JIMMA UNIVERSITY

COLLEGE OF NATURAL SCIENCE

SCHOOL OF GRADUATE STUDIES

DEPARTEMENT OF BIOLOGY

Termite diversity, abundance, distribution and level of damage on Bean crop (*Phaseolus vulgaris*) andon housing structurein Yem district, SNNPRS,South Ethiopia

BY

Addisu Shewaye

A Thesis Submitted to the department of Biology, School of graduate studies, Jimma University in Partial fulfillment for requirements of the degree of masters of Science in Biology (Ecological and Systematic Zoology).

August, 2015

Jimma, Ethiopia

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Declaration Statement of the author

I hereby, declare that this thesis is my original work and has not been presented in degree in any other Universities, and all sources of materials used for the thesis have been fully acknowledged. This Thesis is submitted in Partial Fulfillment for requirements of the Degree of Masters of Science in Biology (Ecological and Systematic Zoology)Jimma University

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List of Acronyms

ACQ Ammonia cal copper quat compound

°C Degree Celsius

CCA Chromate copper arsenate

CNRS Centre National de la Recherché Scientifique

DOT Disodium octoborate tetra hydrate

ETB Ethiopia Birr

FAO Food and Agricultural Organization

KAP Knowledge, Attitude and Practices

LSD Least Significant Difference

m meter

SPSS Statistics Package of social science

SE Standard error

SNNPRS South Nation Nationality and People Region State

Abstract

The aim of this study was to determine termitediversity, abundance, distribution and Level of damage on Bean crop (*P. vulgaris*) *andhousing structurein Yem district, SNNPR, South West Ethiopia. A longitudinal study was employed to collect relevant information on termite diversity, abundance, distribution and the effects in the study area. Standard identification key was used to identify termites to genera level. The sample size of the study was determined using a standard formula. Accordingly, of the 666 total populations180 study participants were selected from the sampling frame using simple random sampling technique with proportional allocation for the two kebeles (Melaka and Angry). A total of 180 houses and 12 farmers' bean crop fields were also surveyed. Data collected during the study were analyzed using SPSS software package version 20.0.Two families of termite were collected, of which 4 sub families and ten genera were identified in this study. From the identified genera the predominant (17%) were Amitermes and Odontotermes.Of the total 4804 bean stalks from12 quadrants, 7.29% were infested by termite pests .There was a significant association between bean infestation and damage level. From the total infested houses, 36.7% infested house had a life span of less than ten years and the remaining 64.3%had above 10 years. Over quarter of house owner's reported that they used indigenous (local) preventive measures before house constructions, such as rolling plastics on the wooden frame and painting the wooden frames with petroleum oil. Termite infestation was significantly correlated with construction materials, season and topography. There was significant association* $p < 0.05$ *between topographyand termite infestation. This study indicates that termite had great impact on farmers' crop and houses. The consequence was leading to repeated and frequent repairing and maintenances. This activity in turn caused economic deterioration of the society. , The results of this study will help asa base line information for designing and implementing local termite protection and control intervention strategies, especially to the Yem special Woreda and studied kebeles.*

Keywords: Adjacent soil, genera diversity, survey, ethanol, Worker, Solider, bean crop, Termite, House.

1. Introduction

Termites are social insects of the order *Isoptera* with about 3000 species (Munthali, 1999: Glaciela *et al*., 2006; Tathiane *et al*., 2009). Termites are predominantly distributed in tropical environment, with the highest species richness in equatorial rainforest, and generally declining with increasing latitude (Yanyong et al., 2003).Africa is by far the richest continent in termite diversity (Eggleton, 2000). Termites were important pests of building timbers, forestry and crops in Africa in general, damage by termites is greater during dry periods or droughts than Periods of regular Rainfall, in lowland rather than highland areas, and in plants under stress (Wightman, 1991). Despite their economic importance, limited published economic loss studies due to termites and related costs of protecting crops and houses/structures currently exist (Sekamatte and Okwakol, 2007). Termites are very serious Pests in several parts of Ethiopia, particularly in the Western parts of the country (Abdurrahman, 1990). They cause considerable damage on agricultural crops, rangelands, forestry seedlings, and wooden structures such as rural houses, stores, fences and bridges crossing streams. According to the studies conducted in West Ethiopia, that roof huts are destroyed in less than five years and corrugated iron roof houses in less than eight years. Termites are social insects found mainly in the tropics between 45^0 north and 45^0 south latitudes. These distribution areas cover over two-thirds of the landmass,(Abdurahman, 1991) .The termite insect order Isoptera around 3000 species of termites in 281 genera which have been described worldwide and about 39% of the total termite species are found in Africa(Eggleton, 2000). Records of termites from Ethiopia indicate 61 species belonging to 25 genera and four families (*Kalotermitidae, Hodotermitidae, Rhinotermitidae and Termitidae*) (Cowie *et al*., 1990).According to Rwabwoog (1997) said that Termites hold two positions from the economic point of view. They damage buildings, forestry and wide range of crops including cash crops such as maize (*Zea mays*), groundnuts (*Arachis hypogaea*), beans (*P. vulgaris*), and pastures Rwabwoog, 1997). On the other hand they are beneficial in that they assist in the conversion of dead trees and other plant products to substances that can be utilized by plants (Dawes, 2005.and De Souza *et al*., 1994).Any material that incorporates cellulose can be devoured by termites, from paper to

palaces (building) and fungi to firtrees. Termites also damage dam linings, fires and electrical faults in large cables. In many of their distribution areas, the termite pest species pose a serious threat to agricultural crops, forest seedlings, rangelands and wooden structures (Wood, 1986). Natural forest is also damaged by termites. Estimated the overall cost of damage to agricultural and forestry resource by termites is over $ 30 billion per year worldwide (Geer, 2005). Stressed trees are generally the most susceptible to infestation. Dry wood termites (*Kalotermitidae)* live and feed in dead wood, but sometimes attack living parts of mature trees. They are pests only in humid tropics, causing local, but sometimes serious damage. *Coptotermes (Rhinotermitidae)* causes more wide spread and serious damage to mature trees. The most serious losses (up to 100%), due predominantly to various *Macrotermitinae* (*Termitidae*) such as *Macrotermes*, *Odontotermes* and *Microtermes,* occur in young, exotic trees. So far successful termite control measures in agriculture have depended largely on the use of persistent organochlorine insecticides. They are usually applied at higher rates and are toxic to the environment. Moreover, these insecticides are less readily available and severe restrictions are being placed on their use (Pearce, 1997). Attack on seedlings, especially by *Macrotermitinae* in Africa can be prevented by the increasingly unacceptable persistent cyclodienes used as mound poisons or as a barrier around the roots preventing infested by subterranean species. Controlled release formulations of otherwise non-persistent insecticides are being developed, but are expensive and not widely available. Many non-chemical measures have been suggested, but none has been rigorously evaluated. The need for alternative strategies is becoming acute. Biological control shows little promise. Use of resistant tree species and development of resistant varieties offers the only long term solution, but until these are available there will be a need to continue using cyclodienes or rapidly to develop alternative control methods. Therefore, products which are environmentally friendly and potentially useful in integrated pest management such as the use of resistant varieties or their extracts and locally available plant extracts have frequently been claimed to be effective in control of termites (Cowie *et al*., 1989).This study was initiated to assess Termites diversity, abundance, distribution and level of damage on Bean crop (*P. vulgaris*) andhousing structure , as there was no research conducted regarding the termites pest so far in the special Woreda of Yem ,SNNPRS of South Ethiopia.

1.2 statement of the problem

Termites are social insects found mainly in the tropics between 45^{o} N and 45^{o}S latitudes. These distribution areas cover over two-thirds of the landmass, involving some countries (Abdurahman, 1991). They damage, wide range of crops including cash crops bean and house build but on the other hand they are beneficial in that they assist in the conversion of dead trees and other plant products to substances that can be utilized by plant. Based on some documented data and personal observation the study area is highly influenced by termite pest damage of houses, different buildings, crops, fences, range land etc. Therefore, early management is vital, as initial plant protection was important for successful yield and economic profits. In the area farmers, crop protection experts used to prevent termites using chemical method (pesticides) year to year even though such method reduce the infestation level for the season, but by the next growing season termites reappear.Even though various studies conducted on termite pests, none of them try to correlate diversity, abundance, distribution and level of damage on crops and on housing structure.To fill this gap for a typical termite pests in area Yem district a cross sectional study was aimed to assess the termite diversity, abundance, distribution and level of damage on Bean crop (*P. vulgaris*) andhousing structure in Yem district, SNNPRSouth Ethiopia.

The study tried to answer the following research questions.

- What is the diversity of termites in the study area?
- What are abundance and distribution and level of damage on Bean crop and housing structure of termites in the study area?
- Which genera of termites more predominant in the study area?
- What is the KAP of the community towards the impact of termite infestation on Bean crop and housing structure?

1.3 objectives of the study

1.3.1 General objectives

To assess termite diversity, abundance, distribution and level of damage on Bean crop (*P. vulgaris*) and onhousing structure in the study area.

1.3.2 Specific objectives

- To determine the distribution, abundance and dynamics of termite pest in study area
- To determine the diversity of termites in study area
- To estimate level of damage potential of termites pests on bean Crops (*P. vulgaris*), on housing structure.
- To determine the KAP of the community towards the impact of termite infestation on

1.4 Significance of the study

Estimating the distribution of termites and its damaging incidence would be relevant for preventing and controlling the distribution of this pest's infestation and their effects for developing control strategies. In addition to collecting information concerning the level of damage potential that might help to select adequate and possible strategies. So, this study can generate information regarding the distribution and level of damage of the termite pest and their relation with the socio economic risk factors among individuals'. Finally the result would give brief recommendation regarding the problem facing the community. Especially to farmers and concerned body so that they can look for the control of termite pest according to the designed recommendation.

2. **Literature review**

Termites belong to the class insect order *Isoptera*, and are characterized by their colonial behavior. They are often referred to as 'white ants', however, morphologically they are very different from the ants and other social Hymenopterans (bees and wasps). The word isopteran originated from the Greek words, in which ' isos' means equal and ' pteron' means wing, and refers to the two pairs of identical wings in the adults (Harris, 1957). They are polymorphic, eusocial insects, living in large communities of several hundred to several million individuals, composed of reproductive (winged) forms together with numerous apterous sterile soldiers and workers. Their numerous colonies have great influence in ecosystems. The dominance of termites in tropical ecosystem is mainly related to their ability of utilizing dead plant material rich in cellulose (the most abundant organic matter on earth) (Wood, 1986).These social insects are found mainly in the tropics between 45^{o} north and 45^{o} south latitude. These distribution areas cover two-thirds of the landmass, (Abdurahman, 1991). Termites damage buildings, forestry and a wide range of crops including cash crops such as maize (*Zea mays*), groundnuts (*Arachis hypogaea*), beans (*P. vulgaris*), and pastures (Rwabwoogo, 1997). Any material that incorporates cellulose can be devouring by termites, from paper to palaces and fungi to fir trees. Termites, in their quest for food, also destroy other material that stands in the way; this has led to breaks in dam linings, fires and electrical faults in large cables (SU and Scheffrahn, 1998).However, on the other hand they are beneficial in that they assist in the conversion of dead trees and other plant products to substances that can be utilized by plants. Moreover, termites are important part of the food chain for many animals including man. They supply materials for many food chains, soil engineering (translocations and altering soils physically and chemically and maintaining soil fertility) (Wood, 1988). Providing a possible input of nitrogen through symbiont fixation, methane gas release and carbon flux (Collins, 1984).

2.1 Termites biology and ecology

Termites live in large communities and the colony members have four castes: the reproductive (king and queen), soldiers and workers. In addition, colonies have a large number of young immature forms in all stages and of all castes (Collins, 1984). Each caste varies morphologically and behaviorally but they have to live cooperatively or the colony will die (Collins, 1984). The number of individuals and ratios of each caste in a colony is very difficult to determine and it varies between species and also depends on the age and size of the colony (Bignell and Eggleton, 1998). Large colonies may include a number of supplementary reproductive, producing eggs to augment or replace the founding queen (Bignell and Eggleton, 1998).The parent termites, the king and the queen are the functional reproductive. The queen's major role is to lay eggs. She develops an enlarged abdomen containing ovarioles and associated tissues, a condition known as being physogastric (Collins, 1984). The queen is also involved in phermonal regulation of the production of each caste in a colony (Noirot and Noirot-Timothee, 1969). Soldiers and workers are wingless and can be either sterile male or female. Soldiers usually represent one-tenth of the population at most (Harris, 1957). There are also termite genera that lack of this caste, such as *Anoplotermes* and *Protohamitermes*. Termites are the only social insects with a true soldier caste whose major role is only to defend the colony (Bignell and Eggleton, 1998). For this reason, morphologically they are bigger in size and have defensive adaptations such as enlarged mandibles or stopper-like heads. In the subfamily *Nasutitermitinae*, the mandibles are reduced and non-functional. Instead the soldiers have a nasus, an elongated projection of the frontal and their way of defenses is by squirting irritating chemical substances through it (Collins, 1984). Besides having mandibles and a sclerotized head, soldiers of some genera such as *Coptotermes* have a frontal gland that discharges a defensive secretion through a frontal pore (Richards and Davies, 1978). This secretion can be toxic or repellent to intruders, such as ants, or tacky and entangle their legs and antennae. The worker caste is the most numerous and plays the major role in the survival of the colony. They collect food, process the digest, feed other castes and construct the mound or nest (Harris, 1957). All living termites, except the *Kalotermitidae*, are known to have a true worker caste. In *Kalotermitidae*, there is no distinct worker caste and the work of the colony is done by immature adults, whose development is stopped temporarily according to the needs of the colony (Harris, 1957). Winged reproductive or alates of both sexes

are produced in large number in a mature colony. These alates swarm out from mature nests at particular times of the year (often during or just before rains) (Bignell and Eggleton, 1998). They make short, often rather feeble, dispersal flights, and then pair-up the ground after the wings have been shed (dealation) (Bignell and Eggleton, 1998). The paired termites will then select a new nesting site and once they are established, mating takes place. The first batch of eggs is produced by the female within a few days. Termites are hemimetabolus in their life cycle. The hatched young are translucent white and feeble at first, but very active from the moment they hatch (Edwards and Mill, 1986). The colony grows slowly for many years, accompanied by a continuous increase in the number of individuals, enlargement of the nest and much building activity (Bignell and Eggleton, 1998). Once the colony is well organized, larvae appear with wing buds, which later will become winged termites and the full cycle of development is complete (Harris, 1957).

To maintain the social structure of the colony, termite communication predominantly relies on the use of sophisticated chemical (pheromone) communication system (Higashi *et al.,* 2000). There is wide range of categories of pheromones such as trail, alarm, aggregation, recruitment, mating, etc. The signals induce and modulate a wide range of individual's and collective behavioral responses such as territorial behavior, attendance of the reproductiveand brood and foraging for food or searching for nesting sites. Each colony develops its owncharacteristics odor. An intruder is instantly recognized and an alarm pheromone is secretedthat triggers the soldiers to attack. If a worker finds a new source of food, it lays a chemicaltrail for others to follow. The proportion of termites in each caste within the colony is alsoregulated chemically. Nymphs or immature can develop into workers, soldiers orreproductive adults depending on colony needs (Michael, 2002).Sound is another means of communication. Soldiers and workers may bang their headsagainst the tunnels creating vibrations perceived by others in the colony and serving tomobilize the colony to defend it. Mutual exchange of foods enhances recognition ofcolony members (Kamble, 2002).

Termite colony success depends on the adaptability to eat different foods. Although Termites are soft-bodied insects, their hard, saw-toothed jaws work like shears and are able to bite of extremely small fragments of wood, a piece at a time. The characteristic food of Termites, considered as a whole, is wood. Almost certainly termites are attracted to wood by its odor,

which they are able to sense at some distance even through the soil. They consume wide range of freshly dead or decaying plant material including dry grass, leaf litter, decaying wood, dung and humus. Living plant tissues, including lichen and mosses are taken by a few species. Although cellulose is the major part of food in wood eating forms Termites cannot digest it (Wardell, 1987). This is because the glands in their digestive tract do not secret cellulose digesting enzymes. But digestion is assisted by symbiont organisms in their tract. Another feeding group that may be common and important in many tropical forests is the soil-feeding termites. Nonetheless, termite species can be categorized into six broad atrophic categories according to their food, foraging galleries or columns, and biology (Eggleton *et al*.; 1997). The feeding categories are described below.

1. Wood- feeders (Xylophagous): Kalotermitida*e* species (Eggleton *et al*.1996, Wardell, 1987).

2. Wood/soil interface-feeders (Termitinae), (Eggleton *et al*., 1996, Wardell, 1987).

3. Soil-feeders (Geophagous):(Termitinae), (Eggleton *et al*,.1995; 1997).

4. Grass-harvesters:Hodotermitidae *Gnathamitermes* species (Krishna, 1970).

5. Litter-feeders (Humivorous)*Laccessititermes* and*Longiditermes* (Eggleton *et al.,* 1997; Collins, 1984).

6. Micro-epiphyte- feeders (Collins, 1988).

2.2 Taxonomy of termites

Classification

Kingdom – Animala

Phylum – Arthropod

Class – Insecta

Order *_Isoptera*:

Family – (*Rhinotermitidae, Mastotermitidae, Kalotermitidae, Hodotermitidae, Termopsidae, Serritermitidae, and Termitidae*)

Genus –*Reiculitermes*

Species -*Reiculitermes flavipes* (Kambhampati *et al*., 1996)

There are seven extant families of termites in the order *Isoptera*: these families are divided in to 14 sub families, 281 genera and over 3000 species (Eggleton, 2000; Logan*et al.*, 1990 and Pearce, 1997). Based on the composition of the symbiont microbiota in the gut, termites are divided into two groups, 'lower termites' and 'higher termites', where lower termites house flagellate protozoan and bacteria. Higher termites house a variety of prokaryotic microbes, but no flagellates. Some Termitinae also house cellulolytic amoebae.

2.3 Termite behavior

Subterranean termites have adapted to live in many different geographic regions, such as the tropical, sub-tropical, and temperate regions of the world. They often infest buildings and damage lumber, wood panel, flooring, sheetrock, wall paper, plastics, paper products, and fabric made of plant fibbers. The most serious damage is the loss of structural strength. Other costly losses include attacks on flooring, carpeting, art work, books, clothing, furniture and valuable papers. Within the wide limits of their geographical distribution, termites will destroy any unprotected timber used in construction work or as fittings, unless it has been rendered unpalatable or is naturally resistant termites (Harris, 1971). Termites can tunnel through mud and known to tunnel through mortar between bricks and thatching in African houses are expected to last for only 5-6 years (Pearce, 1997).Termites are very serious pests in several parts of Ethiopia, particularly in the western parts of the country. They cause considerable damage on agricultural crops, range lands, forestry seedlings and wooden structures such as rural houses, stores, fences and bridges crossing streams (Abdurahman, 2000). Only few are important pests of agricultural crops, forestry seedlings, rangelands and wooden structures. The rest are harmless, feeding either on dead plant materials, dung or soil organic matter. The major termite species that cause damage on wooden structures belong to the fungus-growing subfamilies and to the genera *Macrotermes, Odontotermes, Pseudacanthotermes, Microtermes* and *Ancisrotermes*. The fungus growing forms depend on the fungus cultivated within the nest for digestion of their food (Abdurahman, 2000).

Abdurahman (2000) reported that in western Ethiopia thatched roof huts are destroyed in less than five years and corrugated iron roof houses in less than eight years. Many wooden structures in the same area require maintenance every year. Temperature and humidity are the main factors

affecting termites in buildings. The equilibrium moisture content of wood is affected by temperature and water vapors in the air. Pearce (1997) produced predictions for the dry-wood termites' hazard to tropical and subtropical buildings in coastal regions of Africa. He found that sea fogs and early morning dews in semi-desert coastal regions provide water for building soil runways. As the temperature is often low at this time, termites can even forage on the outside of the runways. Termites can cause direct physical damage often affecting the structural support of crop plants. For example, fungus growing termites, *Microtermes, Ancisrotermes, Macrotermes,Allodontermes* and *Pseudacanthotermes* species are the predominant pests of maize in Southern Africa (Uys, 2002). They can also cause indirect damages by interfering with the food crops and water supply, causing the eventual death of part, of all, of the plant (Pearce, 1997). In many parts of the world termite species are serious pests of growing crops including living trees described that termites cause widespread damages to a great variety of crops in tropical Africa. The damages can occur from the seedlings to harvest and usually occur every year; as termites form almost stable population and foraging by various combinations of several genera occurs throughout the year (Guachan *et al.,* 1998)

2.4 Termite control and management

In the past organochlorine insecticides were effective for the control of termites and other insects. These were often applied at higher rates than required to control and their break down products were not environmentally friendly. One application around a building could prevent termite attack over 30 years (Cowie *et al*., 1989). However, this persistence created potential environmental problems, the toxic chemicals entering food chains and finally humans. Current control options include placement of chemical and physical barriers, wood treatments and population control using baits.

Soil treatment and the treatment of seedlings before transplanting have been used as classical methods of control and prevention of subterranean, arboreal and dry wood termites for many regions of the world for many years. These methods of control have a high environmental impact because of the large amounts of insecticides that have to be applied in open areas that are exposed to leaching. In recent years, new generation insecticides that are active at very low doses

have become available. These chemicals generally also have a low toxicity to other forms (Su and Scheffrahn, 1998).

Termite-susceptible wood can be turned into a termite resistant material by treating it with chemical toxicant (wood preservatives) that inhibits feeding by termites. Wood treatment is most successful in preventing termite infestation when used in conjunction with other termite management strategies, especially proper site preparation (removing cellulose debris and earth-to-wood contacts) and termite resistant building design. Chemicals such as chromate copper arsenate (CCA), ammoniacal copper quat compound (ACQ), and Disodium octoborate tetra hydrate (DOT) are used as wood preservatives. Out of, these borates are gaining popularity because of their low mammalian toxicity, water solubility and ease of application. Wood preservatives are most toxic to termites when ingested. In the case of dry wood termites, treated timber may also discourage new kings and queens (alates) from establishing colonies (Su and Scheffrahn, 1998).

Physical or mechanical method involves physical barriers such as sand or gravel aggregates, metalmesh or sheeting. Physical and cultural control involves mound removal, queen removal, flooding, suffocating, and using repellent or toxic materials and others (Guachan *et al*. 1998).

In Biological control method of termite control, natural enemies such as predators, parasites and pathogens are used. Termites can be preyed by a wide range of predators like birds, lizards, frogs, spiders, bats, mammals (e.g. bats) and ants. These natural enemies can destroy many swarming males and females when they leave the nests or during the flight. Humans, in some parts of the world may also feed on the winged forms. Ants are also the natural enemies of termites, which have the great potential as biological control agents (Su and Scheffrahn, 1998).

3. Materials and method

3.1 Description of the study area and period

The study was conducted from September 2014 to June 2015 in Yem district south Ethiopia (figure 1). Yem district is 239 km south west of Addis Ababa, the capital city of Ethiopia, and 139 k-m from Jimma .The study area is bordered on North direction Gurage Zone, East Hadiya Zone, West Oromia Jimma Zone and South Dawro Zone. It is located at $7^0$37'N Latitude, 30^0 54' E longitude and an altitude of 1000- 2939 meters above sea level. The maximum temperature and minimum temperature is 30^0c and 12^0c, respectively and the annual rain fall ranges between 802 – 1400 mm (PANE, 2008).

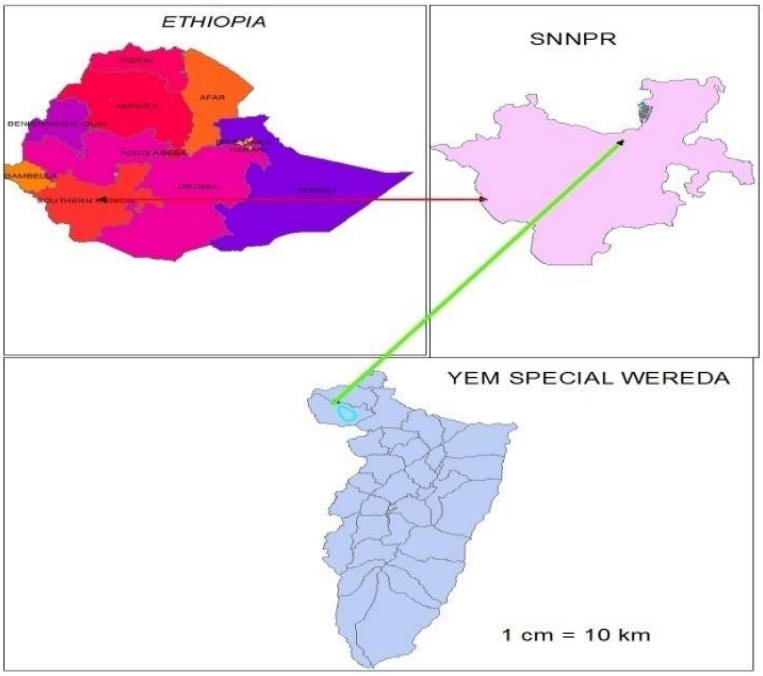

Fig 1 Study sites in Yem districts of South Nation Nationality and People Regional State (Source: S.N.N.P.R, Yem district Agricultural office)

3.2 Survey

3.2.1 Study design

Field survey for the part of pilot study was conducted at the beginning of the study period and then longitudinal design was employed to carry out the intended study among two kebeles, 180 house hold heads of which 146, males and 34, females were selected randomly as a study unit. The kebeles were selected purposively, depending on the result obtained from the Pilat study and the data gathered from the Woreda agricultural office, Secondly depending on their high population size and density and their location with access to transportation. The household head farmers were used as study unit to supply the study with necessary information based on farming field.

3.2.2 Sample size and sampling techniques

To conduct the research samples of 180 household heads were selected randomly (Daniel.1999), and samples were administered using semi structured questionnaires to gather necessary information regarding the distribution of termites and level of damaging on bean and house buildings. A systematic sampling technique were used to address representative of household

$$n' = \frac{N\ Z^2\ P\ (1-P)}{d^2\ (N-1) + Z^2\ P\ (1-P)}$$

Where

N = Population size, =666 householders

n' = sample size,= 180 house holders

Z = Z statistic for a level of confidence,

P = expected distribution or proportion (in proportion of one; if 20%, P = 0.2), and

d = precision (in proportion of one; if 5%, d = 0.05).

Z statistic (*Z*): For the level of confidence of 95%, which is conventional, *Z* value is 1.96. In These studies, investigators present their results with 95% confidence intervals (CI).

$$n' = \frac{N Z^2 P(1-P)}{d^2 (N-1) + Z^2 P(1-P)} = \frac{666 \times (1.96)^2 \times 0.2(1-0.2)}{(0.05)^2(666-1)+(1.96)^2 \times 0.2 \times (1-0.2)} = \frac{409.297}{2.28} \approx 180$$

3.2.3 Data collection instruments

The total study population were 666 of which 543 M, 123 F, Data were collected from 180 households, 146, M. 34 F. Information was gathered from householders and from focus group by administering focus group discussion. The questionnaire consists of a serious a semi structured questions,

3.2.4 Focus group discussion

Group discussion: focusing on the knowledge, attitude and practice of their experience toward termite pest, regarding the distribution and level of damage of termite pests in their area. The study was conducted in two kebeles (Melaka and Angry) which were purposively selected based on the severity of termite problem on housing structure and crops. The district development of agriculture expert provided a sampling frame which contained all crops cultivated byhousehold head farmer from the selected kebeles**.**

Pale-1 Focus group discussions with Yem district agriculture office expert and house holder heads (2014).

Focus group discussion was held with kebele administrative workers regarding the overall information about the infestation of termite on crops and materials (Plate 1). According to the informants, termite was a serious problem of the surrounding people; they repeated the serious damage season was in wet season. The informants' cooperated in replying the questions presented for them in written form. And also the kebeles administrators assigned an individual in accompanying while observations made. The point on which dissection was made includes:

i. Severity of termite damage on crops plant particularly beans;
ii. Distribution of termite genera on house building structure, and crops plant particularly beans.
iii. At which season the incidence of termites high
iv. Estimate level of damages.

The knowledge, attitude and practice of crop protection of experts, head of district agricultural and developmental office and developmental agents towards the effect of termites was collected. The status of termite pest density and damage level of different species in different seasons and level of damaged refers to bean Crops (*Phaseolus vulgaris*) andhousing structure.

3.3 Termites sampling and identification

The study was carried out 2014/2015 in wet season and dry seasons. The equipment's used to collect termites were bicker, petri dish, forceps, collection net, decayed logs and stumps were used (John *et al*.,2013). Termites were preserved in 80% ethanol and later identified to species level using standardized FAO zoological key. Counting damaged bean crop, and house building structure was used to investigate level of damage in dry and wet season..

3.3.1 Field observation

The field observation was made by selecting 12 quadrants, six farmers field from each selected kebeles. The selection was made as follows: bean crop (*P .vulgaris*) used quadrant, and house build were counted by manual.

Yield loss (%) = estimated potential yield without termite attack* 100%. (Mandad *et al*., 2010)

Estimate yield loss due to termite

Six farmers' fields were used for analysis in wet season (September and October, 2014) and dry season (January and February, 2015) from both selected seasons. 5m x 5m area square was used to collect termite sample each quadrant in January and February 2015. The number of crops lodged by termites was counted in each quadrant from the 3 replications at harvesting. A combined analysis of variance across sites was conducted using SPSS /version20 statistical package, to analyze differences between levels of damage. The least significant difference at $p<0.05$ was used to differentiate between statistically significant means. Sample relationship between crop amounts, and house build number of infestation in quadrant and, later converted to percentages observations and recorded on, termite genera which damage beanCrops(*P .vulgaris*) and housing structure. .

3.4 Data analysis

Data was entered in to a computer and then checked for consistency and completeness. The data was analyzed using SPSS version 20.0 software package. Chi-square test at 5% probability level of figures and all tests were considered significant at $p<0.05$ with confidence interval 95%.

3.5 Ethical considerations

The study was carried out after obtaining ethical clearance from ethical committee collage of Natural Science, Jimma university than the objectives of the study was explained to the farmers and agricultural office of the districts at the time of samples collection, brief introduction related to impacts of termite pest, how the pest damage the crops and other related issues were given to the farmers and workers of the districts' agricultural office, especially to the farmers**.**

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4. Results

4.1 Socio- demography characteristics of respondents

Out of 180 contacted study participants, majority of the respondents were in the age groups 30-39, 38.8% followed by age group 18-29, 33.3%, age >60, 11.1%, age group 40- 49, 8.3%, and age group 50-59, 5.5%. Regarding to the sex of the respondents 81.1% males and 18.9% were females. With regard to educational characteristics 25% engaged in the level of read-write 57% respondents completed primary education, 18% completed secondary education. 72. 2% of the study participants depend on cultivation of crops, 10% of them were included in mixed farming and 17.8% were depend on livestock rearing for their lively hood. From the total respondents 180, most 126(70%) of them were coupled, 27(15%) single, 18(10%) divorced and 9(5%) of them were widowed. (Table 1**)**

Table 1: Socio-demographic characteristics of respondents in Melaka and Angary kebele, Yem district, SNNPRS, South Ethiopia (September, 2014-June, 2015)

Variables	Frequency	(%) respondents
Sex of respondents		
Male	146	81.1
Female	34	18.9
Age group (N=180)		
18-29	60	33.3
30-39	70	38.8
40-49	15	8.3
50-59	10	5.5
>60	20	11.1
Main occupation (N=180)		
Livestock production	32	17.8
Crop production	130	72.2
others	18	10
Ethnics		
Amara	5	2.75
Oromo	10	5.41
Yem	163	90.57
Hadiya	2	1.27
Religious		
Orthodox	113	63
Protestant	49	27
Muslim	16	9
Other	2	1.
Marital status		
Married	186	70
Divorced	18	10
Widowed	9	5
Single	27	15
Educational level		
Read-write	45	25
1-8th	102	18
9-12th	33	57

4.2 Sampling of termites from land use patterns

The relative effectiveness of the different methods of sampling termites and the number of termites genera captured from housing structure and bean crops were shown in (Table 2).The termite genera collected by random (casual) sampling method was 4 (40%) , while the termites genera collected by standardized belt transect sampling method was 10(100 %) of the termites genera recorded. With regard to the land-use patterns, from all the ten genera recorded 10(100%) termites genera collected from housing structure ,while six (60%) captured from bean crops. (Table 2)

Table 2percentage of termites collected by random and standardized belt transectmethods in two land-use patterns in Yem district, SNNPRS, South Ethiopia (September,2014-June, 2015)

land use patterns	Sampling methods		% collected Termites genera
	Random population sample responses	Standardized belt transect	
Human settlement area	*Macrotermes Amitermes Odontotermes*	*Crptotermes Odontotermes Macrotermes ,Microcerotermes Amitermes ,Microtermes Trinervitermes , Coptotermes Eremotermes ,Nasutitermes*	*10 (100%)*
Crops field	*Macrotermes Odontotermes Microcerotermes*	*Macrotermes, Microtermes , Amitermes , Coptotermes Microcerotermes*	6 (60%)
% collected Termites genera	4 (40%)	10 (100%)	

4.3 Diversity of termites

Two major families, four sub families and ten genera of termites were recorded. Accordingly, the first recorded family was *Termitidae* grouped under three sub families, namely, *Macrotermitinae, Amitermitinae* and *Nasutitermitinae.* The second recorded family was*Rhinotermitidae,* which has only one sub family called *Coptotermitinae.* The four identified

sub families, sub divided in to ten genera. Of the total ten genera, sub family *Macrotermitinae* and *Amitermitinae* each consisted four genera, family *Nasutitermitinae* consisted two genera and one genera was belongs to sub family *Coptotermitinae*.(Figure 2)

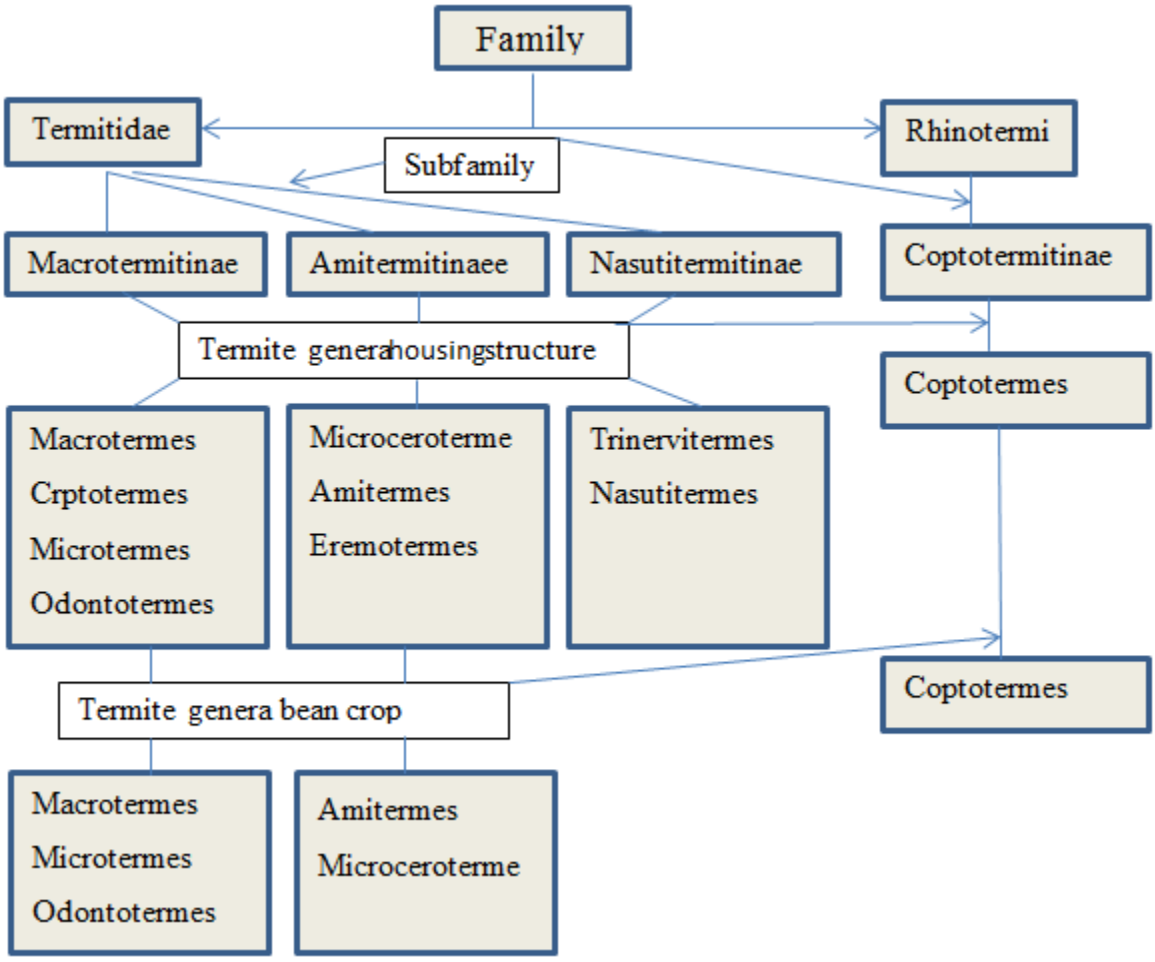

Figure 2: Termite genera in the study area

4.4 Abundance and distribution of termite pests

Of the total 200 collected termite genera, 104(52%) of them were collected from housing structures and 96(48%) collected from bean crops. On housing structures the dominant termite genera was *Odontotermes* constituting 24(12%) and on bean crops *Microtermes* and *Amitermes* genera constituting 24(12%) each. (Table: 3)The relative abundance based on the number of encounters of each genus within land-use types (Housing structure and bean crop) was shown in (Table: 3) .Out of 200 termite occurrences recorded from housing structure and bean crops.

M*acrotermes* occurred 26 times out of which 6% on housing structure and 7% on bean crop. *Macrotermes, Microcerotermes, Amitermes, Microtermes, Odontotermes and Coptotermes* occurred in both of the land-use patterns. *Odontotermes* were the most abundant in housing structure, *Microtermes and Amitermes were on bean crops.Coptotermes, Trinervitermes, Nasutitermes and Eremotermes* were only sampled from housing structures.

Table: 3 Termites genera per-land use pattern in Melaka and Angary kebele, Yem district, SNNPRS (September, 2014-June, 2015)

Termite genera	number(%) of termite genera		Total encounters
	Human settlement area N=104 (52%)	Crop field N=96(48%)	Total N=200(100%)
Macrotermes	12 (6)	14(7)	26 (13)
Microtermes	4(2)	24 (12)	28 (14)
Odontotermes	24 (12)	10 (5)	34(17)
Cyptotermes	6 (3)	0.0 (0)	6 (3)
Microcerotermes	6 (3)	20 (10)	26 (13)
Trinervitermes	6(3)	0(0)	6 (3)
Amitermes	10 (5)	24 (12)	34 (17)
Nasutitermes	8 (4)	0(0)	8 (4)
Eremotermes	14(7)	0(0)	14(7)
Coptotermes	14 (7)	4 (2)	18 (9)

Plate 2 Termite genera collected from been quadrant in Angry kebele (*March-May* 20

Plate 3 Identification of termite genera using microscopy in laboratory (2015)

4.5 Level of damage on housing structure and bean crops by termite pests

From 180 total houses, 52(29%) of them constructed from thatched roof with mud block wall, 121(67%) from thatched roof with wooden framewall and 7(4%) constructed from Corrugated iron roof with cement block wall. (Table 4) Out of the three houses made from mud block wall, from wood frame tenor walland fromCorrugated iron roof with cement block wall. Woody frame tenor wall houses infested severely 67%, mud block wall houses were the second for the exposure of damage constituting 29%, 4% of cement houses were the least infested by termite pests

Table 4:Types of House Construction materialsin Yem district, SNNPRS, South Ethiopia (September, 2014-June, 2015)

Typesof house construction	Noofinfestedhouse	% ofinfestedhouse
Thatched roof with wooden frame wall	121	67
Thatched roof with mud block wall	52	29
Corrugated iron roof with cement block wall	7	4

26.7% of infested houses had a life span of 11-15 years, 35% infested houses had a life span of 6-10 years, 14.5 % infested houses had a life span of 16 years and 1.7% infested houses had a life span of 1-5 years. (Table 5)

Table 5: Reported percentage infestation by age of houses in Yem district, SNNPR, South Ethiopia (September, 2014-June, 2015)

Age distribution of surveyed houses in year	Number of house infested by termites pest (n=180)	%of infested house by termites
1-5 year	3	1.7
6-10year	63	35
11-15year	48	26.7
Greater than 16	26	14.5

From a total 130 different kinds of crop cultivators in the study area, 61.5%cultivate bean, 21.5% wheat and 17% barely. As knotted in the result majority of the study area population cultivate bean crop, and at the same time the highest infestation rate were also recorded on bean crop. Thus the most infested crop type regardless of its abundance wasalso bean crop. Regarding the infestation of house structure and bean crop in the study area, according to the data collected from 180 total informants, 22.2% infestation was on their bean crop and the remaining 77.8% was on housing structure. When we compare the infestation severity of the two variables, housing structure was mostly vulnerable to termite pests. (Table: 6)

Table 6: Reported termite infestation on housing structure and on crops in Yem district, SNNPR, South Ethiopia (September, 2014-June, 2015)

Variable	Number of respondents	%of respondents
Major crops (n=130)		
Bean	80	61.5
Wheat	28	21.5
Barely	22	17
Severity of damage on (n=180)		
Bean crop	40	22.2
House structure	140	77.8

From a total 180 houses found in the study area 109 were found in Melaka kebele of which 18% were none infested by termite pest and 82% houses were infested by the termite pests. At the same time from 71 houses found in Angry 28.2% were none infested by termite pests and 71.8% house infested by termite pests, The association between infestation level and damaging level are highly correlated at significance value , $p< 0.05$) (Table 7)

Table 7 Reported termite infestation in Yem district, SNNPR, South Ethiopia (September, 2014-June, 2015)

Location (N=180)	Termite Infestation	No of respondents	% Of respondents
Melaka(n=109)	Termites not found in their houses	20	18
	Termites found in their houses	89	82
Angry(n=71)	Termites not found in their houses	20	28.2
	Termites found in their houses	51	71.8

Concerning the month of termite infestation, the month at which highest infestation rate recorded were June and September with the infestation rate of 90% and 84.4% respectively. The month of February and January were in which least infestation rate were recorded with 3.3% and 8.3%respectively (Figure3)

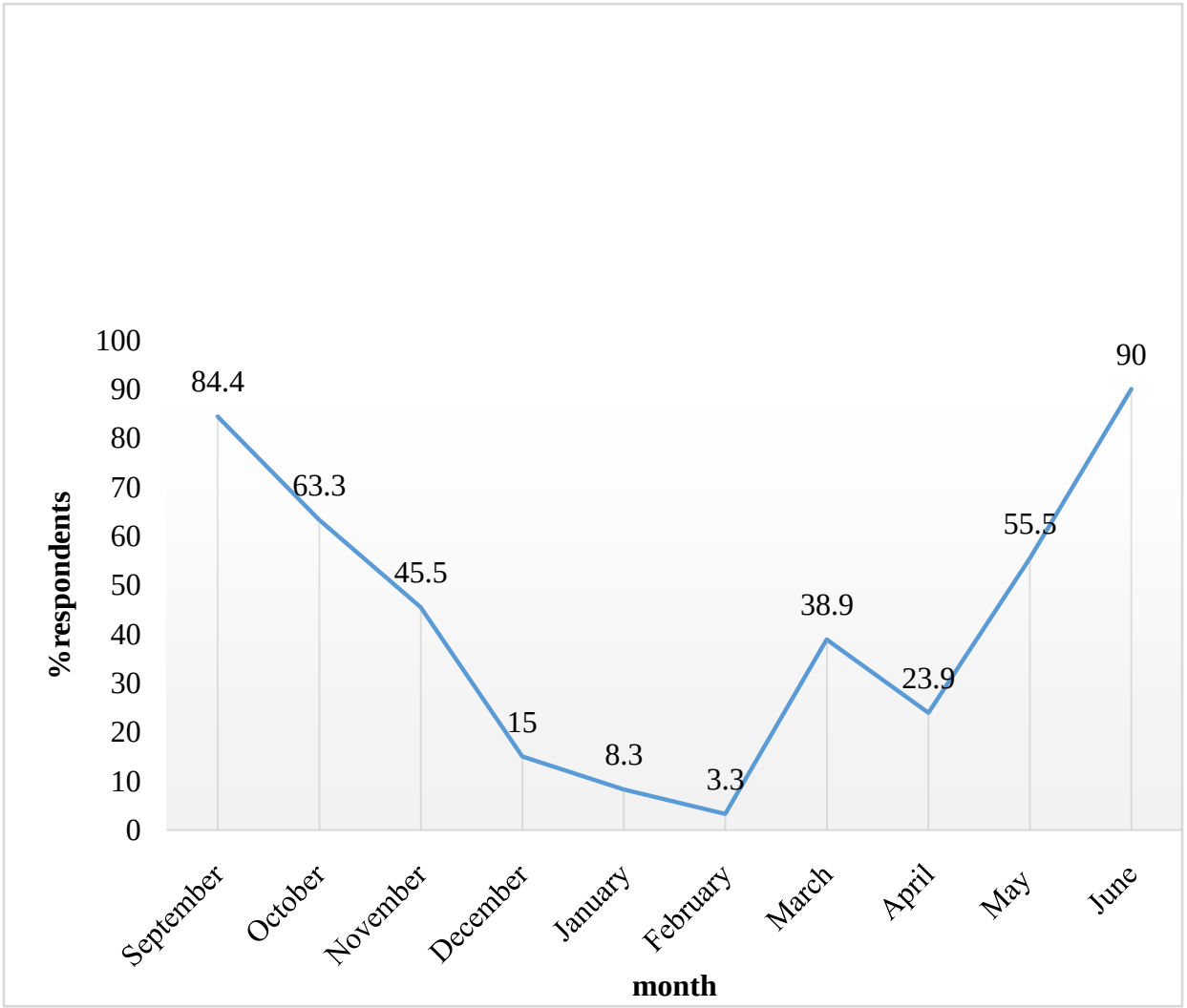

Figure 3 Reported termite infestation by respondents by monthin Yem district, SNNPR, South Ethiopia (September, 2014-June, 2015)

Regarding the question presented for the respondent on the termite distribution in relation to topography, out of 180 respondents 52% perceived the abundance of termite on Plain land, 36% on Steep slope land and 12% on gentle slope land. (Table 8)

Table 8 Reported **a**bundance of termites associate with topography in Yem district, SNNPR, South Ethiopia (September, 2014-June, 2015)

Topography	No of respondents	% of respondents
Plain	94	52
Gentle slope	22	12
Steep slope	64	36

Of the three types of termite observed infesting materials, majority 86(48%) infest dry woody, thus called dry wood termite, the second largest infestation were by Native subterranean termite which infested 70(39%) mostly both wood and crops, 24(13%) Formosan Subterranean termites which infested grasses, bean crops and other related crops (Table 4:9)

Table: 9 Reported types of termite infestation on different materials in Yem district, SNNPRS, South Ethiopia (September, 2014-June, 2015).

Termites	Materials	N=180	%
Native Subterranean Termite (family *Rhinotermitidae)*	Crop ,house wall	70	39
Formosan Subterranean Termite (*Termitidae)*	Grass, Bean, other related crops.	24	13
Dry wood Termite(Family *Kalotermitidae*)	House wall and roof	86	48

4.6 Field observation

Based on observation made three times, in the months of (September, October and Novembe,2014) infestation of bean stalks on quadrants, in the first round observation (September,2014) from a total observed 12 quadrant 4134 bean stalks, 7.69% infested by termite pest and 92.55% remained non infested. On the second round (October) observation from 12 quadrant 4653 bean stalks, 4.53% infested by the termite pest and 95.46% remain none infested by the termite pest. On the last round November (third observation) from the total 12 quadrant 4804 bean stalks 7.29% infested and 92.71% remained none infested. From the overall observations made three times, from 36 quadrants 13,591 bean stalks 6.47% were infested by termite pest and 93.61% remain none infested (Table 4.10) .In this observation one of my resultwere the general loss because of the termite pest on bean crops was 14.47%. This shows that the surrounding bean producers loss 14.47% bean product each year which is calculated using standardized formula of as shown by the following formula (Mandat*ed et al*., 2010) to know yield lose using formula

Yield loss (%) = Estimated potential yield without termite **i**nfestation* 100 %.)

Estimate yield loss due to termite infestation

Yield loss (%) =12722/879*100%=14.473

Table 10: data collected from quadrant to identifying yield loss due to termitein Yem district, SNNPR, South Ethiopia (September, 2014-June, 2015).

Survey Round	Quadrant	Total No of standcount	infested bean		Uninfected bean	
			Noof infested	%	No 0f Non infested	% of non infested
September	$25m^2X12$	4134	318	7.74	3826	92.53
November	$25m^2X12$	4653	211	4.54	4442	95.46
October	$25m^2X12$	4804	350	7.29	4454	92.71
Total	$75m^2x12$	13591	879	6.39	12722	93.61

Table 11 shows the association test between bean infestation status and quadrants. It was observed that, in the month of October 350, September 318 and November 211 bean crops infested by termite pests. The chi-square test was conducted at 5% significance level; it was observed that there were a significant association between bean infestation and month.

Table 11: Association between bean infestation status and level of damage in study area

Survey Round	Total stand count	Infestation status of bean	Chi-square	P-value
	, N=13,591	Infested N=879		
September	4134	318	35.6	0.000
October	4653	211		
November	4804	350		

4.7 Knowledge, attitude and practices of the community toward the impacts of termite infestations

Concerning the perception of the respondents toward termite pest, the study participants responded for the question presented for them, if termites has impact in their day to day life or not. Out of 180 respondents majority 140(77.8%) of them responded yes and 40 (22.2%) said NO. Most of the respondents agreed that the pest is still the major problem of the surrounding community in infesting almost all property of the community. The other question presented for them was, how they name and identify the pests. 40% of the respondents knew four types of termites, and had their own naming style depending on the presence or absence of vents on mounds, Size, color, shape of soldiers , workers and flight period of alates. Regarding termite prevention practice, out of 180 respondents 12% of them use petroleum oil as a preventive measure during house constriction, 8% use plastics, the remaining 80% never practiced any preventive measure.(table 12)

Table: 12 Percentage oftermite genera in Angry and Melaka kebele of Yem district, SNNPR (September, 2014- June, 2015)

Sample area	Sampling methods		% of collected termite generafrom each sample area
	Local name (popular)	Scientifically identified under microscope	
Human settlement area	"Ora" *Macrotermes*	*Crptotermes Odontotermes Macrotermes*	10 (100%)
	"sisal" *Amitermes*	,*Microcerotermes Amitermes* ,*Microtermes*	
	"Kulo" *Odontotermes*	*Trinervitermes* ,*CoptotermesEremotermes* ,*Nasutitermes*	
Crop field	"Ora" *Macrotermes*	*Macrotermes Microtermes* ,	6 (60%)
	"Kulo" *Odontotermes*	*Amitermes , Coptotermes*	
	"Qiu"*Microcerotermes*	*Microcerotermes*	
% of collected termite genera	4 (40%)	10 (100%)	

Table 13 shows the association between termite infestation and different characteristics using the chi-square statistical test. The covariates included in these association tests were the following: Construction, topography (Plain land, Gentle slope land, and Steep slope land), season (March-May, June, Sep-Nov, and Dec-Mar). There were a significant association between the construction material and the termite infestation. Moreover, it was observed that Thatched roof with wooden frame wall were more exposed for the termite. And for the questions which ask the attitude of the household for about termite preference on topography, there were observed significant association between topography and termite appearance. It was observed that June and September reported high number of termite infestation, which showed statistically significant association with termite infestation.

Table 13: Association between termite infestation and different covariates

Characteristics			Infested	Not infested	Chi-square	P-value
House Construction material		Non-woody	15	37	126.5	0.000
		Woody	81	40		
		Cement	1	6		
Topography	Plain	High	40	46	56.2	0.000
		Non	4	94		
	Gentle slope land	High	0	19	6.32	0.06
		Non	10	121		
	Steep slope land	High	40	76	28.37	0.000
		Non	10	64		
Season	March-May	High	0	46	17.65	0.000
		None	40	94		
	June	High	23	134	40.7	0.000
		None	17	6		
	Sept-Nov	High	40	23	95.1	0.000
		None	0	117		
	Dec-Mar	High	0	75	36.7	0.000
		None	40	65		

5. Discussion

Termite genera belonging to two family *(Rhinotermitidae* and *Termitidae*) four subfamilies (*Macrotermitinae, Amitermitinae Nasutitermitinae* and *Coptotermitinae*) and ten genera (*Crptotermes Odontotermes Macrotermes Microcerotermes Amitermes Microtermes Trinervitermes Eremotermes Nasutitermes and Coptotermes*) were recorded in the study area. The abundance of termite genera found during the study were two families, four sub families recorded on house structure and two families and three subfamilies recorded on bean stalk but subfamily *Nasutitermitinae* and genera; *Nasutitermes ,Cyptotermes ,Trinervitermes* and *Eremotermes* were not recorded on bean even if these four genera were not infestd bean crops .The idea was almost agree with the finding of Sekamatte that he noted that two sub-families of termites namely, *Macrotermitinae* and *Termitinae*. (Sekamatte, 2001).Further Sekamatte reported in his findings that the most abundant members were genera *Cubitermes* and *Macrotermes (*Sekamatte, 2001) unlike, my finding the most abundant termite genera dominant in the study area observed *Macrotermes, Microcerotermes, Amitermes, Microtermes, Odontotermes and Coptotermes* were dominated on housing structure and bean crops in the area.

The relative effectiveness of the different methods in sampling termites and the number of termite captured from two kebeles. The collected termites were counted by the method of genera identification under microscope. The identified and recorded termite categorized in to two families, four sub families and ten genera. Regarding to the random naming of the termite by the indigenous inhabitants four genera were recorded of the total termite identified. All the identified ten genera, collected from the area were captured from housing structure, while 60% genera were collected from bean field. Both the identified family showed characteristic of severely infesting housing structure and bean crops. From the identified ten termite genera the dominant one and has high level of infestation on housing structure and bean cropsin particularwere *Odontotermes, Microtermes Amitermes* genera. The findings of this study agree with the study conducted in Ethiopian rift valley by (Debelo and Degaga, 2014, Ahmed and French, 2008 and Abdurahman, 2000).

The results on the genera diversity and distribution show that, the termite groups belonging to two family four subfamily ten genera (40%) was recorded from the 25 termite genera reported earlier in the country by Abdurahman (Abraham, 1990). The indigenous inhabitants' call termites using different kinds of names, the name given to the termite by the local people was based on simple features of morphology and ecology, such as flight mode, alates, size, shape and color of termites, even soldiers, workers and alates were identified. The other naming method of the local people was based on the damaging future of materials. Example, they call *Odontotermes "*Sissa*"* as it damage beans and other vegetables slowly and call *Macrotermes* " Ora" which damage houses, mud building and any kind of woody plants. Likewise study revealed that termites were named locally by the local language of the community based on some future limited to few area farmers noted by (Nyeko and Olubayo, 2005). Further, local names of genera need to be compiled so that researchers and extension workers can communicate effectively with farmers on particular genera rather than using general names of pest groups such as termites, which comprise of over 3000 described species (Kambhampati and Eagleton, 2000). The informants responded, the level of termite damage on housing structure and crops particularly bean was the infested in the wet season. A similar consistent with the general notion that peak termite attack on biomass occurs during wet periods (Logan *et al.*, 1990). However, different kinds of studies reveals termites swarming appear in tropical environments early in the dry season, as the highest food demand for nymph maturation occurs during the subsequent dry season, and this suggests an adjustment in foraging to the needs of the colony (Lepage and Darlington, 2000). The other findings reported that enhance production of enormous amounts of biomass during wet periods and subsequent accumulation of soil feeder during dry season would help to meet the high food demands in dry season. (Mugerwa, 2009).In this regard, respondents pointed that the abundance of pestiferous species was remarkably higher on the Plain lands than Steep lands. Plain lands were mainly associated with (*Termitidae: Termitinae*), which are largely soil feeders and cause significant damage to bean.Termite infestations were correlated with different kinds of variables such as construction materials, season and topography. There is significant association between the construction and the termite infestation. For the questions which ask the attitude of the household about the termite topography preference, there was observed significant association between the Plain lands and termite appearance. This is

statistically significant association at 5% significance level. Similarly, studies agree the variability in levels of termite damage among various topographic classifications was attributed to the differing ecological conditions that resulted into varying distributions and abundance of termite species (Holt and Greens lade, 1979).

From the overall observations made on quadrant three times, from 36 quadrants 13,591 bean stalks 6.47% were infested by termite pest and 93.61% remain none infected. In this observation one of my findings was infestation of the termite pest on bean crops were14.47%. This shows the surrounding bean producer farmers' loss 14.47% bean product each year which is calculated using standardized formula of as shown by the following formula (Mandat*ed et al*., 2010) In the three rounds observations made, 36 quadrants 13,591 bean stalks 6.47% were infested by termite pest and 93.61% remain none infested The chi-square test was conducted at 5% significance level, it was seen that there is a significant association between bean infestation status and level of damage.

6. Conclusion and Recommendations

6.1. Conclusion

Termite pests were more abundant in wet than in dry season. Termites prefer plain land than other topographic futures. Termite pests, observed on housing structure and on bean crop. Termite genera belonging to two families, four subfamilies and ten genera (*Crptotermes Odontotermes Macrotermes Microcerotermes Amitermes Microtermes Trinervitermes Eremotermes Nasutitermes and Coptotermes.*) were recorded during the study. Two families, four sub families observed on housing structure and two families and three subfamilies were observed on bean crops. *Odontotermes, Macrotermes* and *Coptotermes* genera were the dominant recorded termite genera. *Nasutitermes, Cyptotermes, Trinervitermes* and *Eremotermes* genera were observed in scarce amount. Though the genera existed in scarce, they contributed in infestation of both housing structure and bean crops.The community house had not enough understanding in how to prevent the termite pest. Few individuals practiced the usage of cheap termites control measures such as, motor oil and frequent repairing and building of house per year. Most community of the area build houses from three different construction material, woody frame houses were the major house structure vulnerable to termite pest. From the total crop cultivated in thestudy area, bean was the most infested type by the termite pest

6.2 Recommendations

Based on the results of this study, the following recommendations were forwarded:

- Farmers should train and practice cultural and scientific methods of termite pest control methods.
- Agricultural pest control office should help farmers to use appropriate insecticide chemicals against the major insect pests. Because the desired effect of a pesticide can be obtained only if it is applied by appropriate method at appropriate time.
- Pest control professionals and other concerned bodies look for the possibility of using pesticides in necessary time and seasons.
- Training farmers on the prevention of termite pest by concerned body and experts, so that the economic deterioration and drought of the environment will compromised.

- Training the surrounding community on optional method of house construction which resists termite pests, such as mud blocks technology.
- For effective controlling method there should be constant pest monitoring and surveillance applied by agricultural office experts of the district.

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Annex: 1 Questionnaires

JIMMA UNIVERSITY

COLLEGE OF NATURAL SCIENCES

DEPARTMENT OF BIOLOGY

QUESTIONNAIRES TO BE FILLEDOUT BY INTERVIEWER

The main purpose of this questionnaire is to collect relevant information on the knowledge, attitude and practice of people on protection of house build & crop plant towards the effect of termites insects and its control in Yem district south west Ethiopia.

The objective of the study will realized only when you sincerely participate in giving valid and reliable information through this questionnaire. The researcher kindly requests your sincere response and acknowledges your cooperation to greater excellent.

House hold questionnaire for local community of Melaka and Angry Keble and surround

A. Introductory questions

1. Respondent Woreda…_____ Keble_____

2 Age_____ Sex_____

3. Religious A. Orthodox B. Protestant C. Muslim D. Other

4. Ethnics **A.** Amara B. Oromo C. Yem D. Hadiya

5. Marital status._____

6. Educational level a. no formal education_____

B. primary education (1-8) _____.

C. secondary education (9-12) _____.

D. beyond secondary education._____.

7. What is your livelihood activity?

a) Crop production b) keeping livestock c) Farming and livestock

Interview for peoples

1. Is there a pest that damages house build, crop plant and wood in your environment?

A/ yes B/ no

2. Do you know the name of the pests?

A/yes B/ no

3. Do you have knowledge towards the occurrence of the pest?

A/yes B/, no

4 When dose it occurs? Is it

A/ during short – rainy season

B/ during heavy- rainy season?

C/ during – dry season

5. In which season do the occurrence of the pest population is high and damages more? _____

6. Do you know the most damage termites' pest? _____ .

7. Do you know the incidence? _____

8. Does the pest attacks only house or other crop species? _____

9. Which part of the crop specially attacked by the pest?

A/ stem B/ root C/ leaf D/ seed

10. What kind of controlling method do you apply?

A/ cultural method B/ biological method

C/ chemical method

11. Dose the controlling method effective...

12. What measures do you think should be taken by the following in order to Prevent the crop damage caused by termite?

A/ by the agricultural office of the district

B/ by the private sectorsC/ by local community

13. To the best of your knowledge, have termites of any kind ever been found in your home? (Please circle one response)

a) No b) Yes

14a. If YES, in what year(s) or month was termites found in your home?

(Please indicate all years or month that termites

Were found_____

14. If termites have caused damage to your home while you have been the owner, please estimate the total Birr amount of damage. (Please check the most applicable response) _____

15. If termites have been found in your home, please signify which type of termite infestation occurred. (Please circle one answer)

a) Native Subterranean Termite

b) Formosan Subterranean Termite

c) Dry wood Termite

e) I don't know

16. In general, do you consider termites to be an existing problem for homeowners in your neighborhood? (Please circle one response)

a) No b) Yes c) I don't know

Interview for Crop protection experts,

Developmental agents and Head of district agricultural and developmental office

1. When dose termites occurs the first time in the district? _____

2. Is it major or minor termite's species for the environment? _____

3. In which season do Termites highly occurs and attacks the crop more?

   A/ during heavy –rainy season

   B/ during short – rainy season

   C/ during – dry season

4. Why do you think that the termite highly damages the crop in the Season?_____

5. From which developmental stage do the termite starts to cause damaging effect?

   A/ larva stage B/ pupa stage C/ adult stage

6. Which body part of the crop specially damaged the termite?

   A/ stem B/ root C/ leaf D/ seed

7. What kind of controlling method do you?

   A/ cultural B/ chemical C/ biological D/ other

8 Is there any other crop attacked by the termite? _____

9 Do you educate the farmers towards the different modes of protection against termite? _____

Annex: 2 plates

APPENDIX IV Plate of termites' Genera, Yem District, SNNP2014/2015

plate 4 Macrotermes, Microtermes and Amitermestermite . Collected from bean quadrant in Angry kebele. (September-October 2014)

Plate *5 Macrotermes, Microtermes and Amitermes*termite . Collected from bean quadrant in Melaka kebele. (September-October 2014)

Plate 6 *Macrotermes, Odontotermes, Microcerotermes, Amitermes and Coptotermes termite*. Collected from bean quadrant in Angry kebele. (August-June 2015)

Plate 7 .*Macrotermes, Odontotermes, Microcerotermes, Amitermes and Coptotermes*termite . Collected from bean quadrant in Melaka kebele. (August-June 2015)

Plate-8 different topography of Yem district September 2014

Plate 9 Termite genera collected from bean quadrant in Melaka kebeles. (September-October 2014