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**Population status, Distribution and Behavioural ecology of the Gelada baboon (*Theropithecus gelada*) and conflicts with humans in Wonchit Valley, Ethiopia**

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## **DEDICATION**

This thesis is dedicated to my mother, late Turye Eshete for her love, affection and contribution for my academic and personal advancements. Mother, the God rest your souls in eternal peace, Amen!

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**ABSTRACT:** A study on gelada baboon (*Theropithecus gelada*) was carried out to estimate the population status and to determine the seasonal distribution and human – gelada baboon conflict in Wonchit Valley. A band of gelada baboon was selected to study behavioural ecology. The study was carried out from August 2008 to March 2009. Total count method was used to determine the population status and seasonal distribution of gelada baboons. Data on human – gelada conflict was collected using questionnaire interview method. The data were compared using chi-square test. The total average number of gelada baboon in the study area was 1525 during the course of the study. There was seasonal variation in the distribution of gelada baboon across different habitat types. Adult male : adult female sex ratio was 1.00:6.61. The average size of the band was 58.03. The average size of one-male unit was 16.96. The range of group size was from 3 up to 220. They spent 65.18% for feeding, 16.32% moving, 4.59% resting, 13.91% socializing. The home range size was 1.54 km<sup>2</sup> during the dry season and 0.22 km<sup>2</sup> during the wet season. The total time spent feeding on grass blade was 83.75% and it was 11.75% for bulbs, roots and rhizomes. Gelada baboons in the study area caused crop damage, sharing drinking water and livestock pasture and destroying the grazing pasture by digging. Among the respondents 85.33% had negative attitude towards gelada baboon. Among them 41.33% guard their cereal crops for 6 months. Gelada baboon eats crops during harvesting stage more than in the seedling and vegetative stage of the crops.

**Key words:** Distribution, Gelada baboon, human – gelada baboon conflict, population status,

Wonchit Valley

## 1. INTRODUCTION

Ethiopia is one of the countries in the world rich in biodiversity that deserve attention regionally and globally (Leykun Abune, 2000). It has a very diverse set of ecosystems ranging from humid forest type and extensive wetland types to the desert of the Afar depression. The fauna and flora of Ethiopia are remarkable containing distinctive endemic plants and animals (Yalden, 1983). The Ethiopian relief contains a range of altitudes from 116 below sea level to 4620 m above sea level (Afework Bekele and Corti, 1997) and 40% of the country consists of vast highlands about 2500 m above sea level (Afework Bekele and Corti, 1997). Agriculture has been the major human activities during the past centuries and this has resulted in the extensive modification of the vegetation. The forests have been cleared for settlement, fire wood, charcoal, construction and agricultural purposes and the recent rapid population increase has led to destruction of the natural forest at a faster rate (Afework Bekele and Corti, 1997).

There are 284 species of mammals in Ethiopia of which 31 are endemic (Befekadu Refera and Afework Bekele, 2006). Gelada baboon is one of the 31 endemic mammals of Ethiopia. There are nine National Parks, three sanctuaries, eight Game Reserves and eighteen Controlled Areas (Befekadu Refera and Afework Bekele, 2006) where the Ethiopia wildlife forms are conserved. Gelada baboons, not only find in Simien Mountain National Park, but they also live in northern and southern highlands of unprotected areas of the country.

The Order primate comprises 276 species (Feldhamer *et al.*, 2007). Primates are primarily arboreal that arose as an offshoot of Cretaceous period (Kent and Carr, 2001). Primates occupy a wide range of habitats and show a wide diversity of adaptation to their contrasting environments (Macdonald, 1985). They contain terrestrial species as well as those active by day; specialized insectivorous as well as fruit and leaf eaters (Macdonald, 1985). Some primates, such as baboons and chimpanzees have become partly or mostly terrestrial (Vaughan *et al.*, 2000). Among the primates, the Old World monkeys belong to Catarrhine groups is the most successful in terms of number of species (Vaughan *et al.*, 2000).

There are ten species of primates that occur in Ethiopia. These are Hamadryas baboon (*Papio hamadryas*), Olive baboon (*Papio anubis*), Gelada baboon (*Theropithecus gelada*), Black faced vervet (*Cercopithecus aethiops*), Bale monkey (*Cercopithecus djamdjamensis*), Sykes monkey (*Cercopithecus mitis*), De Brazza's monkey (*Cercopithecus neglectus*), Patas monkey (*Erythrocebus patas*), Guereza monkey (*Colobus guereza*) and Blue monkey (*Cercopithecus boutourlinii*) (Grubb *et al.*, 2003).

Gelada baboon (*Theropithecus gelada*) is one of the species of Old World monkeys that inhabits terrestrial habitats with complex social organization (Aich *et al.*, 1987). Gelada baboon is the only survivor of the genus *Theropithecus* and endemic to Ethiopia (Jolly, 1972). There are two subspecies of gelada baboons: *T. gelada gelada* and *T. gelada obscurus* (Yalden *et al.*, 1977). *T. g. gelada* usually has mainly pale brown to dark brown pelage

whereas *T. g. obscurus* has dark brown to almost black pelage (Yalden *et al.*, 1977). *Theropithecus gelada senex* is also considered as another subspecies located south of the Rift Valley in Arsi Provinces (Mori and Gurja Belay, 1990). This species has a disjoint distribution with large population that extends over the great portion of the northern Rift Valley highlands of Shewa, Wollo, Gonder and Gojjam Provinces and a small isolated population limited to the southern Rift Valley in Aris Provinces (Gurja Belay and Shotake, 1998; Gurja Belay and Mori, 2006; Mori and Gurja Belay, 1990). Gelada baboon is found between 1500 m to 4500 m altitudes (Dunbar, 1977b; Iwamoto, 1993) and might ascend in the summit of Ras Dashen at about 4660 m above sea level (Yalden *et al.*, 1977). This species can be physically distinguished from other baboons by having the bright red or pink patch of skin on its chest and this patch is hourglass-shaped (Yalden *et al.*, 1977).

The population status, distribution and other ecological behaviour of a particular species determined by appropriate climate, availability of resources, barriers to dispersal, shelter and inter-specific interaction with other organisms sharing the same area (Vaughan *et al.*, 2000). These factors affect the distribution and other ecological activities of gelada baboon in different part of the area where this species occurs. The rise of human pressure on primate habitats leads to human non-human primate conflicts throughout the world (Hill, 1997). These conflicts intensify if rural poverty and dependency on land increase and rural population grown (Hill, 2002). Crop raiding is severe and poses difficult situations for both farmers and wildlife managers (Bolen and Robinson, 2003).

Gelada baboon is among the most studied primates in different areas of Ethiopia, especially in the Simien Mountain National Park. However, information is lacking on the status, distribution and other ecological aspects and human - gelada baboon conflicts in Wonchit Valley. Hence, this thesis presents data on demographic, distribution and activity budget, home range and feeding ecology and human - gelada baboon conflict in Wonchit Valley.

## 2. LITERATURE REVIEW

Gelada baboon was discovered in 1835 by the explorer Rüpell, who named it by the local name used by the inhabitants of Gonder region where he first observed (Last, 1982). Gelada baboons are large, diurnal primates with dark brown to buff coarse pelage and with dark brown face that live along the edges and steep slopes of cliffs (Last, 1982). Their tail is shorter than the body - head length and has a tuft at the end (Napier and Napier, 1967). The forearms and extremities are black (Napier and Napier, 1967). In adult males, a long heavy cape of hair is present at the back of the shoulder. The most characteristic of gelada baboon is the presence of hairless glass-shaped or triangular patch of bare of pink colour skin located on the chest (von Wolff, 1955). The colour of this bare skin is pink or red depending upon the individual's hormonal and estrus state (Dunbar and Dunbar, 1974c). In females, this patch of skin is surrounded by pearl-like rounded projections of skin (Dunbar and Dunbar, 1974c).

Females on the average weigh around 11 kg while males weigh 19 kg. Head and body length of both sexes range between 50 to 75 cm long and tail 30 to 50 cm long. After a gestation period of 150 to 180 days, females give birth to one infant (Dunbar, 1980b). Sexual maturity of the female and male is reached by the age of 4 and 6, respectively and the life span can extend up to 20 years in the wild (Dunbar, 1980b).

Gelada baboons are one of the most terrestrial, non-human primates and are best described as nearly completely terrestrial with specialized adaptations for feeding and

moving on the ground (Dunbar, 1983b; 1986). They feed and groom in the plain during the days and spend the nights on cliffs (Last, 1982).

## **2.1. Diet and Feeding Ecology**

The challenges presented by inaccessible food resources may have played a large role in the evolution of primate brain. The food of baboons is largely determined by availability and the animal's adaptability to what the environment has to offer (Kingdon, 1971). The diet of gelada baboon is unique among primates (Dunbar and Dunbar, 1974b; Dunbar, 1976; 1977b; 1978a; 1992; Iwamoto, 1979; 1993).

Most herbivores have developed strategies for efficient digestion of their cellulose diet; some have microbial fauna in their stomach or hindgut to ferment the vegetation; the former occurs in ruminant mammals and primates that are mainly foliovorous (Dunbar and Bose, 1991), whereas the latter being found in non-ruminant mammals such as horse and zebra. Gelada baboons have some sort of digestive adaptation (Iwamoto, 1993). The chief method of digestion in gelada baboon is thorough mastication of the vegetation to extract maximum nutrition (Dunbar and Bose, 1991).

Gelada baboons use several types of relatively treeless and montane vegetation for foraging (Dunbar 1976; Kawai and Iwamoto, 1979). This diurnal primate leaves the roosting site at sunrise to ascend the top of the plateau and then start social activities and feeding (Dunbar and Dunbar 1974b; Dunbar, 1977b; Iwamoto, 1993). Gelada baboons

feed by sitting upright for long period of time and foraging by both hands and use their elongated thumbs and shortened forefingers as pincers to pick vegetation (Crook and Aldrich-Blake, 1968). The pieces are transferred to the mouth after accumulated in their hands (Dunbar, 1977b; Iwamoto, 1993). When the gelada baboons wish to move, they shuffle to a new feeding site, by flexing their hips, knees and ankles (Crook and Aldrich-Blake, 1968). Gelada baboons dig the ground surfaces using both hands as shovels to forage on plant parts (Iwamoto, 1993). The variable sizes of their fingers are helpful for digging foods from the ground (Dunbar, 1984a). This ability to dig is superior to the other abilities of monkeys for foraging (Dunbar, 1984a).

The teeth of gelada baboon are similar to other grazing mammals, which are suited for chewing tough food items and they are designed to prolong the life of the teeth row (Dunbar, 1984a). Both fossil and extant *Theropithecus* have small incisors and large molars with deep and heavily ridged enamel layer (Dunbar, 1984a). Although the teeth of gelada baboons are adapted for chewing tough foods, they make efforts to minimize tooth wear by exercising high selectivity in feeding habits and ways of feeding (Dunbar, 1984a).

## **2.2. Social Organization**

Compared to other mammalian orders, primates show a large diversity of social organization. In general, it is believed that social organization is evolutionarily shaped by the ecology of the respective taxon that adapt to certain habitats (Dunbar, 1980b;

Kappeler and van Schaik, 2002). According to socio-ecological models of evolution of primate social systems, ecological factors such as food distribution and predator pressure are among the most important factors of the social organization (Grüter and Zinner, 2004). The dynamic and complex system of the gelada baboon is a nested; multi-level society with the hierarchy of social units similar to that of hamadryas baboons and snub-nosed monkeys (Kawai, 1979; Dunbar, 1993b; Grüter and Zinner, 2004). The society in gelada baboon consists of different sizes as reproductive units, bands, herds and communities (Crook, 1966; Grüter and Zinner, 2004; Ohsawa, 1979; Kawai *et al.*, 1983; Dunbar, 1986). Of the complex social organization, the two major levels are the reproductive units and the bands (Dunbar, 1984b).

In the reproductive unit, there is a strong social bond which is shared by all the females (Dunbar, 1983a; Dunbar, 1986). These bonds between the females are established because of a high relatedness between them (Dunbar, 1986). Females remain in their natal units for their entire life, whereas males leave their natal units upon reaching sexual maturity (Dunbar, 1993b; Ohsawa, 1979). The units undergo foraging and sleeping together and groom each other. A reproductive unit of gelada baboon breaks up when it becomes too large and competition for food outweighs (Dunbar, 1993a; Iwamoto and Dunbar, 1983). The most dominant juvenile male departs with some of the youngest sexually mature females during this time (Iwamoto and Dunbar, 1983). The new unit usually stays close to the natal unit. A dominant female in the reproductive unit is usually the sexually mature female, which can suppress other subordinate females. This rarely happens,

because the subordinate females do not compete with her to interact with the male (Dunbar and Dunbar, 1975). Grooming and other social interactions between females usually occur between pairs, which are kin-related and females do not usually interact at all with more than two or three kin females (Dunbar, 1979; 1983a; 1986).

During aggression, the male uses infants (grooming, mounting, handling, etc) to his advantage, possibly to get help from their mothers (Dunbar, 1984a). After takeover of his harem by a new male through aggression, the former reproductive male can remain in this unit or join another group as a non-reproductive subordinate, and females acknowledge the new reproductive male by presenting to him (Mori and Dunbar, 1985).

Males may leave the harems around 2 years of age but all of them will go from the natal harem by the age of 5 and join all-male groups (Dunbar and Dunbar, 1975). Individuals usually spend 2 to 4 years after emigration in all-male group before joining a reproductive unit (Dunbar and Dunbar, 1975). All-male groups may function as buffer groups in which males, who are not members of a reproductive unit may reside (Mori *et al.*, 2003). These all-male groups undergo grooming each other. They try to fight with the reproductive unit leader. The leaders of the reproductive units cooperate together to chase away the all-male groups from their surroundings.

Gelada baboons live in social units, numbering between 50 to 250 animals, which consist of 2 to 30 harems (each led and controlled by a single adult male) and one or more bachelor groups (Kingdon, 2004). These Bands cluster together on sleeping cliffs and

often feed and move in a single dispersed group (Kingdon, 2004). The band and its constituent reproductive units exist within a common home range (Dunbar, 1984b). Bands typically break apart every eight or nine years with a new band being formed in a new home range (Dunbar, 1980a; 1993a). Members of a band are probably related to each other (Dunbar, 1993a). Between units or their leaders comprising a band, there is no hierarchical order (Mori *et al.*, 1997). Playing among juveniles and immature is cut short during the dry season in periods of environmental impoverishment (Barrett *et al.*, 1992).

Adult gelada baboons have diverse repertoire of discrete vocalizations, including contact, appeasement, solicitation, ambivalence and defensive vocalization (Kawai, 1979; Aich *et al.*, 1990). They have anti-predator behaviour by counter attacks (Iwamoto *et al.*, 1996). Contact calling may be continuous and the common calling and replying between the individuals have important social factors. When vocalizations are directed at the members of a different reproductive unit, they are usually threatening to the side of the cliff (Kawai, 1979). Calls are related to the social status of a gelada baboon (Aich *et al.*, 1990). In captivity, higher rank individuals of both sex exhibit higher call rate (Aich *et al.*, 1987); and female gelada baboons have specific estrus calls that inform males of their condition. Captive experiments have shown that leader males are able to distinguish females from one another exclusively based on their calls (Moos-Heilen and Sossink, 1990). Types of threatening or agonistic gesture including lip roll and raising of the eyelids (Mori, 1979b; Aich *et al.*, 1990) and submission is indicated by fleeing or

presenting (Aich *et al.*, 1990). The beads of skin, which appear on females during estrus, may function in olfactory communication (Aich *et al.*, 1990).

### **2.3. Mating system and Reproduction**

The mating system of the gelada baboon may be characterized as female defense polygyny. The estrus female usually copulates 2 to 5 times per day (Mori, 1979d). Mating can occur at any time in the estrus cycle; however copulation frequently increases around ovulation (Dubar, 1984b; McCann, 1995). Copulation occurs only between the male unit leader and unit females (Mori, 1979d). Before copulation, the male usually approaches the female, inspects her anogenital region and chest and then copulates with her. The female usually solicits copulation, receives or accepts the genital inspection of the male and then copulates with him (Mori, 1979d). Females usually solicit the majority of copulations. Usually female solicitation posture involves the female pointing and raising her posterior towards a male and moving her tail to one side (Dunbar, 1978b). Female emits a specific type of estrus call to show her conditions (Moos-Heilen and Sossinka, 1990). During copulation, the male emit 'haa, haa' vocalization until ejaculation. Copulation usually lasts only around ten seconds and is accomplished by vocalizations (Mori, 1979d). This vocalization has 'hoo, hoo' sound emitted by females. After copulation grooming often occurs (Mori, 1979d). Sometimes, immediately after mating, both male and female commence feeding activity.

When more than one estrus females is found in the group, they compete for copulation with the leader by presenting their posterior quarters to him. During this time, the leader mates to one of those estrus females, occasionally, the others create sound and put their ventral part to the ground. Once females reach sexual maturity, they may try to mate with the dominant male, but usually are unsuccessful (Dunbar, 1978a). During copulation, the sub-adult males run to the mating place and during this time the adult male dismounts and chases them away.

Estrus and hormonal changes in female gelada baboons are externally visible in changing the physical appearance of the pink to red patches of the skin on their chest and anogenital regions (Dunbar and Dunbar, 1974c). This appearance of beads of skin along the periphery of each patches of skin may emit some particular type of olfactory signal (Dunbar and Dunbar, 1974c; Dunbar, 1977a; McCann, 1995). However, changes in the colour of the patches by themselves do not relate with the estrus condition (Dunbar and Dunbar, 1974c). The colour of these patches of skin on chest corresponds with age. Young females have purplish patches that fade to pink in older females (Dunbar, 1977a). In captive animals, the length of estrus cycle varies greatly, but on average it is 37.3 days (McCann, 1995).

Reproduction in gelada baboon occurs throughout the year and the species does not display a specific reproductive season. However, in some areas, there are birth peaks (Mori, 1979a; 1979c; Dunbar *et al.*, 2002). Females reach puberty at three years of age, but

usually give the first birth at around four years old (Dunbar and Dunbar, 1975; Dunbar, 1984a). The interval between births on average is 2.1 years (Dunbar and Dunbar, 1975; Dunbar, 1984b). Males are capable of reproduction at the age of 4 to 5 years. However, they do not become the father of the offspring prior to 8 to 10 years of age (Dunbar, 1984a). This is due to social factors because males emigrate from the natal group at puberty and spend several years in all-male unit (Dunbar, 1993a). Then each of these males attempts to monopolize a reproductive unit usually through agonistic behaviour (Dunbar and Dunbar, 1975; Dunbar, 1993a).

Birth in gelada baboon happens at night but it has been observed in the early morning also (Dunbar and Dunbar, 1974a). During birth, the eyes of the infants are closed, the face is red and the body is covered with black pelage until three months old (Dunbar and Dunbar, 1974a; Mori, 1979a). For sometime after birth, the mother remains on the periphery of the reproductive group in which juvenile, young and adult females show keen interest to the neonate (Dunbar and Dunbar, 1974a; Mori, 1979a). The mother mostly undergoes foraging at the periphery side of the cliff relative to the position of the group. During feeding and moving, the mother supports the infant with her front leg. Until 5 weeks of age after birth, the infant is carried on the ventral side of the mother's body. However, after five weeks of age, the mother carries the infant on her back (Mori, 1979a; Barrett *et al.*, 1995). After five months of age, infants are more likely to be move independently and ventral carrying ceases (Barrett *et al.*, 1995).

## 2.4. Conservation status and Threats

In Ethiopia, gelada baboons are protected only in the Simien Mountain National Park, a UNESCO World Heritage site and hunting of the species is prohibited (Dunbar, 1993a). Degradation and human-induced habitat loss seriously affect the habitat of gelada baboon especially in the unprotected areas of its range. The major threats are the use of preferred gelada baboon habitat for agricultural purposes, human settlement and livestock rearing. Human densities of the Ethiopian plateau are among the highest in Africa and as a result there is a high potential conflict over habitat use (Dunbar, 1993a). Agriculture is so extensive in habitats of gelada baboons and in some places slopes that are too steep for ploughing are cultivated by hand using shovel. As the preferred habitat is destroyed, gelada baboon will likely have to move to marginal areas, reducing their population densities (Dunbar, 1977c). Due to their specialized food habits, gelada baboons do not usually crop raid in Siemen National Park (Dunbar, 1993a). But, during drought, gelada baboons raid croplands especially around harvesting time (Dunbar, 1977c).

Predators of gelada baboons are the leopards, dogs, jackals, foxes, hyenas, servals and raptors such as lammergeyers (Dunbar and Dunbar, 1975; Ohsawa, 1979; Mori *et al.*, 1997). At present predation pressure by leopard is low because of their population decline due to habitat destruction (Iwamoto, 1993). Domestic dogs are the main predator of gelada baboon at present (Dunbar, 1998). Cases of death of the individuals from juvenile to

adults are predominantly due to parasites (Ohsawa, 1979). Tapeworm parasite (*Multiceps servalis*) is one of the most important causes of mortality among gelada baboons (Ohsawa, 1979). This is appeared as small to large swelling that can be seen in various parts of the animal's body. However, even if the above pressures act on this animal, according to IUCN red list 2008, *T. gelada* is least concern.

### **3. OBJECTIVES**

#### **3.1. General objective**

The general objective of the present study is to assess the current population status, distribution of gelada baboons and their conflict with humans in Wonchit Valley.

#### **3.2. Specific objectives**

- To assess the current population size of gelada baboon in Wonchit Valley
- To examine the distribution pattern on gelada baboon in the study area
- To examine activity, ranging and feeding habits of gelada baboon in the study area
- To assess the human – gelada baboon conflict and
- To provide recommendation for future conservation management activities

## **4. THE STUDY AREA**

### **4.1. Location and Topography**

Wonchit Valley is a box canyon, which is located in the Amhara Region between North Shewa and South Wollo zones. The area is located at about 260 km north of Addis Ababa. Wonchit is a perennial river that flows between North Shewa and South Wollo zones from Wore Ilu and Jama Woredas through Merhabete and Mida (Meragna). The river serves as a boundary between South Wollo, specifically Wore Ilu and Jama Woredas from North Shewa specifically, Menzi (Gisha-rabel and Zemero Woredas). Wonchit joins Jema River before reaching Abbay (Blue Nile). The bed of the river occurs at an altitude of 1500 m. The study area specifically is found in Jama Woreda at coordinates within 10° 15' to 10° 30' N latitudes and 39° 15' to 39° 25' E longitudes (Fig. 1). The total size of the study area was 162 km<sup>2</sup>. The site comprises extremely steep escarpments and strip of plateaus. Wonchit Valley is difficult to access, comprising different depths on gently sloping land. It is among the fine scenery areas in Ethiopia separated by dramatic escarpments and gorges. The edge of the terrace consists of unbroken lines of cliffs and very steep slopes and plateaus overlooking a broad shelf covered with agricultural land descending unbroken cliffs and very steep slopes with tiny forest and further covered with agriculture land up to Wonchit River. The altitude ranges between 1500 and 2700 m above sea level. Agriculture is the main activity in the area, followed by livestock rearing. Most of the area is commonly used for agricultural purposes, human settlement and livestock rearing.

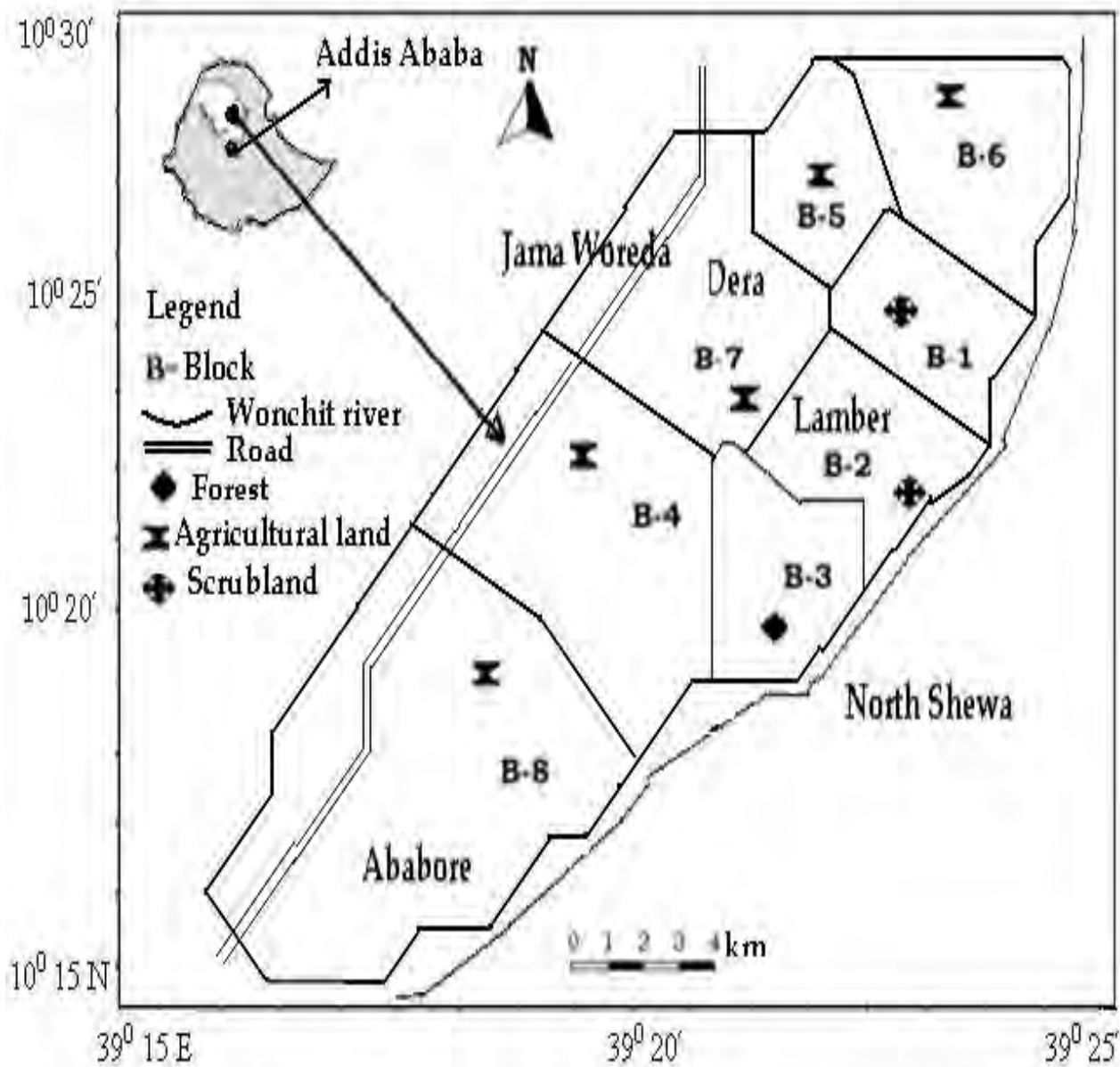


Figure 1. Map of the study area

## **4.2. Soil**

The type of soil in the area is composed of Lithosols. This has heavy textured from clay to sandy soil type. The erodability of the soil is very high especially along the areas that are used for agricultural purposes in sloppy lands.

## **4.3. Climate**

The study area can be divided into three thermal zones: 'Kola', with altitude ranges of 1500 - 2000, 'Weinadega' (2000 - 2400) and 'Dega' (2400 - 2700 m asl). Temperature ranges between 7.4 and 23.7 °C (Fig. 2).

The area has unimodal type of rainfall that occurs from June to the middle of September with the peak rainy days in July. The average annual rainfall in the area is 784 mm. The dry season of the area commences from December to May. The hottest month is May (23.7 °C) and the coldest month is December (7.4 °C).

## **4.4. Flora**

The flora of the area can be classified as forest, scrubland and agricultural/sward land. In general, the vegetation is montane type. Different types of plants in the area are recorded and identified during the study period (Appendix 1). The flora of the area is heavily affected by human activities such as fire wood collection, agriculture and charcoal production.

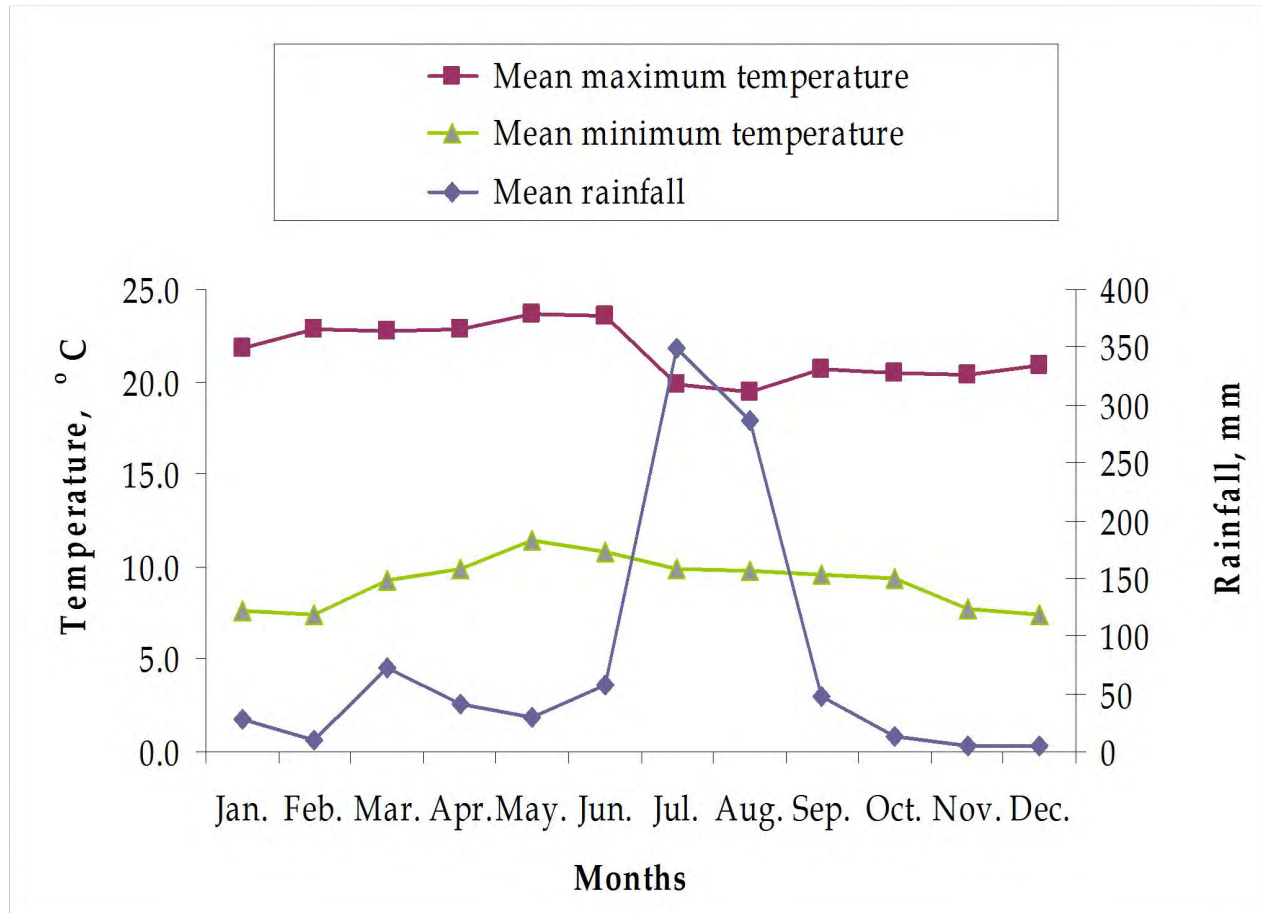


Figure 2. Mean monthly distribution of rainfall and mean monthly maximum and minimum temperature in the study area (1996-2005) (Source: Ethiopia Meteorological Authority).

#### 4.5. Fauna

The large mammal fauna in the Wonchit Valley are recorded during the study period (Appendix 2). Gelada baboons are the dominant native herbivore in the area. Domestic stock (cow, sheep, goat, horse and donkey) are prevalent throughout gelada baboon home range and compete for food resources.

## **5. METHODS**

### **5.1. Preliminary Study and Materials**

The present study was conducted from August, 2008 to March, 2009. A preliminary survey was conducted prior to the actual data collection to familiarize with the area and the rough terrain. Based on this reconnaissance survey, the study site was identified based on altitudinal and vegetation types. The preliminary survey also enabled the observer to distinguish the age and sex classes, group size and distribution. A band of gelada baboon group living in the study area was habituated for scan sampling to record the activity, ranging pattern and diet of the groups in the study area.

The materials used for this study were 8× binocular, Garmin Global Positioning System (GPS) 72 and plant press.

### **5.2. Sampling Design and Data Collection**

#### **5.2.1. Division of the study area**

The study area was divided into three census zones based on altitudinal and vegetation coverage. Each of the census zones again was classified into eight blocks depending upon the natural boundaries such as escarpment, gorges, rivers, farmlands and roads. The size of each census zone varied depending upon the habitat type and topography of the area. The number of blocks in each census zone depended upon the size of census zones (Table 1). Large areas were divided into blocks. However, for small census zone, the whole area

was taken as a block. A total of eight blocks (five from agricultural area, two from scrubland and one from the forest) was used in the study.

Table 1. Habitat type and name of blocks with codes.

Habitat type	Number of blocks	Area in km <sup>2</sup>	Block name	Block code
Scrubland/bushy	2	30	Delemet	B-1
			Mesno	B-2
Forest	1	12	Dabodefer	B-3
Agricultural land/sward	5	120	Kirkimit	B-4
			Janamba	B-5
			Abogaye	B-6
			Leshete	B-7
			Lencho	B-8

### 5.2.2. Population estimation

Total count method was applied to estimate the population size of gelada baboons in different habitats (Melton, 1983; Sutherland, 1996). Eight blocks was censused during both wet and dry seasons. Each block was assessed twice per month to estimate the population status and the distribution of gelada baboon in the study area. Census was conducted by the researcher and an assistant, who is familiar to the study area, using mechanical thumb counter (Hunter, 2001), eye and a binocular. Data were recorded on prepared data sheet. The study area was surveyed following certain path that allowed

access at all parts of the blocks. Morning counts began when all the gelada baboon groups left their sleeping cliffs and moved to the plateau or cliff edge for foraging. Therefore, surveys were not conducted until 9:00 a.m. of the day as used by Hunter (2001). To avoid double count, the observer used group size, swelling on the body part and other special features of the encountered gelada baboons. An intensive effort was made to obtain a complete census of all encounter groups of gelada baboons.

### **5.2.3. Population composition**

During the population census, each of the individuals was grouped into respective age and sex categories after detailed observation. The criteria for age classification depended on body size as adopted by Mori *et al.* (1999). Individuals in the group were categorized as adult male, adult female, sub-adult male, juvenile male, juvenile female yearling and infant (Crook, 1966). Sub-adult males, who are not members of the reproductive units, form all-male units form discrete and long-lasting social groups in their own right (Dunbar, 1980b). Therefore, when such all-male units were encountered, they were categorized as sub-adult males. In addition, when one-male or band groups were encountered, they were categorized as sub-adult in that group. The sub-adult estrous females were categorized as adult females for this study. The juveniles were divided equally between the two sexes. Identification of sex and age categories was carried out using body size, genitalia and red patches of skin on their chest and anogenital regions,

cape of hair on the back, size of mantle and whiskers, bulges on the buttock and pelage colour.

#### **5.2.4. Group size**

The total number of individuals encountered in a group was recorded on prepared data sheet before categorized into respective sex and age categories. Animals were considered as the same group if the distance between them was less than 50 m (Hillman and Hillman, 1987; Befekadu Refere and Afework Bekele, 2004). To determine group sizes, once gelada baboon group was spotted, they were categorized based on social organization and grouped into one of the following: one-male unit also called “harem”, band and all-male units. One-male unit was defined as those groups that lived in reproductive units containing a single adult male and his followers in a particular place. Band was referred as an association with two or more adult males with their followers that lived together in their own home range (Dunbar and Dunbar, 1975). All-male unit was defined as those groups that contain only bachelor sub-adult males in their groups forming their own home range.

#### **5.2.5. Distribution**

Seasonal distribution of gelada baboon in the study area was determined from the encounter rate of the data collected during the wet and dry seasons. The size of the group

observed in different census zones during the wet and dry seasons was compared with the distribution of gelada baboons in the study area.

### **5.2.6. Activity time budget**

Activity data were collected using scan sampling method (Altmann, 1974) on a band group for 5 consecutive days per month during both the dry and wet seasons. Instantaneous scan sampling method was used. Activity time budget at 15 minute intervals was collected (Fashing, 2001) and followed on foot from a distance of 5 to 15 m for full-day follow up from 7:00 a.m. to 18:00 p.m. The scan lasted for five minutes followed by 10 minutes rest until the next scan began. During the scan period, age and sex and the behaviour of each individual were recorded (Di Fiore, 2003). Each animal was observed for 5 seconds after being detected (Di Fiore, 2003) and its predominant behaviour during that period was recorded on prepared data sheet. The observer followed them on foot throughout the day, when they moved from place to place. For each scan, activity record was made from one side of the band of gelada baboon to the other except for yearlings and infants. The activity time budget data were recorded and grouped into one of the four broad categories: feeding, moving, resting and other social activities following Dunbar and Dunbar (1988), Dunbar (1992) and Hunter (2001). Feeding activity was recorded, when the gelada baboons were grazing, foraging or excavating and processing or eating food items. Moving was recorded, when the gelada baboons were walking or running without feeding. Resting was recorded, when the

gelada baboons were lying or sitting without other activity or immobile in quadrupedal stance or self grooming. Socialization was recorded, when the gelada baboons were playing, grooming with other individuals, aggression, paternal or maternal care, copulation, presenting and embracing.

### **5.2.7. Ranging pattern**

During instantaneous scan sampling record of the activity time budget, the GPS coordinate of the centre of the selected band location was also recorded at 15 minutes intervals, walking through the periphery of the group (Wong and Sicotte, 2007). When the band of the group was started moving, the subsequent route was mapped by recording a GPS coordinate at that particular time of the day.

### **5.2.8. Feeding ecology**

Data were collected every 15 minutes during scan sampling to obtain information on gelada baboon diet (Dunbar, 1977b). The observer followed the band of gelada baboon on foot for the focal animals. During active feeding time, the type of plant species consumed was collected (Di Fiore, 2004). The diet structure was determined by recording what a particular gelada baboon was eating (Iwamoto and Dunbar, 1983). These dietary profiles were collected from the particular adult male, adult female and juvenile but not from yearlings and infants. Samples were carried out during both the dry and wet seasons. To determine what the animals were feeding, the observer recorded the species and part

consumed (blades, leaves, rhizomes, roots, bulbs, flowers and fruits) during scan samples (Dunbar, 1977b). Samples of plants were collected and taken to the National Herbarium, Addis Ababa University, for species identification.

### **5.2.9. Human – gelada baboon conflict**

Human – gelada baboon conflict in the study area was conducted using direct observation and personal interviews using questionnaires. Three villages (Dera, Lamber and Ababore) were randomly selected from the study area. A total of 150 people, 50 people from each village were interviewed using the prepared questionnaire. The questionnaire was designed to seek how much intensive the conflicts between human and gelada baboons in the Wonchit Valley. Using the questionnaire, the interview was conducted on the basis of randomly selected interviewers in the study area. These were carried out during the population status survey of gelada baboon and covered the representative communities of the study area of the selected villages.

### **5.3. Data Analysis**

The population status of gelada baboon in the study area was estimated by adding all the recorded count on each census zones and blocks during both the dry and wet seasons. The sex and age ratio of the gelada population was computed from the records of the population data. The average number of the group size for each month and season was

also compared from the data collected from each census zone and block. Seasonal distribution was determined and compared by encounter rates and the average number of animals recorded in each census zones and blocks during each month and season.

To calculate activity time budget of the focal group of gelada baboon, all recorded activities were first assigned to one of the activity categories and the proportion of time budgets was compared to each other. The relative time budget of each activity was estimated by dividing the records of each activity with the records of all activities and multiplied by 100 (Hunter, 2001), using the following formula:

$$\frac{\Sigma(\text{records for specific activity } x)}{\Sigma(\text{records for all activities})} \times 100$$

Where, activity x is one of the four primary activities recorded

The locations recorded during scan period were used to assess a band's total home range and average daily path length in each season. The Minimum Convex Polygon (MCP) method was used to calculate the size of home range in the study area (Di Fiore, 2003). GIS software was used to calculate the home range size of the study focal band (Wong and Sicotte, 2007). The boundary of the home range for the band was constructed by connecting the outermost GPS location of the group during both the wet and dry seasons (Wong and Sicotte, 2007).

The diet structure of gelada baboon was determined by identifying the type of the species being eaten (Iwamoto and Dunbar, 1983; Grassi, 2006; Hunter, 2001). Diet composition was assessed by using proportion of part eaten and type of plant species consumed by gelada baboon in each season. The seasonal proportion of the diet was calculated as the focal individuals of adult male, adult female, juvenile male and juvenile female of gelada baboon feeds upon the particular food items of the plant species in each season divided by all type and part of food item eaten by the group during both the dry and wet seasons.

The human - gelada baboon conflict was calculated by summing the result of the questionnaire and interview provided from the local people living in the study area.

#### **5.4. Statistical Analysis**

All the data collected were conducted using SPSS version 15 computer software program. The differences in the population during the wet and dry seasons were compared using chi-square test. The chi-square was also used to compare the activity time budget, ranging pattern and feeding behaviour to find out seasonal differences. Chi-square also used to assess the differences in human - gelada baboon conflicts among the selected villages and respondents. All tests were two tailed with 95% confidence interval and level of rejection set at  $p = 0.05$ .

## 6. RESULTS

### 6.1. Population status of gelada baboon

#### 6.1.1. Population estimation

The total count carried out on gelada baboon across each block is listed in Table 2. The maximum number of gelada baboon in the study area was 1447 and 1683 during the wet (II) and dry (II) seasons, respectively. On the average the total numbers of gelada baboons counted in the study area of Wonchit Valley were 1431 during the wet season and 1619 during the dry season. The population observed was significantly higher during the dry season than during the wet season ( $\chi^2 = 11.558$ ,  $df = 1$ ,  $p < 0.05$ ). The number of gelada baboon varied among each counting block. Among blocks, on average the highest number was recorded in Block 8 during both the wet and dry seasons and the lowest was recorded in Block 1 during the dry season. They were not recorded in block 7 during the wet season. There was significant difference between the number during the wet and dry seasons in block 1 ( $\chi^2 = 63.859$ ,  $df = 1$ ,  $p < 0.05$ ), block 2 ( $\chi^2 = 22.969$ ,  $df = 1$ ,  $p < 0.05$ ), block 3 ( $\chi^2 = 66.587$ ,  $df = 1$ ,  $p < 0.05$ ), block 4 ( $\chi^2 = 18.601$ ,  $df = 1$ ,  $p < 0.05$ ), block 5 ( $\chi^2 = 70.721$ ,  $df = 1$ ,  $p < 0.05$ ) and block 8 ( $\chi^2 = 7.720$ ,  $df = 1$ ,  $p < 0.05$ ). However, there was no significant difference between the number during the wet and dry seasons in block 6 ( $\chi^2 = 2.845$ ,  $df = 1$ ,  $p > 0.05$ ).

Table 2. Number of gelada baboons counted in each counting block during the wet and dry seasons.

Season	Month	Year	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	Total
Wet I	August	2008	198	196	216	103	120	285	-	297	1415
Wet II	October	2008	212	211	208	97	141	293	-	285	1447
Mean			205	203.5	212	100	131	289	-	291	1431
Dry I	January	2009	78	124	73	143	267	312	201	357	1555
Dry II	March	2009	65	112	75	199	347	350	168	367	1683
Mean			71.5	118	74	171	307	331	185	362	1619

### 6.1.2. Population composition

The mean age and sex number of gelada baboons during the study period is presented in Table 3. There were 84 adult males and 547.5 adult females from the total number of gelada baboons during the wet season census. However, there were 93.5 adult males and 626.5 adult females during the dry season count. There was no significant difference between adult males during the wet and dry seasons ( $\chi^2 = 0.562$ ,  $df = 1$ ,  $p > 0.05$ ). However, there was significant difference between adult females during the wet and dry seasons ( $\chi^2 = 5.311$ ,  $df = 1$ ,  $p < 0.05$ ). There was also significant difference between sub-adult males during the wet and dry seasons ( $\chi^2 = 4.181$ ,  $df = 1$ ,  $p < 0.05$ ). There was no significant difference between yearlings during the wet and dry seasons ( $\chi^2 = 0.920$ ,  $df = 1$ ,  $p > 0.05$ ). There was also no significant difference between infants during the wet and dry seasons ( $\chi^2 = 0.474$ ,  $df = 1$ ,  $p > 0.05$ ).

Table 3. Sex and age distribution of gelada baboons during the wet and dry seasons.

Season	AM	AF	SAM	JM	JF	YR	IN	Total
Wet	84	547.5	137	170	180.5	166.5	145.5	1431
Dry	93.5	626.5	173	185.5	198.5	184.5	157.5	1619

AM=adult male, AF=adult female, SAM=sub-adult male, JM=juvenile male, JF=juvenile female, YR=yearling, IN=infant

During the wet season, 5.87% were adult males, 38.26% adult females, 9.57% sub-adult males, 11.88% juvenile males, 12.61% juvenile females, 11.64% yearlings and 10.17% infants. During the dry season, 5.78% were adult males, 38.69% adult females, 10.69% sub-adult males, 11.46% juvenile males, 12.26% juvenile females, 11.39% yearlings and 9.73% infants. There were no seasonal variation in the sex and age groups.

From the total average number, 88.75(5.82%) were adult males, 587(38.49%) adult females, 155(10.16%) sub-adult males, 177.75(11.66%) juvenile males, 189.5(12.43%) juvenile females, 175.5(11.51%) yearlings and 151.5(9.93%) infants during the course of the study.

### 6.1.3. Group size

The average number of group size, total number of group, range of group size and mean group size of gelada baboons in the study area during the wet and dry seasons is presented in Table 4. The total number of groups encountered during the wet season (August and October) was 98 and 95 during the dry season (January and March). There was no significant difference between the total number of groups during the wet and dry

seasons ( $\chi^2 = 0.047$ ,  $df = 1$ ,  $p > 0.05$ ). The overall range of the group size during the wet and dry seasons was from 3 to 137 and 4 to 220, respectively. The mean group size was 24.88 during the wet season and 33.52 during the dry season. Even though, the mean group size during the dry season was higher than during the wet season, there was no significant difference between the overall mean group sizes during the wet and dry seasons ( $\chi^2 = 1.373$ ,  $df = 1$ ,  $p > 0.05$ ). The average number of gelada baboons was higher during the dry season than during the wet season. The overall mean number of gelada baboons in the study area was 1525. The mean group size was 29.31.

Table 4. Group size of gelada baboons during the wet and dry seasons.

Season	Year	Mean number	N	Range of group size	Mean group size
Wet	2008	1431	98	3-137	24.88
Dry	2009	1619	95	4-220	33.52
Mean		1525			29.31

N=total number of groups

#### 6.1.4. Group type

The group type and group size of gelada baboon social system is presented in Table 5. During the wet season, the maximum group size of one-male unit was 23 and the minimum was 8; whereas during the dry season, the maximum was 25 and the minimum was 14. The maximum and the minimum overall group size of one-male unit type of the gelada baboon social system during both the study seasons was 25 and 8, respectively. During the wet and dry seasons, the mean group size of one-male unit was 16.69 and

17.33, respectively. During the wet and dry seasons, the maximum and minimum group size of all-male unit social system was 12 and 3, and 12 and 4, respectively. The overall maximum and minimum group size for the band type social system of gelada baboon was 220 and 25 during both the wet and dry seasons, respectively. During the wet season, there were 2 - 8 one-male units per band and during the dry season there were 2 - 14 one-male units per band. There was no significant difference between the mean band size ( $\chi^2 = 3.430$ ,  $df = 1$ ,  $p > 0.05$ ), one-male unit ( $\chi^2 = 0.106$ ,  $df = 1$ ,  $p > 0.05$ ) and all-male unit ( $\chi^2 = 0.032$ ,  $df = 1$ ,  $p > 0.05$ ) during the wet and dry seasons. There was also no significant difference between the number of band ( $\chi^2 = 0.333$ ,  $df = 1$ ,  $p > 0.05$ ), one-male unit ( $\chi^2 = 1.600$ ,  $df = 1$ ,  $p > 0.05$ ) and all-male unit ( $\chi^2 = 0.571$ ,  $df = 1$ ,  $p > 0.05$ ) during the wet and dry seasons.

Table 5. Group type and size of gelada baboon social system during the wet and dry seasons in the study area.

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Social system	Season	Group size		Mean group size	N	OMUs/band
		Maximum	Minimum			
One-male unit	Wet	23	8	16.69	51	
	Dry	25	14	17.33	39	
	Overall	25	8	16.96	90	
All-male unit	Wet	12	3	6.17	12	
	Dry	12	4	6.44	16	
	Overall	12	3	6.32	28	
Band	Wet	137	27	54.66	35	2-8
	Dry	220	25	60.98	40	2-14
	Overall	220	25	58.03	75	2-14

OMUs=one-male unit, N=total number of groups

### 6.1.5. Sex and Age ratio

The sex and age ratio of gelada baboon during the wet and dry seasons is given in Table 6. The sex ratio of adult male to adult female during the wet season was 1.00:6.52 and 1.00:6.70 during the dry season. The age ratio of adult female to infant was 1.00:0.27 during the wet season and 1.00:0.25 during the dry season. There was significant difference between adult male and adult female sex ratio during the wet ( $\chi^2 = 340.658$ ,  $df = 1$ ,  $p < 0.05$ ) and dry seasons ( $\chi^2 = 394.021$ ,  $df = 1$ ,  $p < 0.05$ ). There was also significant difference between infant and adult female age ratio ( $\chi^2 = 232.859$ ,  $df = 1$ ,  $p < 0.05$ ) and ( $\chi^2 = 280.205$ ,  $df = 1$ ,  $p < 0.05$ ) during the wet and dry seasons, respectively.

Table 6. Mean sex and age ratio of gelada baboon during the wet and dry seasons.

Season	Sex ratio			Age ratio		
	AM:AF	SAM:AF	M:AF	AF:YR	AF:IN	AM:SAM
Wet	1.00:6.52	1.00:3.99	1.00:2.48	1.00:0.30	1.00:0.27	1.00:1.63
Dry	1.00:6.70	1.00:3.69	1.00:2.35	1.00:0.29	1.00:0.25	1.00:1.85

AM=Adult male, AF=Adult female, YR=Yearling, IN=Infant, SAM=Sub-adult male, M=Adult and sub-adult male

The overall average sex and age ratio of gelada baboon in the study area is given in Table 7. The sex ratio of adult male to adult female was 1.00:6.61. The sex ratio of male that includes adult male and sub-adult male to adult female was 1.00:2.41. The age ratio of adult female to infant was 1.00:0.25.

Table 7. Overall mean sex and age ratio of gelada baboons in the study area.

Sex ratio			Age ratio		
AM:AF	SAM:AF	M:AF	AF:YR	AF:IN	AM:SAM
1.00:6.61	1.00:3.79	1.00:2.41	1.00:0.29	1.00:0.25	1.00:1.75

AM=Adult male, AF=Adult female, SAM=Sub-adult male, YR=Yearling, IN=Infant, M=Adult and sub-adult male

## 6.2. Distribution

The seasonal distribution of gelada baboon in different habitat type is presented both in number (Table 8). The size of each habitat types was not equal in the study area to

determine the habitat use of gelada baboons. However, there was seasonal variation in the distribution of gelada baboon in the study area across different habitat types. In both forest and scrubland habitat, there were more gelada baboons during the wet season than during the dry season. However, in agricultural/sward habitat type, there was more number of gelada baboons during the dry season than during the wet season. Gelada baboons were also observed outside the forests on swards and scrublands. There was significant difference between the number in the sward ( $\chi^2 = 137.067$ ,  $df = 1$ ,  $p < 0.05$ ), scrubland ( $\chi^2 = 80.068$ ,  $df = 1$ ,  $p < 0.05$ ) and forest habitats ( $\chi^2 = 66.587$ ,  $df = 1$ ,  $p < 0.05$ ) during the wet and dry seasons.

Table 8. Seasonal distribution of gelada baboons in different habitat types during the course of the study period.

Season	Number of individuals observed		
	Agricultural land/Sward	Bushy/Scrubland	Forest
Wet	810.5	408.5	212
Dry	1355.5	189.5	74

The mean group size of gelada baboon in each habitat type is presented in Table 9. There was seasonal variation in the number of gelada baboon in each habitat type. The mean group size of gelada baboon in the three habitat categories differed slightly. There were no significant difference detected in mean group size for the animal ( $\chi^2 = 137.067$ ,  $df = 2$ ,

p > 0.05). Therefore, although gelada baboon favours some localities more than the others, the data were not show mean group size variation in contrasting habitats in Wonchit Valley.

Table 9. Group size of the gelada baboons in each habitat type.

	Number of groups and size in different habitat type		
	Sward land	Scrubland	Forest
Mean number of group	32.75	10	5.75
Mean group size	33.07	29.9	24.87

### 6.3. Activity time budget

A total of 3520 individual observations were recorded from the habituated selected band for a total of 880 group scans in 220 hours in 20 days observation period during the wet and dry seasons. During the wet season, the activity of the band in the study was 64.40% feeding, 10.77% moving, 7.03% resting and 17.80% socializing; while during the dry season, 66.00% feeding, 22.25% moving, 2.00% resting and 9.75% socializing. During the wet and dry seasons, the band spent more or less equal time for feeding, and more time for moving during the dry season than during the wet season. There was no significant difference between feeding time budget during the wet and dry seasons ( $\chi^2 = 0.449$ ,  $df = 1$ ,  $p > 0.05$ ) in the study area. However, there was significant difference between the wet

and dry seasons in moving ( $\chi^2 = 27.393$ ,  $df = 1$ ,  $p < 0.05$ ), resting ( $\chi^2 = 25.474$ ,  $df = 1$ ,  $p < 0.05$ ) and socializing ( $\chi^2 = 23.809$ ,  $df = 1$ ,  $p < 0.05$ ) during the course of the study period.

The overall activity budget of gelada baboon in the study area was 65.18% spend for feeding, 16.32% moving, 4.59% resting and 13.91% socializing. There were significant differences across feeding, moving, resting and socializing during the course of the study period ( $\chi^2 = 727.700$ ,  $df = 3$ ,  $p < 0.05$ ). The animal has used the highest time budget for feeding and the smallest for resting in the study area.

#### 6.4. Ranging pattern

The mean daily journey length and home range size of gelada baboons during the wet and dry seasons are presented in Table 10. They travelled about 600 m during the wet season and 1560 m during the dry season a day. There was significant difference in the distance travelled during the wet and dry seasons ( $\chi^2 = 21.429$ ,  $df = 1$ ,  $p < 0.05$ ).

Table 10. Mean day journey and home range size of gelada baboons in the study area.

Season	Mean day journal length	Home range	Group size
Wet	600 m	0.22 km <sup>2</sup>	62

The home range size of the selected band varied between seasons (Fig. 3). It was 0.22 km<sup>2</sup> and 1.54 km<sup>2</sup> during the wet and dry seasons, respectively. The home range size of gelada baboon in the study area is more extended during the dry season than that of the wet season. There was a significant difference between the ranging pattern during the wet and dry seasons ( $\chi^2 = 16.071$ ,  $df = 1$ ,  $p < 0.05$ ) in the study area.

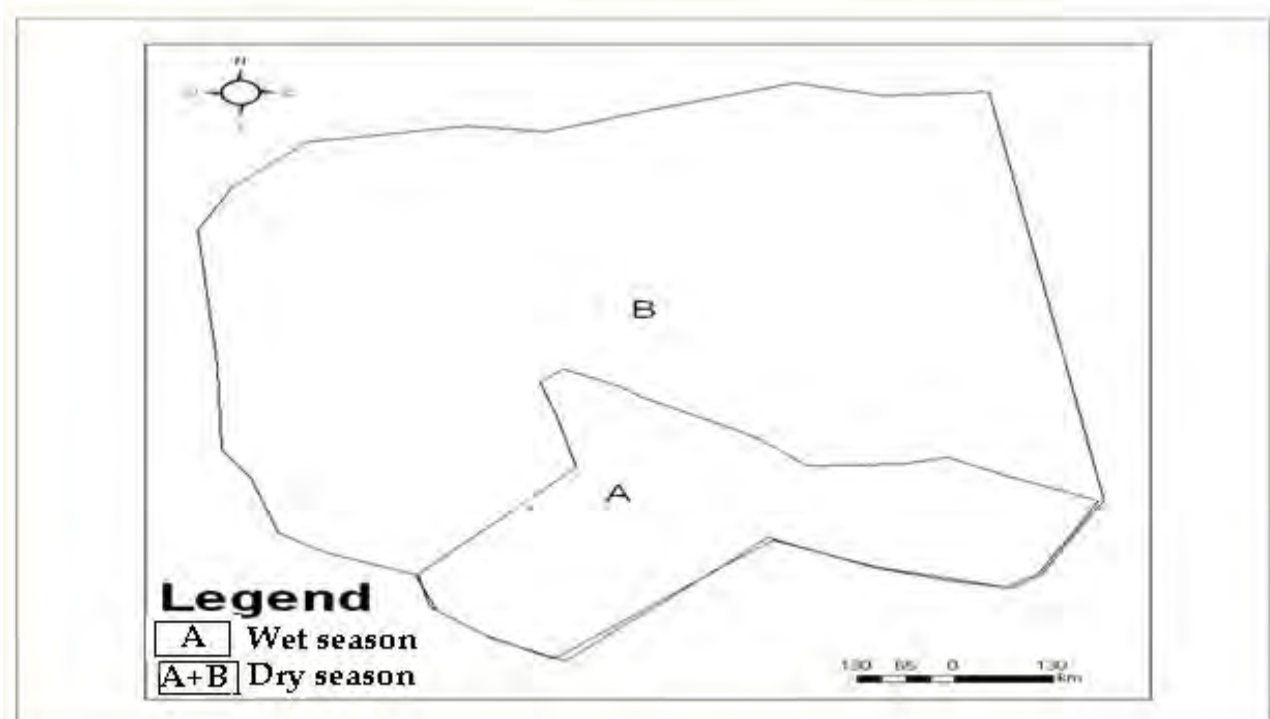


Figure 3. Home range size of the gelada baboons during the wet and dry seasons

## 6.5. Feeding ecology

Table 11 shows the species and parts of plants consumed by the gelada baboons. A total of 60 species belonging to 20 families of plants and three species of animals were identified in the study area as diet of gelada baboons. Grasses were the most common

diet during the wet and dry seasons. Gelada baboons also consumed the resin of *Acacia* spp., *Rhus glutinosa* and *Albiza schimperiana*. In addition to these plants, they also consumed animals which include flying ants, ants (genus *Formica*) and termites. Flying ants were consumed during the wet season, whereas ants and termites were eaten during the dry season.

Table 11. List of plant species consumed by gelada baboons during the study period.

Local name	Species name	Family	Parts consumed	Season	
				Wet	Dry
Akirma	<i>Eleusine floccifolia</i>	Gramineae	BL	x	X
Wisha sar	<i>Sporobolus pyramidalis</i>	Gramineae	BL	X	X
Wisha sindodo	<i>Sporobolus thunbergii</i>	Gramineae	BL	X	X
Serdo	<i>Cynodon dactylon</i>	Gramineae	BL, ST	X	X
Gaja	<i>Chloris pycnothrix</i>	Gramineae	BL	X	X
Gita	<i>Pennisetum sphacelatum</i>	Gramineae	BL	X	X
Shikoko sar	<i>Pennisetum mezianum</i>	Gramineae	BL	X	X
Wisha sindodo	<i>Pennisetum thunbergii</i>	Gramineae	BL	X	X
Labasar	<i>Pennistum villosum</i>	Gramineae	BL	X	X
Nech sar	<i>Pennistum cladestinum</i>	Gramineae	BL	X	X
Wisha sar	<i>Pennistum glabrum</i>	Gramineae	BL	X	X

Cont'd...

Senbelat	<i>Hyparrhenia rufa</i>	Gramineae	BL, ST	X	X
Senbelat	<i>Hyparrhenia hiruta</i>	Gramineae	BL, ST	X	X
Senbelat	<i>Hyparrhenia nyassae</i>	Gramineae	BL, ST	X	X
Yetafa zer	<i>Eragrostis tenella</i>	Gramineae	BL	X	X
Yetafa zer	<i>Eragrostis lepida</i>	Gramineae	BL	X	X

Yetaf zer	<i>Agrostis quinqueseta</i>	Gramineae	BL	X	X
Gaja	<i>Andropogon gayanus</i>	Gramineae	BL	X	X
Gaja	<i>Andropogon abyssinicus</i>	Gramineae	BL	X	X
Gaja	<i>Andropogon distachyos</i>	Gramineae	BL	X	X
Gaja	<i>Andropogon greenwayi</i>	Gramineae	BL	X	X
Lesslassasar	<i>Digitaria abyssinica</i>	Gramineae	BL	X	X
Lesslassasar	<i>Digitaria ternata</i>	Gramineae	BL	X	X
Senbelat	<i>Cymbopogon spp.</i>	Gramineae	BL	X	X
Senbelat	<i>Themeda triandra</i>	Gramineae	BL	X	X
Senbelat	<i>Exotheca abyssinica</i>	Gramineae	BL	X	X
Gaja	<i>Botriochoa inscupta</i>	Gramineae	BL	X	X
Muja	<i>Snowdenia polystachya</i>	Gramineae	BL, ST	X	
Muja	<i>Snowdenia petitiana</i>	Gramineae	BL, ST	X	
Lesilasasar	<i>Ehrharta abyssinica</i>	Gramineae	BL	X	X
Lesilasasar	<i>Poa annua</i>	Gramineae	BL	X	X
Lesilasasar	<i>Poa leptoclada</i>	Gramineae	BL	X	X
Lesilasasar	<i>Poa schimperiana</i>	Gramineae	BL	X	X
Kechinmuja	<i>Bromus leptoclados</i>	Gramineae	BL, ST	X	
Kechinmuja	<i>Bromus pectinatus</i>	Gramineae	BL, ST	X	
Irat	<i>Aloe spp.</i>	Aloaceae	FL		X
Yewofkollo	<i>Romulea fischeri</i>	Iridaceae	BU		X

Cont'd...

Yewofkollo	<i>Merendera abssinica</i>	Colchicaceae	BU		X
Gamedsar	<i>Cyperus rigidifolius</i>	Cyperaceae	LE, RO	X	X
Dog	<i>Kniphofia foliosa</i>	Asphodelaceae	ST	X	
Beles	<i>Opuntia ficus-indica</i>	Cactaceae	FR,LE		X
Yelamtut	<i>Chlorophytum tetraphyllum</i>	Anthericaceae	RO		X

Sindalit	<i>Chlorophytum pterocarpum</i>	Anthericaceae	RO		X
Yeberachew	<i>Epilobium hirsutum</i>	Onagraceae	FL, LE	X	
Maget	<i>Trifolium spp.</i>	Fabaceae	FL, LE	X	
Adayababa	<i>Bidens prestinaria</i>	Asteraceae	FL, LE	X	
Adayababa	<i>Cotula abyssinica</i>	Asteraceae	FL, LE	X	
koshim	<i>Dovyalis abyssinica</i>	Flacourtiaceae	FR		X
Kimo	<i>Rhus vulgaris</i>	Anacardaceae	FR	X	
Agam	<i>Carissa edulis</i>	Apocynaceae	FR	X	
Kega	<i>Rosa abyssinica</i>	Rosaceae	FR	X	X
Dibrik	<i>Salvia schimperi</i>	Lamiaceae	FL	X	
Berakolet	<i>Holothrix unifolia</i>	Orchidaceae	RO	X	
Shenbeko	<i>Arundo donax</i>	Gramineae	BD		X
Enibus	<i>Rus glutinosa</i>	Anacardiaceae	BD		X
Warka	<i>Cordia africana</i>	Boraginaceae	FR		X
Woirra	<i>Olea europaea</i>	Oleaceae	FR		X
Motishi	<i>Becium grandiflorum</i>	Lamiaceae	FL	X	
Gimamuch	<i>Plectranthus ornatus</i>	Lamiaceae	LE	X	
Chifrig	<i>Sida schimperiana</i>	Malvaceae	FL, LE		X

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BL=blade, LE=leave, FR=fruit, FL=flower, BD=bud, BU=bulb, RO=root

A total of 2200 feeding behavioural records were collected from scan sampling of the selected band during the wet and dry seasons. The time spent for feeding grass blade was (83.75%), roots, bulbs and rhizomes (11.75%), fruits (1.87%), leaves (1.38%) and flowers (1.25%) during the course of the study. There was significant difference in the feeding time among the overall food items during the course of the study period in the study area ( $\chi^2 = 511.713$ ,  $df = 4$ ,  $p < 0.05$ ).

During the wet season, the time spent by the selected band for feeding on grass blades was 93.25%, leaves 2.0%, flowers 2.0%, fruits 1.50% and bulbs, roots and rhizomes 1.25%; while during the dry season, grass blades 74.25%, leaves 0.75%, flowers 0.50%, fruits 2.25% and bulbs, roots and rhizomes 22.25%. Gelada baboons spent more time feeding on grass blades during the wet season than during the dry season. The animal spent more time feeding on bulbs, rhizomes and roots during the dry season than during the wet season. They also spent more time feeding on leaves and flowers during the wet season than during the dry season and less time on fruits during the wet season than during the dry season. There was significant difference in time spent for feeding on grass blades between the wet and dry seasons ( $\chi^2 = 4.298$ ,  $df = 1$ ,  $p < 0.05$ ). There was no significant difference in time spent for feeding on leaves ( $\chi^2 = 0.667$ ,  $df = 1$ ,  $p > 0.05$ ), flowers ( $\chi^2 = 1.800$ ,  $df = 1$ ,  $p > 0.05$ ) and fruits ( $\chi^2 = 0.500$ ,  $df = 1$ ,  $p > 0.05$ ) between the wet and dry seasons. There was also significant difference in time spent of feeding on bulbs, rhizomes and roots between the wet and dry seasons ( $\chi^2 = 36.750$ ,  $df = 1$ ,  $p < 0.05$ ).

## **6.6. Human - gelada baboon conflict**

### **6.6.1. Problem of gelada baboons to the local people**

Gelada baboons in the study area caused crop damage, shared drinking water and livestock pasture and damaged the grazing pasture by digging the ground. The problem caused by gelada baboon to the local people in the study area is presented in Table 12. From the questionnaires among the respondents, 62.67% stated crop damage by gelada

baboon, 8% of the respondents had both crop damage and sharing drinking water and 11.33% of the respondents had crop damage, sharing of drinking water and damaging livestock pasture. Among the respondents 18% stated that gelada baboon caused crop damage and sharing livestock pasture. However, none of the respondents had problems of disease transmission from gelada baboon. There was no significant difference among the villages on the problems of gelada baboon ( $\chi^2 = 2.489$ ,  $df = 6$ ,  $p > 0.05$ ).

Table 12. Problems caused by gelada baboons to the local people in the study area.

Problem type	Response of villagers, %			Total
	Dera	Lamber	Ababore	
Crop damage	58	64	66	62.67
Crop damage and sharing dinking water	6	10	8	8
Crop damage, sharing dinking water and livestock pasture	14	8	12	11.33
Crop damage and sharing livestock pasture	22	18	14	18
Causing disease	0	0	0	0

### 6.6.2. Attitude of the local people towards gelada baboon

The attitude of respondents towards gelada baboon in the study area is presented in Figure 4. Out of the whole respondents, only 14.67% had positive attitude toward gelada baboon but the rest (85.33%) had negative attitude towards them in the study area. There was no significant difference among the villages to the attitude of gelada baboon in their settlement area ( $\chi^2 = 0.746$ ,  $df = 2$ ,  $p > 0.05$ ).

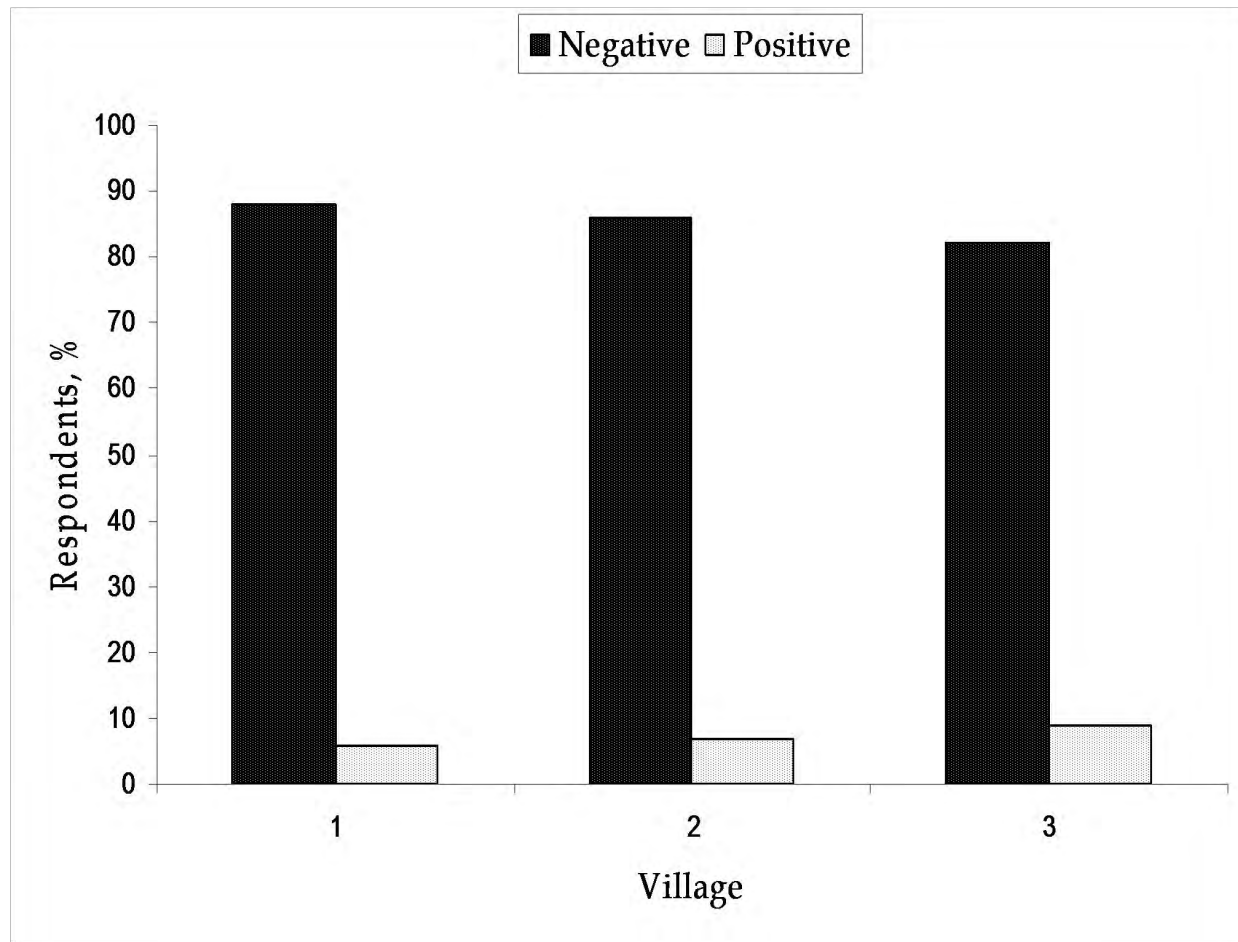


Figure 4. Attitude of respondents towards gelada baboons.

### 6.6.3. Specific time of damage

Out of the total respondents, 4.67%, 7.33% and 32.67% stated that gelada baboon caused great problem during June/July, August/September and December/January, respectively (Table 13). However, 55.33% of the respondents stated that animal caused great problem during October/November. There was a significant difference among the villages on the months that gelada baboon caused problem in raiding crops ( $\chi^2 = 11.584$ ,

df = 6, p < 0.05). Gelada baboons frequented more the seed of cereal crops than the seedling parts in the study area.

Table 13. Month of the year that gelada baboons caused problem in raiding crops.

Month	Response of villagers, %			Total
	Dera	Lamber	Ababore	
June/July	0	4	10	4.67
August/September	0	10	12	7.33
October/November	10	80	76	55.33
December/January	90	6	2	32.67

#### 6.6.4. Government response

From the total respondents, 24.67% stated that the government should wipe out the entire gelada baboon from the study area (Table 14). Among the respondents 33.33% were interested to transfer the entire gelada baboon to other areas rather than killing them. However, 23.33% of the respondents confirmed that the number of gelada baboons in the study area has highly increased in number and so the government should take action in trimming. Only 2% of the respondents stated that the government should develop a park in the study area to conserve gelada baboon in order to reduce crop damage. The rest (16.67%) stated that no action is needed from the government on gelada baboons; because they considered this animal as sacred. There was no significant difference among the villages in their expectation from the government to reduce crop damage by gelada baboons ( $\chi^2 = 4.544$ , df = 8, p > 0.05).

Table 14. Expected response of the local people from the government.

Measurements	Response of villagers, %			Total
	Dera	Lamber	Ababore	
Kill all gelada baboons	22	28	24	24.67
Transfer all gelada baboons to other area	30	38	32	33.33
Decrease their number	28	18	24	23.33
Develop park	4	2	0	2
No measure needed	16	14	20	16.67

#### 6.6.5. Length of time used to protect crops

Among the respondents, 77.33% protected their crops from gelada baboon damage for about 12 hours per day and they were vigilant throughout the day by standing in front of their crops (Fig. 5). The rest 2.67%, 4.00% and 16.00% stated that they protected for about 2, 6 and 9 hours per day from raiding their crops by the gelada baboon, respectively. Those local people who have farmlands near to the cliff protect their crops from gelada baboon damage throughout the day. There was no significant difference among the villages in length of time spent per day to protect crops from gelada baboons ( $\chi^2 = 3.681$ ,  $df = 6$ ,  $p > 0.05$ ).

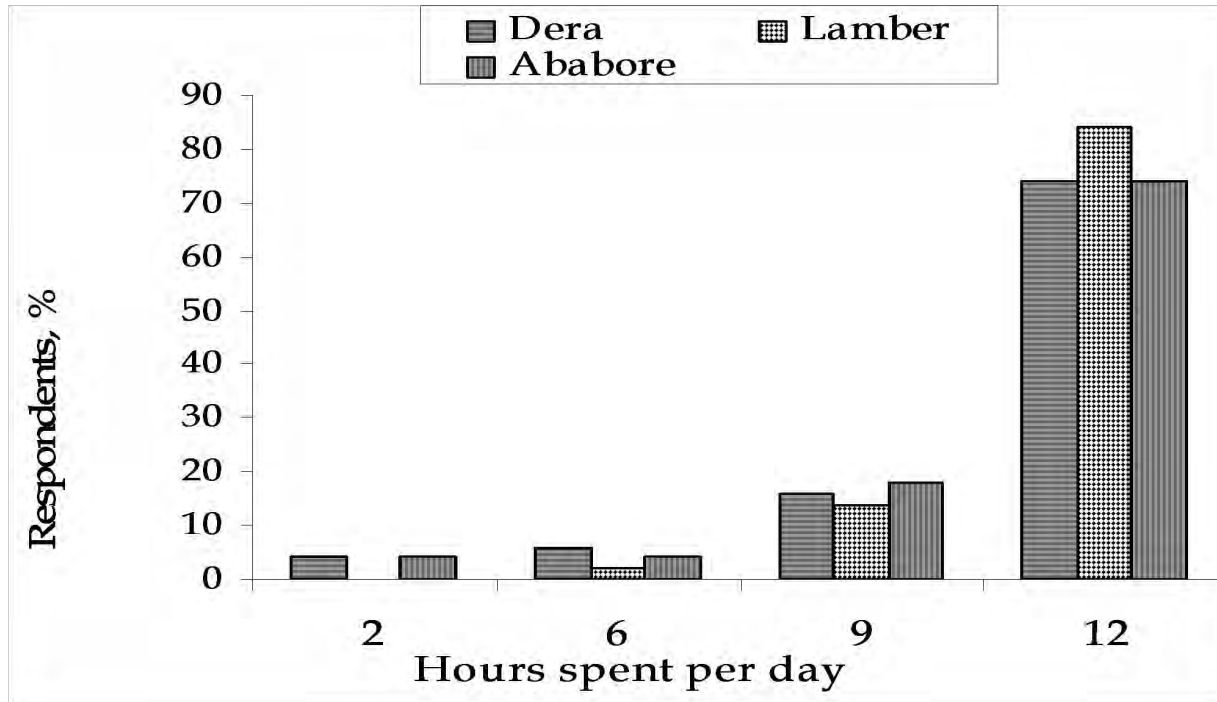


Figure 5. Hours spent per day to protect gelada baboons from crop damage.

Out of total the respondents, 29.33%, 11.33% and 5.33% stated that they devoted 2, 3 and 4 months per year to guard farmlands from raiding by the gelada baboon, respectively (Table 15). The remaining 12.68% and 41.33% of the total respondents informed that they guard their crops for about 5 and 6 months, respectively. They protect their crops starting from sowing until harvesting season. There was significant difference among the villages in number of months to protect crops from gelada baboons ( $\chi^2 = 103.184$ ,  $df = 8$ ,  $p < 0.05$ ).

Table 15. Number of months per year guarding crops from gelada baboon raiding.

Number of months	Number of respondents, %			Total
	Dera	Lamber	Ababore	
2 Months	70	10	8	29.33

3 Months	28	4	2	11.33
4 Months	2	6	8	5.33
5 Months	0	20	18	12.68
6 Months	0	60	64	41.33

### 6.6.6. Effective and frequent method of protection

Out of the respondents in the study area, 81.33% protected their crop by standing in front of their farmlands and watching by eye the progress of movement by gelada baboons (Table 16). This method of protection was the most frequent and effective in the study area. When the gelada baboons approach to the farmland, the guards shout and retreat them away using stick or stone. This requires a lot of energy and vigilant throughout the day. However, 6% of the respondents used dogs and 8.67% used scarecrow as frequent method to protect their crops from being damaged by gelada baboon. They used their dogs to chase gelada baboon away from their farmland. The remaining respondents used snap traps (1.33%) and gun (2.67%). There was no significant difference among the villages in using the frequent and effective method to protect crops from gelada baboons ( $\chi^2 = 10.930$ ,  $df = 8$ ,  $p > 0.05$ ).

Table 16. Most frequent and effective method to protect crops from gelada baboons.

Methods	Response of villagers, %			Total
	Dera	Lamber	Ababore	
Watching eye by	84	82	78	81.33

standing in front of their crops

Retreat with dog	4	8	6	6
Standing scarecrow in front of their crop	10	10	6	8.67
Using snap trap	0	0	4	1.33
Killing with gun	2	0	6	2.67

### 6.6.7. Cause of crop raiding by gelada baboon

Out of the respondents, 20% informed that the cause of crop raiding was due to the large number of gelada baboon in the study area (Table 17). But, 63.33% of the respondents accepted that agriculture expansion towards the gelada baboon habitat was the main factor that caused the raiding of crops. Among the respondents 16.67% claimed that crop damage was not due to the large number of gelada baboons, agricultural expansion and livestock grazing but crops were easily available. None of the respondents considered livestock grazing as a factor that led to crop raiding. There was no significant difference among the villages on the cause of crop raid by gelada baboons ( $\chi^2 = 0.907$ ,  $df = 4$ ,  $p > 0.05$ ).

Table 17. Factors that cause crop raiding by gelada baboons in the study area.

Factors	Response of village, %			Total
	Dera	Lamber	Ababore	
Increase in the number of gelada baboon	22	20	18	20

Agricultural expansion	64	60	66	63.33
Increase of livestock	0	0	0	0
Availability of crops	14	20	16	16.67

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### 6.6.8. Awareness of respondents

Out of the respondents, 72.67% believed that they were not interested to conserve gelada baboon because they damage their crops (Fig. 6). However, 27.33% of the respondents believed that they should be conserve. There was no significant difference among the villagers on their view of the need to conserve gelada baboons ( $\chi^2 = 1.880$ ,  $df = 1$ ,  $p > 0.05$ ).

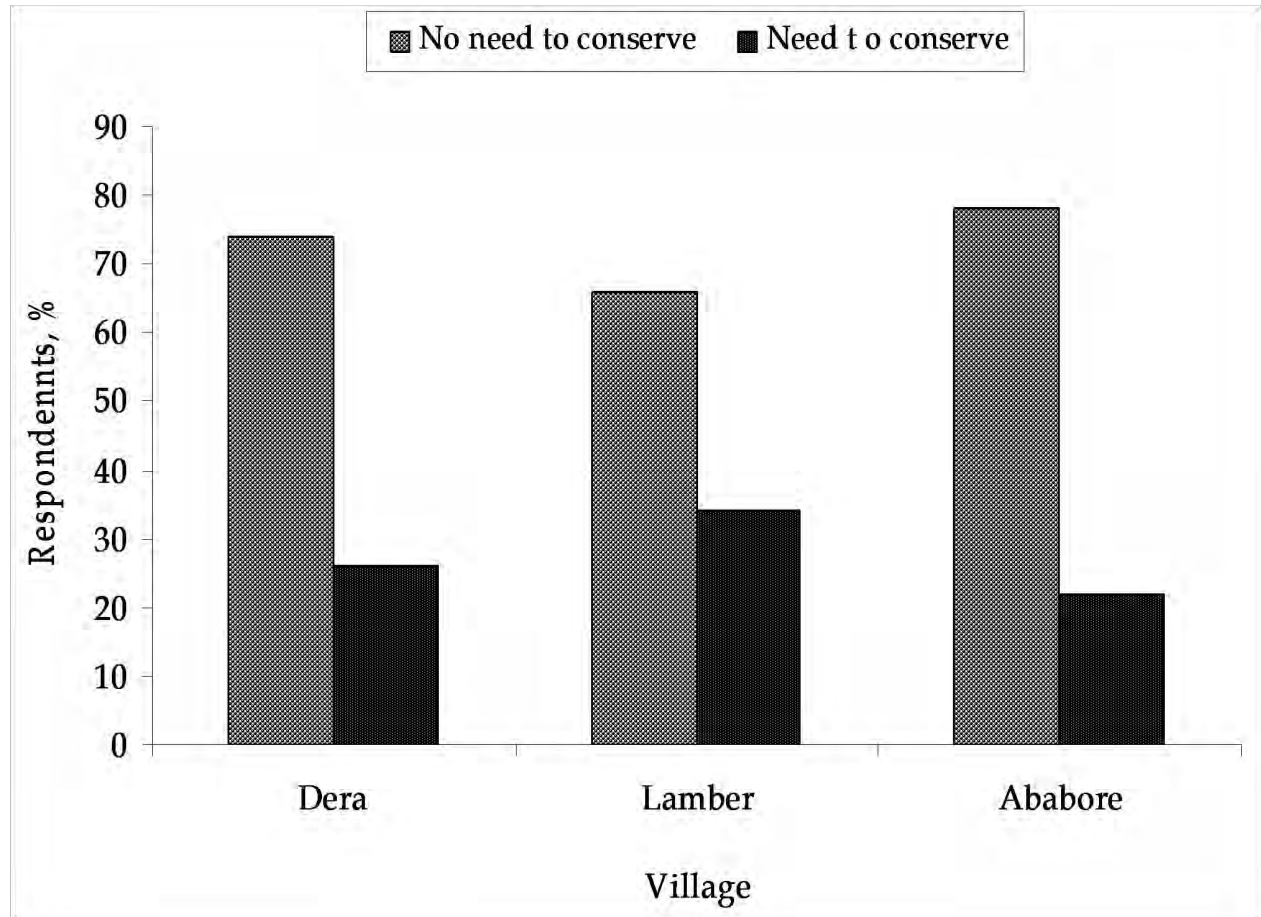


Figure 6. View of villagers in conserving gelada baboons

### 6.6.9. Knowledge of the local people on the endemic species

Among the respondents, 86% had no knowledge on the endemic species in Ethiopia. Only 14 % had knowledge on the gelada baboon being endemic (Fig. 7). There was no significant difference among the villagers about their knowledge of endemism on gelada baboons ( $\chi^2 = 1.142$ ,  $df = 1$ ,  $p > 0.05$ ). Those who had knowledge on the endemism of gelada baboon status were students.

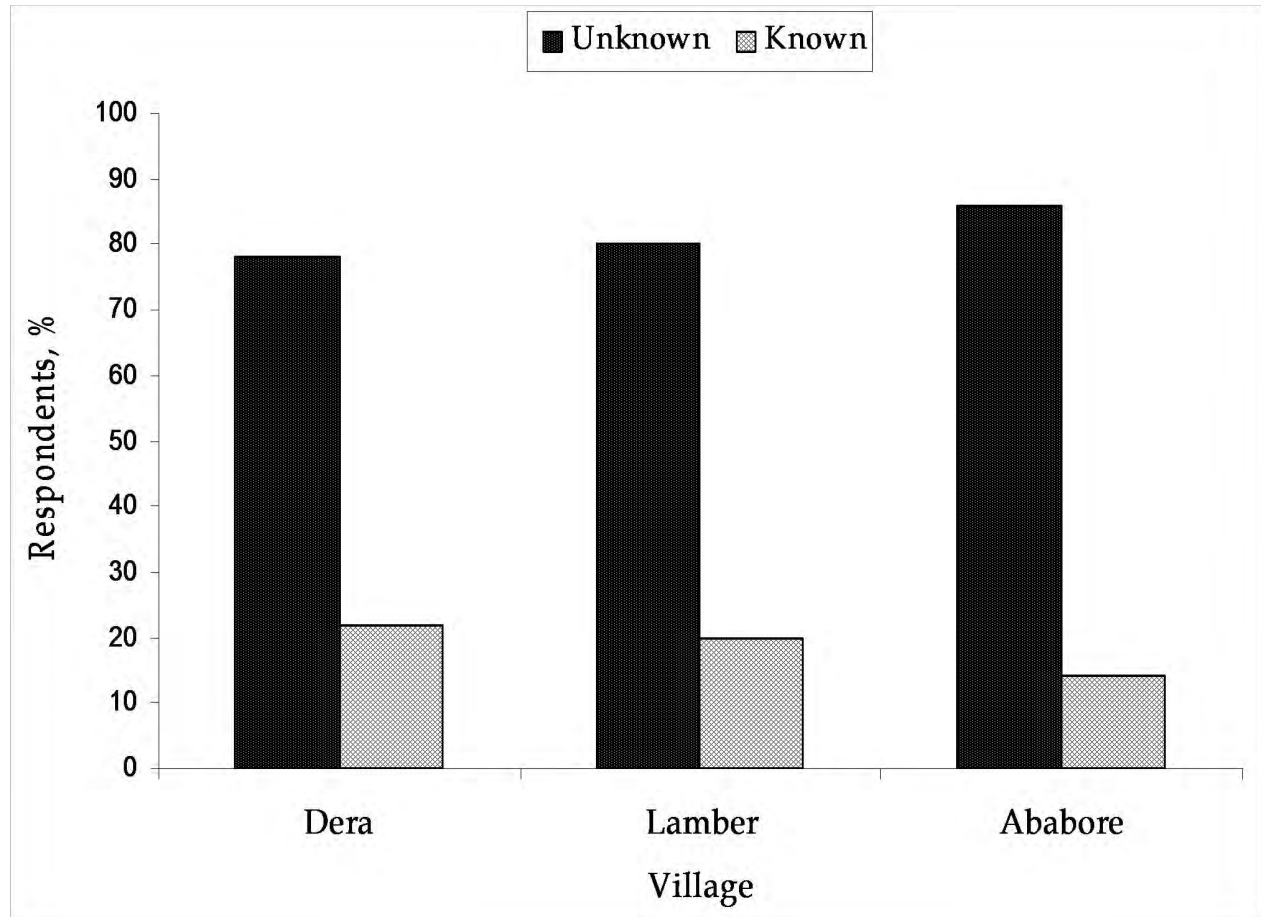


Figure 7. Knowledge of the local people on the endemic species.

#### 6.6.11. View of local people on the importance of gelada baboon

From the respondents of the local people, 10% knew that gelada baboon had importance to the ecology of the environment as well as to the country (Fig. 8). Gelada baboons dig the ground facilitating ploughing of the farmland. They add their scats to the farmland that increases soil fertility. In addition to this, the county can obtain income from tourism industry. However, 90% of the respondents considered that gelada baboon had no

importance except devastating crops. There was no significant difference among the village on their views to the importance of gelada baboons ( $\chi^2 = 0.444$ ,  $df = 1$ ,  $p > 0.05$ ).

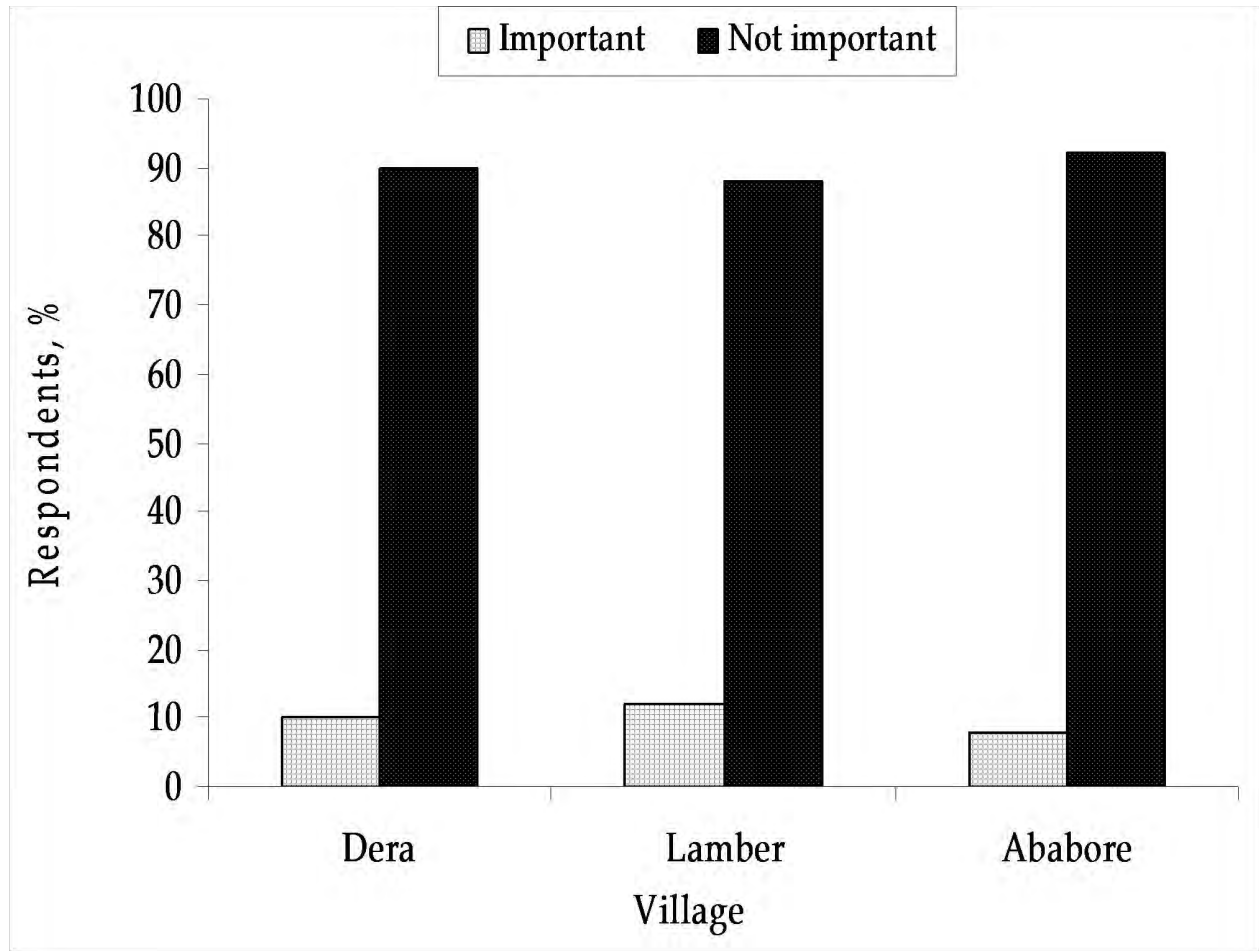


Figure 8. View of respondents on the important of gelada baboons.

## 7. DISCUSSION

It is essential to estimate the population of gelada baboons from time to time in order to take appropriate management and conservation decisions. Separation of the study period into dry and wet seasons was important to know the influence of the two major seasons in the area on the distribution and behavioral ecology of the animal.

There was a significant difference between the number of gelada baboons during the wet season and dry season. This difference may be because of the migration of more gelada baboons from the outside of the study area. The study area was used for human settlements, agricultural and livestock rearing purpose. During the beginning of the wet season, the farmers sow cereal crops. At that time, farmers chase gelada baboons away from their nearby farmlands of the escarpment to other area in order to reduce crop damage. During postharvest season and during threshing more gelada baboons immigrate towards the previous habitat of the study area. In addition to this, some gelada baboons may be stationed on the cliff surface and between gorges. This might result in out of sight distance or poor visibility during the wet season census. Following harvest, the gelada baboons were free to move and they congregate on the few patches of dried sward left by villagers for their domestic animals. Therefore, these might be the reasons that increase in the number of gelada baboons during the dry season compared to the wet season.

The number of gelada baboons varied among each block during the wet and dry seasons. This seasonal variation of gelada baboons among blocks in the study area may be due to human disturbances. During the beginning of the wet season, farmers start to sow and cultivate cereal crops, and they chase gelada baboons from their nearby farmlands of easily accessible cliff to other lower shelf of the escarpment. There are no gelada baboons during the wet season in block 7 due to their migration to other blocks during the wet season. However, during the end of the harvesting season, the animal become free from human interference and come back to the upper shelf of the escarpment. Thus, human disturbance is the main factor for the fluctuation of gelada baboons among blocks during the wet and dry seasons in the study area.

The study shows that the population composition of gelada baboons consisted of unequal sex and age ratio in the area. The numbers of adult males were lower than adult females. The sex ratio of adult male to adult female was 1.00:6.61 during the study period. This ratio was higher as compared to other study areas like Arsi (Mori *et al.*, 1999) and Gich population (Dunbar, 1984a; Ohsawa and Dunbar, 1984) (Appendix 4). This may be due to an increase predation pressure on sub-adult males by dogs and leopards in the study area. At the same time, the group might bond longer alone within small patches of grasslands. The band or the harem feeds on open plain that helps to observe predators easily and control the females from being taken away by bachelor sub-adult males. When the bachelor males approach to the foraging place of the bands, the leader of adult males from the band cooperate together to fight and chase the sub-adult bachelor males away

from that area. This may help the remaining of more females within the harem or the band that leads to large number of adult female per male. However, in Arsi population, each leader face a challenge that make invasion of bachelor males in to a unit more easily and leads the sex ratio of adult male to females become lower as compared to the present study area (Mori *et al.*, 1999). In addition to this, the frequency of adult males migrating out from the band might be high in the present study area in contrast to Arsi population (Mori *et al.*, 1999). This high adult female to adult male ratio may also be due to the combination of adult females to estrous sub-adult females in this study, since females reach sexually maturity earlier than males. This skewed sex ratio in gelada baboon was also proposed due to earlier maturation of females (Ohsawa and Dunbar, 1984). The other reason might be because the bachelor sub-adult males and adult males are bold and they frequently try to steal crops from the nearby farmlands by moving far, separating from the groups. The farmers use snare to trap and kill them leading to decrease in number of adult males compared to females. The high number of adult females per adult males shows the probability to increase the population (Ohsawa and Dunbar, 1984).

The band group size of gelada baboon was higher during the dry season than the wet season. Ohsawa (1979) reported that the largest multi-band troops (up to 620 animals) at Gich occurred most often in the middle of the dry season. The troop size of gelada baboon increases during the dry season than the wet season due to spatial restriction as stated by Grüter and Zinner (2004). Thus, the size of the band increase and forage together during the dry season in an area that contains good cover of grass and

availability of water. After postharvest, gelada baboons congregate on the few patches of dried sward left by villagers for their domestic animals leading to increase in the size of the band during the dry season. However, during the wet season, the farmers disturb the size of bands due to cultivation of cereal crops. At that time, the gelada baboons may be segregated into smaller groups and live in small patches of land on the plain and habitats that are too steep for ploughing. The mean of one-male unit was almost as high as that of the Bole Valley and Sankaber populations as observed by Dunbar and Dunbar (1975). Ohsawa and Dunbar (1984) proposed that, the size of one-male unit is independent of environmental factors. The same was observed in Wonchit Valley in which the mean size of one-male unit was 16.96. This mean size of one-male unit was greater than other study areas and similar to Bole Valley population (Appendix 3), even if, there is low food availability in the study area. One-male units in the study area may act cooperatively to each other in displaying and chasing out challenging and bachelor males, thus increasing the chance of a leader male for several followers. The mean band size of gelada baboons in the study area was lower than to that of Simien population but similar to that of Arsi and Bole population (Appendix 4). According to Crook (1966), in few unbroken grassland areas, the size of the group becomes less. Similarly in Wonchit Valley the available grasslands are broken down into smaller fragmented areas leading to the small size of the band compared to the Simien population, which lives in large unbroken grasslands (Appendix 4). The size of all-male unit was almost similar to that of Bole and Sankaber populations in Simien as observed by Dunbar and Dunbar (1975) (Appendix 5).

It is difficult to discuss the trend of gelada baboons in the study area, since previous census had not been made. However, the result of the present census shows that the population of gelada baboons in the study area is in a better shape even if the area is used for agricultural, livestock rearing and human settlement purposes.

The seasonal distribution of gelada baboons in the study area fluctuates during the wet and dry seasons. This seasonal variation in the distribution of gelada baboons may be due to human disturbance. During the beginning of the wet season, the farmers start to sow and cultivate cereal crops. At that time, they chase the gelada baboons from the nearby farmland of the sward moving to the easily inaccessible cliff and forest habitats. This may lead to the migration of many gelada baboons from the sward land to the habitat of scrubland and forest, which were relatively less disturbed by human activities. However, when the local people collect crops from their farmlands during the harvesting time (dry season) those gelada baboons that stayed in the scrubland and forest habitats during the wet season return back to agricultural/sward lands. This may lead to higher number of gelada baboons during the wet season than during the dry season in the scrubland and forest habitats. Therefore, human activities affect the seasonal distribution and fluctuation of gelada baboons among the available habitat types in the study area.

Open and treeless habitats dominated by short grasses are the main foraging areas for gelada baboons (Crook, 1966; Napier and Napier, 1967; Crook and Aldrick-Blake, 1968; Kawai 1979; Dunbar, 1984b). They were observed outside the forests on swards and

scrublands in the present study area. This may be because of the predator pressure and less availability of grasses in the forest habitat. Leopard is the main predator of gelada baboons in the study area. The mean group sizes of gelada baboons in the three habitat categories differ slightly. However, when the actual sizes observed in each category were considered, no significant contrasts were detected for the animal. Thus, although the gelada baboon favours some habitats more than the other, the data do not show that mean group size difference in different habitats. This was also observed in Debre Libanos population (Crook and Aldrich-Blake, 1968).

Concerning their activity time budget, there were significant differences between the seasons on moving, resting and socializing. These seasonal differences of activity time budget of an animal may be caused by environmental variables (Shah, 2003). The time budget of *T. gelada* is also affected through seasonal changes (Grüter and Zinner, 2004). Gelada baboons spent more time feeding during the dry season than during the wet season (Iwamoto, 1993). However, there was no significant difference in time spent for feeding during the wet and the dry seasons in the present study area. Gelada baboons spend more time moving during the dry season. This may be due to the restriction of gelada baboon in small patches of land left by the farmers during the wet season. These rocky underground small patches of land left by the farmers may not be suitable for agricultural purpose other than pasture for livestock, being the major competitor to gelada baboon in those patches of the study area. Therefore, gelada baboons spend only slightly less amount of time feeding during the wet season by decreasing movement and

by competing with the farmer's livestock in order to compensate the daily energy requirement from these patches. In the study area, livestock and gelada baboon forage together without aggression between them throughout the course of the study. Feeding time may increase as food quality and quantity diminishes increasing the number of competitors within small patches of land. However, during the dry season, when the farmers collect their crops from their farmlands, gelada baboons move from one patch of land to the other through the farmlands to get grass cover between the boundaries of the agricultural land. Therefore, during the dry season, the animal spends more time for moving from one patch of land to the other in order to search and get the available food resource. This in turn might only slightly extend the feeding time budget of gelada baboon during the dry season compared to the wet season. During the wet season, water is available around the foraging area. Thus, the gelada baboons do not move faraway in search of water that reducing the time budget for moving. However, during the dry season, gelada baboons move more distances from the foraging area in search of water increasing the time spent for moving thereby reducing the activities spent for resting and socializing. The type of diet may also be the other factor that may lead to slight increase in time spent for feeding during the dry season. This is due to the fact that gelada baboons eat more bulbs, roots and rhizomes during the dry season which have high nutritional value and water content than blades of grasses to satisfy their daily energy requirements.

It is generally assumed that a diet based on grass requires a bulk feeding strategy, which in turn will impose on animal's time budget as extra time required for feeding (Hunter, 2001). Gelada baboons spend more time for feeding than to other activities and less time for resting as compared to other study areas (Appendix 6). Feeding time increases as the habitat quality of a certain area decline to compensate energy requirements (Iwamoto and Dunbar, 1983; Hunter, 2001). Therefore, due to decline of the habitat quality in the study area, the animal spent more time for feeding to compensate the daily energy requirement. Resting time was used as a reserve store from which additional feeding time could be drawn (Iwamoto and Dunbar, 1983). In addition to this, moving time may be drawn from resting in broken and poor grasslands. Gelada baboons of the northern population live in a relatively rich habitat in terms of food availability throughout the year (Grüter and Zinner, 2004) compared to Wonchit Valley that may lead to increase in time spent for feeding in the present study.

According to Dunbar (1983a), social interaction of animals is restricted by time budget constraints such as availability of nutrition in the area. This is in particular important for gelada baboon time budget for taking less time for socializing in the study area as compared to other areas (Appendix 6). As the environment is very harsh in terms of availability of food, the gelada baboons take more time for feeding by reducing other activities spent for socializing and resting in order to compensate the daily energy requirements.

Studying the home range of animals in a certain area is important to identify the presence of feeding competition (Williams-Guill'en, 2003) and recognize the relationship between ecological variables of ranging behaviour (Di Fiore, 2003). The home range size of gelada baboons was highly varied within seasons. Gelada baboons used more home range size during the dry season than during the wet season. During the wet season, the gelada baboons did not have freedom to move from one patch of land to the other due to human activities. At that time, gelada baboons restrain from movements from one patch of land to the other, so that they may be restricted within that small patch of land. But during the dry season, restriction by the farmers on single patch of land may cease due to the end of the harvesting season. Thus, the gelada baboons may move freely from one patch of land to the other greatly increasing the home range size during the dry season in search of food and water. Differential use of home range by gelada baboon has been observed during the wet and dry seasons in other study sites also as green grass is more patchily distributed during the dry season compared to the wet season (Dunbar, 1977b, Hunter, 2001).

The present study area is highly devastated (i.e. low food availability) due to agricultural activities. Thus, in order to get patches of grass between farmlands, gelada baboons should be able to cross on the farmlands next to the others that lead to increase the home range size during the dry season. The scarcity of water and safe sleeping site may be also other factors that the gelada baboons move far away from the feeding place. These leads to increasing the home range size of gelada baboons during the dry season. A number of

studies have also demonstrated the importance of water sources and the distribution of sleeping sites affecting the length of daily journey (Post, 1982; Barton *et al.*, 1992). However, water availability has no role other than food as a factor in determining ranging patterns in Sankaber populations (Hunter, 2001). In addition to the above reasons, competition with livestock in the study area might have increased the home range size during the dry season. An increase in food competition of organisms may be recognized by an increase in the distance that an animal travels each day to find sufficient food patches to meet its energetic requirements thereby leading to an increase in the home range (Lewis *et al.*, 2001). Gelada baboons do not have specific territory and their daily journey varies from time to time.

Gelada baboons are grass consumers (Crook, 1966; Crook and Aldrich-Blake, 1968; Dunbar, 1977b; Iwamoto, 1979; Iwamoto and Dunbar, 1983) with grasses forming more than 90% of the diet during most seasons (Dunbar, 1977b; Grüter and Zinner, 2004). Blades and stems of grasses, leaves of herbs, flower of herbs and bushes and fruits of bushes and trees are eaten above the ground, and bulbs, rhizome and roots provide a significant contribution to the diet of gelada baboons from underground in the present study area. In addition to these, the resin and bark of bushes and trees and flying ants, ants and termites are eaten. Thus, gelada baboon population in Wonchit Valley feeds on diverse food items that are not identified as a diet of gelada baboons in other study areas. This may be due to the harsh environmental condition in terms of the grazing pressure by livestock that leads to eat some food items, which are not registered as diets of gelada

baboons in other study areas such as Gich and Sankaber areas in the Simien Mountain National Park and in Bole around Debre Lebanos (Iwamoto, 1979; Dunbar and Dunbar, 1974b, Dunbar, 1977b). When the gelada baboons face problems in obtaining their common diet, they may shift to other types of food items. The diet of the Arsi population of gelada baboon consists of considerable amount of fruit as compared to the northern population (Iwamoto *et al.*, 1996). The same was true for the present study in Wonchit Valley in which the diet contains high amount of fruits as compared to the other study area other than Arsi gelada population (Iwamoto *et al.*, 1996).

Gelada baboons are exclusively herbivorous, but their choice of food changes depending on seasonal availability. During the wet season, when green grass blades are abundant, they make up to 93% of their diet. However, during the dry season, 67% of their food is grass rhizomes and 25% grass blades (Dunbar, 1977b). Gelada baboons spent more time feeding on the blade grass during the wet season (93.25%) than during the dry season (74.25%) in the present study area. This may be due to its easy availability during the wet season compared to that of the dry season. However, the animal shifts to consume more bulbs, rhizomes and roots during the dry season (22.25%). This may be due to the grazing pressure and the drying of grass blades. Exploitation of underground food items represents an adaptation that allowed all the Theropithecines to tap into a grassland food source (i.e. subterranean storage parts) that is unavailable to the gelada baboon's main competitors, namely ungulates (Jolly, 1972). Struhsaker (1967) pointed out that, rhizomes and roots represent a highly nutritious dry season food source for vervet monkeys

(*Cercopithecus aethiops*) in savanna environment. Hunter (2001) also pointed out that, as the green grasses dry out, gelada baboons can shift their foraging profile to digging for more subterranean food sources. *Chlorophytum tetraphyllum*, *Chlorophytum pterocarpum*, *Romulea fischeri*, *Merendera abessinica* and *Cyperus rigidifolius* were the main plant components used by gelada baboons during the dry season. These food items may be more nutritious and help the gelada baboons to survive in the study area during the dry season of severe environment. However, the seeds of *Trifolium arvense* and the leaves and roots of *Cotula cryptocephala* were provided the bulk of the plant components in Simien population during the dry season (Dunbar, 1977b).

The result of the questionnaire shows that there was intense conflict between the local people and gelada baboons. This is due the fact that in the study area the local people and gelada baboons live together throughout the day until at night when the animal move to their sleeping sites. Primates are the dominant crop raiders in Africa (Balakrishnan and Ndhlovu, 1992; Naughton-Treves *et al.*, 1998). Most of the respondents from the selected villages reported that the cause of crop damage is very high and intense.

There was significant difference on the number of months per year among the villages in guarding their farmlands from gelada baboon damage. Most of the respondents from Lamber and Ababore villages reported that they guard their crops for about six months per year during the harvesting season. This is because the farmlands of these villages are located near to the edge of gelada baboon habitats. Primate species live in close proximity

to human settlement areas frequently visit villages and become crop-raiders (Saj *et al.*, 2001). Most of the respondents from Dera village guard their crops from gelada baboon damage for about two months after those villagers near the cliff area collect their crops to the threshing land. The local people from Dera chased all gelada baboons from their nearby easily accessible escarpment to the other shelf of the cliff during the harvesting season. Thus, their farmlands concealed from gelada baboon damage by the other nearby villagers during the wet season. The local people who have farmlands near to the edge of the gelada baboon sleeping cliff guard their crops for more months per year than those who have farmlands away from the cliff.

Most of the respondents (85.33%) from the selected villages had negative attitude towards gelada baboons. This may be because of crop raiding by gelada baboons and the expense of energy and human power to guard their crops throughout the day during harvesting season and they considered this animal as agricultural pest. Similarly as reported earlier, (Hill, 2002; Mesele Yihune *et al.*, 2008) reported that, the attitude of the local people towards gelada baboon decline due to crop damage.

Most of the respondents (63.33%) from each village believed that the reason behind crop raiding problems was lack foraging area and all the accessible lands were used for agricultural purpose. When the gelada baboons move from their sleeping cliff up or down they come in contact with the cereal crops leading to more conflict, especially during the harvesting season. When natural food resources are limited, easily digestible

human food items provide an alternative source of nutrition for primates and intensifying the conflict (Horrocks and Baulu, 1994). Gelada baboons may be interested to eat cereal crops more than the grasses in the study area. This may be due to the fact that cereal crop may be more nutritious and tasty than grasses.

According to the respondents from each village, all age groups of the local people in the study area are involved to guard their crops from gelada baboon damage. However, the age groups of the local people that involve for guarding their crops most of the time were children. So that children in the study area were absent most of the times from the school to guard their crops from gelada baboon damage. Thus, guarding the gelada baboons may influence progress of education in children

Gelada baboons raid crops throughout the farming season starting from sowing seed until harvesting cereal crops by the farmers in the study area. In the study area, the most common cultivated crops are pea (*Pisum sativum*), bean (*Vicia faba*), teff (*Eragrostis tef*), barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), sorghum (*Sorghum bicolor*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), nug (*Guizatia abyssinica*), linseed (*Linum usitatissimum*), grasspea (*Lathyrus sativus*) and fenugreek (*Trigonella foenum*). Gelada baboons consume cereal crops at the time of sowing, seedlings, vegetating and harvesting stages. Gelada baboons pick and eat the seeds of pea, bean and barley during sowing using the fingers from the farmlands. This happens in June when the farmers start to sow these crops. Gelada baboon also consume the seedling, vegetating and harvesting stage of

pea, bean, teff, barley, wheat, sorghum, chickpea, grasspea and lentil in the study area. However, this animal does not damage nuga and linseed in the area. Most of the respondents from the village of Lamber and Ababore face peak conflict in October and November. This may be because of the kind of crops they harvest in their farmlands. These villages (Lamber and Ababore) cultivate bean, pea, barley, lentil and wheat species and these crops ripe in October/November. Most of the local people of the respondents from Dera harvest the species of wheat, teff, chickpea, and grasspea and these crops ripe in December/January resulting in severe conflict. In addition, gelada baboons come to the village of Dera after the lowland villagers collect their crops into threshing area. Thus, gelada baboons may find the harvesting stage of crops better than the seedlings and vegetative stages, because harvesting stage of crops was more nutritious than to that of seedling and vegetating stages.

Most of the respondents (72.67%) stated that there is no need to conserve gelada baboons. This may be because of crop loss by this animal and lack of awareness about the income generation from tourism industry in the study area to the local people. Similarly, (Hill, 2002) reported that, Losses to crop-raid and the negative perception of farmers on primates affect the views of local people on usefulness of conservation.

The local people in the study area used different kind of protection method to minimize damage. Most of the respondents (81.33%) considered watching eye as the most frequently used and effective method of guarding their crops from damage by gelada

baboon. Similarly, the majority of the respondents used watching eye (guarding) to minimize crop damage around the Simien National Park, Ethiopia (Mesele Yihune *et al.*, 2008).

## 8. CONCLUSION AND RECOMMENDATIONS

### 8.1. Conclusion

The data collected in the present study provide important information on the population status and distribution of gelada baboons. The average population number of gelada baboons in the study area is 1525. There are more breeding females within the population that confirm the stability of gelada baboon in the study area. The distribution of gelada baboons fluctuates during the wet and the dry seasons due to human interference.

Gelada baboons spend most of its activity time budget for feeding other than moving, resting and socializing in order to compensate the daily energy requirements from the harsh environment. The home range of gelada baboon is restricted into small patch of land during the wet season. This home range increases during the dry season when the farmers collect crops from their farmlands and human interference is minimal. A total of 60 plant species was consumed by gelada baboons throughout the study period. The animal consumes some species of plants in the study area that were ignored in other study areas. Gelada baboons dig the ground until the virgin land seems like the surrounding farmlands in order to get bulbs, rhizomes and roots during the dry season.

The requirements of the animals overlap with the local people and lead to severe competition for resource between them if they use the same habitat. Human - gelada conflict in the study area is extremely severe. The local people in the study area who live

around the gelada baboon habitat expend a lot of energy. The only safe haven for gelada baboons is the cliff.

## **8.2. Recommendations**

The following points should be considered to save the gelada baboon population:

- The government should sensitize the local people and Woreda officials about the importance of gelada baboon.
- Further research should be undertaken to save the gelada baboons in this highly modified environment.
- Further count in subsequent years with the same procedure should be required to determine the trend of gelada baboon in the study area.
- Protected area should be developed in the Wonchit valley by translocating some local people in order to save gelada baboons and other wildlife from local extinction.
- The local NGOs should participate to save gelada baboons in the Wonchit Valley as well as the surrounding areas by providing compensation to those local people during crop damage.
- The government should provide work opportunity for the increasing population to avoid digging steepy lands of the gelada baboon habitat.
- NGOs and government support should not only be involved to the conservation of wildlife reserves and parks but should also involve in the wildlife that occurs unprotected areas.

## 9. REFERENCES

- Afework Bekele and Corti, M. (1997). Forest blocks and altitude as indicators of *Praomys albipes* (Mammalia: Rodentia) distribution in Ethiopia. *Trop. Zool.* **10**: 287-293.
- Aich H., Moos-Heilen, R. and Zimmermann, E. (1990). Vocalizations of adult gelada baboons (*Theropithecus gelada*): acoustic structure and behavioural context. *Folia Primatol.* **55**: 109-132.
- Aich, H., Zimmermann, E. and Rahmann, H. (1987). Social position reflected by contact call emission in gelada baboons (*Theropithecus gelada*). *Zool. Garten.* **52**: 58-60.
- Altmann, J. (1974). Observational study of behaviour: sampling method. *Behaviour* **49**: 227-267.
- Balakrishnan, M. and Ndhlovu, D. (1992). Wildlife utilization and local people: a case study in Upper Lupande Game Management Area, Zambia. *Environ. Conserv.* **19**: 135-144.
- Barrett, L., Dunbar, R. I. M. and Dunbar, P. (1992). Environmental influences on play behaviour in immature gelada baboons. *Anim. Behav.* **44**: 111-115.
- Barrett, L., Dunbar, R. I. M. and Dunbar, P. E. (1995). Mother-infant contact as contingent behaviour in gelada baboons. *Anim. Behav.* **49**: 805-810.
- Barton, R. A., Whiten, A., Strum, S. C., Byrne, R. W. and Simpson, A. J. (1992). Habitat use and resource availability in baboons. *Anim. Behav.* **43**: 831-844.
- Befekadu Refera and Afework Bekele (2004). Population status and structure of mountain nyala in the Bale Mountains National Park, Ethiopia. *Afr. J. Ecol.* **42**: 1-7.
- Befekadu Refera and Afework Bekele (2006). Population status and structure of Swayne's Hartebeest (*Alcelaphus buselaphus swaynei*) in Mazie National Park, Ethiopia. *Int. J. Ecol. Environ. Scien.* **32**: 259-264.
- Bolen, E. G. and Robinson, W. L. (2003). *Wildlife Ecology and Management*. 5<sup>th</sup> edn. Pearson Education, inc., New Jersey. 634 pp.
- Crook, J. H. (1966). Gelada baboon herd structure and movement: a comparative report. *Symp. Zool. Soc. Lond.* **18**:237-258.

- Crook, J. H. and Aldrich-Blake, P. (1968). Ecological and behavioural contrast between sympatric ground dwelling primates in Ethiopia. *Folia Primatol.* **8**: 192-227.
- Di Fiore, A. (2003). Ranging behaviour and foraging ecology of low land woolly monkey (*Lagothrix lagotricha poeppigii*) in Yasuni National Park, Ecuador. *Int. J. Primatol.* **22**: 449-480.
- Di Fiore, A. (2004). Diet and feeding ecology of woolly monkeys in a western Amazonian rainforest. *Int. J. Primatol.* **25**: 767-801.
- Dunbar, R. I. M. (1976). Australopithecine diet based on a baboon analogy. *J. Hum. Evol.* **5**: 161-167.
- Dunbar, R. I. M. (1977a). Age-dependent changes in sexual skin colour and associated phenomena of female gelada baboons. *J. Hum. Evol.* **6**: 667-672.
- Dunbar, R. I. M. (1977b). *Feeding Ecology of Gelada Baboons*. Academic Press, London. pp. 251-273.
- Dunbar, R. I. M. (1977c). *The Gelada Baboon: Status and Conservation*. Academic Press, New York. pp. 363-383.
- Dunbar, R. I. M. (1978a). Competition and niche separation in a high altitude herbivore community in Ethiopia. *E. Afr. Wildl. J.* **16**: 183-199.
- Dunbar, R. I. M. (1978b). Sexual behaviour and social relationships among gelada baboons. *Anim. Behav.* **26**: 167-178.
- Dunbar, R. I. M. (1979). Structure of gelada baboon reproductive units. I. stability of social relationships. *Behaviour* **69**: 72-87.
- Dunbar, R. I. M. (1980a). Demographic and life history variables of a population of gelada baboons (*Theropithecus gelada*). *J. Anim. Ecol.* **49**: 485-506.
- Dunbar, R. I. M. (1980b). Determinants and evolutionary consequences of dominance among female gelada baboons. *Behav. Ecol. Sociobiol.* **7**: 253-265.
- Dunbar, R. I. M. (1983a). Structure of gelada baboon reproductive units. II. Social relationships between reproductive females. *Anim. Behav.* **31**: 556-564.
- Dunbar, R. I. M. (1983b). Theropithecines and hominids: contrasting solutions to the same ecological problem. *J. Hum. Evol.* **12**: 647-658.

- Dunbar, R. I. M. (1984a). Infant-use by male gelada in agonistic contexts: agonistic buffering, progeny protection or soliciting support? *Primates* **25**: 28-35.
- Dunbar, R. I. M. (1984b). *Reproductive Decisions: An Economic Analysis of Gelada Baboon Social Strategies*. Princeton University, Princeton. 265 pp.
- Dunbar, R. I. M. (1986). *The Social Ecology of Gelada Baboons*. Princeton University, Princeton. pp. 332-351.
- Dunbar, R. I. M. (1992). A model of the gelada socio-ecological system. *Primates* **33**: 69-83.
- Dunbar, R. I. M. (1993a). *Conservation Status of the Gelada*. Cambridge University Press, Cambridge. pp. 527-531.
- Dunbar, R. I. M. (1993b). *Social Organization of the Gelada*. Cambridge University Press, Cambridge. pp. 425-439.
- Dunbar, R. I. M. (1998). Impact of global warming on the distribution and survival of the gelada baboon: a modeling approach. *Glob. Chan. Biol.* **4**: 293-304.
- Dunbar, R. I. M. and Bose, U. (1991). Adaptation to grass-eating in gelada baboons. *Primates* **32**: 1-7.
- Dunbar, R. I. M. and Dunbar, E. P. (1974a). Behaviour related to birth in wild gelada baboons (*Theropithecus gelada*). *Behaviour* **50**: 185-191.
- Dunbar, R. I. M. and Dunbar, E. P. (1974b). Ecological relations and niche separation between sympatric terrestrial primates in Ethiopia. *Folia Primatol.* **21**:36-60.
- Dunbar, R. I. M. and Dunbar, E. P. (1974c). The reproductive cycle of the gelada baboon. *Anim. Behav.* **22**: 203-210.
- Dunbar, R. I. M. and Dunbar, P. (1975). Social dynamics of gelada baboons. *Contrib. Primatol.* **6**:1-157.
- Dunbar, R. I. M. and Dunbar, P. (1988). Maternal time budgets of gelada baboons. *Anim. Behav.* **36**: 970-980.
- Dunbar, R. I. M., Hannah-Stewart, L. and Dunbar, P. (2002). Forage quality and the costs of lactation for female gelada baboons. *Anim. Behav.* **64**: 801-805.

- Fashing, P. J. (2001). Activity and ranging patterns of guerezas in the Kakamega Forest: intergroup variation and implications for intragroup feeding competition. *Int. J. Primatol.* **22**: 549-577.
- Feldhamer, G. A., Drickamer, L. C., Vessey, S. H., Merritt, J. F. and Krajewski, C. (2007). *Mammalogy: Adaptations, Diversity, Ecology*. 3<sup>rd</sup> edn. The John Hopkins University Press, Baltimore. 643 pp.
- Grassi, C. (2006). Variability in habitat, diet and social structure of *Hapalemur griseus* in Ranomafana National Park, Madagascar. *Am. J. Phys. Anthropol.* **131**: 50-63.
- Grubb, P., Butynski, T. M., Oates, J. F., Bearder, S. K., Disotell, T. R., Groves, C. P. and Struhsaker, T. T. (2003). Assessment of the diversity of African primates. *Int. J. Primatol.* **24**: 1301-1357.
- Grüter, C. C. and Zinner, D. (2004). Nested societies. Convergent adaptations of baboons and snub-nosed monkeys? *Prim. Rep.* **70**: 1-98.
- Gurja Belay and Mori. A. (2006). Intraspecific phylogeographic mitochondrial DNA (D-loop) variation of Gelada baboon, *Theropithecus gelada*, in Ethiopia. *Bio. Syst. Ecol.* **34**: 554-561.
- Gurja Belay and Shotake, T. (1998). Blood protein variation of a new population of gelada baboons (*Theropithecus gelada*), in the southern Rift Valley, Arsi Region, Ethiopia. *Primates* **39**: 183-198.
- Hill, C. M. (1997). Crop raiding by wild vertebrates: the farmer's perspective in an agricultural community in western Uganda. *Int. J. Pest. Manage.* **43**: 77-84.
- Hill, C. M. (2002). Primate conservation and local communities-ethical issues and debates. *Am. Anthropol.* **104**: 1184-1194.
- Hillman, J. C. and Hillman, S. M. (1987). The mountain nyala (*Tragelaphus buxtoni*) and the Simien fox (*Canis simensis*) in the Bale Mountain National Park. *Walia* **10**: 3-6.

- Horrocks, J. A. and Baulu, J. (1994). Food competition between vervets (*Cercopithecus aethiops sabaeus*) and farmers in Barbados: implications for management. *Rev. Ecol. Terre. Vie.* **49**: 281-294.
- Hunter, C. (2001). *Ecological Determinants of Gelada Ranging Pattern (Theropithecus gelada)*. Ph.D. Thesis, Liverpool University, Liverpool. 208 pp.
- Iwamoto, T. (1979). Feeding ecology. *Contrib. Primatol.* **16**: 279-330.
- Iwamoto, T. (1993). *The Ecology of Theropithecus gelada*. Cambridge University Press, Cambridge. pp. 441-452.
- Iwamoto, T. and Dunbar, R. I. M. (1983). Thermoregulation, habitat quality and the behavioural ecology of gelada baboons. *J. Anim. Ecol.* **52**: 357-366.
- Iwamoto, T., Mori, A., Kawai, M. and Afework Bekele (1996). Anti-predator behavior of gelada baboons. *Primates* **37**: 389-397.
- Jolly, C. J. (1972). The classification and natural history of theropithecus baboons of the African Plio-pleistocene. *Bull. Brit. Mus. Nat. Hist.* **22**: 1-123.
- Kappeler, P. M. and van Schaik, C. P. (2002). Evolution of primate social systems. *Intern. J. Primatol.* **23**: 707-740.
- Kawai, M. (1979). Auditory communication and social relations. *Contrib. Primatol.* **16**: 219-241.
- Kawai, M., Dunbar, R., Ohsawa, H. and Mori, U. (1983). Social organization of gelada baboons: social units and definitions. *Primates* **24**: 13-24.
- Kawai, M. and Iwamoto, T. (1979). Nomadism and activities. *Contrib. Primatol.* **16**: 251-278.
- Kent, G. C. and Carr, R. K. (2001). *Comparative Anatomy of the Vertebrates*. 9<sup>th</sup> edn. The McGraw-Hill Companies, Inc., New York. pp. 64
- Kingdon, J. (1971). *East Africa Mammals: 1. An Atlas of Evolution in Africa*. Academic Press, New York. pp. 36.
- Kingdon, J. (2004). *The Kingdon Pocket Guide to African Mammals*. Princeton University Press, Princeton. pp. 53.

- Lewis, S., Sherratt, T. N., Hamer, K. C. and Wanless, S. (2001). Evidence of intra-specific competition for food in a pelagic Seabird. *Nature* 412: 816-819.
- Leykun Abunie (2000). The challenge of conserving Ethiopian wildlife. Overview. *Walia* 21: 56- 62.
- Last, J. (1982). *Endemic Mammals of Ethiopia*. Ethiopian Tourism Commission, Addis Ababa. pp. 18.
- Macdonald, D. (1985). *The Encyclopedia of Mammals: 1*. George Allen and Unwin, London. pp. 306.
- McCann, C. (1995). *Social Factors Affecting Reproductive Success in Female Gelada Baboons (Theropithecus gelada)*. Ph.D. Thesis, New York University, New York. 320 pp.
- Melton, D. A. (1983). Population dynamics of waterbuck (*Kebus ellipsiprymnus*) in the Umfolozi Game Reserve. *Afr. J. Ecol.* 21: 77-91.
- Mesele Yihune, Afework Bekele and Zelealem Tefere (2008). Human-gelada baboon conflict in and around Simien Mountains National Park, Ethiopia. *Afr. J. Ecol.* 35: 596-606.
- Moos-Heilen, R. and Sossinka, R. (1990). The influence of oestrus on the vocalization of female gelada baboons (*Theropithecus gelada*). *Ethology* 84: 35-46.
- Mori, U. (1979a). Development of sociability and social status. *Contrib. Primatol.* 16: 125-154.
- Mori, U. (1979b). Individual relationships within a unit. *Contrib. Primatol.* 16: 93-124.
- Mori, U. (1979c). Inter-unit relationships. *Contrib. Primatol.* 16: 83-92.
- Mori, U. (1979d). Reproductive behaviour. *Contrib. Primatol.* 16: 183-197.
- Mori, U. and Dunbar, R. I. M. (1985). Changes in the reproductive condition of female gelada baboons following the takeover of one-male unit. *Z. Tierpsychol.* 67: 215-224.
- Mori, A. and Gurja Belay (1990). The distribution of baboon species and a new population of gelada baboons along the Wabi-Shebeli River , Ethiopia. *Primates* 31: 495-508.
- Mori, A, Gurja Belay and Iwamoto, T. (2003). Changes in unit structures and infanticide observed in Arsi geladas. *Primates* 44: 217-223.

- Mori, A., Iwamoto, T. and Afework Bekele (1997). A case of infanticide in a recently found gelada population in Arsi, Ethiopia. *Primates* **38**: 79-88.
- Mori, A., Iwamoto, T., Mori, U. and Afework Bekele (1999). Sociological and demographic characteristics of a recently found Arsi gelada population in Ethiopia. *Primates* **40**: 365-381.
- Napier, J. R. and Napier, P. H. (1967). *A Handbook of Living Primates: Morphology, Ecology and Behaviour of Nonhuman Primates*. Academic Press, London. 456 pp.
- Naughton-Treves, L., Treves, A., Chapman, C. and Wrangham, R. (1998). Temporal patterns of crop-raiding by primates: linking food availability in croplands and adjacent forest. *J. Appl. Ecol.* **35**: 596-606.
- Ohsawa, H. (1979). The local gelada population and environment of the Gich area. *Contrib. Primatol.* **16**: 4-45.
- Ohsawa, H. and Dunbar, R. I. M. (1984). Variations in the demographic structure and dynamics of gelada baboon populations. *Behav. Ecol. Sociobiol.* **15**: 231-240.
- Post, D. G. (1982). Feeding behaviour of yellow baboons in Amboseli National Park. *Int. J. Primatol.* **3**: 403-430.
- Saj, L. T., Sicotte, P. and Paterson, J. D. (2001). The conflict between vervet monkeys and farmers at the forest edge in Entebbe, Uganda. *Afr. J. Ecol.* **39**: 195-199.
- Shah, N. F. (2003). *Foraging Strategies in the two Sympatric Mangabey Species (Cercocebus agilis and Lophocebus albigena)*. Ph.D. Thesis, Stony Brook University, Stony Brook. 205 pp.
- Struhsaker, T. T. (1967). Ecology of vervet monkeys (*Cercopithecus aethiops*) in the Masai-Amboseli Game reserve, Kenya. *Ecology* **48**: 891-904.
- Sutherland, W. J. (1996). *Ecological Census Technique. A Handbook*. Cambridge University Press, Cambridge. 336 pp.
- Vaughan, T. A., Ryan, J. M. and Czaplewski, N. J. (2000). *Mammalogy*. 4<sup>th</sup> edn. Thomson Learning, Inc., Madrid. 563 pp.

- Williams-Guill'es, K. (2003). *The Behavioral Ecology of Mantled Howling Monkeys (Alouatta palliata) Living in a Nicaraguan Shade Coffee Plantation*. Ph.D. Thesis. New York University, New York. 242 pp.
- von Wolff, J. F. (1955). *Mammals of Ethiopia*. Rhodesian Litho limited, Salisbury. pp. 53.
- Wong, S. N and Sicotte, P. (2007). Activity budget and ranging patterns of *Colobus vellerosus* in forest fragments in Central Ghana. *Folia Primatol.* **78**: 245-254.
- Yalden, D. W., Lagen, M. J. and Kock, D. (1977). Catalogue of the mammals of Ethiopia. III. Primates. *Monitore Zoologico Italiano Supplement* **9**: 1-52.
- Yalden, D. (1983). The extent of high ground in Ethiopia compared to the rest of Africa . *SINET: Ethiop. J. Sci.* **6**: 35-39

## 10. APPENDIES

Appendix 1. List of plant species in the study area.

Local name	Scientific name	Family
Girar	<i>Acacia abyssinica</i>	Fabaceae
Girar	<i>Acacia lahai</i>	Fabaceae
Girar	<i>Acacia negrii</i>	Fabaceae
Girar	<i>Acacia pilispina</i>	Fabaceae
Sesa	<i>Albizia shimperiana</i>	Fabaceae
Wanza	<i>Cordia Africana</i>	Boraginaceae
Besana	<i>Croton macrostachyus</i>	Euphorbiaceae
Kitikita	<i>Dodonaea angustifolia</i>	Sapindaceae
Koshem	<i>Dovyalis abyssinica</i>	Flacurtiaceae
Kelkal	<i>Euphorbia abyssinica</i>	Euphorbiaceae
Kelkal	<i>Euphorbia candelabrum</i>	Euphorbiaceae
Tid	<i>Juniperus procera</i>	Cupressaceae
Shenet	<i>Myrica salicifolia</i>	Myricaceae
Weira	<i>Olea europaea</i>	Oliniaceae
Keret	<i>Osyris quadripartita</i>	Sentalaceae
Chocho	<i>Premna schimperi</i>	Verbacaceae
Meraz	<i>Acokanthra schimperi</i>	Apocynaceae
Tilem	<i>Rhus retinorrhoeae</i>	Anacardiaceae
Enibus	<i>Rhus glutinosa</i>	Anacardiaceae
Kimo	<i>Rhus vulgaris</i>	Anacardiaceae
Degita	<i>Calpurnia aurea</i>	Fabaceae
Tega	<i>Rosa abyssinica</i>	Rosaceae
Enbacho	<i>Rumex nervosus</i>	Polygoneceae
Sesel	<i>Justicia shimperiana</i>	Acanthaceae

Cont'd...

Girawa	<i>Vernonia myriantha</i>	Asteraceae
Kichib	<i>Euphorbia tirucalli</i>	Euphorbiaceae
Motushe	<i>Becium grandiflorum</i>	Lamiaceae
Tingut	<i>Otostegia integrifolia</i>	Lamiaceae
Gimamucha	<i>Plectranthus ornatus</i>	Lamiaceae
Atat	<i>Sideroxylon oxyacantha</i>	Sapotaceae
Atat	<i>Maytenus gracilipes</i>	Celastraceae
Dedeho	<i>Euclea divinorum</i>	Ebenaceae
Maget	<i>Trifolium spp.</i>	Fabaceae
Chifrig	<i>Sida schimperiana</i>	Malvaceae
Seged	<i>Psydrax schimperiana</i>	Rubiaceae
Gaga	<i>Andropogon spp.</i>	Poaceae
Beles	<i>Opuntia ficus-indica</i>	Cactaceae
Erate	<i>Aloe spp.</i>	Aloaceae
Amega	<i>Hypericum quartinianum</i>	Hypericaceae
Agam	<i>Carissa edulis</i>	Apocynaceae
Fiyelefeg	<i>Clusia abyssinica</i>	Euphorbiaceae
Atat	<i>Asparagus asiaticus</i>	Asparagaceae
Adeyabeba	<i>Bidens spp.</i>	Asteraceae
Baherzaf	<i>Eucalyptus globulus</i>	Myrtaceae
Gishrit	<i>Impatiens rothii</i>	Balsaminaceae

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Appendix 2. List of large mammals recorded the study area.

Common name	Scientific name
Gelada Baboon	<i>Theropithecus gelada</i>
Hamadryas Baboon	<i>Papio hamadryas</i>
Olive Baboon	<i>Papio anubis</i>
Vervet Monkey	<i>Ceropithecus aethiops</i>
Bushbuck	<i>Traglaphus scriptus</i>
Klipspringer	<i>Oreotrogus oreotragus</i>
Rock Hyrax	<i>Orocavia capensis</i>
Spotted Hyena	<i>Crocuta crocuta</i>
Striped Hyena	<i>Hyaena hyaena</i>
Common Jakal	<i>Canus aureus</i>
Crested Porcupine	<i>Hystrix cristata</i>
Common Duiker	<i>Sylvoicapra grimmia</i>
Common Genet	<i>Genetta genetta</i>
Leopard	<i>Panthra pardus</i>
White-tailed Mongoose	<i>Ichneumia albicauda</i>
Abyssinian Hare	<i>Lepus abyssinicus</i>

Appendix 3. One male units (OMUs) size and composition in different sites in Ethiopia.

Study site	OMUs	AF/OMU	Reference
Gich	10 (2-25)	3.5 (1-8)	Ohsawa, 1979
Gich	9.9 (2-27)	3.9	Dunbar, 1984a
Bole Valley	17.1(8-28)	5.9	Dunbar, 1984a
Sankaber	12.0 (3-26)	4.1	Dunbar, 1984a
Arsi	8.3 (2-15)	(1-6)	Mori <i>et al.</i> , 1999
Wonchit Valley	16.96 (8-25)	(4-10)	This study

Appendix 4. Demography for gelada baboons across the study sites in Ethiopia.

Study site	Band size	Adult		Reference
		M/F	band	
Sankaber	131.5(30-262)	1/2.75	10.7	Dunbar,1984a; Ohsawa and Dunbar, 1984
Gich	107.2 (27-170)	1/2.35	9.7	Dunbar,1984a; Ohsawa and Dunbar, 1984
Bole Valley	60.3 (48-78)	1/4.21	3.3	Dunbar,1984a
Arsi	54	1/1.87		Mori <i>et al</i> , 1999
Gich	(16-170)		(2-18)	Ohsawa, 1979
Wonchit Valley	58.03 (25-220)	1/6.61	(2-14)	This study

Appendix 5. All-male unit (AMU) size and composition in different sites in Ethiopia.

Study site	AMU size	Reference
Sankaber and Bole		
Valley	7.8 (3-13) males and juveniles	Dunbar and Dunbar, 1975
Gich	(13-15) males and juveniles	Ohsawa, 1979
Wonchit Valley	6.32 (3-12) sub-adult males	This study

Appendix 6. Activity budget of gelada baboon in different sites in Ethiopia.

Study area	Time in each activity (%)				Reference
	Feeding	Moving	Resting	Socializing	
Bole Valley	35.7	17.4	26.3	18.5	
Sankaber	45.2	20.4	13.8	20.5	Iwamoto and Dunbar, 1983
Gich	62.3	14.7	5.2	16.0	
Wonchit Valley	65.18	16.32	4.59	13.91	This study

Appendix 7. Questionnaire for the local people in Wonchit Valley

Village name-----

Sex-----Age-----Educational background-----

1. Which problem is caused by gelada baboon?

- A. crop damage
- B. grazing pasture
- C. sharing drinking water
- D. transmission of disease

2. What kind of attitude do you have on gelada baboon?

- A. positive
- B. negative

3. Did you kill gelada baboon during the last 12 months?

- A. yes
- B. no

4. If the answer of question 3 is yes how many did you kill?

- A.1
- B.2
- C.3
- D. 4 and more than 4

5. Which kind of instrument do you used to kill gelada baboon?

- A. stone/stick
- B. snare
- C. gun
- D. poisons

6. State methods of crop protection from gelada baboon damage

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7. Which crop protection is the most effective and frequent method do you use?

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8. What kind of measurement do you expected from the government on gelada baboons?

- B. Kill all gelada baboon from the area
- C. reduce their number
- C. transfer to other area
- D. if you have anther idea\_\_\_\_\_

9. For how many hours do you keep your crop from gelada baboon damage?

- A. 2 hours
- B. 6 hours
- C. 9 hours
- D. 12 hours

10. For how many months do you keep your crop from gelada baboon damage?  
A. 2 months    B. 3 months    C. 4 months    D. 5 months    E. 6 months
11. Who keep the crop most of the time from gelada baboon damage?  
A. children (6-12 ages)    B. adolescents  
C. mothers    D. fathers
12. Do you believe gelada baboon should be conserve?  
A. no    B. yes
13. What is the reason that gelada baboon damage crops?  
A. increase the gelada baboons number  
B. expansion of agriculture to the gelada baboon habitat  
C. over grazing of the gelada baboon foraging area by livestock  
D. human settlement on gelada baboon habitat  
E. if you have other\_\_\_\_\_
14. Do you know the endemism of gelada baboon?  
A. yes    B. no
15. State the importance gelada baboon to the local people as well as the country?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
16. In which stage of crops gelada baboon damage the most?  
A. during sowing    B. seedling stage  
C. vegetating stage    D. harvesting stage



## DECLARATION

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

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Date: July 03, 2009

Signature.....

Place: Addis Ababa University

This thesis has been presented with my approval as supervisor

Prof. Afework Bekele

Date: July 03, 2009

Signature.....