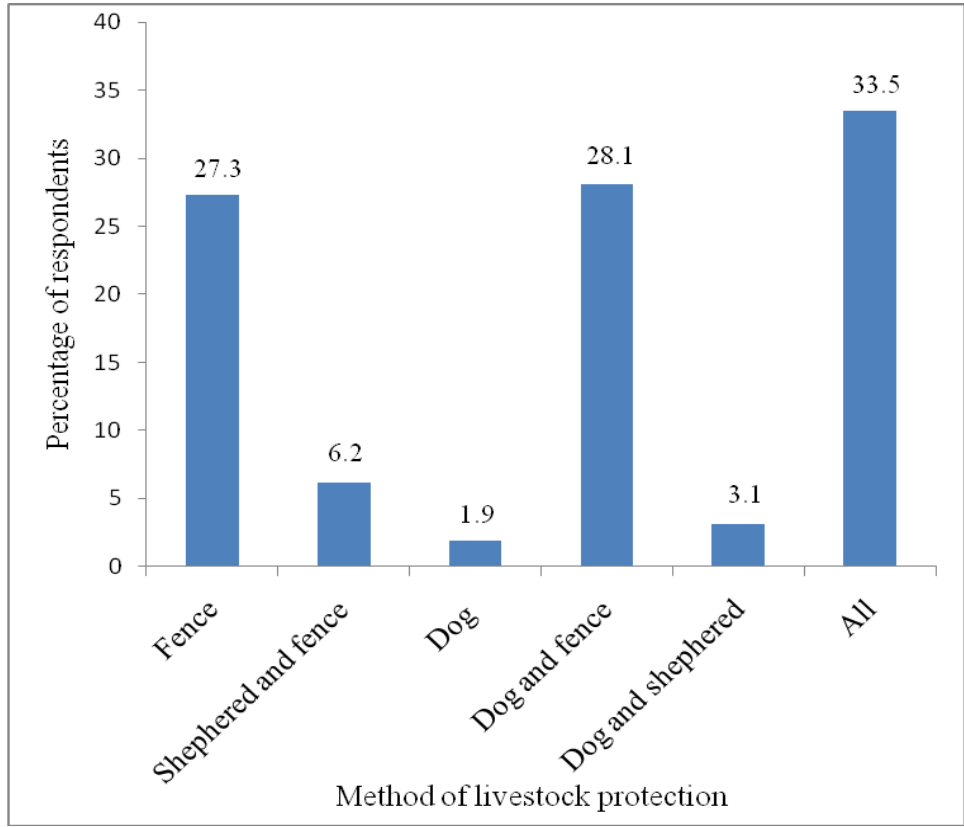
Figure 9: Methods of livestock kept from hyena in the village of around and far away garbage dumping area of Abi-Adi town

Table 6 presents the parameters of logistic regression model estimated by the method of livestock protection from hyena depredation. The coefficients, probability level and odds ratio indicate whether a particular variable is associated with livestock protection statistically significant. If the value of odds ratio is 1, it indicates that the variable has no effect. If the value is greater than 1, there has higher probability of livestock protection and if the value is less than 1, there has lower probability of livestock protection. Based on this binary logistic regression model, fence has higher probability of livestock protected than livestock protected by dog and fence. It is statistically significant (p = 0.013). Livestock protected by all dog, shepherd and

fence was 0.858 times lower compared with livestock protected by dog and fence but there was not statistically significant (p = 0.648). Livestock protected by dog was also 0.452 times lower than livestock protected by reference category (dog and fence). However, there was not statistically significant (P = 0.488) (Table 6).

Table 6: Logistic regression result of the effect of predictor variable on method of livestock protection

Variable	Category	Have you faced livestock loss		B	S.E.	Sig.	Exp(B)	95 % C.I. for EXP(B)	
		Yes %	No %					Lower	Upper
Method of livestock protection from hyena depredation	Dog and fence	Reference category							
	Dog, fence and shepherd	22.7	10.8	-.153	.335	.648	.858	.445	1.655
	Shepherd and fence	3.8	2.3	.081	.571	.887	1.085	.354	3.323
	Fence	11.9	15.4	.847	.342	.013	2.333	1.193	4.560
	Dog	1.5	0.4	-794	1.144	.488	.452	.048	4.258
	Dog and shepherd	2.7	0.4	-1.354	1.097	.217	.258	.030	2.216

The dominant method of livestock protection in the study area was fence with a height range from 2.0m - 2.5m. Total of 255 households had fence for protection of their livestock from hyena predation and the constructing tools of the fence were stone wall, stone + wood and thorn (Appendix 1e). Out of 255 households 115 (45.1%) had very strong fence; 76(29.8%) households had a strong fence and only 2 (0.8%) of households had a very weak fence for protect their livestock (Fig. 10). The study revealed that, strength of the fence was effective for keeping

livestock enclosing inside the fence. There was significant difference (X^2 = 23.384; DF = 4; P < 0.001) between the strength of the fence and place of livestock depredation by hyena (Fig. 11). However, constructing materials of the fence has not significant difference (X^2 = 3.834; DF = 3; p = 0.28) with livestock depredation by hyena inside the fence and also height of the fence was not statistically significant (X^2 = 1.187; DF = 3; p = 0.756) with livestock depredation by hyena inside the fence.
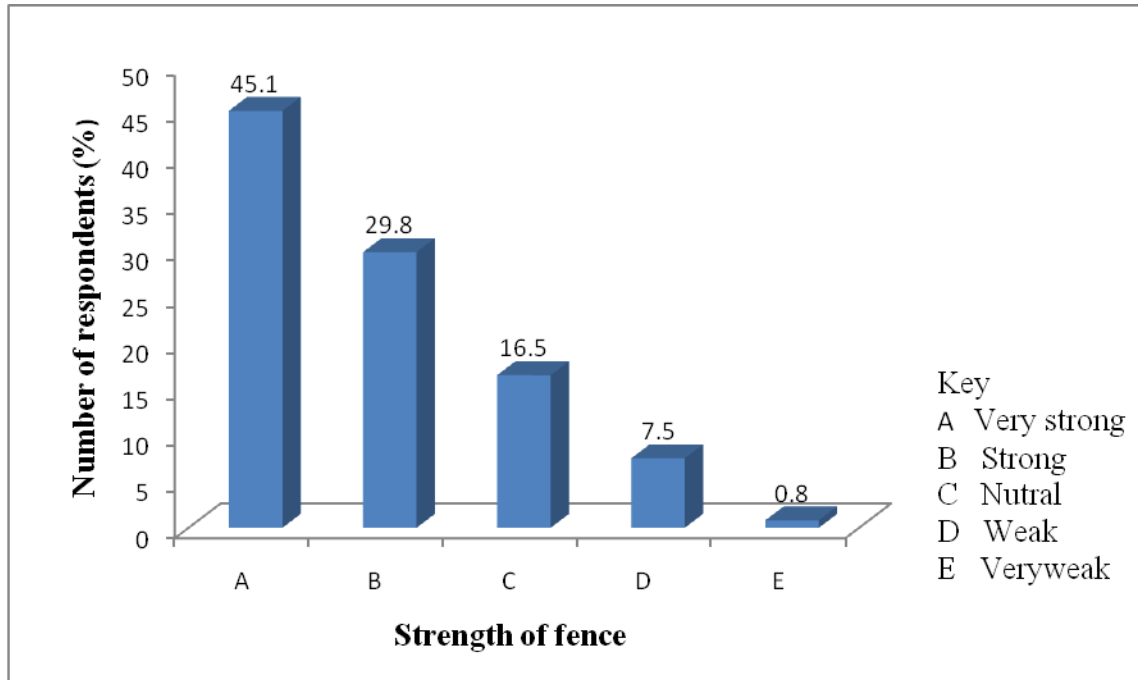
Figure 10: Strength of the fence in the study area of around and far away garbage dumping area of Abi-Adi town (2013)
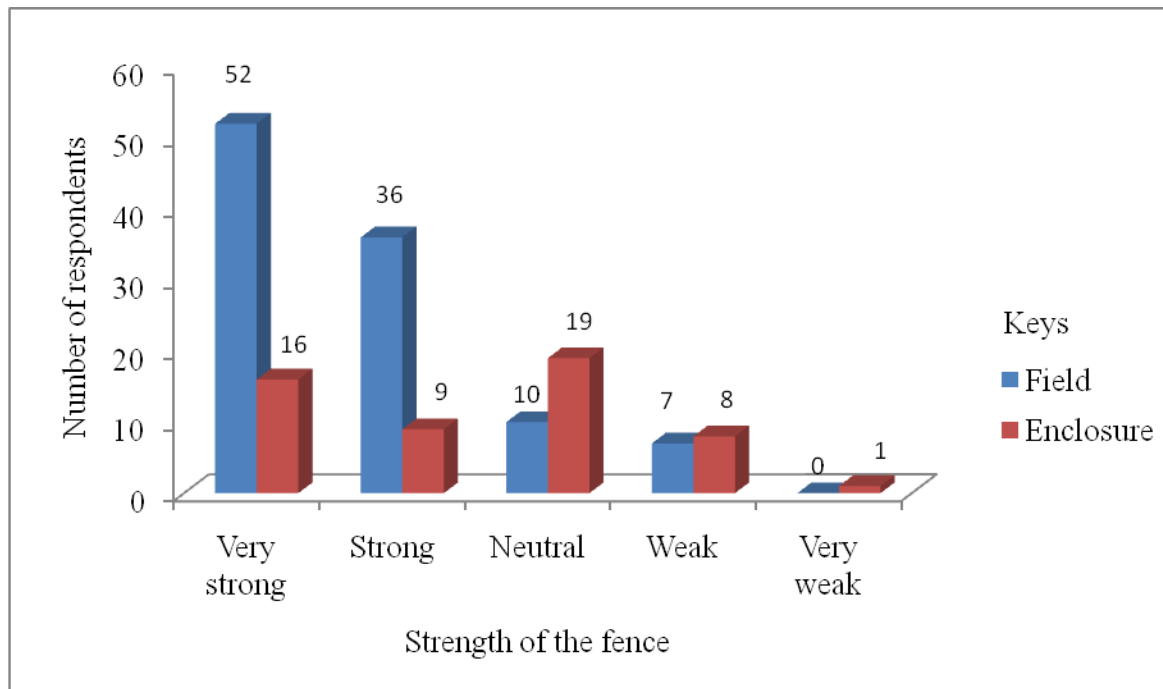
Figure 11: Strength of fence and place of livestock loss by hyena depredation in villages of around and far away garbage dumping areas of Abi-Adi town (n=158)

4.2.4. Attitude of respondents towards spotted hyena

Out of the respondents, majority 237 (66.8%) had negative perception; they reported hyena is a bad animal. Also 291 (82%) respondents had negative feeling of hyena live close to the area and only 40(11.3%) had neutral perception (Table. 7). More than half 201 (56.6%) of respondents had negative perception on the statement of hyena should totally disappear from the area while 116(32.7%) had positive perception. As well 206 (58.1%) of respondents did not support conservation of hyena in the area and 33(9.3%) of responded do not know or neutral (Table. 7).

Table 7: Attitude of human towards hyena in the study areas

(Where; 1= Strongly disagree; 2= Disagree; 3= Neutral; 4= Agree and 5= Strongly agree (N= 355)

R. No	Statements	Response									
		1		2		3		4		5	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	Hyena is bad animal	20	5.6	63	17.7	35	9.9	87	24.5	150	42.3
2	Hyena kills livestock	9	2.5	3	0.8	12	3.4	79	22.3	252	71.0
3	Hyena should live close to your area or home	150	42.3	141	39.7	40	11.3	22	6.2	2	0.6
4	Hyena clean garbage	71	20	85	23.9	91	25.6	88	24.8	20	5.6
5	Hyena is dangerous to human	13	3.7	60	16.9	68	19.2	69	19.4	145	40.8
6	I would be afraid to go into the forest/ filed if there are hyenas	22	6.2	77	21.7	53	14.9	94	26.5	109	30.7
7	I would be afraid to heard the sound of hyena	49	13.8	67	18.9	51	14.4	92	25.9	96	27
8	Hyena should be disappear (loss) from this village (area)	54	15.2	62	17.5	38	10.7	66	18.6	135	38

9	Hyena important for community and ecosystem	121	34.1	87	24.5	55	15.5	56	15.8	36	10.1
10	Hyena should conserve in this area	144	40.6	62	17.5	33	9.3	56	15.8	60	16.9

However, the overall perception of respondents towards hyena calculated based on response categorized into three (positive, negative and neutral) out of the respondents, 170 (48%) feeling negative towards hyena, considered hyena as a bad animal in nature and hyena had a negative impact such as killing and attack on their livelihood and livestock. 95(26.8%) respondents had positive perception towards hyena, because they liked seeing hyenas in your area and considered them as a good municipal for garbage and other leftover animals (Fig. 12).
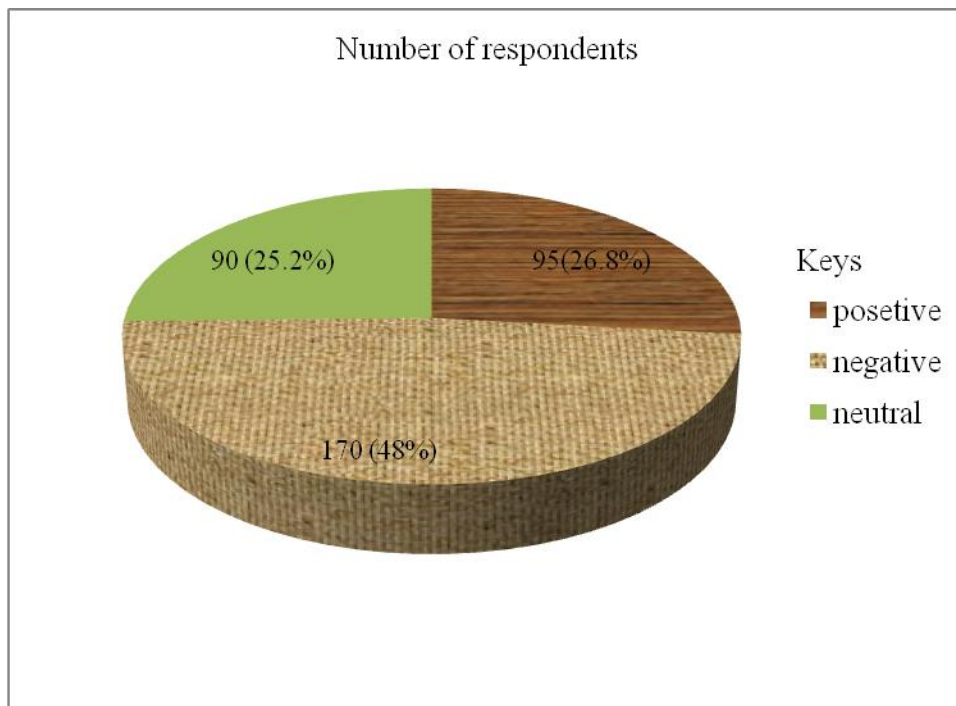
Figure 12: The overall attitude of respondents towards hyena in the study area

Out of 277 respondents 156(43.9%) had negative feeling and 52(14.6%) had positive feeling in the rural area, whereas out of 78 respondents, 43(12.1%) had positive feeling and 21(5.9%) had neutral feeling (fig.13). There was a strong significant difference in the perception towards hyena among rural and urban areas (X^2 =48.868, DF =2, p < 0.001). There was a significant difference

in the perception towards hyena between different age classes (X^2 =43.886, DF=10, p < 0.001). Younger generation, age class (30-39) showed more significantly positive perception than older age group (age > 40 years) (Fig.14). Out of the respondents, male respondents had positive perception (14.4%) than females (12.4%) (Fig.15). However, there was no significant difference (X^2 = 2.775, DF = 2, p=0.25) of perception towards hyena among the sex of respondents.
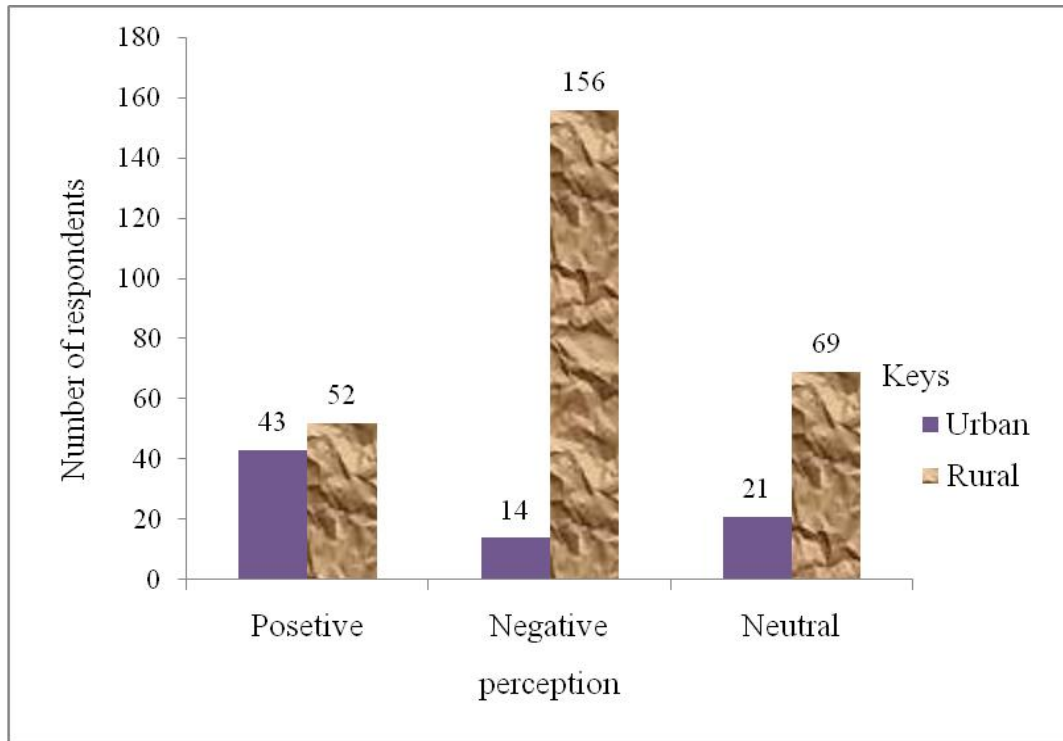
Figure 13: Residence and attitude of respondents towards spotted hyena in the study area.

Figure 14: Age and attitude of respondents towards hyena in the study area
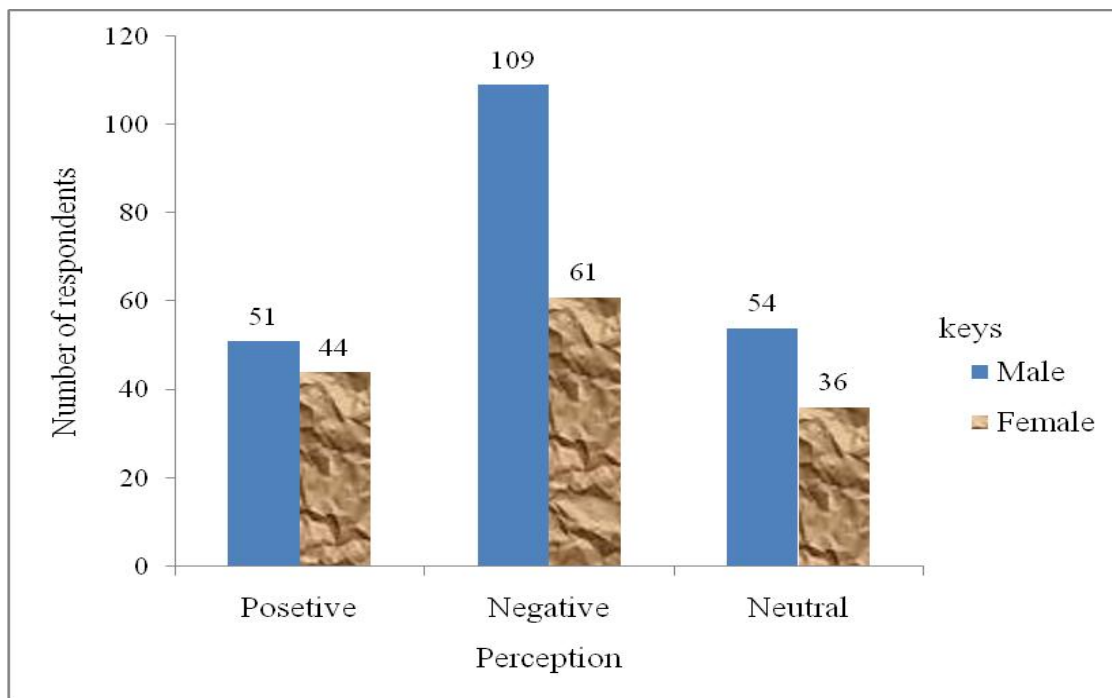
Figure 15: Sex and attitude of respondents towards hyena in the study area

Out of respondents, 29(8.2%) higher level of educated groups (certificate, diploma and above) had more positive attitude than non- educated group 27(7.6%) (Fig.16). There was a significant difference (X^2 =65.246, DF = 6, p < 0.001) among educated and non educated groups. Respondents which are residents around urban garbage dumping area including urban residents 53 (14.9%) showed more positive perception than resident far away urban garbage dumping area 42 (11.8%). There was a significant difference (X^2=19.898, DF = 2, p < 0.001) among residents that live around and faraway garbage area. Livestock losses by hyena in the study area also play a role in the human perception towards hyena. Respondents which didn't face livestock loss by hyena showed more positive perception 31(11.2%) than respondents of faced livestock loss by hyena 21(7.6%) in the study area (Fig.17). There was a significant difference on perception towards hyena among the respondents of faced livestock loss by hyena(X^2=8.621, DF = 2, p = 0.013).
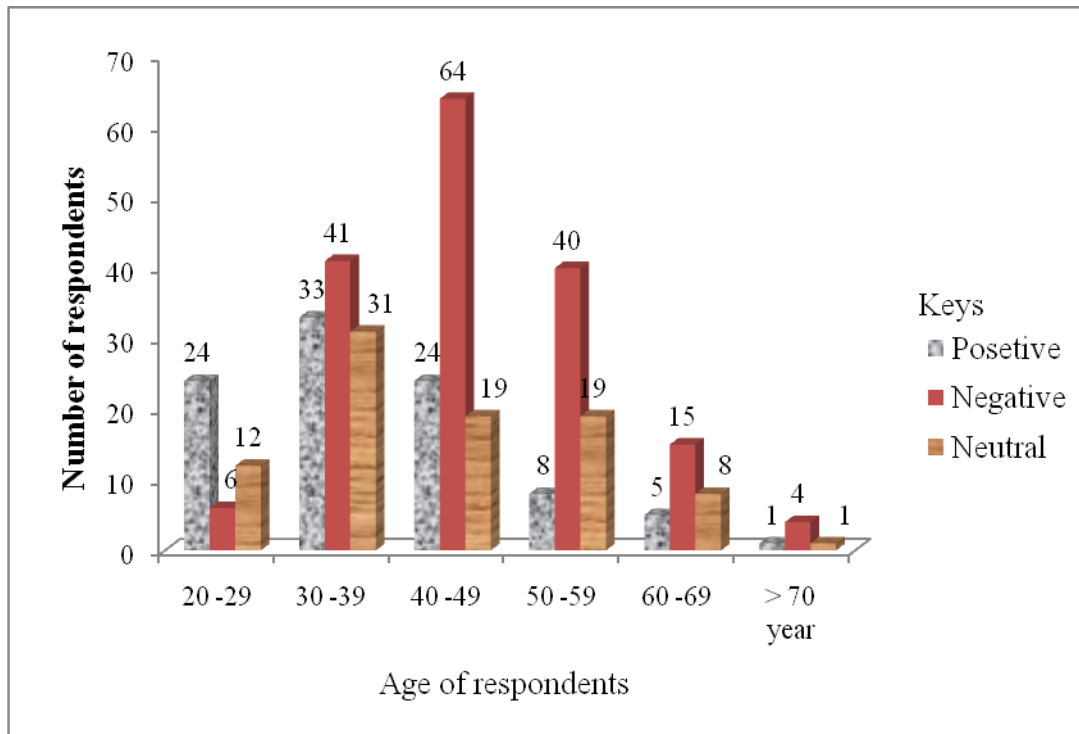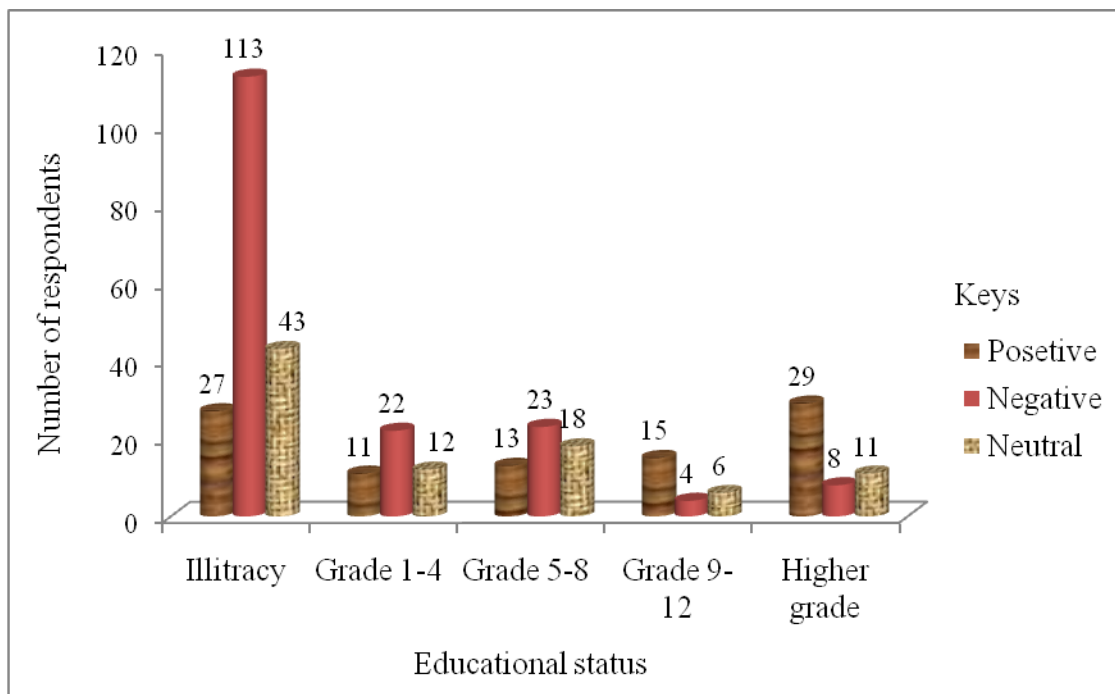

Figure 16: Education and attitude of respondents towards hyena in the study area.

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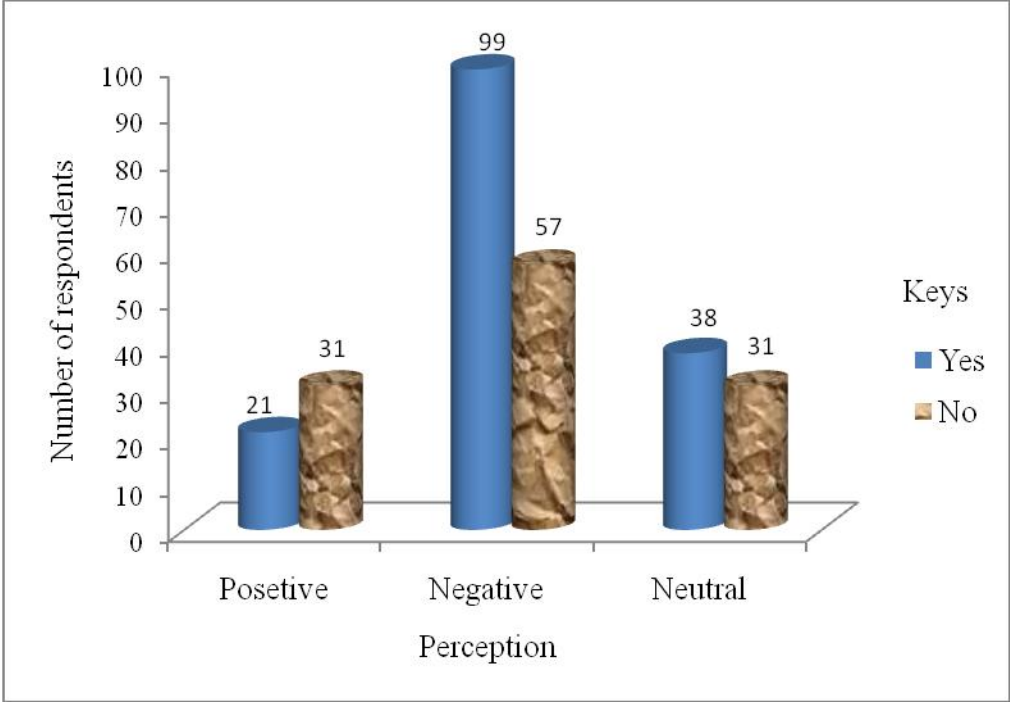
Figure 17: Livestock loss and attitude of respondents towards hyena in the study area

5. DISCUSSION

5.1 Diet of hyena

Based on the scat analysis, the dominant prey items of hyena (about 96.16%) were domestic origins. This shows that hyenas depend primarily on domestic prey base in this area and this might have different reasons such as virtual absence of natural preys and easy availability of domestic animals. This indicates that hyenas might be the major cause of livestock loss in the study area. Other researchers have shown that spotted hyena depend on domestic prey species in northern Ethiopia since the natural prey base is highly depleted due to agricultural expansion, deforestation and human settlements (Abay *et al*., 2011; Yirga *et al*., 2010 and Yirga *et al.,* 2012*).*

Present study has hyena scavenging and depredation food from urban garbage dumping areas during scarcity of natural preys and dominantly the food item was donkeys. This is in line with Yirga *et al*., (2012) who reported that donkeys are in the preferred prey body mass range and also humans strictly follow religious restrictions on complete donkey body part that can be eaten; dead or weak donkeys are abandoned altogether which makes them a relatively easy food source. In addition, in contrast to other livestock species, donkey might be prefer garbage dumping area when to achieve food particularly humans feces and it make easy depredate by hyena in this area. Yirga *et al*. (2012) also suggested that, donkeys are kept outside the compound at night. However, in some areas, it is thought that hyenas are capable to catch livestock or are forced to switch prey species due to depletion of their natural prey choice.

The study revealed that about 3.84% of hyena preyed on wild life animals such as monkeys and other hyenas. This might be monkeys were most available in the study area in contrast to other natural preys and sometimes hyenas are even hunted by other hyenas from different clans, during disease out breaks and they killed by other carnivore; hyena feeds on other hyena. However other researchers have shown that hyenas prey only on domestic origins (Abay *et al.,* 2011 and Yirga *et al*., 2012).

Human hairs were found only in the scats of in and around garbage dumping area. However, it is difficult to differentiate whether it preyed on human or scavenged from garbage dumping areas

because there was no report that hyena killed human during the period of present study. Other studies indicated that about 5.5% of hyena scats contained human hair and are probably from cemeteries and from garbage dumps on which hyenas scavenge (Abay *et al*., 2011). In addition, from the scats cattle hairs were also found dominantly in and around garbage dumping area than natural area. This may have the reason the urban resident's slaughtered large number of cattle at different days of the year for celebrating holydays and eve fasting than other livestock.

5.2. Livestock losses and its economic impact

Hyenas consume prevailing domestic species in the study area. Damage to domestic stock mainly involves donkeys, sheep, goats and cattle and varies widely in intensity. More than half of households 57.3% reported livestock losses and 535 domestic animals were lost over the last five years. Hyenas were an important predator of livestock in terms of the number and economic value of livestock killed. Studies have shown that the importance of hyenas in livestock predation varies significantly across Africa. For example, in Kenya, hyenas were reported to be responsible for < 10% of the livestock predation adjacent to Tsavo National park (Patterson *et al*., 2004), whereas they were reported to be responsible for 53% of the predated livestock adjacent to the Maasai Mara National Reserve (Kolowski and Holekamp, 2006). Similarly this study, hyenas were responsible for 8.2% of livestock predation of their stock in the villages of around and far away garbage dumping areas of Abyi-Adi town. This was still an economic significance to rural people giving widespread financial conditions. Similarly Yirga and Bauer (2010) reported that annual hyena depredation on livestock representing 12.5% of stock in southern Tigray. In Kenya reported annual livestock losses to predators range from 0.7% to 5.5% (Karani, 1994).

Present study revealed that in villages which were found around garbage dumping area, a higher livestock loss per stock was recorded than villages found far from the garbage dumping area. This might be one reason for hyenas were more dependent on garbage dumping areas due to decreasing of natural prey abundances. Hyenas may not obtain enough food in the garbage dumping area when only scavenging on carcasses; may lead them hunt other domestic animals around the garbage dumping area and higher livestock depredation as several hyenas visit this

area. Similarly, Kolowski and Holekamp (2007) reported that livestock depredation was higher where hyenas were more abundant because of attraction from waste.

In the present study, the annual mean economic loss per household was about 518.8 birr and 388.6 birr in villages around urban garbage dumping areas and far away urban garbage dumping areas, respectively. This may be significantly high when compared with poorest households which depended on food security program (food aid). Study conducted in BMNP estimated the cost to be approximately U.S. $12 per household, which may not be significantly high when compared with the available worth of livestock per household (approximately U.S. $1452) (Atickem *et al*., 2010). Livestock depredation can cause considerable pecuniary losses (Bauer *et al*., 2010). Mishra (1997) reported an economic loss of U.S. $15,418 because of livestock depredation worth U.S. $128 loss per family per year among the Indian-trans Himalayan communities. Livestock depredation in highlands of Ethiopia was estimated to represent U.S. $20.2, about 7% of the average annual income of households in the area (Yirga *et al*., 2012). Butler (2000) recorded economic loss averaging U.S. $13 or 12% of each household's net annual income in Zimbabwe.

5.3. Mitigation measure for livestock depredation and effectiveness of fence

The present study has showed that livestock were kept in day herded by shepherd and kept at night in side fence (kraal) and watched by domestic dog to reduce livestock loss by hyena. Woodroffe *et al*., (2007) also reported that dogs have improved livestock security both in the daytime grazing fields and in the bomas at night. Ciucci and Boitani (1998) found that in Tuscany (central Italy), 63% of sheep attacks occurred on free ranging and unguarded, 22% alone in enclosures, 13% guarded only by dogs, and only 2% guarded by shepherds with or without dogs (Mertens and Promberger, 2001). Abay *et al*. (2011) also reported peoples try to reduce livestock loss by enclosing livestock inside enclosures and spend herders and use dog to watch them when hyena is coming. In the present study, dog was not diminished livestock depredation by hyena. Similarly, different reports have shown that dogs did not reduce nocturnal livestock predation by hyenas (Khlowski and Holekamp, 2006; Ikanda and Packer, 2008). Dogs were not associated with reduction of livestock predation by hyenas (Ogada *et al*., 2003).

Construction of strong fence was protected livestock depredation when livestock enclosing inside a fence. There was statistically significant ($p < 0.001$) between the place of livestock loss by hyena depredation and strength of fence. Various researchers have concluded that rate of livestock lost reduced through construction of sturdier fences (Kruuk, 1981; Frank, 2000). In the study, majority of respondents thought that they had effective fence with livestock protection when compared to height, constructing material and strength of fence. However, they faced higher number of livestock depredation by hyena. Because fence was protected only enclosing livestock inside the fence but most livestock of the study area were depredated outside the fence (field area). The present study the height and constructing material of the fence was not effective on livestock loss by hyena depredation. This is agreement with (Ogada *et al.,* 2003) who found no effect of fence height and thickness on depredation rates of fencing at least on pastoral ranches and not necessarily on effective solution to livestock depredation (Kolowski and Holekamp, 2006).

In this study, shepherd has also showed to help in the protection of livestock. However, shepherd was no significant on livestock protection. It might be in the study area livestock are herded by children and when cross long distance for grazing, livestock and children will get tiered and livestock lost from the field and easy depredated by hyena at night. 67.1% of households reported hyena attack on fields, while study on commercial ranches have found ~ 25% of livestock attacks to occur on grazing herds (Ogada *et al.,* 2003). Pastoral ranches have documented up to 90% of predator attacks to be directed at grazing herds (Kruuk, 1981).Besides, attacks on field are probably more frequent on pastoral group ranches due to difference in herdsmen behavior. On commercial ranches herders were paid for their work, may be fired for inadequate herds attendance and work in groups large enough to discourage stock theft (Ogada *et al.,* 2003).

5.4. Human attitude towards hyenas

In the present study about 48%, 26.8% and 25.2% of respondents had negative, positive and neutral feeling towards hyena respectively. Other study reported most community members had negative attitudes towards predators and the most disliked predator was hyena (Romanach *et al*., 2007). Due to the fear large carnivores negatively influences the perception towards people (Ginsberg, 2001) and this low tolerance probably relates to hyena being perceived as a greater threat to livestock and humans than the other large carnivores included in the survey (Berg, 2001).

Most of the respondents feared and believed that hyena as a bad, dangerous and kills livestock. Romanach *et al.,* (2007) stated that if people believed that large carnivores were dangerous, they judge a conflict to be costly and those who reported high levels of fear and concern expressed a negative attitude. Furthermore, self reported financial loss also had a negative effect on attitudes (Naughton-Treves *et al*., 2003). Similarly, (Vitterso *et al*., 1999) reported that farmers who expected continued predation on sheep had strong negative attitudes towards large carnivores.

This study revealed that respondents had negative feeling on both statement of hyena should be disappear and conserve in the area. The presence of large carnivores in human landscapes can have different consequence such as fear evoked by its presence (Quammen, 2003) to fatal attacks on human (Lae, 2004). The most reported consequence of the presence of carnivores in human dominated landscape in livestock depredation (Patterson *et al*., 2004) which often results in under determining the conservation.

The study showed that there was no statically significant difference on perception towards hyena among male and female respondents. However, males had positive perception towards hyena than female. In contrast to earlier study (Williams *et al*., 2002) suggested that gender is not a significant variable explaining the variance in attitudes. However, gender is very important when explaining the variation in levels of fear (Roskaft *et al*., 2003). Moreover, more women report fear of large carnivores than do men and a high level of fear are associated with a more negative attitude (Roskaft *et al*., 2003). All these findings should indicate a more positive attitude towards

large carnivores among men than among women, which is what was actually found when men and women were compared.

In the present study, younger generation, age class (30-39) showed more significantly positive perception than older age group (age > 40 years). Similarly with (Roskaft *et al*., 2007) found People showed more negative attitudes towards carnivores with increasing age. Bjerke *et al*., (1998) found that older age groups (>55 years) in Norway preferred to have the size of the wolf population reduced. This may be attributed to the greater potential for costs from a confrontation for older people, because the older people become the less able they are to defend themselves or outrun a danger. Older generations have grown up with livestock and in rural areas, which can create negative attitudes towards large carnivores (Roskaft *et al*., 2007). In general, the views of older people (age groups > 55 years) show a higher dominionistic, negativistic, utilitarian score and a lower naturalistic score than age groups, < 36 years (Bjerke *et al*., 1998).

The study revealed that higher level of educated groups (certificate, diploma and above) had more significantly positive attitude than non- educated and some educated groups (illiterate, only read and write group, elementary and secondary groups) as (Roskaft *et al*., 2007). Bjerke *et al*., (1998) found that poorly educated people have higher dominionistic, negativistic and utilitarian views, whereas highly educated people showed the opposite pattern.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

Scat analysis was used mainly on identification of animal hairs and provides useful information on the diet of hyena. Hyena consume prevailing domestic species in the study area and the reason for hyena preying on domestic livestock was natural prey species have dramatically declined due to agricultural expansion, deforestation and human settlements. Hyenas are an opportunistic scavenging food from urban garbage dumping areas during the period of scarcity of natural preys. Increase livestock depredation by hyena also noted nearby area of garbage dumping place.

Households of the study areas reported that hyenas were depredating livestock at night time and cause an economic value by livestock killed. Hence, livestock were kept in day herded by shepherd and kept at night in side fence (kaarls) and watched by domestic dog to reduce livestock loss by hyena. Livestock protected by fence has strong significant association with livestock loss by hyena depredation than livestock kept by dog and shepherded. However, the height and constructing tools of the fence were not effective with livestock depredation.

Mainly households of the study areas had negative feeling towards hyena. They considered hyena as a bad animal in nature and they had a negative impact on their livelihood and livestock. However, few respondents had positive perception towards hyena, because they liked seeing hyenas in the area and considered them as a good municipal for garbage and other leftover animals. Age, education and residential areas of respondents had significantly difference on perception towards hyena but among the sex there was no significance difference.

6.2. Recommendations

The following recommendations and suggestions are made based on the findings for the mitigation of livestock depredation by hyena and coexistence of local people and hyena without conflict:

- Hyenas cause high economic loss by livestock depredation in the study area due to decreasing wild prey species. Therefore, mitigation livestock depredation is highly recommendable either through improved animal husbandry or through ecosystem regeneration (A forestation, reforestation and construction dump) which might restore the natural habitat and wild prey species.

- Households of the study areas (Debre-Genet, Debre-Tsehay, Dabanow and Worki-Amba) should be changing protection method of livestock from hyena predation, for example herding with more than one herder, herding livestock by young person rather than child person and livestock comeback from the field and enclosing inside the kraals (bomas) before 12:00 o'clock.

- Livestock were crossed long distances for assessing their enough food due to habitat degradation, during this moment they were lost from the herder and easy to depredate by hyena. Therefore households should be prepared livestock's fodder in their homestead.

- Municipal workers and other concerned body should be dumping the garbage far from villages of human and livestock settlements.

- Educational programs would be helpful to create more positive perception towards hyena and other wild animals. Therefore, the concerned body should give frequent training and education to the residents about the importance of hyena for the community and ecosystem and the importance of conservation of ecosystem in the future.

7. REFRENCES

Abay, G. Y., Bauer, H., Gebrehiwot, K. and Deckers, J. (2011). Peri-urban spotted hyena (*Crocuta crocuta*) in northern Ethiopia: diet, abundance and economic impact. *Europ. J. Wildl. Res*. **57:** 759–765.

Abyi -Adi, Admnstration Finance Bureau (2012). Annual report of general data of the town.52*.

Allen, L. R., and Sparkes, E. C. (2001). The effect of dingo control on sheep and beef cattle in Queens land. *J. Appl. Ecol*. **38**: 76-87.

Arnold, M. B. (2001). Large carnivores in the Kunene Region: an overview of problems and prospects. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek. /Nambia.

Atickem, A., Williams, S., Bekele, A. and Thirgood, S. (2010). Livestock predation in the Bale Mountains, Ethiopia. *Afr. J. Ecol*. **48**: 1076–1082.

Baker, S. E. and Macdonad, D. W. (2000). Foxes and fox hunting on farms in Wiltshire, a case study. *J. Rural stud*. **16**: 185-201.

Bauer, H., De Iongh, H. H. and Sogbohossou, E. (2010). Assessment and mitigation of human-lion conflict in West and Central Africa. *J. Mam*. **74**: 363–367.

Berg, K. A. (2001). Historical attitudes and images and the implications on carnivore survival. *Endan. Spps*.**18** (4): 186–189.

Bjerke, T., Reitan, O. and Keller, S. R. (1998). Attitudes towards wolves in southeastern Norway. *Soci. Natu. Res*. **11**: 169-178.

Boydston, E., Kapheim, K. and Holekamp, K. (2006). Patterns of den occupation by the spotted hyaena (*Crocuta crocuta*). *Afr. J. Ecol*. **44**: 77 -86.

Bureau of Agricultural and Natural Resources development of Abi Adi district, (2012).

Bureau of Urban Development trade and Industry of Abi-Adi, district (2012).

Butler, J. R. A. (2000). The economic costs of wildlife predation on livestock in Gokwe communal land, Zimbabwe. *Afr. J. Ecol.* **38**: 23–30.

Ciucci, P. and Boitani, L. (1998). Wolf and dog depredation on livestock in central Italy. *Wildl. Soci.Bull*. **26**: 504-514.

Cochran, W. G. (1977). *Sampling techniques*. John Wiley and Sons: New York. 74-76.

Conforti, V. A. and Azevedo, C. C. D.. (2003). Local perceptions of jaguars (Panthera onca) and pumas (Puma concolor) in the Iguacu National Park area, south Brazil. *Biol. Conserv*. **111**: 215-221.

Cooper, S. Holekamp, K. and Smale, L. (1999). A seasonal feast: long-term analysis of feeding behavior in the spotted hyaena (*Crocuta crocuta*). *Afr. J. Ecol*. **37**:149–160.

Cooper, S. M. (1990). The hunting behaviour of spotted hyenas (*Crocuta crocuta*) in a region containing both sedentary and migratory populations of herbivores. *Afri. J.Ecol.* **28**: 131-141.

Dikobe, M. L. (1997). Patterns and Economic Impacts of Livestock Predation in Rural Communities Bordering Makgadikgadi Pans National Park in Botswana. Thesis of M.Sc. School of Environment and Development,University of Nata.131.

Dloniak, S. M. (2012). Hyenas of harar. KOMBA, Kenya. 11- 14.

East, M. L. and Hofer, H. (2001). Male spotted hyenas (*Crocuta crocuta*) queue for status in social groups dominated by females. *Behav. Ecol.* **12**:558-568.

Frank, L. G. (1986). Social organization of the spotted hyaena (*Crocuta crocuta*). Dominance and reproduction. *Anim. Behav*. **34**:1510-1527.

Frank, L. G. (2000). Spotted Hyenas and Livestock in Laikipia District, Kenya. *IUCN Hyaena Specialist Group Newsletter.* **7**: 13–18.

Fuller, T. K., Kat, P. W., Bulger, J. G., Maddock, A. H., Ginsberg, J. R., Burrows, R., McNutt, J. W. and Mills, M. G. L. (1992). Population dynamics of African wild dogs. In: McCullough, D. R. and

Barrett, R. H. (2001). *Wildlife Populations*. Elsevier Applied Science, London and New York. 1125 - 1139.

Gade, D. (2006). Hayena and Human in the Horn of Africa. *Geog. Rev.* **96** (4): 609-632.

Ginsberg, J. R. (2001). Setting priorities for carnivore conservation: what makes carnivores different? In J. L. Gittleman, S. M. Funk, D. Macdonald, and R. K. Wayne, editors. Carnivore Conservation. Cambridge University Press, United Kingdom. 498-523

Hanssen, L. (2009). Spotted hyaena ecology and human wildlife conflict in the Caprivi Region, Namibia Report: 1-15.

Harris, S. and Saunders, G. (1993). The control of canid populations. *Sympo. Zool. Soci .Lond.* **65**: 111-161.

Hayward, M. (2006). Prey preferences of the spotted hyaena (*Crocuta crocuta*) and degree of dietary overlap with the lion (*Panthera leo*). *J. Zool.* **270**: 606–614.

Hemson, G. (2003). The ecology and conservation of lions: Human-wildlife conflict in the semi-arid Botswana. University of Oxford.

Hirsch, N. E. (2009). Impact by bomas on the distribution of spotted hyena (*Crocuta crocuta*) in the Mara Region, Kenya. 3-19.

Hofer, H. and East, M. L. (1993). How predators cope with migratory prey: the commuting system of spotted hyaenas in the Serengeti. III. Attendance and maternal care. *Anim. Behav*. **46**: 575-589.

Hofer, H. (2002). Spotted Hyena. IUCN Species Commission Hyaenidae Specialist Group. http://www hayena.ge/spotted.

Holekamp, K. E., Smale, L. and Szykman, M. (1996). Rank and reproduction in the female spotted hyena. *J. Rep. Fert*. **108**: 229–237.

Holekamp, K. E., Cooper, S. M..Katona, C. I. Berry, N. A. Frank, L. G. and Smale, L. (1997). Patterns of association among female spotted hyenas (*Crocuta crocuta*). *J. Mamm*. **78**:55–64.

Honer, O., Holekamp, K. E. and Mills, G. (2008). *Crocuta crocuta*. In: *IUCN 2012. IUCN* Red List of Threatened Species. www.iucnredlist.org

Hussain, S. (2003). The status of the snow leopard in Pakistan and its conflict with local farmers. *Oryx* **37**:26-33.

Ikanda, D. and Packer, C. (2008). Ritual vs. retaliatory killing of African lions in the Ngorongoro conservation area, Tanzania. *Endang. Species Res*.**6**: 67–74.

Infield, M. and Namara, A. (2001). Community attitudes and behaviour towards conservation:An assessment of a community conservation programme around Lake Mburo National Park, Uganda. *Oryx* , **35**(1) :132-139.

Johnson, R. (2006). Epizootiology and Ecology of Anthrax. USA, Washington, DC. Available at http://www.aphis.usda.gov/animal health.

Kaczensk, P. (1999). Large carnivore depredation on livestock in Europe. *Ursus* **11**:59-72

Kalb, J. (2001). *Adventures in the Bone Trade*: The Race to Discover Human Ancestors in Ethiopia's Afar Depression. New York, 70.

Karani, I. W. (1994). An Assessment of Depredation by Lions and other Predators in the Group Ranches Adjacent to Masai Mara National Reserve. M.Sc. Thesis, Moi University, Eldoret, Kenya, 70.

Kellert, S. R., Black, M., Rush, C. R. and Bath, A. J. (1996). Human culture and large carnivore conservation in North America. *Conserv. Biol*.**10:** 977–990.

Kingdon, J. (1977). East African Mammals: An Atlas of Evolution in Africa. Academic Press, New York. 146.

Kissue, B. M. (2008). Livestock predation by lions, leopards, spotted hyenas, and their vulnerability to retaliatory killing in the Maasai steppe, Tanzania. *Anim. Conserv*.**11**: 422–432.

Klare, U., Kamler, F. J. and Macdonald, D. W. (2011). Review: A comparison and critique of different scat-analysis methods for determining carnivore diet. *Mamm. Revi*. **41**: 294–312.

Kolowski, J. M. and Holekamp, K. E. (2007). Spatial, temporal and physical characteristics of livestock depredation by large carnivores along aKenyan reserve border. *Biol. Conserv.* **128**: 529-541

Kolowski, J. M. (2007). Anthropogenic influences on the behavior of large carnivores in the northern serengeti ecosystem. Disertation of PhD. School of Evolutionary Biology and Behavior. University of Michigan State.234.

Kolowski, J. M. and Holekamp, K. E. (2007). Effects of an open refuse pit on space use patterns of spotted hyenas. *Afr. J. Ecol*. **46**:341–349.

Kruuk, H. (1972). *The Spotted Hyena*: *A Study of Predation and Social Behavior*. University of Chicago Press, Chicago, 335.

Kruuk, H. (1980). The Effect of Large Carnivores on Livestock and Animal Husbandry in Marsabit District, Kenya. IPAL Technical Report E - 4. Intergrated Project on Arid Lands. UNEP and MAB (Man and Biosphere Program), Nairobi.

Kruuk, H. (1981). The Effects of Large Carnivores on Livestock and Animal Husbandry in Marsabit District, Kenya. IPAL Technical Report E-4, UNEP-MAB integrated project in arid lands.

Kruuk, H. (1998). Role and Management of Hyaenas in Protected Areas from Hyaenas: Status Survey and Conservation Action Plan. IUCN, Switzerland.

Lamarque, F., Anderson, J., Fergusson, R., Lagrange, M., Osei-Owusu, Y. and Bakker, L. (2009). Human-Wildlife conflict in Africa, Causes, consequences and management strategies. Food and Agriculture Organization of the United Nations, Rome, 1-98.

Lenihan M L. (1996). Public attitudes about wolves: a review of recent investigations. In: The Yellowstone Wolf Guide and Sourcebook. Mill Pond Press, Venice, F.L. 354.

Lindsey P. A., du Toit J. T, Mills M. G. L. (2005). Attitudes of ranchers towards African wild dogs Lycaon pictus: conservation implications on private land. *Biol. Cons*. **125**: 113–121

Linnel, J.D.C., Odden, J. and Mertens, A. (2012). Mitigation method for conflicts associated with carnivore depredationon livestock. 314-394

Litvaitis, J. A.(2000). Investigating food habits of terrestrial vertebrates. In: Boitani, L., Fuller, T.K. (Eds.), Research Techniques in Animal Ecology. Controversies and Consequences. Columbia University Press, New York 165–190.

Madden, F. (2004). Creating coexistence between humans and wildlife: global perspectives on local efforts to address human wildlife conflict. *Hum Dimen Wildl*. **9**: 247–257.

Marker, L., Dickman, A. J., mills, M. G. L. and Macdonald, D. W. (2003b). Aspects of the manage-ment of cheetahs (Acinonyx jubatus) trapped on Namibian farmlands. *Biol. Conserve.*115: 401–412.

Marker, L., Mills, M.G.L. and Macdonald, D.W. (2003a). Factors influencing perceptions and tolerance toward cheetahs (Acinonyx jubatus) on Namibian farmlands. *Conserv. Biol*.17: 1–9.

Mazzolli, M., Graipel M. E. and Dunstone, N. (2002). Mountain lion depredation in southern Brazil. *Biol. Conserv*. **105**: 43-51.

McDonald, R. A. (2002). Resource partitioning among British and Irish mustelids. *J. Anim. Ecol*. **71**: 185-200.

Mertens, A. and Promberger, C. (2001). Economic aspects of large carnivore-livestock conflicts in Romania. *Ursus* **12**: 173-180.

Mills, M. G. L. (1990). *Kalahari Hyaenas: Comparative Behavioral Ecology of Two Species.* Unwin Hyman, London.

Mills, M. G. L. (1992). A comparison of methods used to study food habits of large African carnivores. InWildlife (2001). populations:. McCulloch, C. and Barret, R. H. (Eds). London, 1112–1123.

Mills, M. G. L. and Hofer, H. (1998). *Hyaenas. Status Survey and Conservation Action Plan*. IUCN/SSC Hyaena. Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. 154.

Mishra, C. (1997). Livestock depredation by large carnivores in the Indian trans-Himalaya: conflict perceptions and conservation prospects. *Envir. Conserv*. **24**:338-343.

Muchiru, A. N., Western, D. and Reid, R. S. (2009). The impact of abandoned pastoral settlements on plant and nutrient succession in an African savanna ecosystem. *J. Arid Envir.* **73**: 322–331.

Naughton-Treves, L., Grossberg, R. and Treves, A. (2003). Paying for tolerance: rural citizens' attitudes toward wolf depredation and compensation. *Conserv. Biol.* *17*, 1500–1511.

Nowell, K. and Jackson, P. (1996). *Wild cats*: status survey and conservation action plan. Gland, Switzerland: *IUCN/SSC Cat Specialist Group.*

Ogada, M. O., Woodroffe, R., Oguge, N. O. and Frank, L.G. (2003). Limiting depredation by African carnivores: the role of livestock husbandry.*Conserve. Biol*.17: 1521–1530.

Ogutu, J. O., Bhola, N. and Reid, R. (2005). The effects of pastoralism and protection on the density and distribution of carnivores and their prey in the Mara ecosystem of Kenya. *Lond. J. Zool.* **265**: 281–293.

Oli, M. K., Taylor, I. R. and Rogers, M. E. (1994). Snow Leopard Panthera unica Predation of Livestock: An Assessment of local perception in the Annapurna Conservation Area, Nepal. *Biol. Conserv*.**68**: 63-68

Pangle, W. M. and Holekamp, K. E. (2010). Lethal and nonlethal anthropogenic effects on spotted hyenas in the Masai Mara National Reserve. *J. Mamm*. **91** (1):154–164)

Patterson, B. D., Kasiki, S. M., Selempo, E. and Kays, R. W. (2004). Livestock depredation by lions (Panthera leo) and other carni-vores on ranches neighbouring Tsavo National Parks, Kenya. *Biol. Conserv*.**119**, 507–516.

Polisar, J., Maxit, I., Scognamillo, D., Farrell, L., Sunquist M. E. and Eisenburg, J. F. (2003). Jaguars, pumas, their prey base and cattle ranching: ecological interpretations of a management problem. *Biol.Conserv*. **109**(2): 297-310.

Quammen D. (2003). Monster of God: the man-eating predator in the jungles history and the mind. W.W. Norton, New York.

Ramakrishnan, U., Coss, R. G. and Pelkey, N. W. (1999). Tiger decline caused by the reduction of large ungulate prey: evidence from a study of leopard diets in southern. *Ind. Biol. Cons.* **89**: 113–120.

Reinhardt, I., Rauer, G., Kluth, G., Kaczensky, P., Knauer, F. and Wotschikowsky, U. (2012). Livestock protection methods applicable for Germany a Country newly recolonized by wolves. *Hystrix, It. J. Mamm.* **23**(1); 62-72. http://www.italian-journal- mammalogy.it/article/view/.

Romanach, S. S., Lindsey, A. P. and Woodroffe, R. (2007). Determinants of attitudes towards predators in central Kenya and suggestions for increasing tolerance in livestock dominated landscapes. Oryx, **41** (2):185-195.

Roskaft, E., Bjerke, T., Kaltenborn, B. P., Linnell, J. D. C. and Andersen, R. (2003). Patterns of self reported fear towards large carnivores among the Nor-wegian public. *Evol. Hum. Behav*. **24**: 184-198.

Roskaft, E., Handel, B., Bjerke, T. and Kaltenborn, B. P. (2007). Human attitudes towards large carnivores in Norway. *Wildl. Biol*. **13**: 172-185.

Shivik, J. A., Treves, A. and Callahan, P. (2003). Nonlethal technique for managing predation: Primary and secondary repellants. *Conserv. Biol.* **17**: 1531-1537

Sillero-Z ubiri, C. and M. D. Gottelli, (1992). Feeding ecology of spotted hyaena (Ma mm alia: *Cro cuta crocuta*) in a mountain forest habitat. *J. Afr. Zool*. **106**: 169-176.

Sillero-Zubiri C, Laurenson M. K (2001). Interactions between carni-vores and local communities: conflict or co-existence? In: Gittleman J. L, Funk S. M, Macdonald D. W, Wayne R. K (eds) Carnivore conservation. Cambridge University Press, Cambridge: 282–312

Smale, L., Frank, L. G. and Holekamp, K. E. (1993). Ontogeny of dominance in free-living spotted hyaenas: juvenile rank relations with adult females and immigrant males. *Anim. Behav.* **46**: 467-477.

Smith, J. E. and Holekamp, K. E. (2010). Spotted hyenas. Michigan State University, East Lansing, MI, USA: 335-349.

Tilson, R. T. and Hamilton, W. J. I. (1984). Social dominance and feeding patterns of spotted hyaenas. *Anim. Behav.* **32**: 715-724.

Treves, A. and Karanth, K. U. (2003). Human-carnivore conflict and perspectives on carnivore management worldwide. *Conserv. Biol*. **17**: 1491-1499.

Urbigkit, C. and Urbigkit, J.(2010). A Review: The Use of Livestock Protection Dogs in Association with Large Carnivores in the Rocky Mountains. *J. Sheep and Goat Res*. 25

Van Horn, R. C., McElhinney, T. L. and Holekamp. K. E. (2003). Age estimation and dispersal in the spotted hyena (*Crocuta crocuta*). *J. Mam.* **84**:1019-1030.

Van Meter, P. E., French, J. A., Dloniak, S. M., Watts, H. E., Kolowski, J. M. and Holekamp, K. E., (2009). Fecal glucocorticoids reflect socio-ecological and anthropogenic stressors in the lives of wild spotted hyenas. *Hormo .Behav..* **55**: 329-337.

Vitterso, J., Bjerke, T. and Kaltenborn, B. P. (1999): Attitudes towards large carnivores among sheep farmers experiencing different degrees of depredation. *Hum. Dimen. Wildl*. **4**: 20-35.

Williams, B. K., Nichols, J. D. and Conroy, M. J. (2002). *Analysis and management of animal populations*. San Diego, USA: Academic Press.

Woodroffe, R. and Frank, L. G. (2005). Lethal control of African lions (Panthera leo): local and regional population impacts. *Anim. Conserv*. **8**: 91–98.

Woodroffe, R. (2001). Strategies for carnivore conservation: lessons from con-temporary extinctions. Carnivore Conservation (eds J. L. Gittleman, S. Funk, D.W. Macdonald and R.K. Wayne). Cambridge University Press, Cambridge. 61–92.

Woodroffe, R., Frank, L. G., Lindsey, P. A., Ole Ranah, S. M. K., Romañach, S. (2007). Livestock husbandry as a tool for carnivore conservation in Africa's community rangelands: A case-control study. *Biodiv Conserv*. **16**:1245-1260.

Yirga, G. and Bauer, H. (2012). Farmers' Perception of Leopard (*Panthera pardus*) Conservation in a Human Dominated Landscape in Northern Ethiopian Highlands. *Med .J. Soci. Sci. 2 (5):* 95-102.

Yirga, G., De Iongh, H. H., Leirs, H., Gebrehiwot, K., Deckers, J. and Bauer, H. (2012). Adaptability of large carnivores to changing anthropogenic food sources: diet change of spotted hyena (Crocuta crocuta) during Christian fasting period in northern Ethiopia. *J. Anim. Ecol*. **81**: 1052–1055.

Yirga, G. and Bauer, H. (2010a). Livestock depredation of the spotted hyena (*Crocuta crocuta*) in Southern Tigray, Northern Ethiopia. *Int. J. Ecol. Env. Sci*. **36** (1): 67-73.

Yirga, G. and Bauer, H. (2010b). Prey of Peri-urban Spotted Hyena (Crocuta crocuta) in Southeastern Tigray,Northern Ethiopia. *Asian. J. Agric. Sci.* **2**(4): 124-127.

8. APPENDICES

Appendix 1: photos of the research activities by researcher (2013)

(a) Garbage dumping area of Abi - Adi town
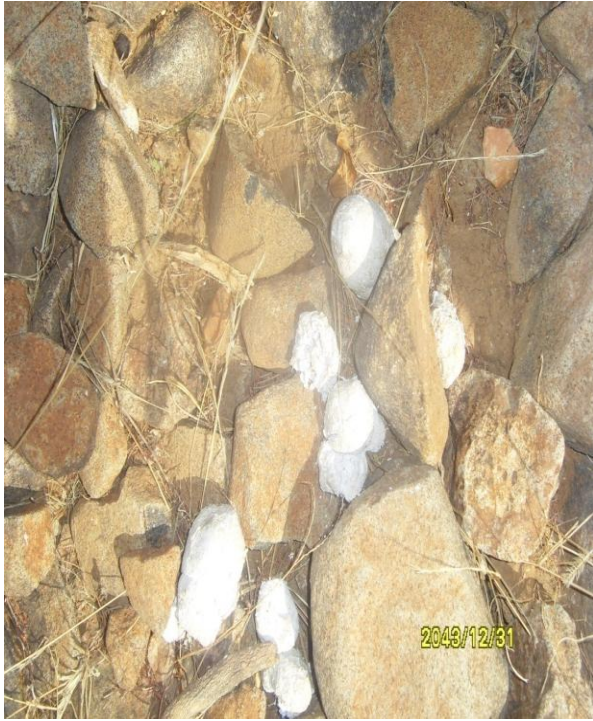
(b) Color and shape of hyena's scat

(c) Hyena's scat collected and stored in plastic

bag in the field

(d) Grinding and washing the scat to separate hair in laboratory and analysis using microscope in laboratory

63

(e) Fence (kraal) spend for livestock protection from predation in the study area

Appendix 2: Average market price of livestock from local traders in market place of Abyi Adi town, 2013 (n = 45)

type	Age (Year)	Sex	Average value (birr)	Final average value (birr)
Goat	1-2	M	450	500
		F	550	
	3-4	M	900	925
		F	950	
	5-6	M	1200	1100
		F	1000	
	>7 year	M	725	675
		F	625	
				800
Sheep	1-2	M	450	400
		F	350	
	3-4	M	750	825
		F	900	
	5-6	M	1100	1050
		F	1000	
	>7 year	M	550	525
		F	500	
				700
Cattle	3-4	M	1700	2350
		F	2500	
	5-6	M	4200	4000
		F	3800	
	7-8	M	5950	5500
		F	5050	
	> 9 years	M	3330	2815

		F	2300	
				3667
Donkey	2	M	800	800
		F	800	
	3-4	M	1700	1550
		F	1400	
	>5 years	M	1400	1300
		F	1200	
				1667

Appendix 3: Questions prepared to evaluate economic loss and human perceptions of spotted hyena.

Dear respondents: The aim of this questionnaire is to study diet, economic loss and human perception of the spotted hyena in and around urban garbage damping areas of Abi- Adi, central zone of Tigray, Northern Ethiopia. The result of this study will recognize the problems of hyena in community, quantifying the economic loss of livestock depredations and give recommended solving the problems. So, to achieve the goal of the study, getting genuine information on the current situation of the study area is vital. Therefore you are kindly requested to give genuine answer for all questions. The information will be gathered only for the purpose this study but not will use for other purpose.

I. Socio-demographic characteristics of respondents

Residence Keble (place)………………

Sex………   male ☐   female ☐

Age………………

Marital status…   Single ☐   married ☐   divorced ☐   widowed ☐

Educational back ground.....   Illiteracy ☐   1-4 ☐   5-8 ☐

9-12 ☐   TTA ☐   Diploma ☐ Degree ☐

Occupation………………………

II. Questions of economic loss and methods of livestock managements for respondents

Have you livestock in your home

Yes ☐   No ☐

If 'yes' question number '1'type of livestock owned in each household…………………

A. Sheep   B. Goats

C. Cattle   D. Donkey

E. Horses   F. Doges

G. Cats   H Others

3. Number of livestock owned in each household ……………

A. Sheep   E. Goats

B. Cattle   F. Donkey

C. Horses   G. Doges

D. Cats   H Others

4. Have you ever faced Livestock losses in your home by spotted hyena?

Yes   ☐   No   ☐

5. If so please describe each loss (type of livestock, number, sex, age, place of loss, year and season)

R.No.	Type of livestock loss	Number	Sex	Age	Place	Time	Year	Season
1	sheep							
2	Goats							
3	Cattle							

4	Donkey							
5	Horse							
6	Mule							
7	Dog							
8	Cat							
9	Pig							
10	Others							

6. How do you know the Livestock losses by spotted hyena?

_____

_____

7. What techniques do you use to protect livestock loss from predator of hyena in your home? Or how do you protect the livestock kill from spotted hyena?

A. Dog guarding   D. others

B. shepherd   F. none

C. kraal (fence)

 8. If your response is more than one which is better and why?

_____

_____

_____

9. If you choice question number '7'is kraal (fence) please fill the following table

Where; 1 = V. Strong;   2. =Strong;   3. = medium; 4. =weak   5. Very weak

1 and 2 are effective;   3 is neutral and;   4 and 5 are not effective

Magnitude		Strength				
Height in (m)	Constructing tools	1	2	3	4	5
>2.5 m						
2.0 -2.49m						
1.5-1.99 m						
< 1.49 m						

III. Questions for Perception of respondents towards the spotted hyena

Please put a mark 'X' in your choice

Where, 1 = strongly disagree;   2= disagree;   3= neutral;   4 = agree and   5 = strongly agree

1 and 2 are Negative;   3 is Neutral;   4 and 5 are Positive

R,No.	Statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Hyena is bad animal					
2	Hyena kills livestock					
3	Hyena should live close your area					
4	Hyena clean a garbage area and other leftovers in the area					
5	Hyena is dangerous to human					
6	I would be afraid to go into the forest/field if there are hyenas					
7	I would be afraid when I heard the sound of hyena					
8	Hyena should be disappear (loss) from this village (area)					
9	Hyena important for community and ecosystem					
10	Hyena should conserve in this area					