

**ADDIS ABABA UNIVERSITY**  
**COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES**  
**DEPARTMENT OF ZOOLOGICAL SCIENCES**



**Feeding Ecology and Pest Status of the Mole Rats  
(*Tachyoryctes splendens*) in Farmland, Masha, Southwest  
Ethiopia**

A Thesis Submitted to the Department of Zoological Sciences in Partial  
fulfilment of the Requirements for the Degree of Master of Science in  
Ecological and Systematic Zoology

By

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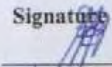
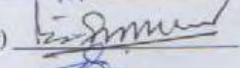

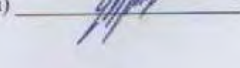
Feeding ecology of molerats (*Tachyoryctes splendens*) on farmland in  
Masha, southwest Ethiopia.

**By**

**Yidnekachew Arega**

*A Thesis Presented to the School of Graduate Studies of the Addis Ababa University in  
Partial Fulfillment of the Requirements for the MSc in Biology (Ecological and  
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Table of Contents	Page
List of Tables .....	i
List of Figures .....	ii
List of Appendices .....	iii
Acknowledgements.....	iv
Abstract.....	v
1. Introduction -----	1
1.1. Back ground and justification -----	1
1.2. Literature review -----	6
1.3. Objectives of the study -----	10
1.3.1. General objective -----	10
1.3.2. Specific objectives -----	10
2. The study area and methods -----	11
2.1. The study area -----	11
2.1.1. Topography and climate -----	13
2.1.2. Land-use type and farming syste-----	15
2.1.3. Vegetation -----	15
2.2. Materials and methods -----	16
2.2.1. Materials -----	16
2.2.2. Methods -----	17
3. Results -----	20
3. 1. Morphological measurements -----	20
3. 2. Population structure of common mole rats -----	22

3.3. Abundance and distribution of common mole rats -----	23
3.4. Burrow system and ecology of common mole rat -----	26
3.5. Stomach contents analysis -----	30
3.6. Assessment of damaged crops by common mole rat -----	31
3.7. Pest status and control mechanisms of common mole rat -----	32
4. Discussion -----	35
5. Conclusion -----	39
6. References -----	40
7. Appendices -----	52

List of Tables	page
Table 1: Mole rats trapped in the study sites -----	22
Table 2: Body measurement and weight of common mole rat trapped -----	23
Table 3: Sex and age distribution of common mole rats -----	24
Table 4: Total count of mounds of mole rats in different habitats of each studysites -----	26
Table 5: Density of common mole rats in the study sites-----	27
Table 6: Measurement of the burrow of mole rats -----	29
Table 7: Damaged crop counts -----	31
Table 8: Percentage loss and income loss due to mole rats on Enset and Potato crops -----	33
Table 9: Pest status and control mechanism of common mole rat -----	34

Lists of Figures	Page
Figure 1: Map of the study area -----	12
Figure 2: Maximum and minimum temperatures in Masha -----	13
Figure 3: Mean monthly rainfall (mm) distribution at Masha -----	14
Figure 4 : Local conical trap (“eche kanbo”) -----	16
Figure 5 : A Live trapped mole rat -----	22
Figure 6 : Fresh soil mound of the common mole rat -----	24
Figure 7 : Map of representative burrow systems -----	27
Figure 8 : Nest of common mole rat -----	28
Figure 9 : Excavated bolt hole of the common mole rat -----	29
Fig 10 : Mole rat excavating soil -----	30
Fig 11 : Mole rat damaged enset plants -----	31

List of Appendices

Page

Appendix I: Sample data collection sheet for population studies of *Tachyoryctes splendens*----52

Appendix II: Questionnaire for data collection for local people ----- 53

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## **Abstract**

### **Feeding Ecology and Pest Status of the Mole rats (*Tachyoryctes splendens*) in Farmland, Masha, Southwest Ethiopia**

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A study on the abundance, distribution, feeding habit, pest status and impacts of mole rats on agricultural productivity was carried out on the farmlands of Masha during July, 2016 – February, 2017. Two study sites (Beto and Gembaka Kebeles) were selected based on the abundance and habitat differences of mole rats. Conical local traps and live traps were used to capture mole rats to determine body weight, external body measurements and stomach contents. Excavations were made to investigate the burrow system (nest, bolt hole and foraging tunnels). Fresh soil mound count was made to determine abundance and distribution of mole rats. Total counts of damaged enset and potato tubers were made and the percentage and income loss were calculated per study site based on the assessment of local markets. A total of 33 common mole rats (22 males and 11 females) were trapped from farmland, grassland and fallowland habitats during the wet and dry seasons. Common mole rats were abundant during the wet season (57.6%). The nest content and stomach content analysis showed grass in large proportion, followed by enset and potato as food items. The mean percentage loss of enset was 0.47% and potato is 0.03%. The mean annual loss monetary value of enset was 236.5 birr and potato is 6.65 birr per ha. However, from interview results the pest status of *T. splendens* ranked high by farmers. They control and manage the pest by using conical trap (61.8%) and rodenticides (23.5%). Proper management of *T. splendens* in the present study area can solve the problems that famers face regarding agricultural yield loss and energy expenditure.

**Key words:** *Burrow system, Enset, Masha, Pest status, Tachyoryctes splendens*

# 1. Introduction

## 1.1. Background and Justification

Mammals are the highly evolved group of the animal Kingdom (Ghose and Manna, 2003). Among the mammals, rodents (Order Rodentia) are the most diverse (Vaughan *et al.*, 2000), with a nearly worldwide distribution (Davis, 1963; Kingdon, 1997; Nowak, 1999). Habitats and behaviour of rodents are highly diverse, due to the large number of species among them (Wilson and Reeder, 1993; Prasad and Kashay, 1995). According to Stoddart (1984), rodents are among the most ubiquitous and numerous mammals, in both species and individual numbers (Delany, 1986; Afework Bekele, 1996a). They occur in every habitat from the high Arctic Tundra, where they live and breed under the snow to the hottest and driest region. Rodents are highly variable in morphology, habitat utilization, behaviour, life history and distribution (Yalden, *et al.*, 1996). They range from the tiny pigmy mice to the large *Capybaras*; from the arboreal flying squirrels to the subterranean mole rats and from opportunistic omnivores to specialist feeders. Of all the mammalian orders, Rodentia (29 families, 468 genera and 2,052 species) is the most diverse in size and adaptations (Daves, 1963; Rosevear, 1969; Kingdon, 1974; Delany and Happold, 1979; Nowak, 1999). Rodents comprise 41% of the entire mammalian species (Nowak, 1999). More than 320 mammalian species have been recorded from Ethiopia (Yalden *et al.*, 1996; Afework Bekele and Corti, 1997; Shibiru Tedla, 1995; Leykun Abunie, 2000; Afwork Bekele and Yalden, 2013). Currently, 44 mammalian species are considered to be endemic to Ethiopia, and this list is not exhaustive (Taylor *et al.* 2011, Afework Bekele and Yalden 2013). The rodent fauna of Ethiopia consists of 84 species (Yalden and Largen, 1992, Hillman, 1993, Afework Bekele 1996 a, b, Lavernchenko *et al.*, 1998 ). Among them 15 are endemic. According to Afework Bekele (1996b), rodents comprise 25% of the Ethiopian mammal fauna and contribute about

50% of the total endemic species of the country. The common mole rat, *Tachyoryctes splendens*, belongs to the genus *Tachyoryctes* (Rüppell 1835) of the Mammalian order Rodentia. The exact number of species in this genus is not clearly known (Nowak, 1999). Modern description and classification of species requires karyotype and DNA analysis. Analysis of karyotype number and morphology are important in taxonomy and characterization of the species (Baskevich *et al.*, 1993). However, Jotter and Bellomo (1984) demonstrated that karyotype is species characteristic as a rule. Despite this, karyotypes of subterranean and fossorial rodents exhibit greater diversity both between species and within species than most rodents (Nevo, 1979, Nevo *et al.*, 1986). This view is not still accepted by some authors (for example: George, 1979; Patton and Sherwood, 1983). Though there are controversies among authors on subterranean rodents especially on common mole rats, karyotype studies shows  $2n = 48$ , but autosomal fundamental numbers and centromere position of sex chromosomes are variable (Baskevich *et al.*, 1993, Ziyin Mihiretie, 2005). George (1979) described the species as *Tachyoryctes srex*; closely related to another Kenyan species. Burda *et al.* (2000) also provided additional information using more material and affirmed the relationship between *Tachyoryctes audax* and *T. rex*. They have noted that the two were similar in coloration but *T. rex* is much larger. According to George, *T. audax* is somewhat darker in color (Musser and Carleton, 2005).

According to Afework Bekele and Leirs (1997), most rodent species play great role in maintaining the ecosystem such as in seed dispersal, pollination, predator-prey relationship and in maintaining ecological balance and habitat modification. They have economical, ecological, social and cultural values and provide major benefits to our environment. They are also important food sources for predators including the endangered and endemic Ethiopian Wolf (*Canis simensis*).

Despite their ecological benefits, some rodent species cause major economical losses. In developing countries, rodent infestation is a serious threat for reduction of income and food shortage by causing substantial damage to food and cash crops worldwide (Shanker, 2001). In the sub-Saharan Africa, the major rodent species causing severe damage to crops belong to the Genus *Mastomys* (Muridae). They occur all over the continent in natural habitats, cultivated areas and human habitats. The most common rodent pests in the sub-Saharan Africa are the multi-mammate rats, belonging to the murid genus *Mastomys* (Leirs *et al.*, 1996) and *Arvicanthis* (Afework Bekele and Leirs, 1997; Nevo, 2007) that destroy as much as 80–100% of crops throughout their ranges in the sub-Saharan Africa (Green wood *et al.*, 1980).

In East Africa, rodent pests mainly cause damage on cereal crops and they have been ranked as major crop pest becoming a threat for national and international food security (Mohammed Kasso, 2013). Rodent pests cause about 30% crop damage worldwide and in Ethiopia, more than 25% loss has been recorded (Afework Bekele and Leirs, 1997). In Ethiopia, maize, enset and potatoes are the crops most affected by rodents (Tristiani *et al.*, 2003; Makundi *et al.*, 1999). Destruction of crops by rodents has resulted in heavy loss of food and human economy (Singleton *et al.*, 1999; Makundi *et al.*, 2005). Singleton *et al.*, 2003 estimated that the severity of crop damage ranged from 5% to 10% in non-outbreak years to losses of 30–100% during outbreak years leading to localized or widespread famine. Afework Bekele *et al.* (2003) estimated rodent damage in maize fields at Ziway, Ethiopia, up to 26.4%. In Ethiopia, comprehensive studies on the effect of rodent damage to agricultural crops are lacking. There are limited quantified estimates of the crop yield that is lost to rodents (Afework Bekele *et al.*, 2003).

The East African mole rats inhabit from medium to high altitudes (Rahm, 1969). Common mole rats prefer open habitats like grasslands, wooded savanna with scattered trees and cultivated areas with loose soil. In Ethiopia, they occur at altitudes ranging from 1300 to above 4000 m a.s.l. in different regions (Yalden *et al.*, 1976; Sewnet Mengistu and Afework Bekele, 2003). However, *T. macrocephalus* is confined only to the Bale Mountains (Yalden *et al.*, 1976; Sillero-Zuberi *et al.*, 1995). *Tachyoryctes splendens* is the least modified for fossorial life among the East African common mole rats.

Rodents show considerable diversity in their diet (Brett, 1991). The food habits of small rodents are poorly known, mainly because the finely masticated food components are hard to identify in the stomach contents (Hansson, 1999). Their diet is usually evaluated by analyzing stomach contents, although it demands sacrificing the animals (Kronfeld and Dayan, 1998). Most rodents are opportunistic feeders, capable of changing their feeding habits depending on the availability of food from season to season (Workneh Gebresilassie *et al.*, 2004).

East African common mole rats (*Tachyoryctes splendens*) mainly feed upon underground plant parts, roots, rhizomes, tubers, as well as stem bulbs and grasses. These are indiscriminately taken into underground hole (Bennett and Jarvis, 1995; Kingdon, 1997). As the foraging tunnels of the common mole rats are usually just below the root levels, the animals always get fresh food (Jarvis and Sale, 1971; Sewnet Mengistu and Afework Bekele, 2003). It also stores food at nesting chambers for the use during food scarce months. Although the usual foraging is through complex underground tunnels, it sometimes comes out to the surface in order to collect nesting materials and food. Mole rat constructs a burrow system consisting of multipurpose central nest, bolt-hole and foraging tunnels (Skliba *et al.*, 2007).

In the present study area (Masha), local people carry out mixed agriculture. Pest mammals have been severely affecting Enset (*Ensete ventricosum*) crop yield and grazing grasslands. Enset cultivation has existed for hundreds of years as a sustainable form of agriculture in southwest Ethiopia. Presently, more than 20% of Ethiopia's population depends upon Enset for food, fibre, animal forage, construction materials and medicine (NTFP, 2004). Its production is strongly intermingled with the economic, cultural and social life of the people in the enset growing region of the country. However, sustainability of Enset; based agriculture is threatened by a number of factors. Main biotic stresses are bacterial wilt, enset root mealybug, nematodes, fungi and vertebrate pests like mole rats. In the southwestern part of Ethiopia, mole rats are major rodent pests.

Mole rats are adapted to a wide range of environments (Nowak, 1999). Despite their wide range of environmental adaptation, the ecology of mole rats are still poorly known in different parts of Ethiopia (Tilaye Wube, 1999). The people in Masha, the study area of the present study, had little biological information about the ecology of mole rates. Therefore, the present study was designed to gather information about abundance, distribution, feeding habit, pest status and impacts of mole rats on agricultural productivity in the present study area.

## 1.2. Literature Review

*Tachyoryctes splendens* is a solitary, aggressive, fossorial rodent. Distribution pattern of this East African species (*Tachyoryctes splendens*) is discontinuous, ranging from Ethiopia and parts of Somalia as far as Eastern Zaire, Burundi and Northern Tanzania (Nowak, 1999). This is native to East Africa and the eastern parts of Central Africa. It is found at elevations of up to 3,300 meters in Ethiopia and up to 3,000 meters in other parts of its range (Musser *et al.*, 2005). It is an adaptable species able to live in a range of habitats including savannas, moist tropical forests, agricultural lands, pasture, coffee plantations and gardens. They seldom occur in areas with less than 500 mm rainfall per year, but they best establish in wet uplands (Kingdon, 1974, 1997; Nowak, 1999).

The distribution pattern of East African mole rat varies and fluctuates seasonally based upon altitude and vegetation cover as well as precipitation of climatic factors. *Tachyoryctes* favours deep, well-drained, often-volcanic soils, rainfall over 510 mm a year and vegetation cover of grass to open forests (Jarvis and Sale, 1971). Additionally, local distribution of any subterranean rodents is influenced by topography, soil and vegetation characteristics of the habitat. As areas of suitable soil and vegetation are patchily distributed, individuals also tend to be spatially clumped (Bennett and Faulkes, 2000). This is easily observed in *T. splendens* (Jarvis and Sale, 1971).

Subterranean mammals spend most of their lives in self-constructed burrows that provide them safety from predation, climatic extremes and ensure access to food resources (Nevo, 1999 ; Busch *et al.*, 2000). The burrow system of all mole rats have a similar architecture, which consist of a superficial network of foraging tunnels interconnected with a system of more deeply located chambers used for nesting, food storage and sanitation (Bennet *et al.*, 1990; Hickman, 1979 ; Brett, 1991; Spinks *et al.*, 2000). The level of social organisation,

group size, habitat characteristics and individual variability are relevant factors influencing the architecture of mole-rat burrow systems (Bennett and Faulkes, 2000; Hickman, 1990; Nevo, 1999).

The physical surface and structure of burrow system indicate signs of presence or absence of mole rats in the area. As it is a ubiquitous feeder, its habitats provide grass roots, rhizomes, stems, leaves, herbs, shrub, tree roots, tubers, bulbs and corms (Broekman *et al.*, 2006). Subterranean rodents are food generalists whose diets contain a large proportion of the underground vegetation (Vleck, 1979). They are exclusively herbivores feeding on a wide range of vegetation including grasses, herbs and underground roots (Jarvis, 2013). Common mole rats eat plant roots. Its presence results in a change in vegetation on the mounds, which have fewer grasses and more woody plants (Rundel *et al.*, 1994). Ethiopia's annual crop yield loss by rodents is about 20% (Goodyear, 1976; Afework Bekele and Leirs, 1997). For a poor, repeatedly drought and famine-affected country, such crop loss is a severe problem.

Mole rats feed on a wide range of roots and shoots searching through underground tunnels. They spend limited periods on the surface to forage and for nesting materials, and food such as grasses and cultivated legumes (Šklíba *et al.*, 2007). Foraging tunnels are longitudinal with circular cross sections and diameter of 5 to 7 cm for *T. splendens*. It runs fairly at constant depth of 19 to 22 cm for *T. splendens* (Burda *et al.*, 2000), 10 to 15 cm for *T. macrocephalus* (Yalden, 1975) and 8 to 20 cm for *Cryptomys* (Hickman, 1979). The total length of the foraging tunnel is determined by the availability of food and need of food (Taylor and Green, 1976). These tunnels are air tightly plugged to maintain temperature and protect them against predation. According to Jarvis and Sale (1971), the total length of the *T. splendens* burrow system may reach up to 52 meters and the depth of foraging tunnels is regulated by root (rhizome) level of the plant on which the mole rats feed upon. Thus, depth of foraging tunnel

varies depending on the position of the tunnels in relation to the nest (Hickman, 1983), breeding season and water level (Nevo, 1996).

The East African common mole rats construct a burrow system consisting of a nest chamber, a bolt-hole, and a number of foraging tunnels. The large, single, multipurpose nest chamber is used for food storage, sleeping, sanitation as well as for breeding (Jarvis, 1973; Jarvis and Sale, 1971). When the mole rat is alarmed, it retreats into this tunnel and plugs it in order to mislead the source of the alarm. Thus, bolt hole serves as an escaping tunnel from danger (Jarvis and Sale, 1971). However, Hickman (1979) argued that the deep tunnel bolt hole primarily functions to keep humidity high in the burrow system. For many mammals including rodents, subterranean burrows play an important role in the environment. Burrows may be used as places of refugia and storage as well as nest sites (Carter and Encarnacao, 1983; Carter and Rosas, 1997). The construction, use and maintenance of the burrows are the central element to the subterranean species. Despite the assumptions that a subterranean life style imposes similar selective pressures on mammalian inhabitants, regional variation in climate, soil and vegetation is considered important in generating adaptive differences among populations and species. As a result, convergent taxa may display different local adaptive peaks that reflect variation in local environment (Musser and Carleton, 2005).

Population dynamics of rodents follow seasonality in relation to variations in rainfall and reach peaks towards the end of the rainy season when resources are plenty (Massawe *et al.*, 2008). Breeding decreases during the dry months and rainfall is the ultimate source of variation in rodent density (Tilaye Wube, 2005). Temperature and humidity play also a significant factor in determining the rodent activity (Ghobrial and Hodieb, 1982; Shurchfiesd, 1997).

Many environmental factors have effects on the timing of reproduction in rodents (Happold and Happold, 1989). Vaughan *et al.* (2000) have indicated that temperature, energy and nutrition are probably of prime importance in this respect. Afework Bekele and Leirs (1997) showed that extended rainy season results in high litter size, which leads to an increase in population size.

Jarvis (1973) found an average annual litter size of 2.1 per female and gestation period of 37–40 days in Kenya, while Rahm (1969) determined the gestation period to be 45–50 days in eastern Zaire (Congo).

Females may deliver up to four young per litter, but usually only one or two. The young are weaned at 4–6 weeks, leave the mother about one month later, reach sexual maturity at 6 months of age. The average life expectancy is about one year (Nowak, 1999). This species is solitary, each adult live alone in its own burrow system.

The ratio of adult male to adult female varies among the species of subterranean rodents. Female-biased ratios are observed for some solitary species like *Ctenomys talarum* (Busch *et al.*, 2000), *Tachyoryctes splendens* (Jarvis, 1973) and *Pappogeomys castanops* (William and Baker, 1976). in contrast, *Heterocephalus* is male biased (Genelly, 1965).

Out of the 84 rodent species recorded in Ethiopia, 11 species are major agricultural pests (Afework Bekele and Leirs, 1997). Mole rats are one of the major agricultural rodent pest species in Ethiopia distributed along the central and eastern Africa, throughout the highlands of Ethiopia to northern Tanzania (Jarvis and Sale, 1971; Kingdon, 1997; Nowak, 1999).

Rodent pests are a worldwide problem, and are responsible for considerable damage to crops, stored food and human properties (Jacob *et al.*, 2003). Rodent damage is a major cause of harvest loss, mainly cereal crops, and most of the damage occurs during the sensitive young

seedling stage and just before harvest (Parashad, 1999; Workneh Gebresilassie *et al.*, 2004). Reliable quantitative assessments of crop losses caused by pests are required to quantify the magnitude of pest problems. Many sampling techniques have been employed for rodent damage estimation at different locations and for different crops (Jacob *et al.*, 2003).

Mole rats are specialized on roots and tubers and cause major problems on Enset, potatoes, tomato and cassava in Ethiopia (Tristiani *et al.*, 2003). The least mentioned pest rodent group but not least in their level of damage was mole rat (Mohammed Kasso, 2013).

### **1.3. Objectives of the study**

#### **1.3.1. General objective**

The general objective of this study was to assess distribution, abundance, feeding habit and economical impact of common mole rats on Enset and other agricultural products in Masha, southwest Ethiopia.

#### **1.3.2 Specific objectives**

- To determine the abundance, feeding habit and population structure of common mole rat in Masha, Ethiopia.
- To identify the type of crops most affected by the common mole rat.
- To estimate the economic impact of common mole rat.
- To suggest ways of mole rat control and management strategy for enset and other crop plantation.

## **2. The Study Area and Methods**

### **2.1. The Study Area**

The study area (Masha) is located at about 676 km southwest of Addis Ababa. The area is in Sheka Zone of Ethiopia and lies between  $7^{\circ}24' - 7^{\circ}52'N$  latitude and  $35^{\circ}13' - 35^{\circ}35'E$  longitude (Fig.1). The name Masha serves for one of the three Woredas (Administrative Distribution) in the Zone where the study was conducted. It is also the name of the town, which is the capital of the Zone. Masha Woreda, shares a boundary with Oromiya Region on the north, Gambella on the west, Yeki Woreda on the south and Anderacha Woreda on the east. Statistical abstract from the district Finance and Economic Development Coordination Office shows that 47,860 (25,806 male and 22,252 female) people inhabit this woreda. Out of the total population, 10,523 (5,062 males and 5,461 females) live in the town. This Woreda has a total population density of 41.5 persons per square km (NTFP, 2004).

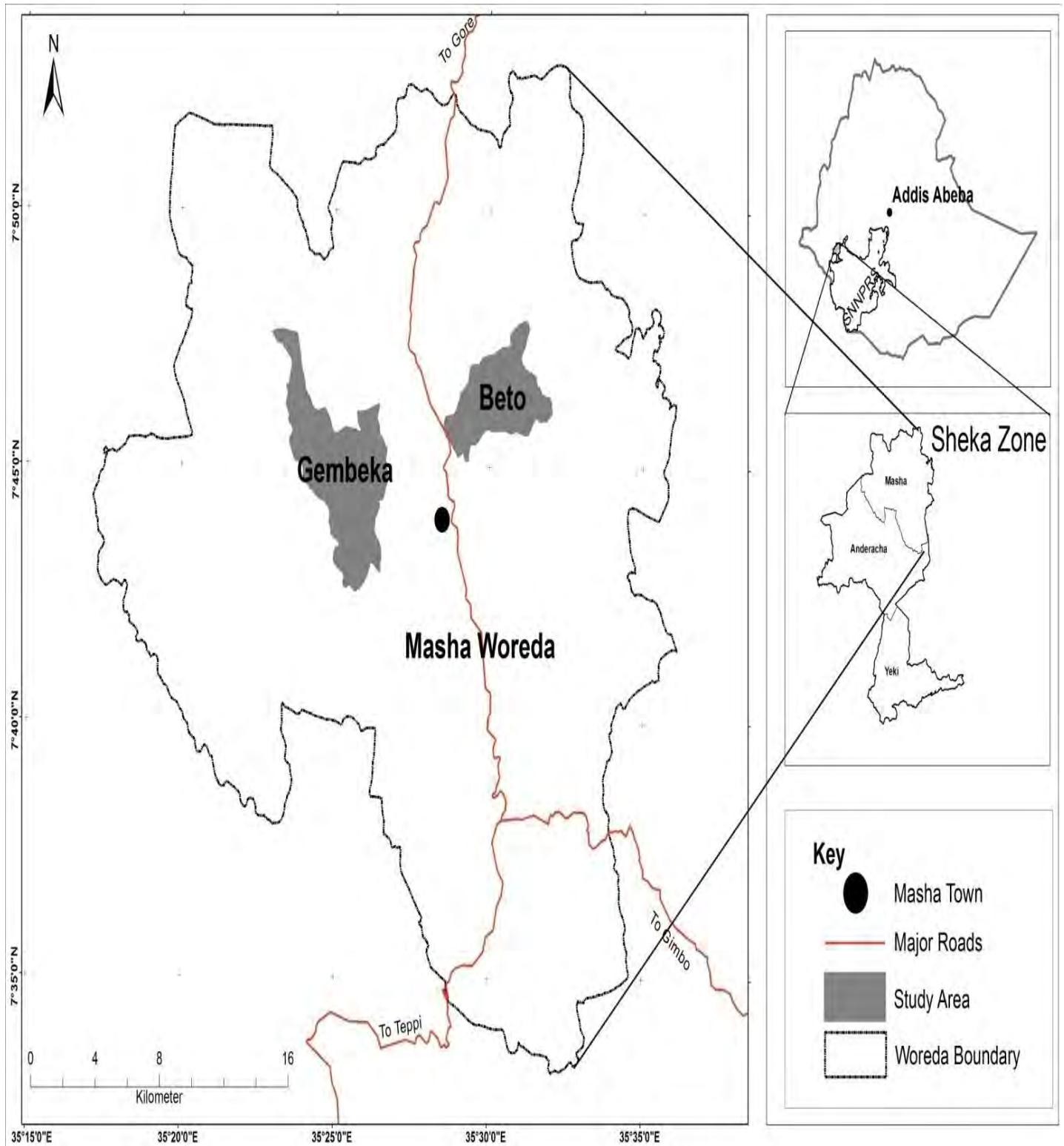


Figure 1. Map of the study area

### 2.1.1. Topography and Climate

The study area is mountainous covered with green vegetation. The topography of the area comprises different land features such as flat area, rugged topography, plateau and steep slopy areas commonly observed in the study area (Alemayhu Mulatu, 2010).

The mean monthly temperature at Masha is 17.7 °C with a mean monthly minimum of 10.9 °C and a mean monthly maximum of 24.5 °C (Fig. 2). In the area, the peak monthly temperature is during the month of March. The coolest months with low monthly temperature are July and August.

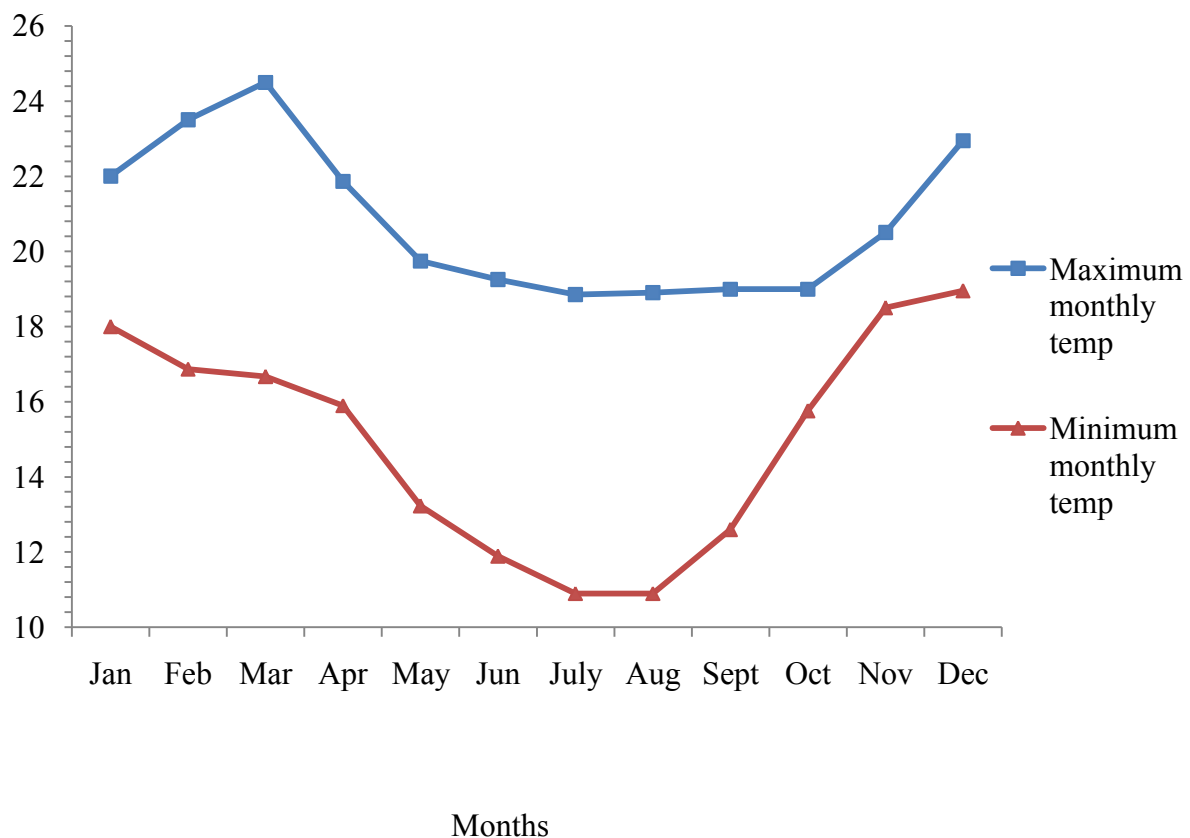


Figure 2. Maximum and minimum temperatures of Masha during 2010–2015.  
(Source: National Meteorological Service Agency Masha)

The Masha highlands are parts of the southwest Ethiopian highlands, which receive the highest amount of rainfall in Ethiopia (NTFP, 2004). The altitude of the area falls between 1700–3000 m above sea level. The annual rainfall ranges from 1800–2200 mm.

The mean monthly rainfall is 156.8 mm with high variation (80 – 250 mm) from year to year (Fig. 3).

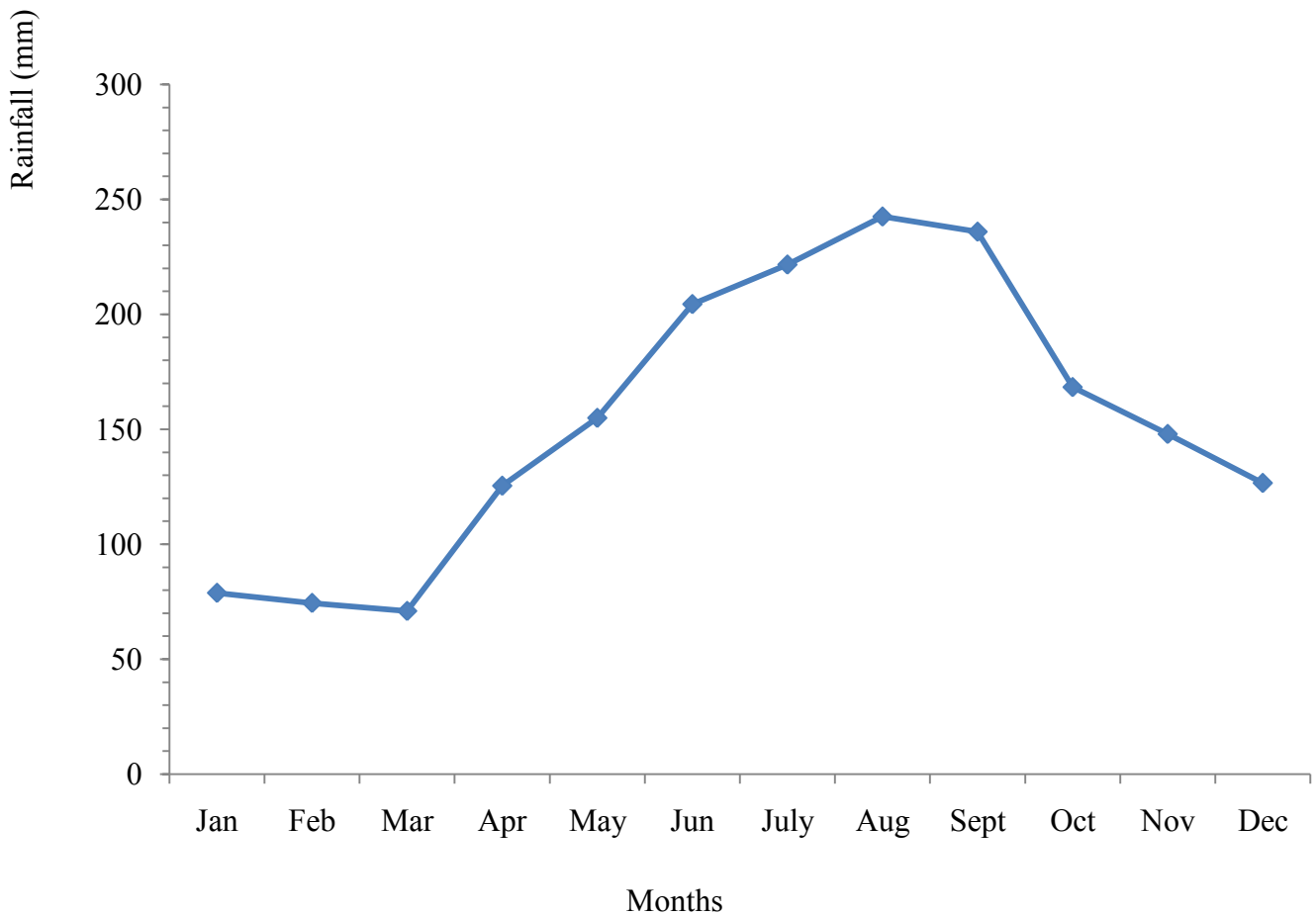


Figure 3. Mean monthly rainfall (mm) distribution at Masha during 2010–2015.

(Source: Ethiopian Meteorological Service Agency Masha)

### 2.1.2. Land-use and Farming system

Masha has a total area of 763.73 km<sup>2</sup>. Out of this land area, about 23.9% is cultivated, 2.8% is grazing land, 40.5% is covered by forest, 5.5% arable land, 5.9% non-arable land and

21.4% is settled land area (NTFP, 2004). In the study area, uncultivable land; use type includes mainly wetlands and sacred land.

Agricultural activities in the area include both crop production and animal husbandry. The main livelihood pattern is mixed farming. The productions of cereals are maize (*Zea mays*), teff (*Eragrostis teff*), wheat, barley, bean, pea, enset (*Ensete ventricosum*), sugarcane and potato (*Solanum tuberosum*). Livestock (cattle, goats, sheep and horses) and non-timber forest products, especially coffee, honey, false cardamom (*Afromomum corrorima*) and wild pepper (*Piper capense*) are important means of income for domestic use and households in this area (NTFP, 2004).

### **2.1.3. Vegetation**

The study area is one of the few areas in Ethiopia with high forest cover. Currently, about 40.5% is estimated to be covered by forest. With variation of altitude, riverine forest and afro-montane forest can be recognized in the study area. Riverine forest is a type of ecosystem most found along waterways (Schmitt, 2006). Most tree species found in this habitat are *Ficus sycomorus*, *Acacia polyantha*, *Celtis africana* and *Mimosops kummel*. Masha forest is an Afromontane rainforest in the southwest Ethiopia. Many Afromontane species are local endemics. Accordingly, broadleaved Afro-montane forest with coffee, broadleaved Afromontane forest without coffee and pure stands of highland bamboo (*Arundinaria alpina*) forests are found from lower to higher altitude (NTFP, 2004). Large areas of the forest in Masha were described as cultural forests where the culture consequently forms the foundation in making decision on the use and conservation of natural forests and other resources (Schmitt, 2006). In recent years, however, the rate of deforestation is increasing at an alarming rate, which is threatening the forest biodiversity, ecosystem, pristine habitats and the livelihood of the local community.

## 2.2. Materials and Methods

### 2.2.1. Materials

Materials like GPS, Camera, Dissecting kits, meter tape, digital balance, spade and axe were used during field study. The conical local traps made of iron wire string and wooden plug commonly known as “Yeshibo-Wotimed” (“eche kanbo”) were employed for snap trapping (Fig.4).



Figure 4 . Local conical trap (“eche kanbo”) used to trap mole rat in the study area.

### **2.2.2. Methods**

A preliminary survey was conducted for ten days (last week of year 2016) before the actual data collection, to gather relevant information about the study area. This helped to determine specific study sites, based on the abundance of common mole rat signs (mound) and the severity of crop damage. A preliminary survey was also conducted to gather information on farming activities of the local community and to map the study area. Relevant informations were gathered from concerned bodies such as local people living around the study area and from experts of agriculture and natural resource management office of the district.

Data collection for the study was carried out during wet season (July to August 2016) and dry season (January to February 2017). The feeding ecology of common mole rat in the selected study sites was studied by the type of crop plant they feed, by observation, interview and laboratory analysis. Animals were trapped using conical local traps made of iron wire string and wooden plug ( locally known as “eche kanbo”) and live trapped during excavation of burrow system to determine the number of common mole rats, to recorder weight and different morphological structures, sex, approximate age (juvenile, sub-adult and adult) and the stomach content in the study site. Trapped animals were sexed and the age was assessed in the field by close observation on colour, size and reproductive conditions following Afework Bekele (1986).

Soil mound counts and burrow system excavations following the method used by Jarvis and Sale (1971) and Shimels Beyene (1986) to investigate abundance, distribution and population structure of mole rat in each of the selected sites. The density of common mole rats in different habitats was estimated based on the abundance of fresh soil mounds and quarter ha of each habitat was used. Burrows in crop fields was also excavated in enset, potato, open grassland and fallowland adjacent to crop fields by using spade and axe. A total of sixteen

excavations were made in each habitats and the mean value per site for both wet and dry seasons was taken. The burrow systems of the mole rat were determined using soil mound and digging the burrow line.

Total count of damaged enset, potato and other crop plants were recorded from the plotted farmland to investigate the impact of mole rat during both wet and dry seasons. The total count of damaged crop plants was carried out for a total of 39 days in both wet and dry seasons. A total of 60 ha of enset farm and 28 ha of potato farm were assessed in both seasons to count damaged crop and to calculate percentage and income loss. The income loss was also calculated per study site based on assessment of local market. The income loss on enset crop was calculated per individual matured enset plant on the basis of local market price and for potato crop per kilogram cost of the local market price. From the damaged enset and potatoes, the percentage of loss was calculated per ha. Information about the damage of crops by common mole rat and the control mechanism was also collected with the help of semi-structured interview with open and closed-ended questions from local people of this study area (Appendix II). To gather information on the pest status and control mechanism of mole rats a total of 34 randomly selected farmers were interviewed (16 individuals from Beto and 18 individuals from Gembaka study sites).

Stomach content analysis was performed following the method used by Workneh Gebresilassie *et al.*, 2004 and Demeke Datiko *et al.*, 2007. The contents of the stomachs were collected and examined to determine the food items consumed by the animal and were checked with the vegetation of the area. By direct observation of damaged crop plant by common mole rat was assessed (Yalden, 1975; Mohammed Yaba, 2007). Twenty four (fourteen during wet season and ten during dry season) representative trapped mole rats were dissected for stomach content analysis. Stomach samples from the dissected animals were

removed and preserved in glass containers, each with 70% alcohol. All stomach contents were brought to the Department of Zoological Sciences Laboratory, Addis Ababa University for microscopic examination of the contents. The stomach contents were spread onto a petridish and mixed thoroughly. Then, the contents were added into 0.25 mm sieve and washed with a jet of water to remove finely chewed or digested food and fine particles for proper identification.

Stomach contents were dried in open air for a day to and weighed by using digital balance to record the amount of food consumed and variation in the amount of food consumed by mole rat among seasons. A preliminary examination was carried out to identify the most common types of food items. The contents were put on a glass slide to observe the type and proportion of food items under dissecting and compound light microscopes. Each food fragment was collected and weighed to determine the amount for each sample.

#### **2.2.2.1. Data Analysis**

Data were analyzed using SPSS version 20.0 software. Descriptive statistic was used and responses were compared using TWO-factor ANOVA and students paired t-test. Two-factor were used to analyze the morphometric measurement and employed to compute significance levels within and between sites and crop fields (habitats) for mole rat distribution and its impacts.

### **3. Results**

Results of the present study are given in the following seven separate sections:

The first section highlights the body measurements of trapped and observed mole rats in the study areas. The second section deals with the results obtained from trapped mole rats. This deals with the population structure of mole rats. The third section deals with the abundance and distribution of *T. splendens* in different habitats. The fourth section tried is on the burrow system and ecology of *T. splendens*. The fifth part is concerned with stomach content analysis which aimed to identify the food items consumed by the common mole rats. The sixth part is on assessing damaged crops by mole rats and the last section is on the pest status of *T. splendens* and its control and management techniques.

#### **3. 1. Morphological measurements**

A total of 33 common mole rats trapped by using local conical trap and live trap during wet and dry season trappings. Differences in the number of capture of common mole rats were recorded from trapping in two Kebeles. More individuals (18) were trapped in the Gembeka Kebele (Table 1). Out of the 33 individuals of common mole rats captured in all trapping occasions, 66.7% was males whereas the remaining 33.3% was females. The difference in the rate of capture of females and males was statistically significant ( $p < 0.001$ ).

Table 1. Total mole rats trapped in the study sites, Beto and Gambeka during wet and dry seasons.

Study sites	Geographic position	Altitude in metre above sea level	Male	Female	Total
Beto	7°46'48''N – 35°29'37''E	1800–2120	10	5	15
Gembaka	7°44'52''N – 35°24'53''E	2339–2430	12	6	18
Total			22	11	33

There was a variation in body weight and external body measurements among males and females. The maximum weight of mole rat was recorded in the Beto site (288g), This was only observed in one pregnant trapped female during the wet season. However, in external body measurements, there was no significant difference ( $p>0.01$ ) between seasons (Table 2). The t – test for body measurements showed significant differences for body weight in Beto and Gambeka sites ( $t = 6.264$ ,  $df = 1$ ,  $p = 0.003$ ). A live trapped mole rat is shown in Figure5.

Table 2. Body measurements (cm) and weight (g) of common mole rats trapped. (W=Weight, TL=Total length, HB=Head body length, T=Tail length, HF=Hind foot Length).

Study sites	Sex	Body measurements				
		W	TL	HB	T	HF
Beto	Male	269± 2.1	29± 1.2	23 ± 1.3	6± 0.5	3± 1.4
	Female	253± 4.2	27.5± 1.8	22± 1.5	5.5± 1.2	3± 2.0
Gembaka	Male	278 ± 2.3	27.5± 0.8	21.5± 1.7	6± 1.6	3 ± 1.0
	Female	268± 4.1	27.5± 1.0	21.5± 0.9	6± 1.7	2.5± 2.2



Figure 5. A live trapped mole rat

### **3. 2. Population structure of common mole rats**

A total of 87 (45 during wet season and 42 for dry season) days of trapping was made in the two study sites. The whole area of the two study sites were assessed for trapping based on the presence of fresh soil mound. The overall number of common mole rats trapped between the two seasons was statistically significant ( $p < 0.01$ ). More individuals (57.6%) were trapped during the wet season and less (42.4%) during the dry season. From a total of 33 trapped mole rats, 22 were males and 11 were females. The sex ratio was (2:1). The population structure among the different age groups was 48.5% adults, 27.3 % sub-adults and 18.2% juveniles (Table 3). There was significant variation in population of *T. splendens* among the three age classes and sex during different trapping sessions ( $P < 0.001$ ).

Table 3. Composition of sex and age distribution of common mole rats at Beto and Gembaka study sites.

Study sites	Season	Sex		Age			Total
		Male	Female	Adult	Sub adult	Juvenile	
Beto	Wet	5	3	5	2	1	8
	Dry	5	2	3	2	2	7
Gembeka	Wet	7	4	6	4	1	11
	Dry	5	2	2	1	2	7
Total	Wet	12	7	11	6	2	19
	Dry	10	4	5	5	4	14
Percentage		66.7	33.3	48.5	33.3	18.2	100

### 3.3. Abundance and distribution of common mole rats

During the present study, the abundance and distribution of fresh soil mound varies in different habitats (crop farm, open grassland and fallowland) and seasons. Based on fresh soil mounds, the distribution of common mole rat was discontinuous. Figures 6a, b show fresh mounds.



Figure 6. a, Fresh soil mound in an enset farm

b, Fresh soil mound in open grassland

A total of 62 fresh surface mounds were counted during this study seasons. More fresh mounds were recorded in Gembaka Kebele. The number of fresh mounds varied from habitat to habitat during both wet and dry seasons. It shows statistically significant variation ( $P < 0.001$ ) between different habitat types and seasons (Table 4). The highest (20) as well as the lowest (9) fresh mounds were recorded during both seasons from the enset plantation and cereals, respectively and more mounds were abundant during the wet season study.

Table 4. Total count of fresh mounds of mole rats in different habitats of each study sites.

Seasons	Farm type	Study sites		Total
		Beto	Gembaka	
Wet	Enset	5	8	13
	Grassland	4	2	6
	Potato	2	3	5
	Fallowland	4	4	8
	Cereals	3	3	6
	Total	18	20	38
Dry	Enset	3	4	7
	Grassland	2	3	5
	Potato	2	3	5
	Fallowland	1	3	4
	Cereals	-	3	3
	Total	8	16	24

In both wet and dry seasons, more mole rats were trapped from enset farm (14) followed by fallowland (8), potato (6) and grassland (5). Enset and fallowland habitats had  $4.0 \pm 1.8$  and  $3.7 \pm 2.2$  mole rats per plot and 10 and 8 individuals per ha, respectively. The least was grassland habitat ( $0.6 \pm 0.5$  per plot and 2 individuals per ha) (Table 5). The two factor ANOVA showed that there was significant variation between habitats at  $p < 0.05$ . The highest density of mole rats population was recorded during wet season in Gembeka site

Table 5. Density of common mole rats in the study sites

Habitats	Seasons	No of study sites	Estimated population size	
			Mean $\pm$ SD/plot	Density/ha
Enset	Wet	2	4.0 $\pm$ 1.8	10
	Dry	2	3.6 $\pm$ 1.4	8
Grassland	Wet	2	3.0 $\pm$ 1.2	4
	Dry	2	1.7 $\pm$ 1.3	2
Potato	Wet	2	3.0 $\pm$ 2.2	7
	Dry	2	2.7 $\pm$ 2.5	7
Fallowland	Wet	2	3.7 $\pm$ 2.2	8
	Dry	2	2.6 $\pm$ 2.4	6

### 3.4. Burrow system and ecology of common mole rats

Excavation of the burrows of *T. splendens* was made in enset farm, fallowland, open grassland and potato farm. The observed burrow system consisted of multipurpose nest, bolt hole and one or more foraging tunnels. Excavation on different habitats of study area revealed that the nest site lied at the depth 20 – 40 cm below the ground (Table 6). The diameter was about 30 cm. The bolt hole has the depth of 105–130 cm and 250–400 cm length. The foraging tunnels have the length of 8.5 –12.5 m and 16 – 20 cm depth (Fig.7).

Table 6. Measurement of burrow of the mole rat (Season I=wet season and Season II=dry season)

Study sites	Seasons	Burrow length in m	Depth and length				
			Foraging tunnel		Bolthole		Nest
			Depth (cm)	Length (m)	Depth (cm)	Length (m)	Depth (cm)
Beto	I	16.5 ± 2.2	20 ± 1.4	12.5 ± 2.5	120 ± 3.7	4.0 ± 2.4	40 ± 2.2
	II	14.5 ± 1.2	16 ± 2.4	12 ± 1.7	105 ± 3.2	2.5 ± 2.8	35 ± 3.1
Gambaka	I	17.5 ± 1.8	17 ± 1.2	14 ± 2.3	115 ± 3.0	3.5 ± 2.7	20 ± 2.0
	II	11.5 ± 3.9	18 ± 2.1	9 ± 4.2	130 ± 3.2	2.5 ± 1.8	32 ± 2.2

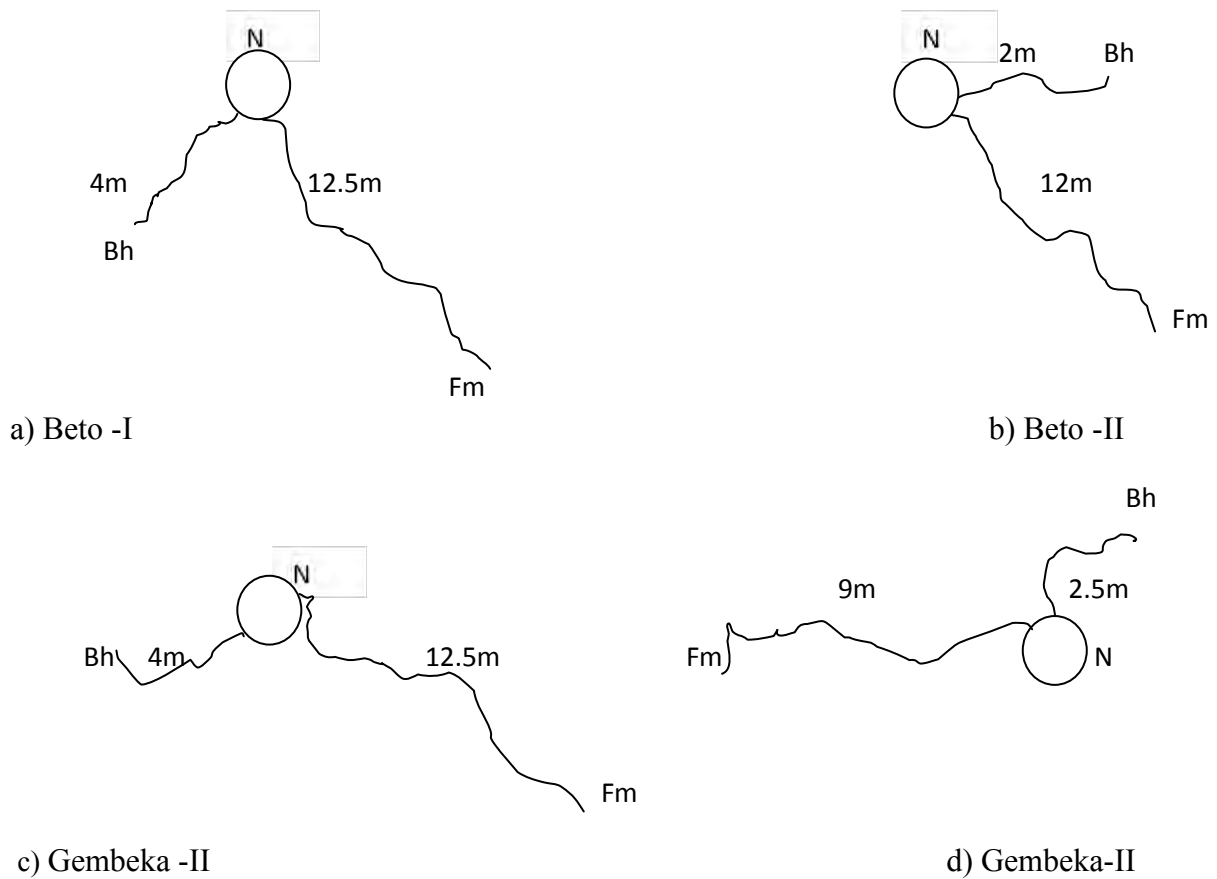


Figure 7. Map of representative burrow systems (Fm= fresh mound, N= nest and Bh= Bolthole).

There was no variation in the nest structure of male and female mole rats. The nesting chamber consisted of sleeping area with the nesting materials, food storage and sanitary area (Fig.8). The nest materials observed at study sites were enset corm, dry leaves of enset, grasses (*Stellari* spp and *Cynnodon* spp), potato tubers (*Solium tuberosum*) and roots of maize. The nesting chamber interlinks one or more tunnels which make up the burrow system together.



Figure 8. Nest of common mole rats

Mole rats were caught from the bolt holes in all burrows (Fig 9). A deep bolthole is near to the nest, which is 2.5 – 4 m long from the nest and 105 – 130 cm deep.



Figure 9. Excavated bolt hole

Common mole rats excavate soil using well developed incisors and forelimbs. This was clearly observed during the present study on live trapped mole rats from excavated bolt holes after they were released (Fig.10).



Figure 10. Mole rat excavating soil

### **3.5. Stomach contents**

Dietary information was obtained from 24 stomach contents removed from the mole rats. Data on food items obtained from mole rats showed that major food sources were underground parts of the vegetation. Among these, grass (*Stellaria sennii*) was in high proportion followed by enset and potatoes. However, in some mole rats the stomach contents had soil and unidentified matters which might have been ingested unintentionally during burrowing. There was no variation in the food items consumed by *T. splendens* in both wet and seasons. However, the proportion of food items consumed by the common mole rats was more during the wet season than the dry season.

### 3.6. Assessment of damaged crops by common mole rats

From total count on damaged enset and potatoes, high number of mole rat attacks was observed during the wet season (63) mainly on enset plantation (43). Severe damage on enset and potato plants by mole rat was observed in Gembeka study site (Table 7).

Table 7. Damaged crop count

Study sites	Crop type	Seasons		Total
		Wet	Dry	
Beto	Enset	18	12	30
	Potato	8	5	13
Gembeka	Enset	25	18	43
	Potato	12	5	17
Total	Enset	43	30	73
	Potato	20	10	30

Mole rats consume small proportion of the enset corm and expose the plant to bacterial wilt, nematodes, fungi and other vertebrate pests for more damage (Fig 11 a, b).



Fig 11. a. Damaged young enset plants



b. Damaged matured enset plant

As local market of the study area, a matured enset plant on average is worth 180 birr and on average 3 birr per kg for potatoes. Each potato plant can yield an average of 2 kg and a hectare of potato farm yields on average of 7000 kg. A hectare of enset farm can support an average of 200 enset plant. The highest income loss on both enset plant and potato was recorded during the wet season in Gembeka site. The highest percentage loss of enset plant (0.9%) and potato (0.04%) was recorded at Gembeka site (Table 8). The annual income loss of enset per hectare showed variation 322.5 birr and 151 birr at Gembeka and Beto sites, respectively. This loss was not significant related to the total hectare of crops on the area. The mean annual percentage loss of enset is 0.47 and potato is 0.03.

Table 8. Percentage loss and income loss due to mole rat impact on enset and potato.

Study sites	Crop	Wet season	Dry season	Loss of Birr per ha	Percentage loss
		Loss in Birr	Loss in Birr		
Beto	Enset	3240	2160	151	0.04
	Potao	48	30	4.8	0.02
Gembeka	Enset	4500	3240	322.5	0.9
	Potato	72	30	8.5	0.04
Total	Enset	7740	5400	236.75	0.47
	Potao	120	60	6.65	0.03

### **3.7. Pest status and control mechanisms of common mole rat**

Enset as staple food of this study area, among the respondents 94.12% responded that enset is the most valued crop by them. 88% of respondents revealed that enset is the crop largely damaged by mole rat attack. Among the respondents, 64.7% responded that highest mole rat attack was during the wet season. 55.9% of the respondents considered the animal as a serious pest on Enset and other crops. As shown in Table 9 majority (70.6%) of the respondents estimated loss of their crops by mole rat attack was low (<25%) and 20.5 % of the respondents blame moderate loss (about 50% on their agricultural product). Among the respondents 61.8% remarked that the control mechanism used by farmers to control mole rat was by local conical trapping, while 23.5% responded that rodenticides was used to control common mole rats (Table 9)

Table 9. Pest status and control mechanism of common mole rats

Interview Questions	Variables	Study Sites		Total	
		Beto	Gembaka	Number of respondents	Percentage
		Number of respondents	Number of respondents		
Crop types valued most	Enset	14	18	32	94.12
	Potato	2	-	2	5.88
	Cereals	-	-	-	0
	Other	-	-	-	0
Crops mostly damaged by mole rats	Enset	14	16	30	88
	Potato	2	1	3	8.8
	Vegetables	-	-	-	0
	Cereals	1	-	1	2.9
	Other	-	-	-	0
Season of the highest mole rat attacks	Wet	10	12	22	64.7
	Dry	2	1	3	8.8
	Both	4	5	9	26.5
Damage of each crop types by mole rat attack	Low (<25%)	10	14	24	70.6
	Medium (25%-50%)	3	4	7	20.5
	High (>50%)	1	2	3	8.8
Control and management method	Trapping	9	12	21	61.8
	Rodenticides	4	4	8	23.5
	Both	3	2	5	14.7
	Other	-	-	-	0
Pest status of mole rats	High	10	9	19	55.9
	Medium	5	7	12	32.3
	Low	1	2	3	8.8

#### 4. Discussion

The present study was aimed to provide valuable information on the feeding ecology and pest status of the common mole rat in Masha, southwest Ethiopia. Local conical trap used as snap traps was used to trap the mole rats. Among trapped common mole rats male biased ratio and variation on morphometric measurement were identified. There was also sexual dimorphism in body weight and other external measurements among males and females trapped in each study sites during wet and dry seasons. The study of Jarvis and Sale (1971) also showed weight and morphometric variations among sex. Colour variation among different age group of trapped *T. splendens* was observed. Nowak (1991) also revealed that *T. splendens* displays varieties of color.

The present study on the population structure of *T. splendens* showed variation among the age classes and sex ratio of common mole rats during the wet and dry seasons. Most of the individuals trapped were adults. This could be due to the presence of large home ranges for adults and sub-adults to alleviate the cost of competition with juveniles. This is supported by Workneh Gebresilassie *et al* ( 2004) in that adult and sub-adult individuals have wider home range than young rodents. The age structure analysis among different age groups showed adults comprising 48.5%. The findings of Jarvis (1973) showed 66% adult and Abebe Kokiso and Afework Bekele (2008) 78.57% adult.

In the study area, the distribution of *T. splendens* is discontinuous among different habitats and study sites based on the altitude and abundance of food. More fresh soil mound count of *T. splendens* was recorded in Gembeka study site, indicating abundance of common mole rats in the area. The studies of Hickman (1990), Nevo (1999) and Bennett and Faulkes (2000) revealed the physical surface and structure of the burrow system as signs of presence or absence of mole rats in the area.

Fresh soil mound count observed during the present study showed variation in the distribution of *T. splendens* between different habitat types and seasons. The habitat preference of mole rat was based on vegetation cover and abundance of food. Fresh soil mounds were recorded most in enset plantation and least in the cereal farm. The highest density of mole rat population was recorded during the wet season at Gembeka site (study area with high altitude). This might be due to the availability of food and water. Jarvis and Sale (1971) had revealed that the distribution pattern of East African mole rat varies and fluctuates seasonally based upon altitude and vegetation cover as well as precipitation. The overall abundance of *T. splendens* in the current study showed seasonal variation. Such seasonal fluctuation was frequently related to the abundance of vegetation cover, availability of food and water. According to Spinks *et al* (2000), different weather conditions can influence the appearance of rodents. For many species of rodents, breeding is during the rainy season (Taylor and Green, 1976).

Density of common mole rats recorded in different habitats varied. The highest density was from enset farm (10/ha) and the lowest was estimated in grass land (2/ha). In general, comparisons of population density are difficult. Comparison of densities and biomasses are difficult due to the variation of habitats and weights in different species of small mammals, in addition to underestimation of the available numbers ( Afework Bekele ,1996a).

The findings of the present study demonstrated that in the study area the burrow system of *T. splendens* had a single multipurpose nest, bolt hole and one or more foraging tunnels. The study conducted by Jarvis (1973), Jarvis and Sale (1971) also demonstrated that *T.splendens* constructs a burrow system consisting of a nest chamber, a bolt-hole, and a number of foraging tunnels. During excavation of the burrow system, in the nest the obtained foods

items of roots and grasses. Foraging is the critical element of the common mole rat to occupy habitats.

As observed during the present study, foraging tunnels extended mostly from fallowlands and grassland towards enset farming and other crops. The foraging tunnels were longer and cover a greater area as the soil was loose (need less energy-cost to excavate) during wet season. The diameter of foraging tunnels and nest chamber was varied based on their size. In the entire excavated burrow system, a single mole rat was frequently found, which confirm that they are solitary and aggressive mammals. The length of foraging tunnel varied among different habitats. This deviation might be due to availability of food resources. Agricultural fields possessed short distance resulting in a decrease the total length of burrow system as well as foraging tunnel. Jarvis and Sale (1971) also mentioned the total length of the foraging tunnel is determined by the availability and need of food.

The investigation in the study sites and all habitats showed that the depth and diameter of nest site varied compared to Abebe Kokiso and Afework Bekele (2008) and Burda *et al*, (2000).

Stomach contents of mole rats in the study sites showed that the largest proportion of food sources is grass, followed by enset and potatoes. The findings on the present study strongly agree with findings of Abebe Kokiso and Afework Bekele (2008), that the predominant food item was grass species and the least of cereal plants. Other studies also support that East African common mole rats mainly feed upon underground plant parts, roots, rhizomes, tubers, as well as stem bulbs and grasses (Bennett and Jarvis, 1995; Kingdon, 1997).

Total counts carried out on damaged enset and potatoes in the present study area illustrates the loss in the yield of the crops. Damage by the mole rat attack on cereal crops was insignificant. Damages on enset plant and potatoes were high during the wet season. The intensity of damage and income loss was high in Gembaka study site due to high density of

mole rats with high altitude and cooler climate. As observed during field assessment of damaged crops young enset plant was more susceptible to mole rat damage compared to medium and matured plants. Tristiani *et al.* (2003) also pointed out that rodent damage is a major cause of harvest loss and most of the damage occurs during the sensitive young seedling stage and just before harvest (Workneh Gebresilassie *et al.*, 2004).

The attack by mole rat was more pronounced on potatoes and other root and tuber crops. The interview result showed that enset and potato plants are largely damaged by the mole rats. Similarly, other investigators have revealed that in Ethiopia, maize, enset and potatoes are the crops most affected by rodents (Tristiani *et al.*, 2003; Makundi *et al.*, 2005; Afework Bekele *et al.*, 2003). The pest status of mole rat on enset and other crop plants ranked as highest compared to other rodents and insect pests by the inhabitants of the study area. The findings in this study strongly agree with the findings Abebe Kokiso and Afework Bekele (2008) that 78% of local inhabitants considered the mole rat as a serious pest on Enset, grass and potatoes. The damage by mole rat was an important cause of harvest loss and forcing farmers often to list them as one of their most significant crop pests. Nevertheless, the present investigation damage of crops due to mole rats is insignificant; the mean annual percentage loss of enset was 0.47% and potato is 0.03%. The mean value on percentage loss when converted to income loss in terms of money valued about 236.5 birr for enset and 6.65 birr for potato per ha annually.

## 5. Conclusion

The present study on mole rat feeding ecology and its impact in agricultural fields at Masha revealed different ecological parameters. There were variations in abundance, distribution and density of mole rats between sites and habitats (crop fields, grassland and fallowland). The cause of these variations could be altitude, climatic factors, availability of food resources and regular agricultural field cultivation. The present study indicated that the length of burrow system is highly reduced in crop fields and dry season. Despite this, an exclusively solitary behaviour of the animal and the burrow component nest, foraging tunnels and bolthole were similar to findings of others.

In the present study, mole rat impact on agricultural fields, especially on Enset and potato crops were high during the wet season. *T. splendens* is a major pest on farmland and cause reduction of yield and income loss of the study area. However, the statistics showed that their pest status is insignificant (<1%). The current local communities control mechanism of mole rat to reduce its pest status relies majorly only on local conical trapping. Therefore, assessing the farmers' perception on pests status, existing control methods and costs and efficiency of controlling methods facilitate the decision made on the application of successful pest management strategies. Introducing and using different integrated pest management technique will also reduce mole rat attack and ensure agricultural productivity.

The present study provides important information on feeding ecology and effect of mole rats on farmlands. However, further detailed study with prolonged duration is likely to yield more information on the ecology and pest status of mole rats. In addition, studies on population ecology of mole rat community and their effect on crops are still poorly known for many regions of Ethiopia.

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## 7. Appendices

### Appendix-I

Data collection sheet for population of Common mole rat, *Tachyoryctes splendens*

Name of data collector \_\_\_\_\_

Species \_\_\_\_\_

Season \_\_\_\_\_

Place \_\_\_\_\_

Site \_\_\_\_\_

Altitude \_\_\_\_\_

S.No	Sex		Total	Age		
				Adult	Sub adult	Juvenile
	M	F	Total			
1						
2						
3						
4						
5						
6						
7						

## Appendix-II

### Questionnaires for respondents

The purpose of this interview is to gather information on feeding ecology and pest status of common molerats in Masha. Thus you are kindly requested to be considerate in responding to the interview. Your cooperation is highly appreciated.

#### Note

- A. Any of your information or suggestions will be kept secret and used for research purpose only.
- B. Your names will not be recorded.
- C. Give appropriate response to the following interview

### I. Background and farming activity

1. Sex    a. Male        b. Female
2. Age of respondent.    a. < 18    b. 18 – 24    c. 25 – 34    d. 35 – 44    e.) 45 – 54    f. ≥ 55
3. Residence \_\_\_\_\_ a. District \_\_\_\_\_ b. Kebele \_\_\_\_\_ c. Village \_\_\_\_\_
4. Educational status of respondents  
a. Illiterate    b. No formal education    c. Primary    d. Secondary    e. College/University
5. Family size \_\_\_\_\_ Male \_\_\_\_\_ Female. \_\_\_\_\_ Total \_\_\_\_\_
6. How long (in years) you have been living in this village?    a) < 10    b) 10– 30    c) >30
7. How many hectares of land do you own?  
<0.5 ha \_\_\_\_\_ 1 ha \_\_\_\_\_ 1.5 ha \_\_\_\_\_ 2.0 ha \_\_\_\_\_ .>2.0 ha \_\_\_\_\_
8. Cultivated farmland size by crop in hectares  
Enset \_\_\_\_\_ Potatoes \_\_\_\_\_ vegetables. \_\_\_\_\_ Maize \_\_\_\_\_ Cereals \_\_\_\_\_ Other \_\_\_\_\_
9. Crop types valued most: a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_ d \_\_\_\_\_ e.  
\_\_\_\_\_

## II. Crop pests

1. Which rodent pests severely attack the crop plants? \_\_\_\_\_ If it is mole rat mention the extent of the damage. High \_\_\_\_\_ Moderate \_\_\_\_\_ Low \_\_\_\_\_
2. Types of crop mostly damaged by mole rat .A. inset B .potato C. maize D. cereals and coffee  
E. others
3. What part of the crop is most likely attacked by common mole rat? \_\_\_\_\_
4. The season of the highest mole rat attacks. A. Dry \_\_\_\_\_ B. Wet \_\_\_\_\_ C. Both dry and wet \_\_\_\_\_
5. What percentage of each crop types are damaged by mole rats? Use traditional methods such as count, arm, feet, etc.  
A. Low (<25%)      B. Medium (25%-50%)      C. High (>50%)
6. Which method is most usual and more effective to control and manage mole rats?  
A. Trapping \_\_\_\_\_ B. Rodenticides \_\_\_\_\_ C. both    D. Mention if there is other



