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Farmers' Perception of Termite Infestation and Their Indigenous Management Practices in Abedengoro Resettlement Areas, Western Ethiopia

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Abstract
This study is aimed to assess farmers' perception of termite infestation and their indigenous management practices in Abedengoro resettlement areas. Four termite hot spot rural resettled kebeles (lower Ethiopian administrative units) were selected purposively to include highly termite infested areas. Questionnaires were used to collect data from 240 respondents which account 3.5% of the total population those selected proportionally from the sample kebeles. Descriptive statistics was used to analyze the collected data. The results show that the local farmers' perception about termite infestation was very high. They reported that termites mostly damage crops, forest trees, and grazing land. However, the damage is serious to annual and biennial plants. Maize, sorghum and teff were reported to be the most infested crops among the crops produced in the study settings. The farmers also reported that termites that pose damage are prevalent year-round, but abundantly found in dry season. The farmers in study area knew termite infestation problems and indigenous management practices. Among the indigenous termite management practices reported, disturbing mound and suffocating mound with flood were the major indigenous termite management practices identified in the study setting. In conclusion, utilization of farmers' indigenous knowledge will not only promote ownership and sustainable use of intervention tools against termite pests but also has paramount importance in complementing ecologically friendly methods of termite control in an Integrated Termite Management in rural Ethiopia.
Keywords: Farmers perception, Resettlement, Termites, Termite infestation, Termite management
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1. INTRODUCTION

Termites are the most problematic pests against plant communities and building infrastructure compared to others, in which 300 of them are considered to be pests among so far discovered species (Kumari *et al.,* 2013). The potential of termites to damage and destroy agricultural crops, buildings and land escapes which may account to high economic loss in the world is becoming the main concern of study in the present days (Bong *et al*. 2012).Termites are able to exert this kind of damage with their indiscriminate species which estimated over 3000 species in all over the world (Engel *et al,* 2011).

The worldwide distribution of termites is due to their adaptation to high degree of resource specialization which enables them to be familiar to range of dietary, foraging and nesting habits. In this regard, subterranean termites are known as economically important species that encounter 80% loss in the world specifically to tropical, subtropical ecosystems and temperate region (Su and Scheffran, 2002) .Father more, termite distribution, diversity and abundance are influenced by climate that enable the existence of the different zoogeographical areas of the globe.

Africa accommodates the largest termite fauna in the world. The termite species richness in Africa is due to the friendly climatic conditions prevalent in the continent (Ahmed *et al*.2002). However, the abundance of termite in Africa is restricted by desert areas and at high altitude where low temperatures are found (Lee and Wood, 2002).

In East Africa, termites pose a major threat to agricultural crops, forestry seedlings, rangelands and wooden structures. In Ethiopia, the problem is most severe in the western parts of the country including Wollega area (Abdulahi et al. 2010). Because of population pressure and degradation of natural resources in Ethiopian highlands, high altitudinal mobility and agricultural resettlement in more fertile lowlands has become a common event in the country (Deressa *et al*., 2006). Resettlement is the phenomenon of population redistribution, either planned or "spontaneous" into new sites called resettlement sites or schemes (Rahmato, 2003). Termites are abundant and widely distributed in the low land of the country (Wood, 1991). Termite in Ethiopia induces negative impact interpreted in terms of economic as expenditure for damage, repair and preventive treatments cost. Nevertheless, an estimate of the annual losses caused by termite attacks is not clearly known. However, Wood, (1986) stated 60% damage record due to termite.

Moreover, severity of termite damage to the western parts of the country on agricultural crops, range lands, forestry seedlings and wooden structures of rural houses, stores, fences and bridges are common reports (Abdurahman 2000). In this regard over 90% of this termite damage to agriculture, forestry and urban settings is

attributed to members of the Macrotermitinae (Sileshi et al., 2009; Abdurahman et al, 2010).

Termite damage is also evident in Horo guduru-Wollega major districts specifically in Abedengoro districts low lands, where there are resettlements of Derge regime. In this district, termite population is vastly increasing as cultivation advances timely for in need of surplus product and construction purposes. This condition favors termite to aggressively attack crops, grazing, forest and construction till the present time.

In combating termite damage resettles use different synthetic chemicals, that they were given as supports from governmental and, none governmental organization for termite protection and boost production through varies devised techniques. Nevertheless, termite's damage continues to clear forest, grazing land, hamper production and damaging building. Moreover, the resettlement areas termite protection is remained over looked by researchers. Therefore, the presenet study was undertaken to assess farmers' perception of termite infestation and their indigenous management practices in Abedegoro resettlement areas in western Ethiopia.

1.1. MATERIAL AND METHODS

1.1.1.The study area

Abedengoro district (ADD) is one of the 21 districts located in Horo Guduru Wollega zone of Oromia Regional State, western Ethiopia with total land area of 109, 209 ha. The district capital, Tullu Wayu is located 567 kilometers from Addis Ababa and at about 40 km from Shambu, capital town of the zone. Agro-climatically, ADD is composed of three agro-ecological zones (AEZ): *Dega* (High altitude), *Woyina Dega* (mid altitude) and *Kola* (lowland). There were four high land, 11 mid (moderate) land and six *kola* (lowland) *kebeles* in ADD. The area exhibits a mono modal rain fall receiving rain during April to October. The annual rainfall ranges from 900-1800 millimeters and mean annual rainfall of about 950 mm. The dry season is from November to March. The highest temperature is 34 ^{o}c and the lowest is 18 ^{o}c, with an average annual temperature about 21 ^{o}c. The topography of the area is mainly characterized by gentle slopes and few undulating hills steep/slopes and swamps. According to Agriculture and Development office of ADD (2018), the main land use patterns in the district is classified in to rain fed farm land which was about 46,753ha and irrigated land accounts 3425 ha. The same source indicated that natural forest and artificial forest covers 25,232 ha and 180 ha respectively, whereas grazing land covers 11,210 ha. The settlement area covers 7,381 ha.

Most of the farmers in the study area were able to identify the soil based on its color as red soil (*Biyyoo Diimtuu*) and black soil (*Biyyoo Gurraacha*). Based on texture, they categorized as clay (Biyyoo *Suphee*), loam, sandy (*Biyyoo Cirrachaa*) the reddish soil is dominant in all 21 *kebeles* of the district. The total rural population of ADD was (Male 12155, Female 1146) plus urban (male 2265, female 342). The livelihood in the area is mixed farming; major crops include maize, sorghum, sesame, peanut, teff, wheat, haricot bean, barley, finger millets, bean, chickpea, rice, cabbage, pea, sun flower and others. The cash crops are coffee, ginger, pepper and sesame. Shallot, pepper spices fruits and vegetables are onion, mango, banana, papaya, apple, potato, sugarcane among others.

1.1.2. Research design

Descriptive survey research was used to describe farmers' perception of termite infestation and management practices used to control the prompt problems. This type of research design is used for it is concerned with describing the characteristics of a particular issues (Kothari, 2004). Along with this research design mixed qualitative and quantitative research approach was used.

1.1.3. Types and sources of data

The study used primary data which are qualitative and quantitative in nature. Primary data were collected from respondents, Key Informants (KI) and Focus Group Discussion (FGD) on farmers' perception on termite infestation level and their indigenous management practices.

1.1.4. Sampling techniques and sample size

Among 11 districts of Horo Guduru Wollega zone, ADD was purposively selected for this study because almost all of the low land areas (*kebeles)* of the district were suffering from termite damage and hosting resettlement kebeles. Among the six low land *kebeles* of the districts, four *kebeles* were selected using simple random sampling techniques. Accordingly, *kebele* 15, 20, 24 and 25 were sampled to be included in the study.

Indeed, the target population of the area is homogenous (small holder resettled farming community) and engaging in similar agricultural production and farming system. Thus, small sample size was preferred for the study. As a result, 3.5% of population was sampled which accounts for 240 respondents from 6,956 target population of the four sample *kebeles*. By applying proportionality sampling the sample size in each *kebel*e was as presented in table 1.

Table 1. Number of sample respondents per *kebele* engaged in the study

Kebles	No of House Hold	% of house hold from each kebele	No of respondents
Mender 15	2575	3.5	90
Mender 24	2009	3.5	70
Mender 20	1555	3.5	54
Mender 25	727	3.5	25
Total	6,956		240

Source: Abedengoro district Agricultural office, (2018)

Individual respondents were selected proportionally from among household heads of sample *kebeles* using systematic sampling method as

$$I = \frac{N}{n}$$

Where:
I= sample interval;
N = number of household heads per *kebele*
n = number of sample per *kebele*.
Then every I^{th} respondent was included in sample until the required individual obtained from respective sample *kebele.*

Six KI were selected by using judgment sampling method to include the very informed people about termite problem and management aspects. Moreover, four agriculture extension agents working in the sample *kebeles* and two agricultural experts from the district were selected. One FGD was administered with 12 people composed of one elder farmer; one trained farmer and one *kebele* administrative representative from each sample *kebele* and pulled together for discussion.

1.1.5. Data Collection Tools and Procedures

Since single data collection tools is believed to have limited adequacy and relevance to achieve the objectives of the study, different tools were employed to collect data to have better and adequate information for analysis. Thus, semi-structured (open-ended and closed-ended) questionnaire merely to collect primary data from respondents, in-depth interview to collect data from key informants and discussion guide to collect data from FGD were used in the study. Data were also collected by personal observation using observation checklist.

The data from respondents were collected by enumerates who were trained by the researchers on how to approach the respondent and filling the questionnaires and the data collection tool were first prepared in English and later translated in to Afan Oromo to make it convenient to data collectors. However, the key informant interview and focus group discussion were administered by the researchers.

1.1.6. Data analysis

The collected data were sorted and analyzed using descriptive data analyzes statistics. The results presented using table, frequency and percentages. The data analysis was done using Statistical Package for Social Sciences (SPSS-version 20) software. Qualitative data obtained from interview and discussion were analyzed and described through concepts and opinions, by sorting out, grouping and organizing in order to supplement the results obtained from descriptive analysis

1.2. Results and Discussion

1.2.1. Farmers' Perception of Termite Infestation

From the entire surveyed small holder farmers 97.91% agreed that they recognized termites as a pest, while 2.09% of them fail to locate. These results revealed that most of the farmers in the study area knew termite as pest. In line with these results Debelo and Degaga (2015) reported that Ethiopian farmers from eastern part of the country were knowledgeable about the existence of termites in their crop fields. Concerning termite infestation status, 35.41% of the farmers reported that termites infest mainly crops, Grass, and houses all together. However 20.17%, 20.83%, and 15.6% the farmers said termite infest only crops, grasses, and houses respectively. The views of KI and FGD also indicates termite's infest and damage all crops, chop grasses, damage houses and other materials where they inhabit and are general feeders in the study settings.

Table 2. Farmers' perception of termites as pest

	Response	Respondents	
		Frequency	Percentage
Termite recognized as pest	Yes	235	97.91
	No	5	2.09
	Total	240	100
Termites damage	Crops	70	29.17
	Grasses	50	20.83
	House	35	15.6
	All	85	35.41
	Total	240	100

1.2.2.Termite as a pest of crops

Some three crops were reported by farmers as most susceptible to termite infestation (Figure 1). Among them, maize 33.33% the most susceptible followed by teff 27.08% and sorghum 22.92%. Others 15.95% were found less susceptible. The incident of sorghum damage on crop fields is observed less than maize and teff. Because, sorghum may be protected from termite damage due to its role as a reservoir of termite predatory ants (Sekamatte et al., 2003). This result is supported by KI and FGD in that maize is the most known produced crop among others and its estimated loss report was greater than one quintal per hectare (key- informants).

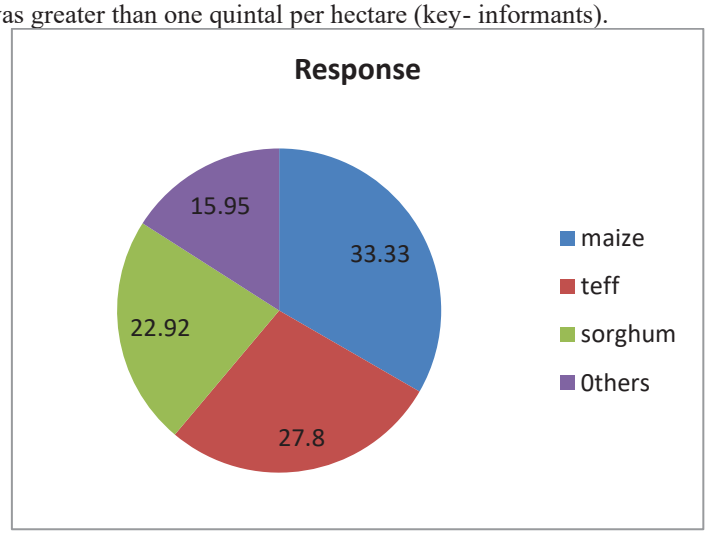

Figure1.Farmers' Perception of crops severely damaged by termites in Abedengoro resettlement villages in 2018.

1.2.3. Termites as pest of grazing land and forest

With regard to grazing land and forest tree damage, 75% of the farmers agree that damage in tree is common and 25% of them replied grasses. The farmers also reported the consequence of forest tree damage by the termites in the study area in which the highest cause was deforestation (50%) followed by running water depreciation (25%) and soil degradation (20.83%) in that order. However few of the farmers (3.17%) fail to distinguish the impact of termite effect on their ecosystem.

Table 3. Termites as a pest of grazing land and forest

	Category	Respondents	
		Frequency	Percentage
Termites damage	Grazing land	60	25
	Forest trees	180	75
	Total	240	100
Consequence forest damage	Soil degradation	50	20.83
	Deforestation	120	50.00
	Running water depreciation	60	25.00
	I don't know	10	3.17
	Total	240	100

The current study also shows that forest trees are the most susceptible to termite attack than grasses. Deforestation was the most reported consequence of forest damage by termites followed by soil degradation and depreciation of running water. It was reported by KI and FGD that termite's damage majority of the trees. However, there is a difference in terms of tolerance to termite attack.

The preference of termites for this tree may be due to its water content as supported by (Loko *et al*, 2014).

As a result, the soil degradation is estimated as 10% in the study area. (District agricultural office, 2017) In similar occasion, FGD report indicates that Eucalyptus tree species grow long down to drain water from the most ground to its bark where the termite species harbor and extract fluid (Plate 3)

1.2.4. Season favoring termite infestation

Table 4 shows favorable time period for termite activities. The farmers most frequently reported (31.25%) that termites are most abundant in dry season with the least report between wet and dry season (13.92%). This result is supported by KI and FGD, they perceive that termite's damage is more apparent during dry time. The result is in harmony with findings of Logan *et al.,* (1990) and Nyeko and Olubayo (2005) that indicate termite is more prevalent in dry season than during the periods of regular rainfall.

Table 4. Favorable time for termite abundance

	Respondents	
Category	Frequency	Percentage
Summer season	60	25.00
Dry season	75	31.25
Between Winter and Dry	31	13.92
All the time	74	30.83
Total	240	100

1.2.5. Farmers' Perception of Susceptible and Resistant Plants to Termite Infestation

In the assessment of plant age 42.67% respondents replied that annual plants are easily attacked while 31.67% of the farmers viewed biennial plants and 26.66% respondent answer that termite damage more perennial plants. In supporting this Haris (1961) and Roonwal (1979), state the damages being more serious in young plants of about one or two year of age.

With regard to plant stage of development vulnerability to termite infestation, 38% respondents viewed that all seed, seedling, flowering stages of plants were easy to be damaged. On the other hand, 28.3%, 27.9% and 5.8% agreed that the damage can happen to seed, seedling and flowering stage of development respectively (Table 5).

Table 5. Susceptible and resistant plant sage to termite damage

	Category	Respondents	
		Frequency	Percentage
Susceptible plants	Annual plants	100	41.67
	Biennial plant	76	31.67
	perennial Plants	64	26.66
	Total	240	100
Susceptible age to termite damage	Seed	68	28.3
	Seedling	67	27.9
	Flowering	14	5.8
	At all age	91	38
	Total	240	100

1.2.6. Farmer perceptions of termite management practices

Termite management endeavor follow traditional termite identification by the local people. The results indicate the presence of two locally known termites; called 'usually observed' and 'immigrant' type. Accordingly, 41.66% respondents say the usually observed type, and others 45.84% replied the immigrant and few 12.5% respondents do not differentiated the two types of termites (table 6). This kind of local naming agree with the local names given to the two types of termites *Werrartu (*meaning *'invaders' in* Afan Oromo*)* and *Marimartu* (meaning '*common to the area'* in Afan Oromo (Hirpa *et al*, 2012).The *Marimartu* have mounds and stay in some places whereas, the *Werrartu* are non-mound forming and migratory type.

Table 6. Termite traditional category in Wollega, Ethiopia

	Category	Respondents	
		Frequency	Percentage
Local name of termites	Usually appeared	100	41.66
	Immigrants	110	45.84
	I don't know	30	12.5
	Total	240	100

1.2.7. Termite resistant plant species utilized by farmers

The severity of termite damage to different construction impose farmers to look for termite resistant plant species. .To this aspect, 41.25% of the respondents replied that they knew *Cyzyum guniems, Ficus Species, Cordia africana and Trunus africana* which called *Badessa, Harbuu, Waddessa* and *Hoomii* in Afan Oromo as resistant plants, however, 16.66%, 16.25%, 13.33% and 12.5% respondents view *Ficus Species, Cyzyum guniems, Cordia africana* and *Trunus africana* respectively (Table 7).

Table 7. Termite resistant plants identified by the farmers with their local names

	Scientific Names	Local Name (Afan Oromo)	Respondents Frequency	Percentage
Resistant plants identified	*Cyzyum guniems*	Badessa	39	16.25
	Ficus Species	Harbu	40	16.66
	Kordia Africana	Waddessa	32	13.33
	Trunus Africana	Hoomii	30	12.5
	All		99	41.25
	Total		240	100

The farmers reported that *Ficus Species, Cyzyum guniems, Cordia africana and Trunus africana* which called Badessa, Harbuu, Waddessa and Hoomii in afan Oromo are the major resistant plants in the study settings. KI and FGD supplement the result in that these plants are used for construction purpose for they resist termite damage. In supporting this, Owusu et al., (2008) state that, some plants are resistant to termite damage, indeed, their exudate (natural extract) repel termite and that is why people use those plants for construction.

1.2. 8. Suppressing termite population in the mound

The stress due to termite damage imposes farmers to control termite culturally with their indigenous knowledge. Having this, respondents were asked how they manage termite mounds and found that 99.17% said that they disturb mound to remove Queen and others 8.33% respond not using mound disturbance. Concerning termite control by flooding 66.67% respondents replied they use flooding the termite mound to suppress termite population. However, it is found that majority of the respondents use the indigenous knowledge of termite management practice like sealing with chopped removed weeds (79.17%), smoking the mound to suffocate termite (68.75%,), adding pepper dissolved with ash (85.42%,), irrigating with Tela and Areke Residue (tela*)* (83.33%,), goat urine and hot animal dung (95.83%) (Table 8)

Table 8. Traditional termite mound management practices in Abedengora in 2018.

Category	Response	Respondents Frequency	Percentage
Flooding termites' mound	Yes	160	66.67
	No	80	33.33
	Total	240	100
Sealing with Chopped removed weeds	Yes	50	20.83
	No	190	79.17
	Total	240	100
Smoking the mound to suffocate termite	Yes	75	31.25
	No	165	68.75
	Total	240	100
Disturbing mound to remove queen	Yes	220	99.17
	No	20	8.33
	Total	240	100
Adding pepper dissolved with ash	Yes	35	14.58
	No	205	85.42
	Total	240	100
Irrigating with Tela and Areke Residue	Yes	40	17.66
	No	200	83.33
	Total	240	100
Goat urine and Hot animal dung	Yes	10	4.17
	No	230	95.83
	Total	240	100

In the study of indigenous knowledge traditionally used to suppress termite population in the mound in surveyed area reveals that majority of the farmers are practicing to disturb mound to remove Queen and use flooding termite mound thereby suppressing the termite population. Views of KI and FGD supplementing the result in such a way that those traditional termite management practices are practiced. This is in line with a research finding by Akutse *et al*, (2012) in Ghana, several indigenous methods including wood ash, sand, toads and shell/scallop of tortoise are used by farmers to prevent and control termites.

1.2.9. The use of termite's predator

Regarding the use of termite's predators, 91.3% of respondents agree with the use of termite predators, while 8.8% of them do not know the termite predators. Out of the identified predators, 46.7% are birds and 38.3% ants. However, 15% claim the presence of other predators (table 9).

Table 9. Prevalent predators

		Respondents	
	Category	Frequency	Percentage
Presence of termite predators of termites	Yes	219	91.35
	I do not Know	21	8.75
	Total	240	100
Types of predators	Birds	112	46.7
	Ants	92	38.3
	Other	36	15
	Total	240	100

Source; computed from observation of (2018).

The study on prevalence of predator in study area reveals that most of farmers aware that birds and ants are the most known termites' predators. This, finding is supported by KI and FGD in that they familiar to those aforementioned predators. They also added that, worms and other arthropods which they fail to name living in the soil are observed foraging termites.

1.3. CONCLUSIONS

Results showed that the local farmers are well aware of termite as pest with the most infested and susceptible crop reported by the farmers being maize than teff, sorghum and other crops. The Farmers perceive and use several ways of mitigating termite damage. Among the indigenous termite management practices, results underline that the farmers relay on disturbing mound by digging to exclude termite queen, flooding termite mounds, sealing of mound with chopped removed weeds, adding pepper dissolved with ash, and salt, irrigating with tela and areke residue (atela), got urine mixed with hot animal dung to cause suffocation that might induce termite removal from their farm. Therefore, using farming community indigenous knowledge has a great potential to complement non-chemical and ecologically friendly methods of termite control programs in an Integrated Termite Management programs in rural Ethiopia.

Competing interests

The authors have read the manuscript and declared that no competing interests exist.

Authors' contributions

TB participated to the study design, conducted data collection, analysis and interpretation and drafted and revised the manuscript. OK involved in designing the study, revised the manuscript and has given approval of the version to be published. All authors read and approved the final manuscript.

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