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Research Article

Termite Diversity, Abundance, Distribution and Level of Damage on Bean Crop (Phaseolus Vulgaris) and on Housing Structure in Yem District, Central Ethiopia, Regional State

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Abstract

Background: Termites are destructive pests that threaten agriculture and housing, especially in tropical regions. In Ethiopia, they significantly impact rural communities that depend on farming and traditional housing. This study in Yem Special District, SNNPR, aimed to evaluate the impact of termites on bean crops (Phaseolus vulgaris) and housing, focusing on their abundance, distribution, and economic effects on the community. Methods: A cross-sectional study was conducted in two kebeles, Melaka and Angery, with 180 participants selected from 666 households using proportional random sampling. The study surveyed 180 houses and 12 bean fields to identify termite genera and measure infestation. Data on housing and crop impacts were analyzed using SPSS, with chi-square tests assessing correlations between infestation and factors such as topography, season, and construction materials. Results: Two termite families comprising four sub-families and ten genera were identified, with Amitermes, Eremotermes, and Odontotermes being predominant (12%). Termite infestation affected 7.29% of 4804 bean stalks, causing a 0.07% yield loss. Housing structures built with untreated wood or in low-lying areas were more prone to infestation, with 36.7% of infested houses lasting under ten years. Indigenous preventive measures were reported but were largely ineffective. Termite infestation was significantly linked to construction materials, topography, and season ($p < 0.05$). Conclusion: Termites significantly impact bean crop yields and housing durability in Yem Special District, leading to economic strain on the community. Traditional preventive methods were inadequate, highlighting the need for modern termite management strategies, improved construction materials, and enhanced pest control measures to protect agricultural productivity and housing stability.

Keywords

Adjacent Soil, Genera Diversity, Ethanol, Bean Crop, Termite, House

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1. Introduction

Termites are social insects of the order Isoptera with about 3000 species [16, 12, 22]. Termites are predominantly distributed in tropical environment with the highest species richness in equatorial rainforest and generally declining with increasing latitude [25]. Africa is by far the richest continent in termite diversity [10]. Termites were important pests of building, timbers, forestry and crops in Africa general, damage by termites is greater during dry periods or droughts than Periods of regular rainfall, in lowland than highland areas, and in plants under stress [23].

Termites are social insects found mainly in the tropics between 450 north and 450 south latitudes. These distribution areas cover over two-thirds of the landmass [3]. 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 [10]. Despite their economic importance, limited published economic loss studies due to termites and related costs of protecting crops and houses/structures currently exist [20].

Termites are very serious Pests in several parts of Ethiopia, particularly in the Western parts of the country [2]. 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 Western Ethiopia, that roof huts are destroyed in less than five years and corrugated iron roof houses in less than eight years.). Records of termites from Ethiopia indicate 61 species belonging to 25 genera and four families (Kalotermitidae, Hodotermitidae, Rhinotermitidae and Termitidae) [4]. According to Rwabwoog [19] 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, [19]. 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 [7, 9]. Any material that incorporates cellulose can be devoured by termites, from paper to palaces (building) and fungi to fir trees. 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 [24]. 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 [11]. Stressed trees are generally the most susceptible to infestation.

Dry wood termites (Kalotermitidae) live and feed in dead wood, but sometimes infested 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 [18]. Infest 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 [5]. This study was initiated to assess the impact of termite genera on housing structure and Bean crop (Phaseolus vulgaris) in some selected kebele's of Yem special district, SNNPRS, South Western Ethiopia.

2. Materials and Methods

2.1. 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 70 37'N Latitude, 300 54' E longitude and an altitude of 1000- 2939 meters above sea level. The maximum temperature and minimum temperature is 300c and 120c respectively and the annual rain fall ranges between 802 - 1400 mm [17]. Most of the study participants 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 in-

cluded 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.

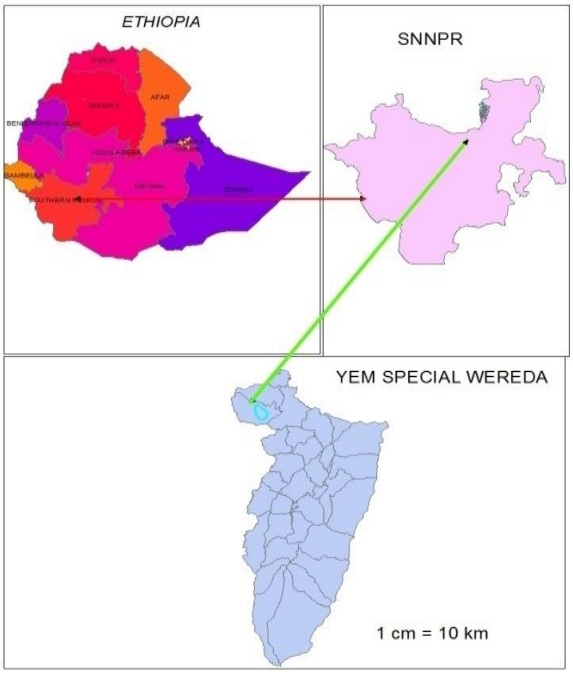

Figure 1. *Study sites in Yem districts of South Nation Nationality and People Regional State South Western Ethiopia (Source: S.N.N.P.R, Yem district Agricultural office).*

2.2. Survey

2.2.1. Study Design

Field survey for the part of pilot study was conducted at the beginning of the study period and then a cross sectional 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 purposely, 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.

2.2.2. Sample Size and Sampling Techniques

To conduct the research samples of 180 household heads were selected randomly [6], 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

$$n = N Z^2 P (1-P)$$

$$d^2 (N- 1) +Z^2 P (1-P)$$

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'= (N Z2 P (1-P) = 666x(1.96)2x0.2(1-0.2) = 409.297 ≈180

d2 (N- 1) +Z2P(1-P) (0.05)2(666-1)+(1.96)2x0.2x(1-0.2) 2.28

2.2.3. Data Collection Instruments

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

2.2.4. 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 Angery) 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 by household head farmer from the selected kebeles.

Figure 2. *Focus group discussions with Yem district agriculture office expert and house holder heads 2023.*

Focus group discussion was held with kebele administrative workers regarding the overall information about the infestation of termite on crops and materials (Figure 2). 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:

1. Severity of termite impact on crop plants particularly beans.
2. Distribution of termite genera on house building structure and crop plants particularly beans.
3. At which season the incidence of termites high

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 impacts of different genera in different seasons and level of infestation refers to bean Crops (*Phaseolus vulgaris*) and housing structure.

Termites sampling and identification

The study was carried out from September 2022 to January 2023 in two selected kebeles. Termite sample collection was made using bicker, petri dish, forceps, collection net and decayed logs [13]. Termite samples were collected from each of six transects (5mX5m plot) per kebele and separately preserved in 80% ethanol and later identified to species level using dissecting microscope and standardized FAO zoological key [1]. In each visit the entire area of the plot was searched for the presence of termite. Collection was made in September for wet season and in January for dry season. Concurrently damaged bean crop, and housing structure was investigated to determine the level of damage in dry and wet season. Thus, field observation was made by using a total of 12 quadrants, six farmer fields from each selected kebeles. Yield loss was determined using the following formula.

$$Yield\ loss = \frac{Estimated\ yield\ loss\ due\ to\ termite\ infestation}{Estimted\ potential\ yield\ without\ termite\ infestation} 100\%$$

2.3. Data Analysis

A combined analysis of variance across sites was conducted using SPSS /version 20 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 percentage observations and recorded on termite genera which damage bean Crops (P. vulgaris) and housing structure.

Data were 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%.

2.4. Ethical Considerations

The objectives of the study was explained to the respondents and to the concerned body brief introduction related to impacts of termite pest, how the pest damage the crops and other related issues were illustrated to the farmers and workers of the districts' agricultural office. On the hand the study community was asked for verbal consent about their right of answering or rejecting the question.

3. Results

3.1. Sampling of Termites from Different Housing Structure and on Bean Crops

The number of termites genera captured from housing structure and bean crops were shown in (Table 1). The termite genera collected by standardized belt transect sampling method was 10(100 %) of the termites genera recorded. With regard to two sample area 10(100%) termites genera collected from housing structure, while six (60%) captured from bean crops field. (Table 1)

Table 1. *Percentage of termites collected by standardized belt transect methods on housing structure and bean crops field in Yem district, SNNPRS, South Western Ethiopia September, 2022.*

Variables	Sampled termite genera	#Collected Termites genera
Housing structure	Crptotermes, Odontotermes, Macrotermes Microcerotermes, Amitermes, Microtermes *Trinervitermes, Coptotermes, Eremotermes Nasutitermes*	*10*
Bean crops field	*Macrotermes, Microtermes, Amitermes, Coptotermes and Microcerotermes*	6
% collected Termites genera	10 (100%)	

3.2. Distribution of Termites

Two 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 (Table 2).

Table 2. *Termite genera recorded from the housing structure and bean crops field.*

Family	Subfamily	Termite genera house structure	Termite genera bean organs
Termitidae	*Macrotermitinae*	Macrotermes Crptotermes *Microtermes* *Odontotermes*	*Macrotermes* *Microtermes* *Odontotermes*
	Amitermitinae	*Microcerotermes* *Amitermes Eremotermes*	*Amitermes* *Microcerotermes*
	Nasutitermitinae	*Trinervitermes* *Nasutitermes*	
Rhinotermitidae	Coptotermitinae	Coptotermes	Coptotermes

3.3. 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. Macrotermes 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 on housing structure and bean crops. 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. *Percentage of termites genera on housing structure and bean crops in Melaka and Angery kebele, Yem district, SNNPRS South Western Ethiopia (September, 2022-June, 2023).*

Termite genera	Number (%) of termite genera		Total encounters
	Housing structure 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)

Termite genera	Number (%) of termite genera		Total encounters
	Housing structure N=104 (52%)	Crop field N=96(48%)	Total N=200(100%)
Nasutitermes	8 (4)	0(0)	8 (4)
Eremotermes	14(7)	0(0)	14(7)
Coptotermes	14 (7)	4 (2)	18 (9)

Figure 3. *Identification of termite genera using microscopy in laboratory 2023.*

3.4. Impacts of Termite Pests on Housing Structure and Bean Crops

From 180 total houses, 52(29%) of them constructed from thatched roof with mud block wall, 121(67%) from thatched roof with wooden frame wall 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 wall and from Corrugated 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 materials in Yem district, SNNPRS, South Western Ethiopia (September, 2022-June, 2023).*

Types of house construction	No of infested house	% of infested house
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 Western Ethiopia (September, 2022-June, 2023).*

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

Age distribution of surveyed houses in year	Number of house infested by termites pest (n=180)	%of infested house by termites
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 noted in the result most of the study area (Melaka and Angery kebele) population cultivate bean crop, and at the same time the more infestation rate were also recorded on bean crop. Thus, the most infested crop type regardless of its abundance was also 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 Western Ethiopia (September, 2022-June, 2023).*

Variable	Number of respondents	%of respondents
Major crops (n=130)		
Bean	80	61.5 21.5
Wheat	28	17
Barely	22	
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 Angery 28.2% were none infested by termite pests and 71.8% housing structure infested by termite pests. The association between infestation level and damaging level are highly significance at $p< 0.05$) (Table 7).

Table 7. *Reported termite infestation in Yem district, SNNPR, South Western Ethiopia (September, 2022-June, 2023).*

Location (N=180)	Termite Infestation	No of respondents	% Of respondents
Melaka(n=109)	No	20	18
	Yes	89	82
Angery(n=71)	No	20	28.2
	Yes	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 (Figure 4).

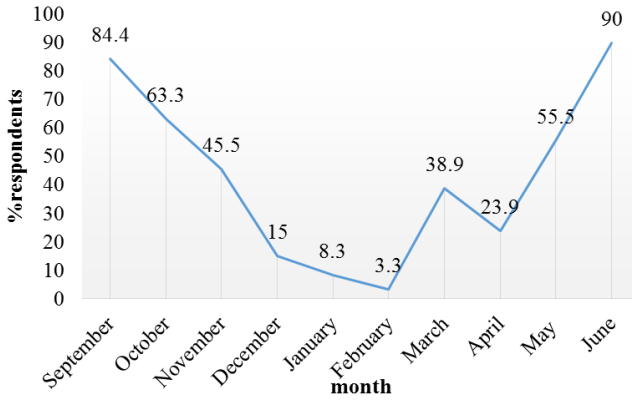

Figure 4. *Reported termite infestation by respondents by month in Yem district, SNNPR, South Western Ethiopia (September, 2022-June, 2023).*

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 abundance of termites associate with topography in Yem district, SNNPR, South Western Ethiopia (September, 2022-June, 2023).*

Topography	No of respondents	% of respondents
Plain land	94	52
Gentle slope land	22	12
Steep slope land	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 9).

Table 9. *Reported types of termite infestation on different materials in Yem district, SNNPRS, South Western Ethiopia (September, 2022-June, 2023).*

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

3.5. Field Observation

Based on observation made three times, in the months of September, October and Novembe,2022 infestation of bean stalks on quadrants, in the first round observation September, 2022 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 10). In this observation the general loss because of the termite pest on bean crops was 0.07%. This shows that the surrounding bean producers loss 0.07% bean product each year which is calculated using standardized formula of as shown by the following formula [15, 8] sited in [14] to know yield lose using formula.

$$\text{Yield loss} = \frac{\text{Estimated yield loss due to termite infestation}}{\text{Estimted potential yield without termite infestation}} 100\%$$

$$\text{Yield loss (\%)} = \frac{879}{12722} * 100\% = 0.069 \approx 0.07\%$$

Table 10. *Data collected from quadrant to identifying yield loss percent due to termite in Yem district, SNNPR, South Western Ethiopia (September, 2022-June, 2023).*

Survey Round	Quadrant	Total No of stand count	infested bean		Uninfected bean	
			No of 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 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		
October	4653	211	35.6	0.000
November	4804	350		

3.6. 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. *Reported percentage of termite genera in Angry and Melaka kebele of Yem district, SNNPR South Western Ethiopia (September, 2022- June, 2023).*

Sample area	Sampling methods		#collected termite genera from each sample area
	Local name (popular)	Scientifically identified under microscope	
Human settlement area	*"Ora" Macrotermes*	*Crptotermes Odontotermes Macrotermes*	10

Sample area	Sampling methods		#collected termite genera from each sample area
	Local name (popular)	Scientifically identified under microscope	
Crop field	"sisal" *Amitermes*	*Microcerotermes Amitermes, Microtermes*	6
	"Kulo" *Odontotermes*	*Trinervitermes, Coptotermes Eremotermes, Nasutitermes*	
	"Ora" *Macrotermes*	*Macrotermes Microtermes,*	
	"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		

4. Discussion

The study identified termite genera belonging to two families, Rhinotermitidae and Termitidae, across four subfamilies: Macrotermitinae, Amitermitinae, Nasutitermitinae, and Coptotermitinae, encompassing ten genera: Cryptotermes, Odontotermes, Macrotermes, Microcerotermes, Amitermes, Microtermes, Trinervitermes, Eremotermes, Nasutitermes, and Coptotermes. Termites infested housing structures and bean crops, with varying distribution patterns. Subfamily Nasutitermitinae and four genera (Nasutitermes, Cryptotermes, Trinervitermes, and Eremotermes) were absent from bean crops but present in housing structures.

The findings align partially with previous studies, such as Sekamatte [21] (and others from Ethiopia, which noted different dominant genera and patterns. The dominant and most damaging genera identified in this study were Odontotermes, Microtermes, and Amitermes, significantly affecting both housing structures and bean crops. Termite distribution and abundance varied by topography, with infestation being higher in plain lands compared to steep areas, attributed to ecological conditions favoring certain species.

Local communities used indigenous naming systems for termites based on their morphology, behavior, and damage characteristics. For instance, Odontotermes was called "Sissa" for its slow damage to crops, while Macrotermes was known as "Ora" for its destructive impact on buildings and woody plants. These local naming conventions underscore the importance of integrating local knowledge into termite management strategies.

The study found that termite infestation on bean crops was higher during the wet season, consistent with earlier findings that termites are more active during this period due to increased biomass production. Despite this, infestation rates on bean stalks were relatively low (6.47%), with an annual crop loss of only 0.07%.

Statistical analysis revealed a significant association between termite infestation and factors such as season, topography, and construction materials. The findings emphasize the need for targeted pest management strategies that consider ecological and seasonal variables, as well as the incorporation of indigenous knowledge into extension services and pest control initiatives.

5. Conclusion

This research has revealed that termites were serious pest of housing structure and bean crops of resource, farmers were well aware of problem. Macrotermes, Microcerotermes, Amitermes, Microtermes, Odontotermes and Coptotermes larger extent and Nasutitermes, Cyptotermes, Trinervitermes and Eremotermes to a lesser extent were the termites genera found causing damage to housing structure. the farmers had attempted a number of traditional control methods mostly plastic sheets and painting use of petroleum oil, but they were ineffective. Other than the traditional management options attempted, the home owners had no awareness regarding what measures they may take or whom to contact in order to safeguard their homes and crops.

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 recorded crop cultivated in the study area, bean was the most infested type by the termite pest.

Few persons realized that the safest and cheapest termite control measures are dusting of borates frequent repairing and rebuilding of house within a few years is uneconomical for subsistence farmers besides, it has negative environmental impacts as plants are the major source for building materials. Therefore, farmers should be given awareness about the general views of termites and ways by which they can protect their house and crops from damage. Therefore, there is a need for comprehensive termites control approaches, which should involve both the local communities, concerned government bodies and more use of resistant wood species.

The results of this study will help as a base line information for designing and implementing local termite protection and control intervention strategies, especially to the Yem special Woreda and studied kebeles.

6. Recommendations

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

1) Farmers should train and practice cultural and scientific methods of termite pest control methods.
2) 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.
3) Training the surrounding community on optional method of house construction which resists termite pests, such as mud blocks technology and should involve communities, concerned government bodies and more use of resistant wood species.
4) For effective controlling method there should be constant pest monitoring and surveillance applied by agricultural office experts of the district.

Abbreviations

ACQ	Ammonia Cal Copper Quat Compound
℃	Degree Celsius
CCA	Chromate Copper Arsenate
CNRS	Centre National de la Recherch é 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 Stat

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Author Contributions

All authors were involved in analyzing and interpreting the data, drafting and revising the manuscript as well as approved the final manuscript.

Conflicts of Interest

Authors declared that there was no competing interest.

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