

*ADDIS ABABA UNIVERSITY*  
*SCHOOL OF GRADUATE STUDIES*



Species Composition, Abundance and Diet of Rodents  
in Chilelo Irrigated Field, Legedaddi Area, Ethiopia

**By**  
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## **ABSTRACT**

An ecological study on the population dynamics of rodents was carried out in the Legedaddi Chilelo irrigated and non-irrigated agricultural field and bushland from June 2006 to January 2007. Two trapping grids were selected randomly in the irrigated field and additional two with non-irrigated field. An additional trapping grid was selected in the nearby bushland. A total of 166 captures were made in 3675 trap nights in live traps and 30 individuals of small mammals were snap trapped. *Mastomys natalensis* (42.8%) was the most dominant species followed by *Arvicanthis dembeensis* (38.6%) and *Stenocephalemys albipes* (18.6%). The abundance of rodent species varied among the Chilelo irrigated and non-irrigated agricultural field and bushland. There were statistically significant seasonal variations in the abundance of the rodent species. Similar species composition was obtained during different seasons and habitats. All age groups were represented in the population of the obtained species. There was significant variation in trap success among different habitat types. The diets of the rodents from the stomach content analysis of snap trapped individual showed plant matter with few animal matters. The density and biomass of rodents were high in the irrigated field and least in the bushland. The density in irrigated field was 246/ha. However, the density in non-irrigated field and bushland were 72/ha and 20/ha, respectively. There was high population of rodents in the first two trapping sessions.

Key word: Irrigated field, rodents, species composition

# **1. INTERODUCTION AND LITERATURE REVIEW**

## **1.1 Introduction**

Ethiopia has a wide variety of habitats and altitudes ranging from 110 m asl at Kobar sink, the Afar depression, to a peak of 4620 m asl at Ras Dejene (Shibru Tedla, 1995; Tesfaye Hundessa, 1997). The highlands constitute less than 50% of the total area of the country and harbor 74% the human population (Afework Bekele and Corti, 1997). Ethiopia is one of the most physically and biologically diverse countries in the world (Leykun Abune, 2000). The diverse topographical features of Ethiopia, coupled with variations in temperature, have resulted in diversification of the mammalian fauna (Yalden and Largen, 1992; Yalden *et al.*, 1996).

Ethiopia is known for its diversity of species, with 861 species of birds and 277 species of mammals, of which 16 birds and 30 mammals are endemic (Hillman, 1993). This is due to high geographical and altitudinal diversification. The order Rodentia comprises by far the largest mammalian species. Nearly half of all mammal species are rodents (Lawlor, 1979; Nowak, 1999; Buckle and Smith, 1994).

About 5000 species of mammals exist all over the world. Among them, more than 2000 are rodents, which comprise 40% of the entire mammal species (Meehan, 1984). Rodents occur in every habitat, from the high Arctic Tundra, where they live and breed under the snow, to the hottest and driest of deserts (Kingdon, 1997; Stoddart, 1984). The distribution and abundance of small mammals is diversified. The availability and distribution of food

and water are the main factors in determining the relative abundance of rodents. Moreover vegetation densities affect the micro climate and also provide protection for small mammals against predator. Rodents often occur in close association with humans, so consume huge quantities of stored food and spread fatal disease by contaminating food and water (Macdonald, 1984; Leirs *et al.*, 1993).

According to Delany and Monoro (1985), rodents are the most ubiquitous and numerous among mammals in both species and in numbers. More than 1150 species of mammals are currently listed from Africa (Kingdon, 1997). In East Africa, rodents account for about 28% of the total mammal fauna (Delany 1986; Kingdon 1997). The most common rodents in sub-Saharan Africa belong to the genus *Mastomys* (Stenseth *et al.*, 2001). They occur all over the continent in natural grasslands, thickets, cultivated areas and in human habitations.

Rodents are nearly cosmopolitan in distribution, exploit a broad spectrum of foods, are important members of terrestrial fauna, and often reach extremely high population density (Vaughan *et al.*, 2000). The rodent fauna of Ethiopia consists of 84 species and constitutes more than 25 percent of the total mammalian fauna of Ethiopia (Yalden and Largen, 1992). Out of these rodent species, 15 are endemic (Yalden *et al.*, 1996; Yalden, 1988; Afework Bekele 1996a, 1996b; Afework Bekele and Corti, 1997; Lavrenchenko *et al.*, 1998), which contribute for 50% of the endemic mammalian fauna of Ethiopia (Hillman, 1993).

Limited study has been carried out on the Ethiopian rodents (Afework Bekele, 1996a, b; Afework Bekele *et al.*, 1993; Afework Bekele *et al.*, 2003; Afework Bekele and Leirs, 1997; Afework Bekele and Corti, 1997; Lavrenchko *et al.*, 1998; Tadesse Habtamu, 2005; and Alemu Fetene, 2003). However; these studies are concentrated in protected areas, open grasslands, non- irrigated fields and in laboratories. Population dynamics of small mammals in irrigated fields should be unique due to availability of food throughout the year (Workneh Gebresilassie *et al.*, 2006). Therefore; additional study on the population dynamics of rodents in irrigated field is very essential for the present expanding irrigation system in Ethiopia as a poverty reduction strategy. The aim of the present study is to give information on the population dynamics and diet of rodents and to promote rodent pest management strategy in the Chilelo irrigated and non- irrigated agricultural fields and bushland.

## **1.2 Literature Review**

Although rodents are diverse, they share common feature. The major feature of rodent is their dentition. The incisors grow continuously throughout their life (Davis, 1963; Weisz, 1973; Nowak, 1999). Rodents are the most noxious among mammals' in terms of their pest and vector status (Makundi, *et al.*, 1999; Singleton *et al.*, 1999, 2003). Farmers in many parts of the world, particularly those in developing countries, tend to view economic losses due to rats and mice as unavoidable (Singleton, *et.al.*, 1999). Therefore, rodents disproportionately affect the poor, having multiple impacts upon natural and human capital by damaging food crops and stores, by spreading disease, contaminating food and water, and reducing productivity.

However, of the 2000 species of rodents world wide, less than 5% of cause significant losses to agricultural crops (Singleton *et al.*, 2003). Out of the 84 species of rodents in Ethiopia only 11 species were identified as agricultural pest (Afework Bekele and Leirs, 1997). Globally, rodents are major agricultural pests. They damage and destroy 30% of the crops in both pre-harvest and post-harvest conditions (Singleton, 2001). Most damage occurs during the sensitive young seeding stage and just before harvest. However, the pattern and levels of rodent infestation, and the extent of damage, vary in different crop and geographical regions. In Africa, rodents are the most important pre-harvest pests in economic terms. In Tanzania an estimated annual yield loss of 5-15% of maize is recorded (Leirs, 2003). In Ethiopia, although comprehensive studies on the effect of rodent damage to agricultural crops are lacking, few

studies estimated that rodents destroy 20-26% of cereal crops (Goodyear, 1976; Afework *et al.*, 2003).

The abundance and distribution of rodents depend on many factors. For instance, in agricultural areas, rodent populations fluctuate from season to season. The seasonal distribution and quantity of rainfall are considered as major climatic variable in determining population dynamics of rodents in East Africa (Delany and Monro, 1985). The abundance and distribution of the rodents depend mainly upon the nature and density of vegetation for food and shelter (Workneh Gebresilassie *et al.*, 2004; Lyawe, 1988; Oguge, 1995; Happold, 1974; Afework and Leirs, 1997; Adler, 1985; Hansson, 1999). Rodent density in any area correlates with the availability of food (Dalby, 1975; Cole and Batzli, 1979). Therefore, species distributional patterns are not random (Hagmeier and Stults, 1964), and follow geographic patterns (Krytufek and Griffiths, 2002). Moreover, many environmental factors have same effect on the time of reproduction in rodents. Among these temperature and nutrition are the most important factor (Vaughan *et al.*, 2000).

Diurnal small mammals prefer dense vegetation than nocturnal ones (Lobue and Darnell, 1959). In irrigated field due to continuous cultivation and availability of food sources, intensive breeding of rodents are observed (Workneh Gebresilassie *et al.*, 2006). There is a positive relation between wet years and the occurrence of outbreaks. The outbreak may occur when prolonged rainfall allows better survival of the young. When conditions are met at the end of

a long dry spell of several years, it shows a warning for rodent outbreaks (Fiedler, 1988).

The increase in agricultural production occurs by using improved seed and fertilizer on the already used land. This will intensify the pest concentration. The higher the yield, the higher the damage by rodents (Tristian and Murakami, 2003). Rodent damage on higher yielding varieties of cereals is severe, and supports high rodent concentration. The utilization of irrigation during the dry season will create a favorable condition for the continuous damage by rodents, particularly if the fields are surrounded by uncultivated areas (Fitzgibbon, 1997; Workneh Gebresilassie *et al.*, 2004).

Rodent problem in the developing countries is immense. Despite this, the contributions of the developed countries to solve these problems have been minimal. Countries in North America and Europe are best equipped to develop rodent control programs, and most of the theoretical researches on rodent populations have been carried out in these regions. As a result, rodent pests are not serious agricultural problems in some of the temperate regions as compared to the tropics and subtropics (Singleton, 2001). Rodent pests are in general omnivorous, an additional reason why they are successful pests. Compared with the other rodents, *Mastomys natalensis* (multimammate rats) are the most successful seed and cereal feeders. They consume grass stems and rhizomes, and they are the only animals to feed on covered seed from a ploughed land (Taylor and Green, 1976; Workneh Gebresilassie *et al.*, 2006).

Rodents are in general opportunistic feeders, capable of changing their feeding habits depending on the availability of food from season to season. This behavior makes them the most destructive pest in agriculture (Taitt, 1981; Leirs, 1999). All *Mastomys* species cause problems in Agriculture and public health (Leirs *et al.*, 1996; Fielder 1988; Odhiambo and Ogue, 2003). Certain characteristics of the species, such as high reproductive capacity and dispersal are thought to contribute to the success of *M. natalensis* as a serious pest causing extensive damage to crops and stored grain (Leirs *et al.*, 1993, 1996).

The other pest rodent widespread in tropical Africa is *Arvicanthis* species (Rodentia, Muridae). They are common in the savanna regions of northern and central tropical Africa (Corti and Fadda, 1996; Delany and Monro, 1985). Population levels of the species are normally low, but large irregular increase causes extensive damage to crops (Delany, 1986).

Therefore, by considering their economic importance, controlling rodent population using appropriate pest management methods such as Integrated Pest Management (IPM) approach is important to reduce crop damage by them (Gratz, 1997; Stenseth *et al.*, 2001).

Rodents have ecological, economical, social and cultural values (Singleton *et al.*, 2003). Rodents are the main food supply for many predatory mammals, birds and reptiles (Hvass, 1961; Linzey and Kesner, 1997). They are also important food sources to people in many regions of Africa. They are also useful in the study of environmental gradient (Heaney, 2001; Mena and Vazquez-Dominguez, 2005). They have been also used as a model organism in laboratories for years and contribute to biology and bio-medical research (Nowak, 1999).

## **1.3 Objectives of the study**

### **General objective**

- To identify the species composition, abundance and diet of rodents in Chilelo irrigated, non-irrigated and bushland.

### **Specific Objectives**

The specific objectives of the present study are the following:

- To identify the species composition of rodents.
- To estimate the population size (abundance).
- To identify the feeding habit of rodents in irrigated and non-irrigated agricultural fields and bushland.

## **2. MATERIALS AND METHODS**

### **2.1 The study area**

The present study was conducted at the Legedaddi, Chilelo irrigated field, which is located about 24 km east of Addis Ababa. The study area lies in a UTM coordinate system from 497270-493134 E and from 1003953- 1011738 N with an average elevation of 2200 m asl (Fig.1).The irrigated farm is owned by local cooperative farmer associations. They get technical support from Legedaddi Agricultural Office. They grow vegetable and supply to the Addis Ababa market. The study area comprises Chilelo irrigated and non-irrigated fields and bushland.

Chilelo irrigated field covers about 7 ha. The field is mainly used for growing vegetables such as potato, carrot and tomato. The field gets water from the Legedaddi dam throughout the year. The non-irrigated field is located about 200 m away from the irrigated field. The field is mainly used for cultivation of cereals and covers about 3 ha. The bushland is located about 300 m away from the irrigated field. It covers about 2 ha and has bushy vegetation.

The climate of the Legedaddi, Chilelo irrigated field is of highland type with seasonal wet and dry seasons. The short rains (March to May) merge in to the main rainy season from June to mid-September. The mean annual rainfall is 587 mm (Fig.2). The mean monthly temperature minima range between 7.1c° and 8.8C° and that of maxima between 25.6 c° and 26.6 c°. The minimum temperature was 7.1 c° registered in November and maximum

temperature 26.6c° registered in May. The hottest month of the year usually May and the coldest in November (Fig.3).

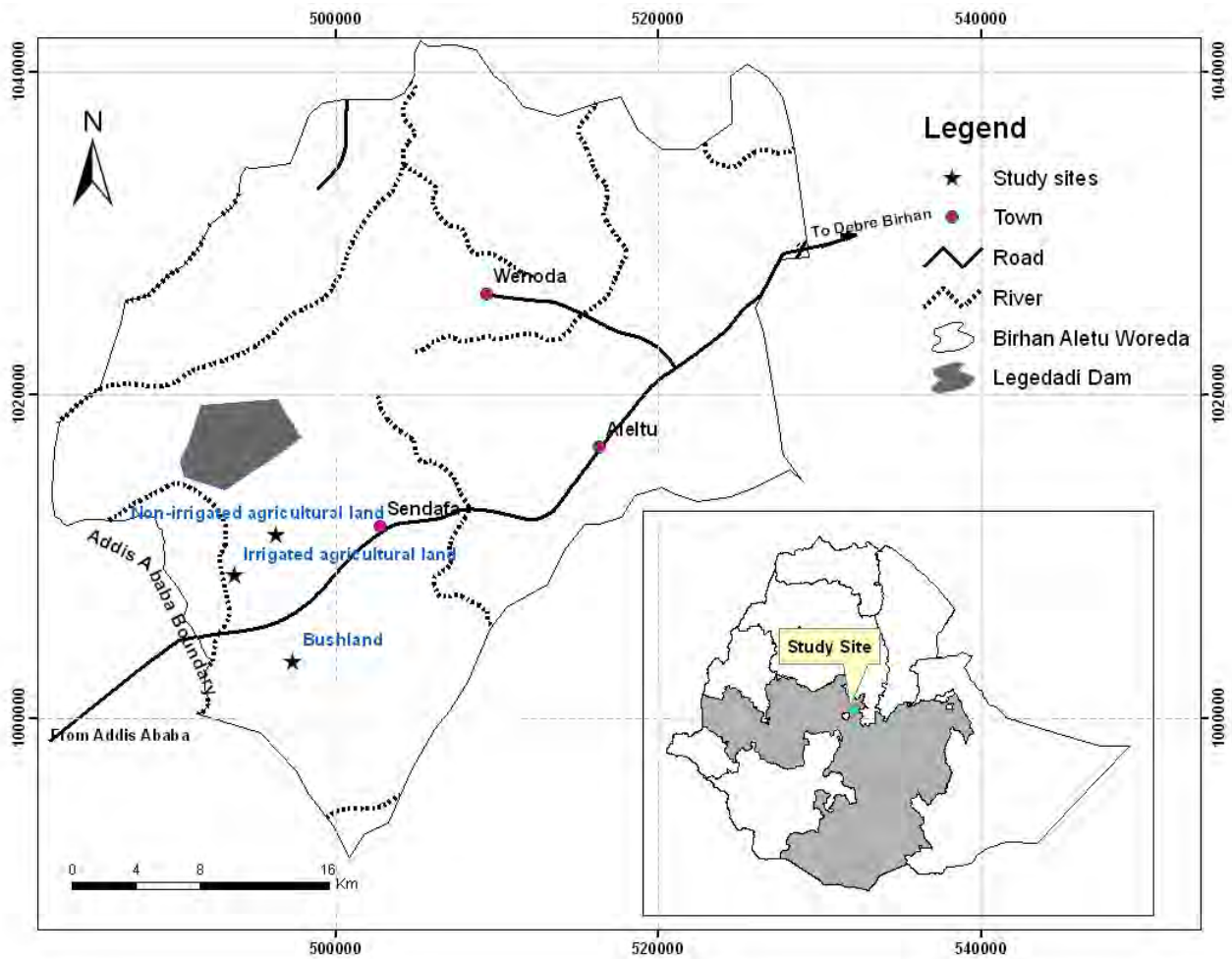


Figure 1. The Map showing the location of the study area

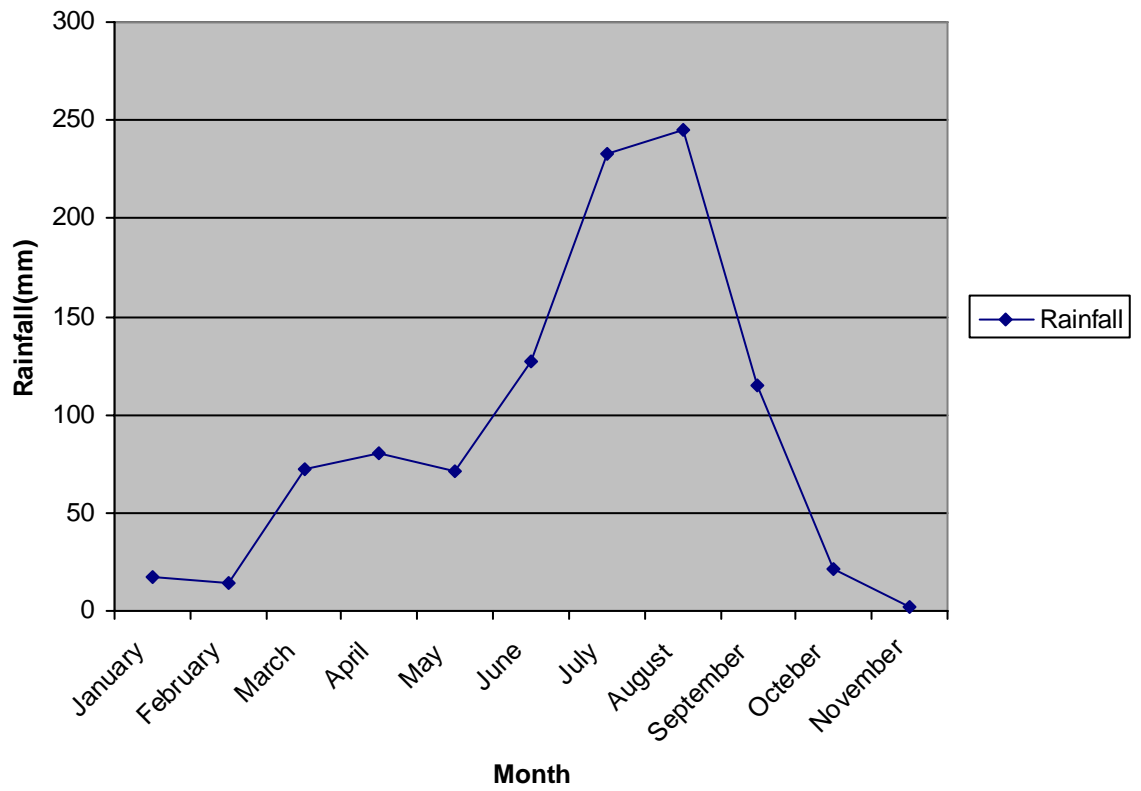


Figure 2. Monthly average rainfall in Legedaddi area (2000-2006)

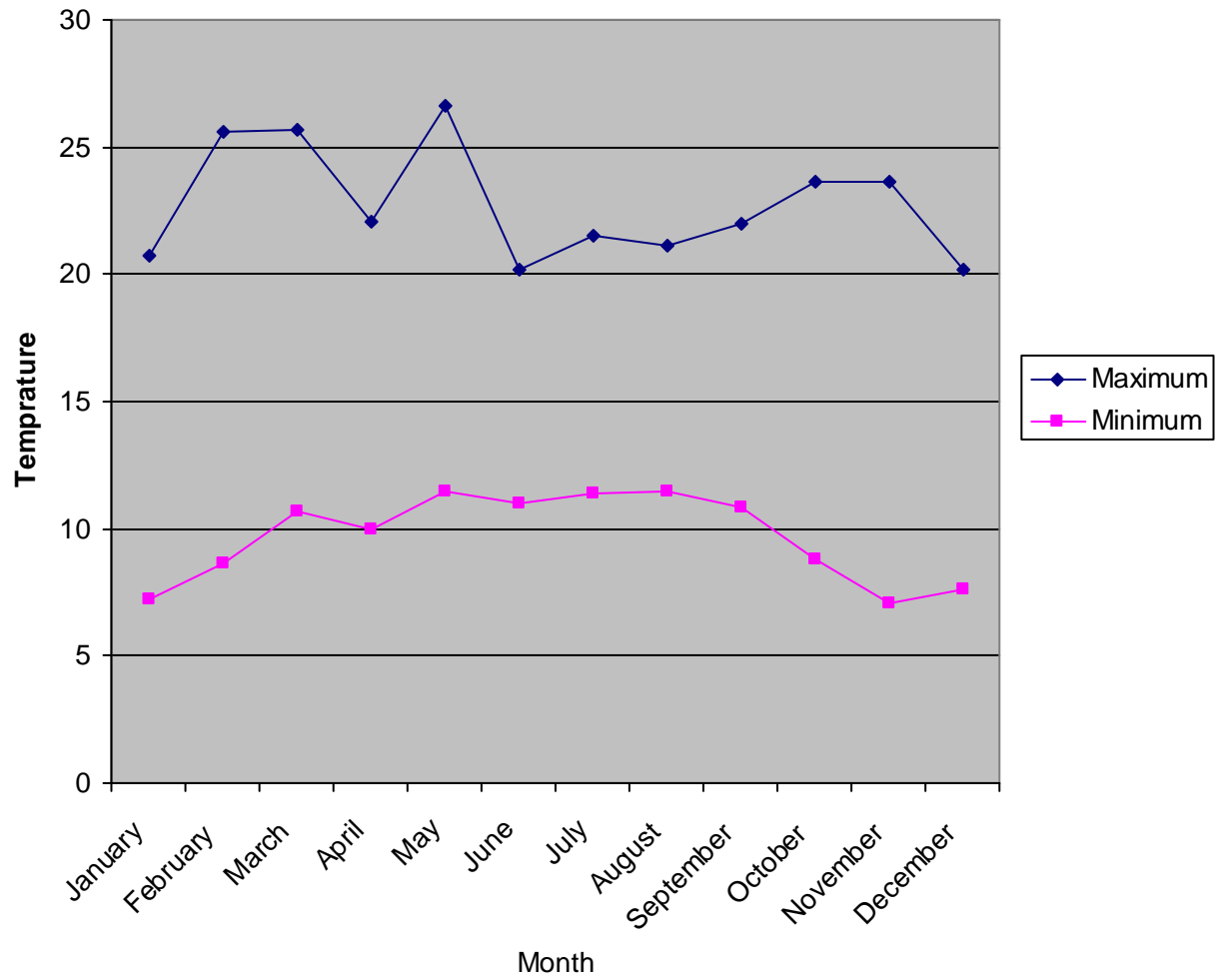


Figure 3. Monthly average Maximum and minimum temperature (C°) in Legedaddi area (2000-2006).

## **2.2. Materials**

Materials used during the present study were: Sherman live-traps, snap-traps, bait (peanut butter), polythene bags, spring balance (digital balance), ruler, dissecting kit, camera, GPS, field guides, data sheets and gloves. A light microscope was used for stomach content identification. Formalin was used as a preservative.

## **2.3. Methods**

### **2.2.1 Data collection**

Data on the species composition, abundance and diet of rodents in the Legedaddi area, Chilelo irrigated field, non-irrigated field and bushland habitats were collected. The data collection was based on capture- mark- recapture (CMR) method. Trapping was made in five trapping sessions covering different seasons. The first, three trapping session was in the wet season (June, July August) and the last two trapping sessions was in the dry season (October – December).

### **2.2.2 Grid design and sampling**

Duplicate grid samples were selected randomly in the irrigated field and non-irrigated agricultural field area and nearby bushland. Among these, two sample grids each were taken from the irrigated and non- irrigated agricultural fields and the one sample was from the bushland.

Thus, there were five grid samples; each of 70x70 m (4900 m<sup>2</sup>) encompassing 49 trap stations at 10 m interval (Fig.4). Trapping stations were marked with white scotch tape, approximately a meter above the traps.

A <sub>1</sub>	B <sub>1</sub>	C <sub>1</sub>	D <sub>1</sub>	E <sub>1</sub>	F <sub>1</sub>	
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
A <sub>7</sub>	B <sub>7</sub>	C <sub>7</sub>	D <sub>7</sub>	E <sub>7</sub>	F <sub>7</sub>	G <sub>7</sub>

Figure 4. Diagrammatic representation of a live-trapping grid with trap locations.

### **2.2.3. Trapping**

Sherman live traps were used to trap rodents. Snap traps were placed 200 m away from Sherman live traps and placed at 20 m interval. Each trap was baited with peanut butter. The traps were checked twice a day, early in the morning hours (7:00-8:00 a.m.) and late in the afternoon hours (5:00-6:00 p.m.). The trapped specimens were removed from the trap and kept in polyethylene bags. For each individual trapped, grid and trap station number, toe-clipping code, body mass and sexual conditions were recorded. Body measurements were also taken from the snap trapped animals. Sexual conditions in males were noted by the position of testicles (scrotal or abdominal) following Ghobrial and Hodieb (1982). Among females, pregnant ones were identified by their enlarged nipples, large swollen abdomen and body weight. Age structure (adult and young) was also recorded based on their body weight (Afework Bekele, 1996a).

Dissection of all snap-trapped rodents was carried out for stomach content analysis. The stomach contents from the dissected rodents were removed and preserved in formalin. The contents were put on a glass slide and observed under a light microscope to identify the type of the food following the techniques of Leirs (1994).

#### **2.2.4 Data analysis**

The taxonomic characteristics listed in Yalden *et al.* (1976), Nowak (1999) and Afework Bekele (1996a), were used for species identification. Moreover, the prepared voucher skins and skulls were compared with the specimens deposited in the Zoological Natural History Museum of Addis Ababa University.

Abundance of rodents in the irrigated, non-irrigated fields and bushland was assessed by the percentage of the trap success and between the seasons. Population number of rodents in each trapping session and grids was estimated by minimum number alive (MNA) estimation method. SPSS (14.0) computer program was used to analyze the data. The density of individual rodent population in each trapping sessions and grids was estimated as number of individual per hectare. The biomass of rodents was estimated as the total weight of the population per hectare for each habitat and for each trapping session.

### 3. RESULTS

#### 3.1. Abundance of rodent species

During the five trapping session of 3675 trap nights, a total of 166 captures made. The following where the rodent species were trapped. *Mastomys natalensis* 71 (42.8%), *Arvicanthis dembeensis* 64 (38.6%), and *Stenocephalemys albipes* 31 (18.6%). *Mastomys natalensis* was the most dominant species followed by *Arvicanthis dembeensis* and *Stenocephalemys albipes* (Table 1).

Table 1. Abundance of rodents in the study area

Species	Total capture	Abundance (%)
<i>M. natalensis</i>	71	42.8
<i>A. dembeensis</i>	64	38.6
<i>S. albipes</i>	31	18.6
Total	166	100

*M. natalensis* constituted the largest number of individuals (42.8%) of the total catch. It was trapped in both agricultural and non-agricultural fields. The percentage abundance in the irrigated area was 73.2%, while in the non-irrigated field, it was 21.1% and in bushland 5.7%. *A. dembeensis* was the second largest number of individuals constituting 38.6% of the total catch. It was also trapped from both agricultural and non-agricultural areas. The percentage abundance in the irrigated field was 73.4%, where as 18.7% in non-irrigated field and 7.9% in bushland. The least was of *S. albipes* which comprised of 18.6% of the total catch. They were also trapped in agricultural and non- agricultural field. The species comprised 77.4% from irrigated area, 12.9% was from non-irrigated area and 9.7% was from bushland (Fig.5). The abundance of *M. natalensis*, *A. dembeensis* and *S. albipes* in different habitats was statically significant ( $\chi^2= 53.437$ ,  $p<0.001$ ,  $\chi^2= 47.469$ ,  $p<0.001$ ,  $\chi^2= 27.161$ ,  $p<0.001$ , respectively). The over all difference of species abundance between irrigated, non-irrigated field and bushland was statistically significant ( $\chi^2=127.37$ ,  $p<0.001$ ) (Table 2).

Table 2. Abundance of captured rodents in different habitats.

Species	Habitat		
	Irrigated	Non-irrigated	Bushland
<i>M. natalensis</i>	52	15	4
<i>A. dembeensis</i>	47	12	5
<i>S. albipes</i>	24	4	3
Abundance (%)	74.1	18.7	7.2

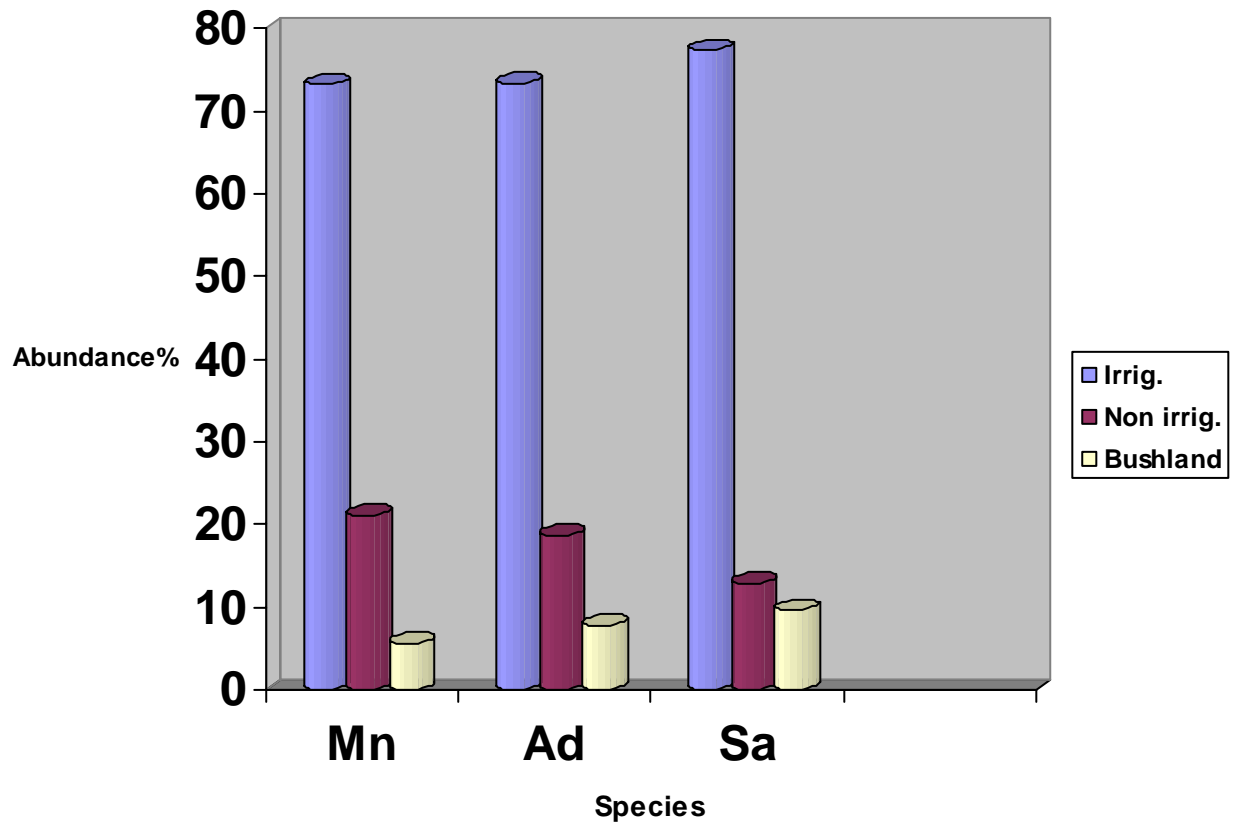


Figure 5. Abundance of the rodent species from different habitats  
(Mn= *M. natalensis*, Ad= *A. dembeensis*, Sa= *S. albipes*)

The total number of rodent species during wet and dry season was the same (3). There was difference in the capture of individual rodent during wet (124) and dry seasons (42). Among the total capture of 124 rodents during the wet season, 98 was *M. natalensis* (45.2%), followed by 19 in *A. dembeensis* (34.6%) and 7 *S. albipes* 7(20.2%). During the dry season the number of *A. dembeensis* was 21(50.0%) followed by *M. natalensis* 15 (35.7%) (Table 3). The abundance of rodents during the wet and dry seasons was 74.7% and 25.3% respectively. The overall difference in the abundance of rodent species between the two seasons was statistically significant ( $\chi^2=40.506$ ,  $P<0.001$ ).

Table 3. Capture of individuals during different seasons and habitats (*Mn*= *M. natalensis*, *A.d*= *A. dembeensis*, *Sa*= *S. albipes*).

Habitat	Species							
	<i>M. n</i>		<i>A. d</i>		<i>S. a</i>		Total	
	Wet	dry	wet	dry	wet	dry	wet	dry
Irrigated field	44	8	34	13	20	4	98	25
Non-irrigated field	9	6	7	5	3	1	19	12
Bushland	3	1	2	3	2	1	7	5
Total	56	15	43	21	25	6	124	42

### **3.2 Distribution of rodents**

The distribution of rodents in the present study area varied from habitat to habitat. *M. natalensis* was the most widespread and abundant in both irrigated (42.2%) and non-irrigated fields (48.3%). However, *A. dembeensis* contributed the highest abundance in bushland, constituting 41.6%. The third abundant species that occurred in all habitats was *S. albipes* (Table2).The overall abundance of the rodent species with in the habitat was statistically significant ( $p < 0.05$ ).

### **3.3 Trap success at different season and different habitat**

Trap success at different habitats varied. The number of captured rodents and trapping success varied from habitat to habitat and from season to season. The trap success was highest in the irrigated area (8.4%) and lowest in the bushland (1.6%). The variation in the trap success between irrigated, non-irrigated agricultural field and bushland was statistically significant ( $p < 0.001$ ). Trap success during the wet season was 5.6% and during dry season was 2.9%. During the wet season, trap success for irrigated field was 11.1% and for non-irrigated area it was 2.15% (Table.4, Fig. 6). Trap success between these habitats during the wet season was statistically significant ( $\chi^2 = 118.274$ ,  $p < 0.0001$ ). The trap success for the dry season was the highest in the irrigated field (4.25%).The variation in the trap success in all habitats during these seasons was also statistically significant ( $\chi^2 = 14.714$ ,  $p < 0.001$ ).

Table 4. Trap success of rodents during different seasons and different habitats

Habitat	Season	Trapping nights	Capture	Trap success (%)
Irrigated field	Wet	882	98	11.1
	Dry	588	25	4.25
Non- irrigated field	Wet	882	19	2.15
	Dry	588	12	2.04
Bushland	Wet	441	7	1.59
	Dry	294	5	1.7

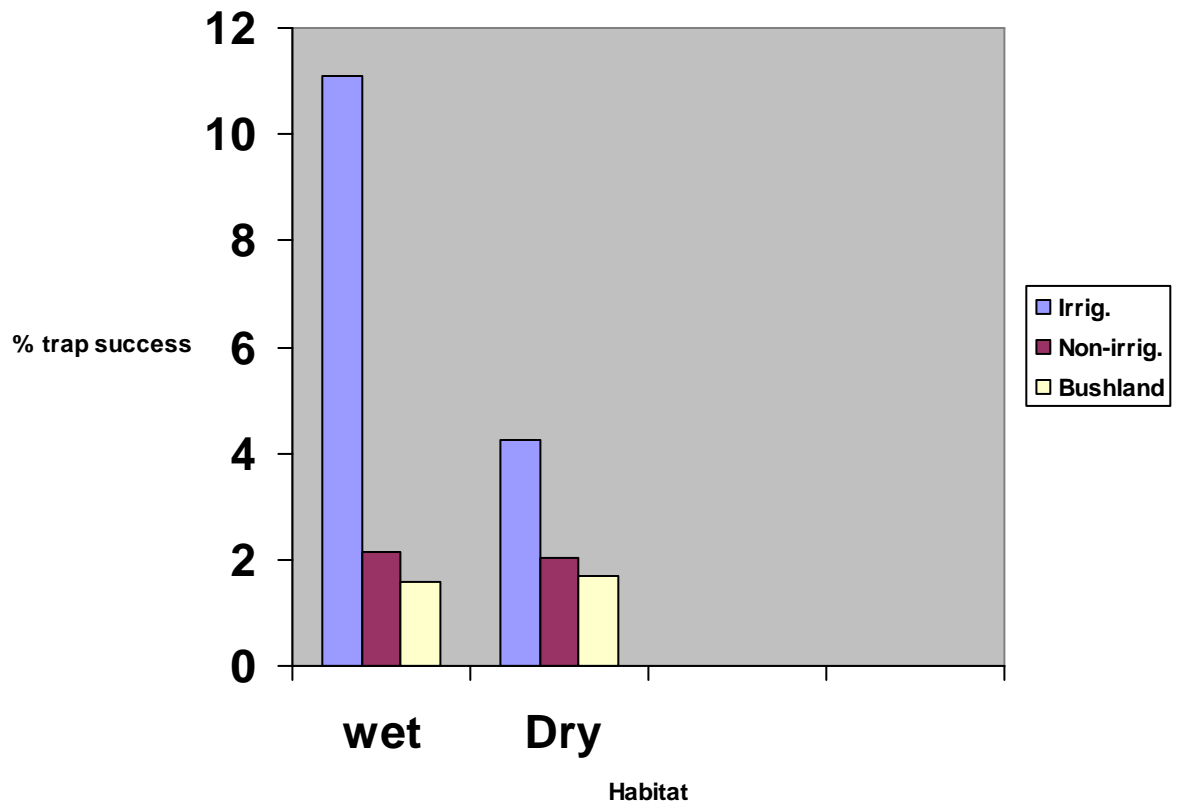


Figure 6. Trap success in the three habitats during wet and dry seasons

### **3.4 Age structure and sex ratio**

During the wet season, young and adult individuals constituted 36% and 64%, respectively of the total capture. During the dry season, young and adult individuals constituted 24% and 76%, respectively (Table 5).

The sex ratio of trapped rodents from different habitats is given in Table 6. Out of the 166 rodents trapped during all trapping sessions, males and females comprised 80 (48.2%) and 86 (51.8%), respectively. The difference in the sex ratio was not statistically significant ( $p>0.05$ ). This was also true for sex ratio between seasons (1.0:1.1 for wet and 1.0:1.1 for dry seasons).

Table 5. Age structure of rodents from different trapping sessions  
 (*Mn* = *M. natalensis*, *Ad*= *A. dembeensis*, *sa*= *S. albipes*).

Seasons	<i>Mn</i>			<i>Ad</i>			<i>Sa</i>		
	Young	adult	Total	Young	adult	Total	Young	adult	Total
1	10	15	25	7	12	19	3	8	11
2	9	12	21	6	10	16	4	6	10
3	3	7	10	2	6	8	1	4	5
4	3	6	9	1	6	7	1	2	3
5	2	4	6	2	12	14	1	1	2
Total	27	44	71	18	46	64	10	21	31

Table 6. Sex structure of rodents trapped at different seasons

Species	Season					
	Wet		Dry		Total catch	
	Male	female	Male	female	Male	female
<i>M. natalensis</i>	27	29	7	8	34	37
<i>A. dembeensis</i>	21	22	10	11	31	33
<i>S. albipes</i>	12	13	3	3	15	16
Total	60	64	20	22	80	86

### **3.5 Population estimation**

A population estimate of rodents in the Legedaddi Chilelo irrigated field was high during the first trapping session of the wet season. However, the population declined during the last two trapping sessions of the dry season. The highest population (N=106) was recorded during the wet season. Whereas, the minimum population ((N=35) was recorded during the dry season. The present study showed that there is statistically significant variation ( $P < 0.001$ ) in the population size between seasons. Estimation for population of rodents in the irrigated, non-irrigated field and bushland was 111, 25 and 5 respectively (Fig. 7).

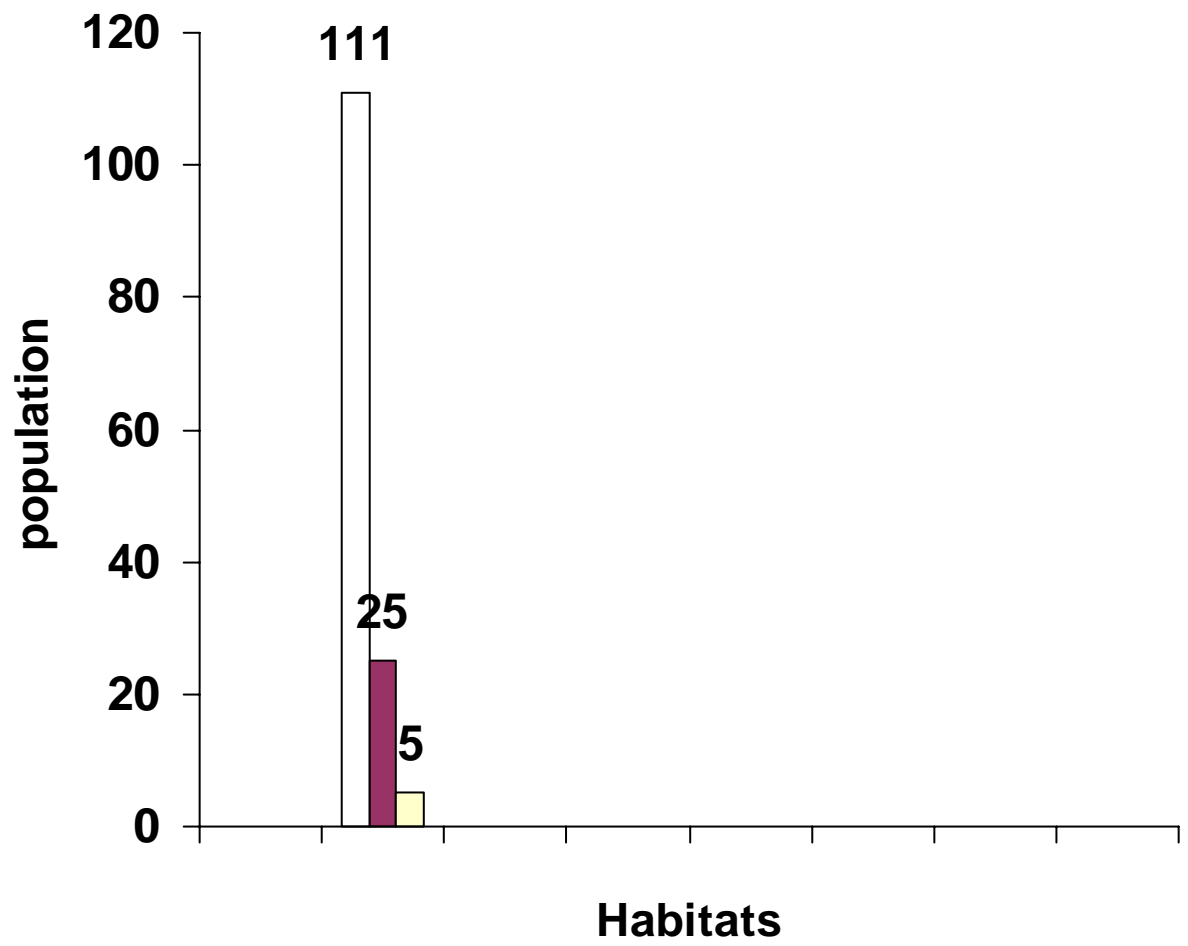


Figure 7. Population of rodent at different habitats

### **3.6 Density**

In the irrigated field the density of *M. natalensis* was 6/ha during the dry season and 100/ha during the wet season. The density of *A. dembeensis* also 12/ha during the dry season and 80/ha during the wet season and the density of *S. albipes* was 6/ha during the dry season 42/ha during the wet season (Table 7).

In the non-irrigated field, density of *M. natalensis* was 24/ha during the dry season, 15/ha during the wet season. The density of *A. dembeensis* was 20/ha during the dry season, 4/ha during the wet season. Moreover, the density of *S. albipes* was 4/ha during the dry season, 2/ha during the wet season (Table 7).

The density of *M. natalensis* in the bushland was 0/ha during the dry season, 4/ha during the wet season. The density of *A. dembeensis* was 10/ha during dry season and 2/ha during wet season and the density of *S. albipes* was 0/ha during the dry season and 4/ha during the wet season (Table 7).

Table 7. Density of small mammals per hectare in the five grids during each trapping Months.

Species	Grids	June	July	Aug.	Oct.	Dec.
<i>M.n</i>	A	24	26	2	4	0
	B	24	20	4	0	2
	C	0	2	8	10	6
	D	0	0	6	4	4
	E	2	2	0	0	0
<i>A.d</i>	A	18	16	6	2	4
	B	20	16	4	2	4
	C	0	0	2	2	8
	D	0	0	2	4	6
	E	0	0	2	4	6
<i>S. a</i>	A	12	10	4	2	0
	B	8	8	0	4	0
	C	0	0	2	0	0
	D	0	0	0	2	2
	E	2	0	2	0	0
Total		110	98	42	40	42

(A and B = Irrigated field, C and D= Non-irrigated field, E= Bushland)

NB: The density is calculated based on the table in the appendix I

Table 8. Density of each species per hectare in each grid (number of individuals/ha).

Grid	species			Total
	<i>M. n</i>	<i>A. d</i>	<i>S. a</i>	
A	56	46	28	130
B	50	46	20	116
C	26	12	4	42
D	14	12	4	30
E	4	12	4	20
Total	150	128	60	338

Where A and B=Irrigated field, C and D=Non-irrigated field, E = Bushland

In the present study the density *M. natalensis* was highest (150/ha) and the density of *S. albibes* was least (60/ha) (Table 8). The density of wet season (254/ha) was higher than the density of dry season (84/ha). Irrigated field showed highest density (246/ha) however, it was least in the bushland (20) (Table 9).

Table 9. Density (individual/ha) in each grid at different seasons

Grid	Wet	Dry	Total
A	118	12	130
B	104	12	116
C	14	28	42
D	8	22	30
E	10	10	20
Total	254	84	338

(A and B = Irrigated field, C and D= Non-irrigated field, E = Bushland)

### 3.7 Reproductive condition

During the wet season, more pregnant females were caught than during the dry season, in all the three habitats. During the wet season, out of the captured females, *M. natalensis* (75%), *A. dembeensis* (60%) and *S. albipes* (50%) were pregnant. However, during the dry season the numbers of pregnant females decreased in all species. Among the number of embryos observed from the snap trapped females, the highest numbers of embryo was recorded from *M. natalensis* (6-9) and the least from *S. albipes* (2-5) (Table 10).

Table 10. Pregnant female and number of embryos observed during wet and dry seasons.

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Species	season	Female Pregnant	Embryo no.
<i>M. natalensis</i>	Wet	8	6-9
	Dry	1	4-5
<i>A. dembeensis</i>	Wet	6	5-7
	Dry	3	4-6
<i>S. albipes</i>	Wet	3	4-6
	Dry	1	2-5

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### **3.8 Biomass**

The data on the rodent biomass (g) (Table 12) shows that Irrigated field had maximum biomass (7857 g). Whereas, bush land had the least (810 g). Maximum rodent biomass was recorded during the first trapping session (3467 g) and minimum during the fourth trapping sessions (1214 g).

The body weight and external measurements of the three rodent species are given in Table 11. Variation in body weight is statistically significant ( $p < 0.05$ ) between seasons within a species. However, in other external body measurements, It was statistically in significant ( $p > 0.01$ ) between seasons.

Table 11. Body weight (g) and measurements (mm) of rodents snap-trapped during dry and wet seasons.

Species	season	No.	Body measurements				
			BW	HB	TL	HF	ER
<i>Mn</i>	Wet	4	63.5	15.1	15.9	2.8	1.5
	Dry	5	51.4	14.0	13.6	3.6	1.4
<i>Ad</i>	Wet	7	87.9	14.2	10.3	3	1.3
	Dry	10	68.8	12.5	8.9	2.4	1.2
<i>Sa</i>	Wet	3	52.2	10.0	8.5	1.1	0.9
	Dry	2	46.0	8.1	6.2	0.8	0.6

(BW = body weight, TL = tail length, ER = ear length, HB = head + body length, HF = hind foot length, *Mn*= *M. natalensis*, *Ad* = *A. dembeensis*, *Sa*= *S. albipes*).

Table 12. Mean biomass (g.) of each rodent species in each trapping sessions

Species	Habitat	Trapping sessions				
		1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>
<i>Mn</i> (57.5g)	Irr	1437.5	920	402.5	287.5	172.5
	Non-irr	-	230	115	172.5	172.5
	Bld	-	57.5	57.5	57.5	-
<i>Ad</i> (78.4)	Irr	1411.2	1097.6	313.6	313.6	470.4
	Non-irr	-	78.4	156.8	156.8	548.8
	Bld	78.4	78.4	78.4	78.4	78.4
<i>Sa</i> (49.1)	Irr	441.9	392.8	98.2	98.2	-
	Non-irr	-	49.1	98.2	49.1	49.1
	Bld	98.2	49.1	49.1	-	49.1
Total		3467.2	2952	1369.3	1213.6	1540.8

Where, Irr=irrigated field, Non-irr= non-irrigated field and Bld= bushland, *Mn*= *M.natalensis*, *Ad*= *A. dembeensis* and *Sa*= *S. albipes*.

### 3.9 Diet Analysis

For stomach content analysis 30 snap trapped individual were analyzed during wet and dry seasons. The food items were grouped into plant matter (grass, monocot seed and monocot leaf) and animal matter. Some food items that were not categorized were grouped under unrecognized material (Table 13). There was no significant variation among the snap trapped rodents in the type of food items ( $p > 0.05$ ). However, there was a significant variation ( $P < 0.05$ ) in the proportion of the diet of each species. Even though the three rodent species depended mostly on plant matters, their relative proportion of the food items varied among the seasons and among the species. The diet of *A. dembeensis* comprised mostly grass. The consumption of animal matter was higher during the wet season than the dry in the three species of rodents (Table 14).

Table 13. Stomach content from snap trapped rodents (✓=presence, x= absence).

Species	Grass	Monocot seed	Monocot leaves	Animal matter	unrecognized material
<i>M. natalensis</i>	✓	✓	✓	✓	✓
<i>A. dembeensis</i>	✓	✓	✓	✓	✓
<i>S. albipes</i>	✓	x	✓	✓	✓

Table 14. Percentage of the diet of snap trapped rodents.

Species	season	Identified food items (%)				
		GR	MS	ML	A.M	UNM
<i>M. natalensis</i>	Wet	30.5	15.7	23.4	20.8	9.6
	Dry	25.8	27.6	18.5	15.6	12.5
<i>A. dembeensis</i>	Wet	50.4	16.5	15.8	8.6	8.7
	Dry	47.3	22.8	11.6	6.9	11.4
<i>S. albipes</i>	Wet	46.8	–	26.4	8.6	18.2
	Dry	44.9	–	25.7	6.6	22.8

(GR= Grass, Ms= monocot seed, ML= monocot leaves, A.M = animal matter and UNM= unrecognized material).

#### **4. DISCUSSION**

The abundance of rodents in the Chilelo irrigated area varied compared to non- irrigated agricultural areas and bushland. Among them, irrigated area contained the highest number of rodents. This may be due to continuous supply of food and shelter throughout the year. This is in line with the findings of Workneh Gebresilassie *et al.* (2006).

There was variation in the abundance of rodents number from season to season. The multimammate rat, *M. natalensis* was abundant during the wet season in all irrigated and non-irrigated agricultural fields and bushlands. Rainfall had a positive impact in the breeding of rodents (Taylor and Green, 1976; Stenseth *et al.*, 2001; Hubert and Adem, 1985). Rainfall also favored the growth of weeds and grass around the agricultural and non-agricultural areas. This had an additional advantage for the *M. natalensis*. As stated by the findings of Leirs *et al.* (1994), the breeding of African multimammate rat was linked to rainfall periods, probably through the stimulating effect of germinating weeds.

*A. dembeensis* was the most abundant species during the dry season. The present study is well in line with the finding of Delany (1986) and Afework Bekele *et al.* (1993) that *A. dembeensis* reaches maximum number during the mid- dry season.

In general, the species composition of rodents among the three habitats and between the seasons was similar, but the only difference observed among them was the population size. Irrigated,

non-irrigated and bushland constituted 74.1%, 18.7% and 7.2% respectively of the total catch. This was similar to the findings of Happold (1974) and Workneh Gebresilassie *et al.* (2006), because continuous cultivation in the area provides sufficient food and better cover against predators

The multimammate rat, *M. natalensis* was the dominant species in irrigated and non- irrigated agricultural fields constituting 42.2% and 48.3% of the total catch, respectively. However, in the bushland it constituted 33.3% of the total catch. These findings were similar to the study of Capula *et al.* (1997), where the species usually favors savanna habitats at lower altitude. *M. natalensis* was a common rodent in many parts of Africa (Lavrenchenko *et al.*, 1998). It is also widely distributed over most of Ethiopia. (Yalden *et al.*, 1976).

*A. dembeensis* was the second most dominant species in both irrigated and non-irrigated agricultural areas constituting 38.2% and 38.7% of the total catch. The species is a major agricultural pest in Ethiopia (Afewerk Bekele *et al.*, 1993; Lavrenchenko *et al.*, 1998). Therefore, its occurrence in the farm is expected. *A. dembeensis* is a lowland species with most records between sea level and 2200 m asl (Capanna *et al.*, 1996). According to Delany and Monoro (1985) and Capula *et al.* (1997), *A. dembeensis* is common in the savanna regions of northern and central tropical Africa. Moreover, *Arvicanthis* is also an African diurnal rodent of grasslands extending from the Sahel as far as northern Tanzania (Corti and Fadda, 1996). According to Yalden *et al.* (1976), it is widely distributed in Ethiopia.

The Ethiopian endemic rodent species, *S. albipes* was trapped from all the three habitats. It had the third position, in all the three habitats, constituting 19.6%, 13.0% and 25.1% respectively of the total catch. According to Afework Bekele and Corti (1997), this species is common in forest scrubs at an altitude between 1500-3300 m asl. It is also widely distributed in forested habitats of Ethiopia (Yalden *et al.*, 1976).

Trap success varied from habitat to habitat. In the present study trap success during the wet and dry season was 5.6% and 2.9% respectively. Trap success is influenced by many factors. Rain can significantly increase the capture rate of rodents (George, 1984; Sidorowicz, 1974). This might be the reason for the high capture of rodents during the wet season. During the wet season, the highest trap success was obtained from irrigated agricultural field and least from the bushland. This may be due to a continuous supply of food in the irrigated area. This finding goes with the study of Workneh Gebresilassie *et al* (2006).

The overall trap success in the Chilelo irrigated and non-irrigated agricultural field and bushland was 4.5%. The trap success in the agricultural field was 5.2%. This was similar success rate compared to Jacob *et al.* (2003), who obtained 5.1% success in 3060 trap nights from rice field in West Java. However, this was lower compared to the trap success 11.5% obtained by Afework Bekele *et al.* (2003) and 18.7% by Yalden (1988).

There was a fluctuation in rodent populations in the Legedaddi Chilelo irrigated agricultural and non-agricultural field during different trapping sessions. During the first two trapping sessions, the rodent population was high. However, the least rodent capture was recorded during the last trapping session. These were not in agreement with the findings of Gliwicz (1985), Happold and Happold (1991) and Linzey and Kesner (1997). There are different environmental factors that cause the population fluctuation in rodents, such as quality and abundance of food, weather conditions and predation (Fernandez *et al.*, 1996).

Rainfall had a significant role for the occurrence of high population of rodents during the wet season. For many rodents, breeding and rainfall are directly correlated, and rainfall facilitates the growth of ground cover around the agricultural and non-agricultural field, which provides habitat and food for the rodents. However, during the dry season, trappings were carried out during harvesting and land preparation time. Therefore, only few rodents were trapped, probably due to migration.

The difference in the population of rodent with higher records for irrigated field showed that continuous agricultural practices, which enhance the availability of food throughout the year, might act as a major factor for rodent population to increase in the area.

The density of small mammals observed in the present study was comparable with the finding of Misonne (1963), who recorded only 61 rodents per hectare in savanna area in Uganda, Happold (1974) also estimated population densities in western Nigeria that ranged from 16-106 rodents per hectare. However, the density obtained during the present study was lower to the other studies in Africa. Dieterlen (1967) found densities of 236-361 rodents per hectare in Congo and Delany and Kanseriimubanga (1970) recorded 160 rodents per hectare in Uganda. The density of small mammals in the present study area was 246/ha in irrigated field, 72/ha in non-irrigated field and 20/ha in the bushland.

The highest rodent biomass was recorded in the irrigated field during the first trapping session. This may be due to the availability of adequate food. The monthly range of biomass recorded in the irrigated field during the present study (643-2291g/ha) was comparable to that of Menagesha forest (454-1569g/ha) (Afework Bekele, 1996b). However, It was lower to biomass recorded in the Agricultural field (620-3193g/ha) (Workneh Gebresilassie *et al.*, 2006).

The result of the body measurement (Table 12) shows a significant decrease in body weight for most of the rodents during the dry season. It might be related to shortage of food, both in quality and quantity. Similar result was observed by Taylor and Green (1976). This might be related to the limited availability of food sources during the dry season than the wet season.

In the present study all age groups were represented. Age distribution in a population of most species at different seasons was an indication of seasonality in reproduction. All age groups appear in the population within specific season, when reproduction is seasonal. The presence of a relatively equal number of pregnant females in both trapping seasons may support this conclusion. If all age groups are represented in both seasons, then it would mean that reproduction is contentious.

During the wet season young and adults constituted (1.0:1.8) ratio, respectively. This shows, there was a correlation between rainfall and seasonality in breeding. This is similar to the studies carried out by Happold (1974); Taylor and Green (1976); Perrin *et al.* (1992); Afework Bekele and Leirs (1997). During the dry season, young and adult members constituted 24% and 76%, respectively. This decline in of the young during the dry season was may be due to those species which can breed seasonally.

In the present study, pregnant females of *M. natalensis* were trapped during both seasons, although searched more in number during the wet season. This may be due to the presence of adequate food for continuous breeding throughout the year. Positive association was also seen in the studies of Happold (1974) and Perrin *et al* (1992). However, this contradicts with the study by Leirs *et al.* (1994) that *M. natalensis* breeding appears to be strongly correlated with rainfall.

Pregnant females of *A. dembeensis* were trapped during both seasons. Continuous breeding throughout the year was reported by

Delany and Roberts (1978). However, the findings by Lavrenchenko *et al.* (1998) and Taylor and Green (1976) show positive correlation with rainfall in the breeding of *Arvicanthis* species. Similarly, during both the seasons, pregnant females of *S. albipes* were also trapped. This may be due to continual breeding throughout the year. This is similar to the findings of Happold (1974) and Afework Bekele (1996a).

Studies of food preferences of rodents are important to predict control measures and management programs. According to the study by Campos *et al.* (2001), the feeding ecology of small mammals throughout the world is highly diverse. Most species of rodents appears, to be opportunistic feeders (Johnson, 1961). The result of the present study confirms this finding. The result of the stomach content analysis showed that regardless of the proportional difference, all rodents consumed plant and animal matters. For instance, the stomach contents of *M. natalensis* and *A. dembeensis* included monocot seeds; monocot leaves and animal matters. However, the stomachs of *A. dembeensis* contained high percentage of grass in addition to other ingredients. This is in line to the finding by Workneh Gebresilassie *et al.* (2004), who have recorded higher percentage of grass and monocot seeds in the stomachs of *A. dembeensis*.

## 5. CONCLUSION AND RECOMMENDATIONS

The present investigation provides valuable information on the species composition, abundance and diet of rodents in the Chilelo irrigated and non-irrigated agricultural fields and bushland. Three species of rodents were recorded from the area. Variation in abundance among the rodents was observed in all habitats. The abundance of rodents was high in the irrigated agricultural field where as the abundance least in the bushland.

Species composition in all habitats and seasons was similar. In the present study, rainfall had significant role in the seasonal abundance of rodents. There was more number of pregnant females resulting in the high population of rodents during the wet season. These confirm that breeding of rodents is strongly correlated with rainfall.

In the present study, the abundance of rodent species in relation to season was significant. *M. natalensis* was the most abundant of the total captured rodents during the wet season. However during dry season, *A. dembeensis* was the most abundant. There was variation in density of the rodent per hectare within different habitats and seasons. The biomass of the present study varied from habitat to habitat. The body mass of rodents in this study was higher during the wet season than during the dry season.

In the present investigation, the feeding habit of the three species of rodents was similar consuming plant and animal matters. Due to both availability of food in the irrigated field large number of

rodents was captured, causing high damage in the irrigated area as compared to non-irrigated agricultural area and bushland.

Based on the above results the following recommendations area made.

- There should be effective control of grass cover around the irrigated area to decrease the effect of migration of pest rodents from the surrounding area to the farmland
- Rodent control measure should be taken before the breeding season of each rodent species.
- The pest status of rodents in this area should be studied in detail to quantify the intensity of damage and to predict pre-control measure.

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Appendix I

Number of rodents known to be alive during each trapping months.

Species	Grids	June	July	Aug.	Oct.	Dec.
<i>M.n</i>	A	13	9	4	3	2
	B	11	7	3	2	1
	C	0	2	1	2	2
	D	0	2	1	1	1
	E	0	1	1	1	0
<i>A.d</i>	A	10	7	4	3	4
	B	8	7	0	1	2
	C	0	1	2	2	3
	D	0	0	1	0	4
	E	1	1	1	1	1
<i>S. a</i>	A	5	4	2	2	0
	B	4	4	0	0	0
	C	0	0	2	1	0
	D	0	1	0	0	1
	E	2	1	1	0	1

Appendex II

Number of rodents during each trapping session at different habitat (dash indicates absence).

Species	Habitat	Trapping sessions				
		1 <sup>s</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>
Mn	Irr	25	16	7	5	3
	Non-irr	-	4	2	3	3
	Bld	-	1	1	1	-
Ad	Irr	18	14	4	4	6
	Non-irr	-	1	2	2	7
	Bld	1	1	1	1	1
Sa	Irr	9	8	2	2	-
	Non-irr	-	1	2	1	1
	Bld	2	1	1	-	1

Where, Irr= irrigated field, Non-irr= non-irrigated field and Bld= bushland