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Preliminary studies on termite damage on rural houses in the Central Rift Valley of Ethiopia

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Termites are serious pests of agricultural crops and rural houses in Ethiopia. Some attempts were made to control termites on crops. However, termite problem on rural houses is a neglected area regardless of the intensity of the problem which at times results in total collapses of newly constructed houses. To collect preliminary information on status of termite infestation to rural houses, surveys were conducted in three districts of the Central Rift Valley of Ethiopia in 2012. Data were collected by direct observations and through semi-structured interviews. A total of 58 houses were inspected in the three districts of which 91% were termite infested at deferent levels. About 81% of the houses aged less than 10 years. Over half of the homeowners used pre-construction preventive measures such as plastic sheet cover and painting with used engine oil. Even though termite infestation was common and serious, only 35% of the homeowners took post construction preventive measures mainly because of lack of knowledge on the problem. The post construction termite control methods used in the study area were removing or scratching mud tubes from the infested parts and painting of the houses with used engine oil. There was no evidence of using synthetic chemicals for the management of termites on rural houses. The local government officials or Development Agents were not aware of termite problems in rural houses as the problem was only seen as a secondary problem. Termite samples were collected from houses, wooden fences and mounds built attached to the exterior walls of the houses. The collected termites were only from the genera *Macrotermes* and *Odontotermes* where about 79% was found to be from the former genus. This study explicitly indicated that termites have a great impact on local houses leading to frequent repairing and rebuilding. This damage will eventually lead to deforestation and environmental degradation in addition to its economic impact and spread of the termites. According to key informants of the study areas termite resistant tree species became rare and/or went extinct since they are used for all types of construction. In this study, preliminary information which can clearly demonstrate the level of termite infestation on local houses was obtained which can serve as an important input for the government both for awareness creation and developing best termite management practices.

Key words: *Macrotermes*, *Odontotermes*, rural houses, survey, termites, termite control measures.

INTRODUCTION

Termites are social insects which belong to the insect order Isoptera. Termites are an essential member of the soil ecosystem and are found throughout the world (Abdel and Skai, 2011). They are the most important and most efficient lignocellulose decomposers. Though termites have beneficial values such as organic matter

recycling, improving soil fertility and serving as food sources for other animals, they have also harmful effects which include damage to crops, forestry and wooden structures (Changlu et al., 2009; UNEP, 2000). Damage may extend to household furniture, paper products, many synthetic materials and food items. Each year hundreds of thousands of structures such as bridges, dams, decks, homes, retaining walls, roads, utility poles, and underground cables and pipes require treatment against termites (UNEP, 2000).

Of about 2800 described species of termites, 185 species are known as pests of agricultural settings and housing structures (Krishna and Weesner, 1970). The number of species causing damage to building is between 70 and 80 out of which 50 species are serious pests that require management (Edwards and Mill, 1986; Pearce, 1997).

More than 1,000 of the 2,600 recognized species of termites are found in Africa (UNEP, 2000). Some of the most economically important wood feeding species of termites found in the tropics, sub-tropics and temperate regions are in the genera *Coptotermes, Odontotermes, Macrotermes*, *Microcerotermes*, *Microtermes*, *Reticulitermes Ancisrotermes*, *Schedorhinotermes* and *Pseudacanthotermes* (Abdurahman, 2000; Ahmed and French, 2008).

Within the wide limits of their geographical distribution, termites will destroy all unprotected timber used in construction work or as fittings, unless it has been rendered toxic, unpalatable or is naturally resistant to termites (Harris, 1971). Termites may attack timber anywhere in a building from below floor level to the highest point in the roof. The workers of most subterranean species enter from the soil, either directly into timber, through cracks in concrete flooring or by constructing shelter tubes over brick or concrete footings and walls (Edwards and Mill, 1986).

The annual economic cost of structural damage to buildings from termites in urban areas is about $ 15-20 billion dollars worldwide (Geer, 2005; Abdel and Skai, 2011).

In the majority of the local houses in developing country like Ethiopia, the wall is made of mud, while the roof is grass thatched which is conducive for termite infestation. Thatching in African houses can be expected to last 5 to 6 years (Pearce, 1997). The wood/straw thatch buildings, characteristics of farming communities in Ethiopia and much of sub-Saharan Africa are susceptible to termite damage, particularly in the tropical savanna areas where Macrotermitinae are abundant. Abdurahman (1990) 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.

The Central Rift Valley of Ethiopia is among the termite prone regions of the country probably next to western Ethiopia. However, no information is available on the severity of termites particularly on the local houses from this part of the country. Hence, the current study was initiated with the following objectives:

(a) To survey termite damage to rural wooden houses;
(b) To collect information on public opinion concerning termite damage to local houses and control practices used by the local people, and
(c) To identify termite species infesting local houses.

MATERIALS AND METHODS

Description of the study sites

Surveys of termite infested houses were conducted in four Peasant Associations (PAs) of three districts of the Central Rift Valley of Ethiopia. The PAS were Tuqa Langano (08°16'N, 38°55E,1686 masl) in Bora District, Oda Boqota (08°10'N, 38°50'E, 1666 masl) in Dugda District, Warja Washgula (07°56'N, 38°41'E, 1652 masl) and Garbi Widana Boramo (07°53'N, 38°41E, 1650 masl,) in Adami Tullu Jiddo Kombolcha District (Figure 1). The Central Rift Valley is well-known for its biodiversity and the vegetation is characterized by Acacia trees or species (Huib and Herco, 2006). The study sites were characterized by semi-arid climates. The average annual precipitation was about 700 mm of which 42% falls between June and September. The monthly maximum temperature varies from 25 to 30°C and the minimum temperature ranges between 10 and 20°C (Huib and Herco, 2006). The mean annual temperature was 20°C. The driest months were November and December, while May is the hottest month with a mean maximum temperature of 28°C. December is the coldest month with a mean minimum temperature of 10°C. The greatest proportion of the land is grown with maize and haricot bean (Mengistu, 2008).

The surveys were carried out from September 2012 to January 2013 just after the long rainy season which is said to be the highest termite activities period. Selection of the districts was proposed by the Agricultural Bureau at zonal and district levels based on termite abundance and accessibility.

Survey methods and data collection

The surveys were conducted using an open-ended semi-structured questionnaire and interviews with the homeowners, and observation of termite infested houses. The questionnaire was dispatched to 51 farmers selected randomly from the four PAs of the three districts and the respondents' filled the questionnaire with the help of Development Agents. Short training was also given to the farmers on how to fill the questionnaire. A total of fifty-eight homeowners, different from those who filled the questionnaire, were selected randomly and their houses were assessed for termite infestation.Before carrying out the assessment and the interview, each homeowner was asked whether his/her house was infested by termite or not. Termite infestation assessment to houses comprised of visual observation of signs such as termite galleries (mud tubes) on walls, pores in walls, damaged parts such as roofs (wood and

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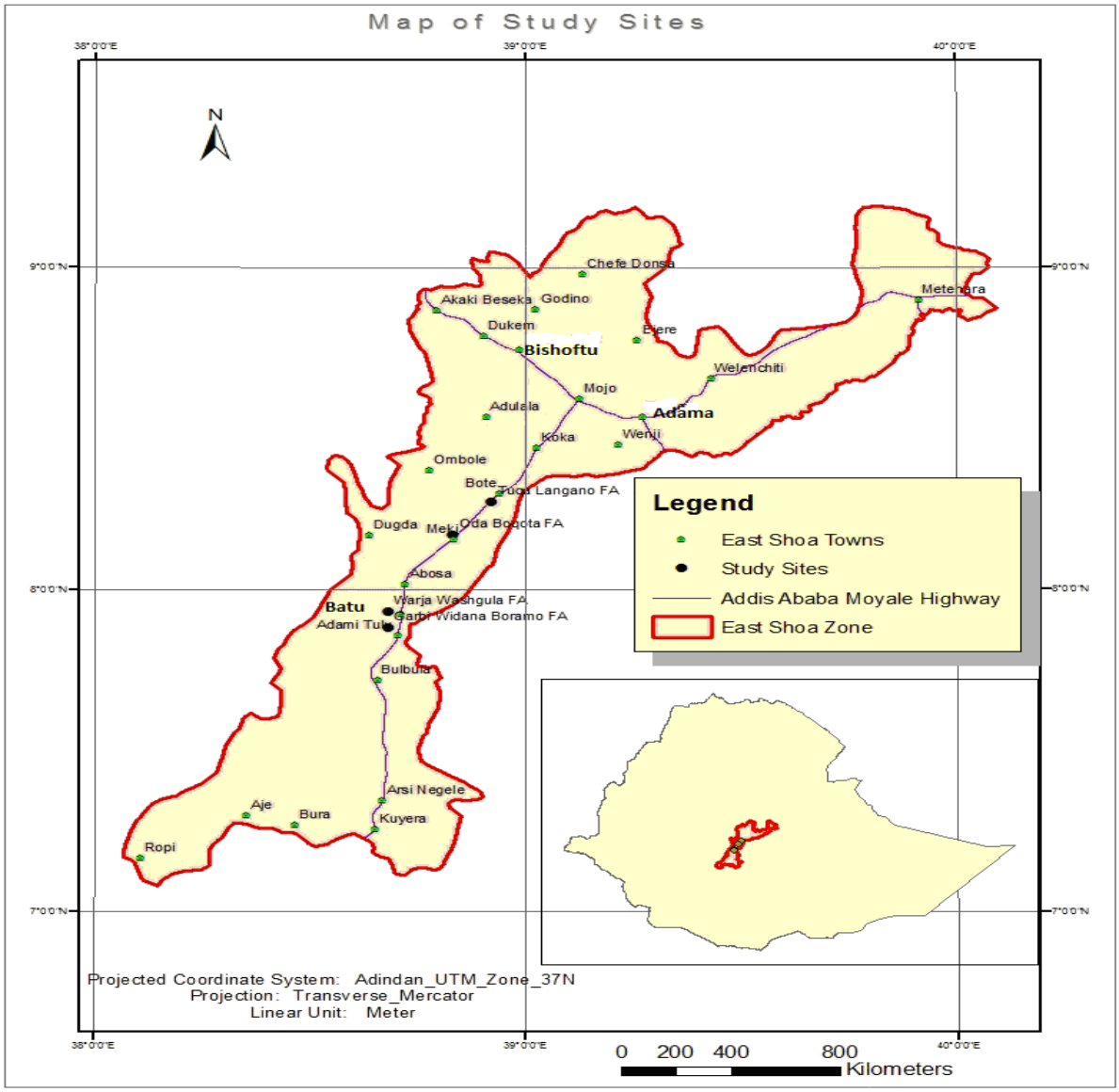

Figure 1. Map of the study sites.

grass), window and door frames, wood in walls and wooden furniture among others. Pieces of wood in the premises and wooden fences were also inspected for those houses which had wooden fences.

The age of the houses and when the wall was made of wood, the type of plant from which the wood came were also recorded by asking the owners. A house was said to be infested when there was any sign of termite attack to the house itself, furniture found in it, presence of mud tubes on walls or floors and spots of fecal pelletamong others. When a house was found infested, its condition was recorded as:

1. Slightly infested: Mud tubes on walls, roof, window and door frames, presence of mounds found externally at the base of walls and inside houses without any sign of damage or little damage.
2. Moderately infested: Woods in wall, window and door frames, grass in grass thatched roofs or woods supporting roofs partially eaten, but were not cut completely.
3. Severely infested but not collapsed: Window, door frames, some of the woods in wall and/or roof were eaten and cut completely, grass in roof thatched houses was eaten and the house drips as a result, window and/or door frames were cut and left their original normal position, or as a result of termite attack the house was tilted and was about to collapse.
4. Collapsed: The house was highly damaged and as a result tilted and the owner supported it by wooden pole to prevent it from collapsing, or totally collapsed.

Preconstruction preventive methods and post construction control measures used by the homeowners, type of wood in wooden wall houses, resistance level of the wood to termites, availability of the plants were recorded during the interviews. Termites were collected and preserved in 80% alcohol and were later identified with the help of taxonomic keys of Abdurahman (1991). Plant species used for the construction of the houses were identified at the National Herbarium of Addis Ababa University, using freshly collected plants

Table 1. Percent termite infestation on rural houses as affected by age.

Age distribution of the surveyed houses in year (n=58)	Percentage of houses belonging to each age group	Percentage houses infested by termites
1-3	20.7	19.0
4-6	44.8	39.7
7-9	17.2	15.5
10-12	10.3	10.3
13-15	5.2	5.2
16+	1.7	1.7

Table 2. Percent termite infested houses in relation to construction materials.

Wall material of the houses	Number of houses surveyed	Status of the houses in terms of termite infestation	
		none infested	Infested
Mud brick	35	8.6	51.7
Wood	23	0.0	39.7
Total	58	8.6	91.4

of the same species.

Data analysis

As the study was none replicated experiments descriptive statistics such as mean and percentage among others were used to determine termite infestation on rural houses. Data collected from respondents and participants were qualitatively interpreted.

RESULTS

Table 1 depicts the effect of age on termite infestation. Houses aging from 1 to 3 years were less infested than old houses greater than 7 years. Over 65% of the studied houses were less than 7 years old and the highest percent termite infestation for this age group houses were about 40%. Table 2 demonstrated that about 60% of the surveyed houses were made of mud brick, while 40% of them were wooden wall. Only 8.6% of the houses were free of termite infestation (Table 2). About 55% of the respondents indicated that within 1 to 2 years time newly built houses can be infested by termites. Less than 5% of the respondents indicated that newly built houses can be infested by termites within 7 to 8 years (Figure 2). Over 50% of the respondents indicated that newly built houses require repair within 3 to 4 years. Less than 5% of the respondents indicated that houses may require repair at greater than 8 years old (Figure 3).

Over 45% of the surveyed houses were 4 to 6 years old, while only 3% of the surveyed houses were greater than 16 years old (Figure 4). Nearly 50% of the surveyed houses were rated as severely termite infested houses, while 3% of the houses collapsed due to termites (Figure 5).

Samples of pictorial descriptions of termite infested houses are shown in Plates 1 to 3. The plates demonstrate a roof supporting timber completely cut by termites (Plate 1), termite infested houses supported by poles (Plate 2) and severely damaged door frame (Plate 3).

Both susceptible and resistant plant species were used for the construction of the surveyed houses (Table 3). *Acacia tortillis*, *Eucalyptus* spp., *Acacia albida*, *Balantes aegyptus* and *Croton macrostachyus* were the susceptible plant species used for the construction. The resistant plant species used in the construction include *Acacia etbaica*, *Dichrostachys cinera*, *Flueggea virosa* and *Acacia Senegal*.

Plastic sheet cover followed by used engine oil before construction and mud tube removal followed by wood ash and used engine after construction were found to be the major termite management options in the study areas (Table 4). About 79% of the termites causing damage to houses in the study area were the genus *Macrotermes*, while the rest 21% consists of the genus *Odontotermes*.

DISCUSSION

The absence of very old houses, the infestation of most of the houses, and severe damage recorded show frequent rebuilding of houses and termite severity to rural houses. Most of the farmers believed that houses would collapse if they were not repaired within six years after

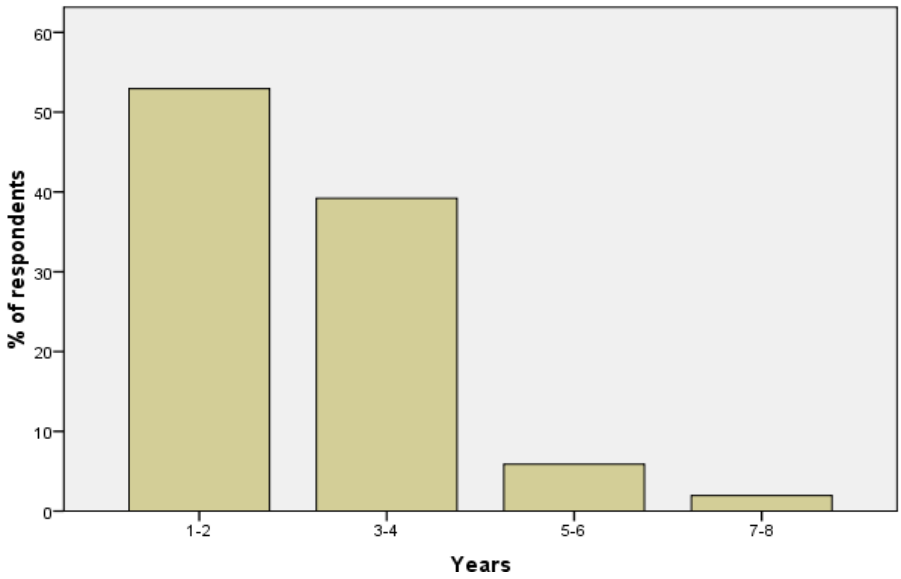

Figure 2. Percentage respondents showing years after which newly constructed houses can be infested by termites.

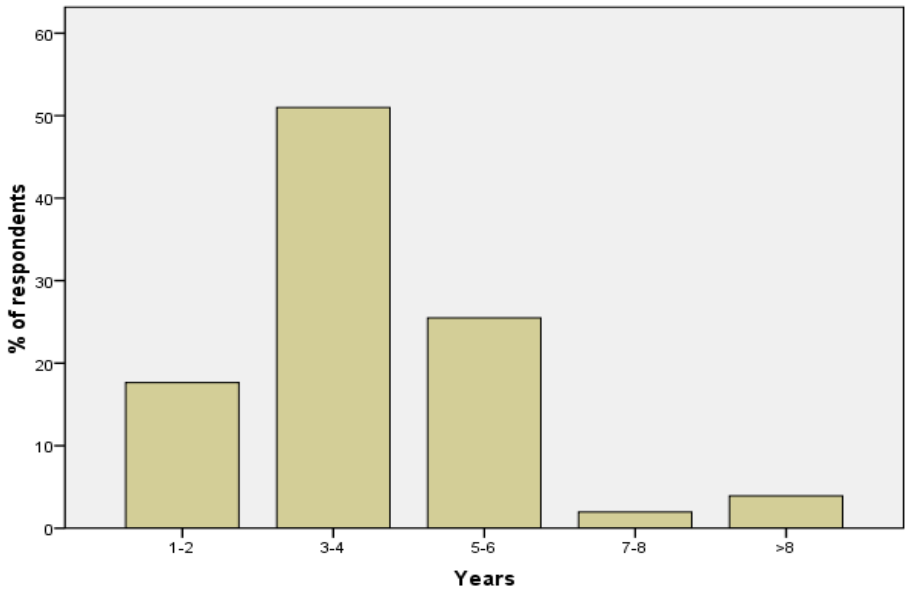

Figure 3. Percentage respondents showing years after which newly constructed houses need repair due to termite infestation.

construction. Termite damage to buildings in tropical countries is a serious concern which is in part due to the diversity of termites in these areas and poor building design (Abdel and Skai, 2011). Thatching in African houses can be expected to last 5 to 6 years (Pearce, 1997). In western Ethiopia thatched roof huts are destroyed in less than five years and corrugated iron roof houses in less than eight years (Abdurahman, 1990).

Higher infestation of wooden wall houses than mud brick houses could be attributed to the attraction of termites to wood (cellulose) used in construction and the woody debris left in soil and around houses after construction. It is also more likely that infested wooden wall houses have shorter life than mud brick houses because as termites eat woods in the former, the walls will lose support and eventually collapse. But in mud brick walls, termites simply move through the walls to reach the roof and thus they have little effect on the integrity of

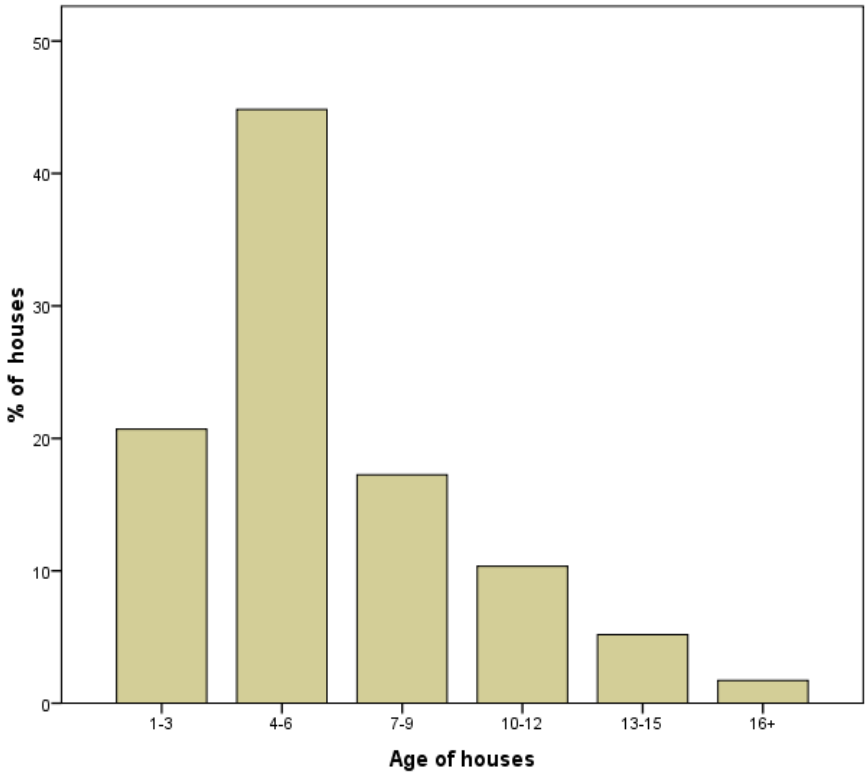

Figure 4. Percentage age distribution of surveyed houses.

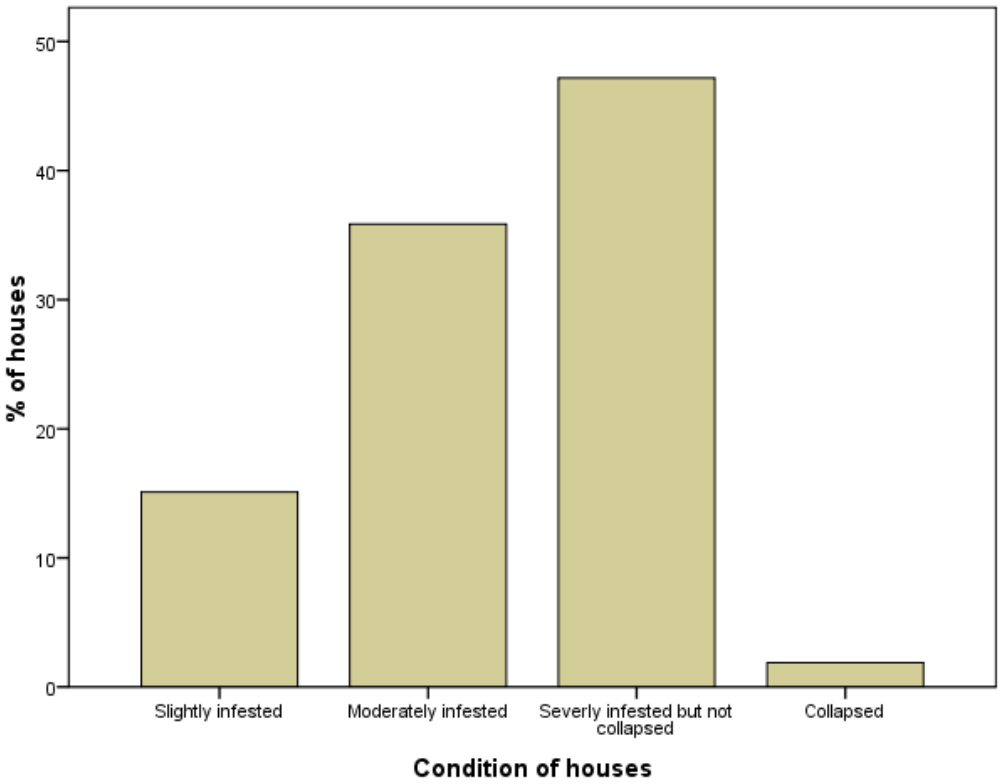

Figure 5. Percent of houses fall under different termite infestation category.

Plate 1. A roof supporting timber completely cut by termites.

Plate 2. Termite infested houses supported by poles.

the wall. But, once they have reached the roof, especially iron corrugated roof houses, which contain only a few roof supporting timbers, termites ring-cut the timbers at their junction with the wall leaving the roof without being fixed to the wall. As the damage is not usually visible, the homeowners do not take action timely, and thus the whole roof will be removed completely even by a slight wind. Some participants told the authors that in Warja Washgula Farmers' Association, roofs of 20 iron corrugated houses were removed by wind at the same time in the year 2008.

The homeowners used different kinds of wood species in building their houses and they were able to identify susceptible and resistant woods to termites that were used in their area for house construction. All farmers regarded *D. cinerea,* A*. etbaica*, and *F. virosa* as highly resistant to termites. Logan et al. (1990) reported that many timbers contain chemicals or complex mixtures of

Plate 3. Severely damaged door frame.

Table 3. Plant species used for the construction of the studied rural houses and their reaction to termites.

Plant reaction	Names of plants	
	Local name	**Scientific name**
Susceptible	Dhaddacha/Ajoo	*Acacia tortillis* (Forskk)
	Muka Bargama/Barzafii	*Eucalyptus* spp.
	Garbii	*Acacia albida* Del.
	Badana	*Balantes aegytica* (L.) Del
	Bakanissa	*Croton macrostachyus* Del.
Resistant	Doddota	*Acacia etbaica* Schweinf
	Geetoo/haxxee/jirmee	*Dichrostachys cinera* (L.) Wight & Am
	Daboobessa	*Flueggea virosa* (Willd) Voigt
	Saphanga/Qarxafaa	*Acacia Senegal* (L.) Willd

Table 4. Numbers of homeowners used different control/management strategies identified during the survey,

Management options	Preconstruction (%)		Post construction (%)	
	No. of users	**% of users**	**No. of users**	**% of users**
Synthetic termiticide (Malathion)	0	0.0	2	6.7
Herbicide	0	0.0	2	6.7
Wood ash	5	9.8	5	16.7
Decomposed cow dung and/or goat urine	1	1.9	2	6.7
Mound destruction/queen removal	0	0.0	2	6.7
Plastic sheet cover	24	47.1	2	6.7
Used engine oil	13	25.5	5	16.7
Mud tube removal (scratching)	-	-	8	26.7
Site selection	1	1.9	-	-
Debris removal /sanitation	1	1.9	1	3.3
Use of grass free of termites	2	3.9	-	-
Floor, perimeter – cement	1	1.9	0	0
Kerosine	0	0.0	1	3.3
Use of mud brick instead of wood	2	3.9	-	-
Sand, gravel	1	1.9	-	-

- = Not applicable.

chemicals that repel or kill termites or interfere with their gut fauna. Factors affecting wood consumption by termites are numerous and complexly related. Among the most important of these factors are wood species and hardness, presence of toxic substances, feeding inhibitors or deterrents, presence or absence of fungi and degree of fungal decay, moisture content of wood and soil among others (Hickin, 1971; Getachew et al., 2003; Regina et al., 2004; Behailu et al., 2011).

Over 90% of the houses were infested, although about 60% of the homeowners used preconstruction preventive measures implying that the methods are ineffective. Plastic sheets were the most popularly used method and their inefficacy could be attributed to their non-termite resistance and may be incorrect use. It is also practically impossible to exclude the house totally from termites by plastic materials. Hickin (1971) and Pearce (1997) have reported that plastic materials are often eaten by termites and their resistance depends mainly on their density, the compounds they contain, thickness, and intrinsic hardness. UNEP (2000) and Ahmed and French (2008) also reported that when certain plastic materials are used as exclusion or barrier they can be breached and bridged over by foraging mud tunnels. Use of engine oil was also ineffective in protecting houses from termite attack. Behailu et al. (2011) noted that at field condition stakes of different timber species, treated with used engine oil using hot-and-cold dipping open tank thermal method, were attacked by termites before the third year of staking

Farmers had awareness about the control of termites by mound destruction and queen removal and most of the homeowners believed that termites came out of the mounds which were found around their homes. *Macrotermes* termite mounds were recorded in the vicinity of most of the infested houses. However, only a very small proportion (3.5%) of farmers destroyed mounds after their houses were infested. About 79% of the termites sampled from infested houses belonged to mound-forming *Macrotermes* while the rest belonged to *Odontotermes* (21%). Therefore, the result of this study indicated that *Macrotermes* was a serious pest to wooden construction.

CONCLUSION AND RECOMMENDATIONS

This research has revealed that termites were serious pests of rural houses of resource poor farmers and the farmers were well aware of the problem. *Macrotermes* to a larger extent and *Odontotermes* to a lesser extent were the only termite genera found causing damage to rural houses. The farmers had attempted a number of traditional control methods mostly plastic sheets and painting of used engine oil, but they were ineffective. Other than the traditional management options attempted, the homeowners had no awareness regarding what measures they may take or whom to contact in order to safeguard their homes. Few persons realized that the safest and cheapest termite control measures are dusting of borates, like 20 Mule Team Borax (2014).

Frequent repairing and rebuilding of houses 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 homes from damage. Therefore, there is a need for comprehensive termite control approaches, which should involve both the local communities, concerned government bodies and more use of resistant wood species.

Conflict of Interest

The author(s) have not declared any conflict of interest.

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