Int. J. Pure Appl. Sci. Technol., 28(1) (2015), pp. 8-23

International Journal of Pure and Applied Sciences and Technology

ISSN 2229 - 6107

Available online at ***www.ijopaasat.in***

Research Paper

Termite Infestation on Farmlands at Ugoniyekorhionmwon Community, Edo State, Nigeria: A Farmers' Perception

A.B.O. Ogedegbe[1,*] and B.C. Ogwu[2]

[1] Department of Science Laboratory Technology, University of Benin, Benin City, Nigeria

[2] Department of Animal and Environmental Biology, University of Benin, Benin City, Nigeria

* Corresponding author, e-mail: (crestedsas_4good@yahoo.com)

(Received: 8-4-15; Accepted: 11-5-15)

Abstract: *Termite infestation is a major feature of the landscape of farmlands in Ugoniyekorhionmwon community of Edo state. This was carried out from January, 2013 to December, 2014 and study is aimed at evaluating the farmers' perception of the effect, extent of damage as well as to the control measures employed by the farmers in the area. Structured questionnaires were administered on farmers, using random sampling technique and the responses were analyzed with descriptive statistical method. The major occupation of the area was agriculture. Cultivation was for both sale and consumption. The farming system was a low input and low output, because individual farmlands were relatively small. Various species of termites were identified in the area, some of which included; Macrotermes bellicosus, Odontermes sp., Coptotermes curvignathus, Nasutetermes arboreum, Amitermes evuncifer, and Microtermes sp. The major constraint caused by termite infestation in the area was the presence of numerous mounds of Macrotermes bellicosus on the farmlands which took up large arable land area which would have been used for cultivation. Termites also affected crops and other materials such as wood, paper and household furniture. The control measures adopted by farmers whose farmlands had large numbers of mounds included chemical (Such as Deildres, Appron plus and Furadam) and non-chemical (such as physical removal of queen, human excreta and smoke) methods.*

Keywords: Termites, Infestation, Farmlands, Cultivation, Ugoniyekorhionmwon, Farmer.

1.0 Introduction

There is relatively abundant data to ascertain the positive roles that termites may play in improving soil fertility. There is however very few agronomic experiments to confirm these roles. Some of the prominent positive effects of termites include; termites are the most important soil fauna in the semi-arid tropics (Lobry and Conacher, 1990). It is also well known that termites may have a great impact on soil properties and soil genesis and formation. The dense network of their nests and gallaries improve soil proximity and aeration (Humphreys, 1994; Lee and Foster 1991; Wielemaker, 1984). Their tunneling activities which results in the infiltration and water storage of the soil, consequently increase the primary productivity of the soil (Elkins et. al., 1986)

Termites also play a key role in nutrient recycling (Bachelier, 1978; Basppa and Rajagopal, 1991). They also modify soil chemical characteristics by mixing soil from different layers. West African farmers, therefore deliberately seek out lands with many and large termite mounds or termite foraging areas for reasons of fertility or availability of soil water (Fairhead and Leach, 1994). Termite mounds or termite foraging areas are considered to influence vegetation succession and patterns and fallow dynamics. They are also contributors to atmospheric gases. For instance, Termites release methane gas (Martius et. al., 1996).

However, it can be argued that termites have little or no negative effect on environments unaffected by humans. Of the over 2600 species of termites, fewer than 185 are considered pests (Pearce et al., 2000). Termites gain pest status, because as they fulfill their ecological role of recycling plant materials, they encounter and endeavor to utilize materials used in building construction or agronomic and forestry commodities (Iroko, 1996).

Controls of termites have largely relied on broad spectrum band persistent of organic chlorine insecticides (Logan et. al., 1990). Emphasis is being made on the need for other alternative methods of control due to serious limitations and increasing legal restrictions associated with the application and efficiency of these chemicals (Cowie et. al., 1989; Logan et. al., 1990). These non-chemical methods include; physical removal of the Queen, destruction of termite mounds, Biological control methods, agronomic practice and use of plant extracts and resistant species (Wardell, 1987; Logan et. al., 1990).

The negative impact of termites is essentially a human perspective that is too often found in apprehension rather than in facts. Understanding the biology and ecology of termites in different areas species diversity and distribution on farmlands would be a very important initial step to developing realistic compatible management strategies of termite population. This is because, not all termite species are pestiferous (Cowie et. al., 1989).

Aims and Objectives of this study therefore include:

1. To determine the level of termite infestation on farmlands in the study area.
2. To determine from the farmers' perspective, the constraints caused by the termite infestation in the areas.
3. To know how agricultural activities thrive in the area, despite the large number of mounds on individual farmlands.
4. To determine the methods of control used by the farmers in the area.

2.0 Materials and Method

Description of Study Area

This study was carried out in Ugoniyekorhionmwon Community of Orhionmwon Local Government Area in Edo state, Nigeria from January, 2013 to December, 2014. Ugoniyekorhionmwon is located

between Latitude 6°04'16.05"N and Longitude 60°00'06.39"E, along the highway from Benin City in Edo state to Abraka in Delta state. The project site is a fallow farmland, about 20km along the highway, between 'Ugo' and 'Evboesi' villages. The fallow farmland has been heavily inundated with termiteria (also called Ant hills) of various sizes.

The soil type in this community is of the red-yellow kind of Ferralsols. The climate condition in this region is grouped into two; The rainy season (around March to September) and The dry season (around October to February). The study area lies in the Rain Forest Region of southern Nigeria. It has a population density of about 5,961 according to 1991 Census figure.

The area is characterized of relatively high concentration of termite infestation, concentration of Agricultural activities and presence of termites and mounds on Agricultural farmlands.

Materials

The materials used for this study is the administration of questionnaires on the target Population (farmers). This process was aimed at assessing the distribution, extent of spread, problems and constraints caused by the termite infestation on the locality and the extent of damage done to the crop yield in the area through farmers' perceptions. The questionnaire contained open and close-ended questions, which were administered directly and informally. The content of the questionnaire covered personal details, farmland details, crop population, conceived production constraints and effects, and role of the Government and Non-governmental organizations in combating the problems associated with termite infestation

The research question was based on:

- What are the demographic characteristics of the farmers?
- Do the numerous termite mounds that characterize the area constitute major constraints to crop production?
- What are the types of crops produced in the area and the extent of infestation of the various crops?
- Why and how are farmers able to cope with the challenges of cultivating in this highly infested area?
- What advantages do farmers receive by planting in the infested area?
- What are the termite control strategies used in the area?

Target Population, Sample Size and Procedures

The target population comprised of farmers in the infested area. Random sampling procedures were used in the distribution of questionnaires.

The questionnaires were administered to farmers at different locations. These locations include;

- On individual farmlands: Some of the farmers were visited while working on their farms. These farms were selected due to the abundance of termite mounds on them.
- At the Community market: Questionnaires were administered randomly on farmers at the local community market ('Ugo' market). The market is usually held on a nine day interval. The market is the major route for trade and sales of agricultural produce in the community and other neighboring communities. Traders and farmers from both rural and urban centers converge at this market for trade purposes.
- House to house: Farmers were also visited at their residence. These houses were also randomly selected.

Data Analysis

The results of the questionnaire administered on the farmers were analyzed, using descriptive statistical method.

Results

Farmers' Profiles

A total of 59 farmers were interviewed in Ugoniyekorhionmwon Community in Orhionwon Local Government Area of Edo state. Of the 59 responses, 9 were discarded due to poor documentation. Thus, 50 responses were used for compiling the final results for the study. It was observed that almost everyone in the village was either a full time or part time farmer. Thus, the dominant occupation in the area is farming (table 1).

Table 1 also revealed that the average age of the respondents varied from 30 to 50 years. Majority of the farmers (about 68%) were middle aged (31-50years). 54% 0f the respondents were females while 465 were males. About 46% have been on this occupation for more than 20years, while 28% have been on the occupation for between 16-20years. The remaining 26% represented those that have practiced for less than 15years (table 1).

In terms of level of education, about 86% of the respondents had some form of education, with some of proportions claiming to have stopped in primary or secondary level. During the survey there was no farmer with tertiary education. About 60% of the respondents had about 4-5 acres of farmlands (table 1) which were some distance from their homes. All the farmers reported that their production was generally for sale and consumption.

Table 1: Demographic characteristics of the farmers (respondents), in the study area

Characteristics / respondents (%)						
Age (years)	<20	20-30	31- 40	41-50	51-60	>60
	2	24	30	38	6	
Gender	Female	Male				
	54	46				
Level of education	None	Primary	Secondary			
	14	54	32			
Occupation	Farming	Others				
	98	2				
Number of years of farming practice	<5	6-10	11-15	16-20	>20	
	4	6	16	28	46	
Type of farming practiced	Subsistence	Commercial	Both			
	-	-	100			
Size of farmland (Acres)	2	3	4	5	>5	
	8	14	36	24	18	

The Dominant Farming System in the Study Area:

Farmers in the area were involved in the cultivation of a variety of crops. The major crops grown include cassava, yam, groundnut, maize, pepper, okra, citrus fruits (such as oranges), oil palm, plantain, and garden eggs. The major crop cultivated by the farmers was cassava. About 86% of the farmers had cassava farms. This explains why the community serves as one of the major rural markets involved in the distribution of garri to the urban centres around the state.

Table 2 shows that, 24% grew yam, 64% of the respondents planted maize, 14% cultivated plantain, 26% were involved in the production of oil palm, about 20% of the farmers grew orange, okra, pepper, and garden eggs. Another 6% cultivated groundnuts.

The major sources of the farm labour were hired and family efforts. The quantity of land cultivated and area of each plot were relatively small. This results in low inputs which in turn led to low output. The products were normally sold to middlemen from urban centres at the rural market (‘Ugo’ market) in the community.

Table 2: Number and percentage of farmers engaged in production of common crops in the area

Crop	Number of farmers	%
Cassava	43	86
Yam	12	24
Maize	32	64
Plantain	7	14
Oil palm	13	26
Orange	2	4
Okra	5	10
Pepper	2	4
Garden egg	3	6
Groundnut	3	6

Farmers’ Perception on Diversity, Abundance and Distribution of Termite Species

Farmers identified some of the termites encountered during the study by their local (Bini) names. 3 species were well identified in the local language. Farmers’ identification of termites was based on a number of characteristics. These include mould building, size of mould, presence or absence of vents on mould and the size, colour and odour of soldiers, workers or alate (winged reproductives).
The most abundant termite species in the area (locally called ‘ite’) was Macrotermes bellicosus, locally called ‘edon’ by the farmers. Macrotermes bellicosus moulds which were numerous on individual farmlands were mostly involved in the destruction of wood. Other termite species identified in ‘Bini’ language by the farmers are ‘Okan’ and ‘Igwun’.

Table 3: Farmers' identification of termite in the area

Scientific name	Local name	Characteristics
Macrotermes bellicosus	'Edon'	Build big mounds with large vents round the base of the mound. Soldiers are very aggressive and their bites very painfull.
***Odontotermes* spp**		Does not build mound, but usually make hols around tree base. Soldiers are small in size.
Amitermes evencifer	'Okan'	Builds small blackmounds without holes.
***Microcerotermes* spp**	'Igwun'	Build small mound without vents and much or the mound are underground. Builds subterranean mound
Nasutitermes arboretum		Builds mounds at certain height on trees, above ground level.
Coptotermes curvignathus		Does not build mound. Form curved lines on tree trunk

Plate 1a: Soldier of Macrotermes bellicosus locally called 'edon'

Plate 1b: soldier of Odontermes sp

Plate 1c: soldier of Coptotermes

Plate 2a

Plate 2b

Plates 2a and 2b: Macrotermes bellicosus mounds on a farmland locally called ‘ite’

Plate 2c: Nasutitermes arboreum builds mound on trees some height above ground

Plate 2d: Microtermes mound on farmland

Plate 2e: Amitermes evencifer mound on a farmland

Plate 2f: Copepermes curvignathus on a tree trunk

Plates 2a, 2b, 2c, 2d, 2e, and 2f: Various mound structures of termite spp used in identification by farmers in the area.

Spread of Termite Mounds

It was observed that all the respondents had termite moulds on their farmlands but the number of mould varied. The average number of mould on a farmland was about 14 to 18. According to the farmers, the number of moulds is dependent on the location of the farmland.

None of the farmers knew when the moulds first appeared on their farms. They explained that the moulds had been on the farmlands even before they started cultivating in the area.

Benefits of Termites

Majority of the respondents (about 92%) claimed that they did not derive any benefit from the infestation. A few of the farmers (8%) agreed that termites were used as food. The termites (i.e. alate) were collected through water traps in basins after rains. These were fried and eaten alone or with other foods. One of the farmers claimed that termites were also used as constituents of some local traditional medicines.

Constraints Caused by Termite Infestation

Farmers reported that they experienced different types of constraints as a result of termite infestation. These include:

i. Constraints Caused by Mounds: According to the farmers, the giant mound of termites (‘ite’) on the farmlands is a major challenge to them. It was observed that very numerous mounds locally called ‘ite’ built by Macrotermes bellicosus, identified as ‘edon’ were distributed on the farmland. The farmers reported that, these mounds posed a serious problem of inadequate space on the farmlands. Areas which would have been used for planting on the farmlands are covered with these numerous mounds. The farmers explained that they do not plant on the mounds or areas around the mounds. This is because the soils in/around the mounds were hardened and this does not support the growth of crops. These constraints have led to highly reduced area of arable land per farmer.

ii. Effect of Infestation on Crops: 42% of the respondents reported that termite affected crops in the area. However, the net damage on total yield was generally low, as shown in table 3. Yam, cassava, maize, oil palm and groundnut are the crops that are mostly affected by the infestation, in decreasing order. According to them, termites prevent germination of the seeds or other planting materials. They also destroyed the crops by destroying the roots and making some feeding tunnels through the stem. This lead to stunted growth and eventually death of the crops, especially those planted very close to the termiterium.

About 62% of the respondents did not notice any variations in the intensity of infestation due to seasonal changes. They claimed that the intensity of infestation was somewhat the same at any time of the year. However, 38% noticed higher infestation rates during dry months, than in wet months. They attributed this to the fact that, several crops mature and are harvested at this time. According to them, the crops are more susceptible to attack at maturity.

In yam, the termites tunnel through the tuber and darken it with their waste products. Farmers also reported that the termites also eat up the wood used in stalking the plants, which could lead to death of the crop. Cassava cuttings are attacked in different ways. It could be hollowed out below the ground and other parts of the cassava apart from the cuttings which could also be affected. According to the farmers, when cassava is planted too close to the mounds, the crop dies out due to lack of adequate amount of water in the soil.

Maize and guinea corn were attacked if harvested late. The termites attacked and ate the lower part of the plant and hollowed it out. Seeds in contact with the ground were also eaten by termites. Damage to groundnut was usually serious towards the end of the growing season, just before harvest. Termites caused damage by penetrating the tap root and hollowing them out. The pods were also damaged, either on the outside or the nuts were eaten away. Oil palm seedlings and mature trees were also reported to have been attacked by the termites.

Table 4: Farmers rating of damage caused by termites on individual crop

Crop	Mean Damage
Cassava	1.4
Yam	1.8
Maize	1.0
Plantain	0.0
Oil palm	1.2
Orange	1.2
Okra	0.0
Pepper	0.0
Garden egg	0.0
Groundnut	1.0

Damage level was scored as: 0 = Nil, 1 = Low, 2 = Moderate, 3 = High, 4 = Very high.

iii. Damage on Trees and Fruit Trees: Termites also caused serious damages to trees and fruits. They make tunnels on the trees and try to feed on the bark of the tree. These causes considerably yield loss as it reduces the photosynthetic area of the plant. Seedlings and young saplings of citrus trees are cut off below the ground level, while some of the matured trees may be damaged by piping , by the termites. They also destroy fruits which fall under trees.

Plate 3: Oil palm tree in close proximity with a termite mound

iv. Damage on Other Materials: Farmers also admitted the constraints caused by termite infestation on other areas of livelihood apart from agriculture. That is, on cellulo-lingnotic materials which includes buildings, cloths, wood and wooden materials, furniture, papers and books e.t.c. Termites destroy and eat up these house hold materials. This leads to economic losses. One of the respondents claimed that a house was completely abandoned in the village, just because of the devastating effect of termite infestation.

Plates 4A: A tree being tunneled through and damaged by termites

Termite Control Measures Used by Farmers

Farmers who had farms which contained few numbers of mounds were not involved in any control measures for these termites. This is because the termites posed very little or no problems to them. Whereas, Farmers whose farmlands were located in areas with heavy infestation claimed to have attempted various control strategies. These farmers adopt chemical and non-chemical control measures.

Chemical Control Measures: Table 5 reveal that farmers used various chemicals such as DDT, Dieldres, Furadam, Appron plus and other broad spectrum insecticides were used to spray termites. Some also claimed to use 'insect powder' to control termites and other insects. This whitish powder is sprinkled on the mound or around the house as a repellant. The black material of used batteries (carbon) is also used as a control measure. The carbon is diluted in water and the solution is poured into the termiterium.

Non-Chemical Method: The respondents also reported a number of non-chemical methods used in termite control. These include physical control and the use of indigenous materials. The physical control method includes the breaking of the mounds or termiterium and the removal of the queen and king. They also used indigenous materials such as human excreta and smoke. These are poured into the mound through vents on the mounds and are believed to have repellant effects. These control strategies and their mode of application is as shown in table 5.

However, although the farmers claimed that these control strategies were effective, they noted that the destruction of a termiterium did not prevent the establishment of another by the termite on the same farm.

Table 5: Farmers control strategies

Control	%frequency	Method of application used by farmers
Insecticides	41	Dieldres (1 pint mixed in 5 gallons of water and Sprayed on the termites). Furadam and Appron plus(5g mixed in half bucket of water poured into the Termiterium)
'Insect powder'	20	Sprinkled around mound and around the house.
Batteries	46	Diluted in water or the powder is poured into the Mound
Physical method	8	Dig up mound and remove the Queen.
Human excreta	36	Poured into mounds through vents.
Smoke/Fire	4	Fire is put into the mound and its vents are covered To allow the

	smoke to circulate inside the mound. This has repellant effect on the termites.

Discussion

Pest Status, Diversity, Distribution and Benefits of Termites

The main stay of the economy of respondents in the study area is agriculture. Farmers rated the direct effects of termite infestation on cultivated crops in the area as relatively low. However, the indirect effect of the infestation on net crop yield as a result of the abundance of giant termite mounds on farmlands was rated high.

In this study, it was discovered that farmers used effective indigenous methods such as mound building, size of mound, presence or absence of vents on mounds, as well as the size, colour, and odour of soldiers, workers or alate (winged reproductives), as basic means of identifying the various termite species. Similar features have been used by farmers in Uganda, for identifying termites (Nyeko and Olubayo, 2005). Some of the termites were identified by the local farmers in their local 'Bini' language. For adequate pest management, a basic knowledge of pest biology and ecology is a prerequisite. This information is crucial to the design and success of control measures, as well as to the initial evaluation of the need for control (Logan et. al., 1990).

More research is needed to ascertain and identify the biodiversity of termite species in the area. Knowledge of the individual species is important in determining suitable control and management strategies for these termites. This is because, termite species differ in ecology and biology and majority are not considered pestiferous (Cowie, 1989; Bignell and Eggleton, 2000).

The most abundant termite species in the area was Macrotermes bellicosus. It produces gaint mounds, whose sheer numbers dominate the land scape of this study area. The mounds posed major constraint on the farming system of the area because individual farmlands were relatively small in size and the presence of these numerous mounds greatly reduced the available arable space on the farms for cultivation and this in turn greatly affected the production output. The farmers avoided planting on and around termite mounds, because crops planted in close proximity with the mounds did not thrive. This may be due to: i. poor conditions for germination, as a result of hardened soil. ii. Poor conditions for the plant between germination and emergence from the soil, because of reduced water content of the hardened soil. or iii. Lower seed stocks on the mounds because seeds are easily eaten up by the termites or other animals such as rodents, which are usually associated with mound in which the termites had been destroyed.

Macrotermes spp were mainly involved in the destruction or degradation of wood materials in the area. However, they were found to attack crops such as cassava, groundnut, maize and guinea corn, planted in close proximity with the mounds. These termites also attacked trees such as oil palm and citrus trees. They usually attack these plants by cutting off young seedlings and plants at soil level (Pearce et. al.. 1995).

Amitermes evuncifer constructs smaller mounds but they are not as numerous as the Macrotermes mounds. Amitermes were found to cause damage to root crops such as cassava, and yam. In yam, they tunneled through and darken the tuber in the field during dry season, as well as in barns. A few other crops are also attacked by this species. Similar observation on the effect of Amitermes sp on crops, have been reported by Pearce in 1995.

All other species of termites found in the area, especially those of the genus Microtermes and Nasutitermes consisted mainly of wood feeders. They made tunnels on the bark of trees, which tend to affect their photosynthetic ability and other wood materials such as woods used in staking yams, are

also eaten up by termites, which in turn led to the death of the crop. They were the major cause of damage to trees and other lingo-cellulose materials found in home such as paper and clothing materials. These materials are usually eaten up by the termites and as a result, cause major financial losses to the farmers. A similar effect of termites have also been reported by Obi et. al. 2008, in Nigeria.

Researchers have considered termites as serious pests of agriculture and other aspects of livelihood such as the destruction of cellulo-lignotic materials. The nuisance of termites in wood, books, food, etc., is serious and has been reported (Wood et al., 1980; Collins, 1984; Aisagbonhi, 1989).

Damages particularly in agro ecosystems, caused by termites have been observed by several authors. Johnson et. al. (1981) made a survey of termite damages on groundnuts and an estimation of yield-loss in northern Nigeria and noted that the foliage was attacked by Odontotermes. Damages were restricted in the Sudan savanna and loss in yield was less than 5%. Damages caused by Microtermes lepidus were more important since it attacks also pods, the roots and the yield. Wood et. al. (1980a) have also studied the abundance of termites, damages to plants and loss in yield in the southern Guinea savanna zone of Nigeria. They reported that virtually all damage was caused by Microtermes which has deeper subterranean nests diffusion and attacks maize. Yield losses varied from 0.1 to 9.5%. Wood et. al. (1980b) made a survey of yield losses in yam due to soil pests: a wide variety of pest including termites (Amitermes), yam beetles, nematodes and various 'rots' are reported to cause significant losses.

In this study, it was observed that very little or no benefit was derived from the infestation by the farmers. However, very few farmers used termites as source of food and constituents of local medicines. This observation is quite different from that of farmers in Ghana, where termites were greatly used in agriculture, as food, in medicine, feed to poultry birds and the mounds are also used for constructing buildings (Akutse et. al., 2012). Termites are also recognized to be major agents of woody matter and soil breakdown in lowland tropical systems (Wood and Sands, 1978; Bignell and Eggleton 2000). The result of the economic analysis showed that there would be economic benefits to the farmer from using dried termite meal to replace fish meal in the diet of Heterobranchus longifilis at 50% inclusion levels of the meal as also specified by the broken-line analysis (Sogbesan and Ugwumba, 2008).

In the fields, Odontotermes, Microtermes and Psammotermes cycle and degrade crop residues (including canes of millet) and cow dung used for fertilizing. The degraded organic matter would return to the soil like minerals (C, N, P, K .etc.). By their construction activity (nests, galleries, veneer), these termites rework and aerate the soil, increasing its porosity, its absorption ability and retention of water. Such observation has been reported by Black and Okwakol (1997) and Jouquet et. al. (2004). In natural ecosystems, termites are typical ecosystem engineers and dominant species in semi-arid ecosystems. Fungivorus termites (Isoptera, Macrotermitinae) play an important role in tropical ecosystems: they modify soil physical properties and so avail food for other organisms.
Within tropical ecosystems, termites (Blattaria: Termitoidae) play a key role as ‘ecosystem engineers’, modifying the biotic and abiotic environment, in turn affecting resource availability for other organisms. Termites provide a range of ecosystem services: decomposition, carbon and nitrogen cycling, soil structuring and the stimulation of microbial activity (Wood and Sands, 1978).

The origin of the presence of termites in the area could not be determined. The farmers in the area did not know exactly how and/or when these mounds appeared on the farmlands. Although majority of the farmers did not notice any variations in the intensity of the infestation as a result of seasonal changes, a few farmers claimed that the level of termite damage to crops and trees was most severe in dry periods and at crop maturity. A similar negative relationship between termite damage and rainfall was reported by farmers in Uganda (Nyeko and Olubayo, 2005). Rainfall can have a negative effect on termite species richness and abundance in tropical rain forest systems, as very high levels can lead to inundated microhabitats and colony death (Bignell and Eggleton, 2000).

Marked variations were observed, as to the extent of damage on various crops and trees caused by termite attacks. These variations may have been influenced by factors such as locality and plant age and conditions of planting, such as proximity to the mounds. (Cowie et al., 1989; Logan et. al. 1990)

Termite Control Practices

According to Nyeko and Olubayo (2005), any attempt at management of termites need careful consideration of their benefits against the rate of loss to the ecosystem. Chemical sprays are the most common current control strategies. However attempt aiming at using of entomopathogenic fungi have been studied (Rath, 2000).

Farmers' attempts on control as revealed by this study were dependent on individual farmlands. It is usually a function of the sheer number of the mounds on the farm. Hence, Farmers whose farms were located on areas with high Macrotermes mound intensity were observed to have attempted various control strategies; both chemical and non-chemical methods, whereas, farmers whose farms were not highly infested were not involved in any control measure.

Chemicals such as insecticides (such as Dieldiers, furadam and Appron plus), and Carbon from old batteries are widely used by farmers in the control of termites. However, there is a need for further research on environmental impact assessment of the influence of the chemicals used for termite control in the area. This is because, these chemicals could have more negative effects on the environment in the long run, especially when they are not used within certain standardized range or measurements.
The farmers have also attempted various indigenous materials such as human excreta and smoke as control measures. The farmers claimed that these indigenous methods were effective in the control of termites.

Farmers in Tororo District in Uganda, have attempted a wide variety of indigenous control measures against termites. Some of which include; use of red pepper, paraffin, dry cell, fire, dead snake, mud-fish intestine, used engine oil and so on. The farmers claimed that these methods were highly effective against termites (Nyeko and Olubayo, 2005). Chemical sprays are the most common current control strategies worldwide. Logan et. al., (1990), have also observed that the control of termites, it was largely based on broad spectrum and persistent organochlorine insecticides and this method of control was associated with serious limitations and disadvantages. They have emphasized the need for alternative control methods. Non-chemical control of termites on farmlands was based on physical destruction of termite mounds, biological control and use of plant extracts, amongst others.

Conclusion

Overall, farmers rated the constraints caused by the giant mounds of Macotermes bellicosus to agriculture as the most important. Farmers who had very numerous mounds on their farms showed that the control of termites is of high priority to them and will be receptive to innovative control measures. This study has provided some basic information about farmers' knowledge of the biology, ecology, perceived extent of damage on individual crops and effect on net yield, as well as management of termites. This information could play a great role in the development and promotion of sustainable termite control measures in agriculture.

Indigenous identification characteristics could aid taxonomists in the identification of termite biodiversity. Farmers claimed that the various control strategies employed in the control and management of termites in the area were effective, especially against Macotermes bellicosus. Mechanisms are needed to educate farmers on appropriate termite management strategies and encourage the transmission of such information from farmer to farmer in the area (Nyeko and Olubayo 2005). Finally, there is a need to verify, standardize and promote the various indigenous control practices reported by farmers in this study.

References

[1] I.L. Ackerman, W.G. Teixeira and S.J. Riha, The impact of mound-building termites on surface soil properties in a secondary forest of Central Amazonia, *Applied Soil Ecology*, 37(2007), 267-276.

[2] C.I. Aisagbonhi, A survey of the destructive effect of Macrotermes bellicosus Smeathman (Isoptera: Termitinae-Macrotermitinae) on coconut seed-nuts at NIFOR, Benin, Nigeria, *Tropical Pest Management*, 35(4) (1989), 380-381.

[3] K.S. Akutse, E.O. Owusu and K. Afeh-Nuamah, Perception of farmers' management strategies of termites control in Ghana, *Journal of Applied Bioscience*, 49(2012), 3394-3405.

[4] G. Bachelier, La fauna du Sol, Son Action, *ORSTOM*, Paris, (1978), 391.

[5] H. Basppa and D. Rajagopal, Physico-chemical properties of termite-modified soils due to foraging on dung in comparison with the surrounding soil, *Sociobiology*, 16(1991), 175-185.

[6] H.I.J. Black and M.J.N. Okwakol, Agricultural intensification, soil biodiversity and agro ecosystem function in the tropics: The role of termites, *Applied Soil Ecology*, 6(1997), 37-53.

[7] R.H. Cowie, J.W.M. Logan and T.G. Wood, Termite (Isoptera) damage and control in tropical forestry with special reference to Africa and Indo-Malaysia: A review, *Bulletin of Entomological Research*, 79(1989), 173-184.

[8] R.G. Davies, L.M. Herna´Ndez, P. Eggleton, R.K. Didham, L.L. Fagan and N.N. Winchester, Environmental and spatial influences upon species composition of a termite assemblage across Neotropical forest islands, *Journal of Tropical Ecology*, 19(2003b), 509-524.

[9] R.G. Davies, P. Eggleton, D.T. Jones, F.J. Gathorne-Hardy and L.M. Herna´Ndez, Evolution of termite functional diversity: Analysis and synthesis of local ecological and regional influences on local species richness, *Journal of Biogeograghy*, 30(2003a), 847-877.

[10] R.G. Davies, P. Eggleton, L. Dibog, J.H. Lawton, D.E. Bignell, A. Brauman, C. Hartmann, L. Nunes, J. Holt and C. Rouland, Successional response of a tropical forest termite assemblage to experimental habitat perturbation, *Journal of Applied Ecology*, 36(1999), 946-962.

[11] P. Eggleton and D.E. Bignell, Monitoring the response of tropical insects to changes in the environment: Troubles with termites, In: R. Harrington and N.E. Stork (eds.), Insects in a Changing Environment, Academic Press, London, (1995), 473-497.

[12] P. Eggleton and D.E. Bignell, Secondary occupation of epigeal termite (Isoptera) mounds by other termites in the Mbalmayo Forest Reserve, Southern Cameroon and its biological significance, *Journal of African Zoology*, 111(1997), 489-498.

[13] P. Eggleton, D.E. Bignell, S. Hauser, L. Dibog, L. Norgrove and B. Madong, Termite diversity across an anthropogenic disturbance gradient in the humid forest zone of West Africa, *Agricultural Ecosystem Environment*, 90(2002), 189-202.

[14] P. Eggleton, P.H. Williams and K.J. Gaston, Explaining global termite diversity: Productivity or history, *Biodiversity Conservation*, 3(1994), 318-330.

[15] J. Fiarhead and M. Leach, Termite society and ecology: Perspective from Mando and Central West Atlantic regions, *Paper Presented to the African Studies Association Biennial Conference*, University of Lancaster, (1994), 5-7.

[16] G.S. Humphreys, Bioturbation, biofabrics and biomantle: An example from the Sydney Basin, In: A.J. Ringrose-Voase and G.S. Humphreys (Eds), Soil micromorphology: Studies in management and genesis, *Developments in Soil Science*, 23(1994), 421-436.

[17] A.F. Iroko, L'homme et les termitieres en Afrique, Collections Economie et Developpement, Karthala, Paris, (1996), 298.

[18] R.A. Johnson, R.W. Lamb and T.G. Wood, Termite damage and crop loss studies in Nigeria: A survey of damage to groundnuts, *International Journal of Pest Management*, 27(3) (1981), 325-342.

[19] P. Jouquet, N. Boulain, J. Gignoux and M. Lepage, Association between subterranean termites and grasses in a West African savanna: Spatial pattern analysis shows a significant role for Odontotermes n. pauperans, *Applied Soil Ecology*, 27(2004), 99-107.

[20] K.E. Lee and R.C. Foaster, Soil fauna and soil structure, *Australian Journal of Soil Research*, 6(1991), 745-775.

[21] M.G. Lepage, The impact of foraging populations of Macrotermes micchaelseni (Isoptera: Macrotermitinae) in a semi-arid ecosystem, *Insect Sociaux*, 28(1981), 309-319.
[22] D.E. Lobry, L.A. Bruyn and A.J. Conacher, The role of termites and ants in soil modification: A review, *Australian Journal of Soil Research*, 28(1990), 55-93.
[23] J.W.M. Logan, R.H. Cowie and T.G. Wood, Termites (Isoptera) control in agriculture and forestry by non-chemical methods: A review, *Bulletin of Entomological Research*, 80(3) (1990), 309-330.
[24] S.L.O. Malaka, Termites in West Africa, University of Lagos Press, (1996), 165.
[25] A. Mando and R. Miedema, Termite-induced change in soil structure after mulching degradaded (crusted) soil in the Sahel, *Applied Soil Ecology*, 6(1997), 241-249.
[26] A. Mando, Effect of termites and mulch on the physical rehabilitation of structurally-crusted soils in the Sahel, *Land Rehabilitation and Development*, 8(1997b), 269-278.
[27] A. Mando, The role of termitemes and mulch in the rehabilitation of crusted sahelian soils, *Tropical Resource Management Papers No 16*, Wageningen Agricultural University, Wageningen, (1997a), 101.
[28] C. Martius, P.M. Feamside, A.G. Bandeira and R. Wassmann, Deforestation and methane release from termites in Amazonia, *Chemosphere*, 33(3) (1996), 517-536.
[29] P. Nyeko and F.M. Olubayo, Participatory assessment of farmers' experiences of termite problems in agroforestry in Tororo District, Uganda, *Agricultural Research and Extension Network*, 143(2005), 1-7.
[30] J.C. Obi, A.O. Ogunkunle and N.T. Meludu, Effect of termite infestation on the farming system characteristics of an Endemic area in the Guinea savanna region of Nigeria, *Australian-Eurasian Journal of Scientific Research*, 3(1) (2008), 1-6.
[31] A.C. Rath, The use of entomopathogenic fungi for control of termites, *Biocontrol Science and Technology*, 10(2000), 563-581.
[32] A.O. Sogbesan and A.A.A. Ugwumba, Nutritional evaluation of termite (Macrotermes subhyalinus) meal as animal protein supplements in the diets of Heterobranchus longifilis (Valenciennes, 1840) fingerlings, *Turkish Journal of Fisheries and Aquatic Sciences*, 8(2008), 149-157.
[33] G. Stoops and C.E.G.R. Schaefer, Pedoplasmation: Formation of soil material, In G. Stoops, V. Marcelino and F. Mees (eds), Interpretation of Micromophological Features of Soil and Regoliths, Elsevier, Amsterdam, (2010), 67-79.
[34] D.A. Wardell, Control of termites in nurseries and plantations in Africa: Established practices and alternative courses of action, *Commonwealth Forestry Review*, 66(1) (1987), 77-89.
[35] W.G. Wielmaker, Soil forming by termites: A study in the Kissi area, Kenya, *PhD Thesis*, Wageningen Agricultural University, Wageningen, (1984), 251.
[36] T.G. Wood, R.A. Johnson and C.E. Ohiagu, Populations of termites (Isoptera) in natural and agricultural ecosystem in southern guinea savanna near Mokwa, Nigeria, *Geo-Eco-Tropical*, 1(2) (1977), 139-148.
[37] T.G. Wood, R.A. Johnson and E. Ohiagu, Termite damage and crop loss studies in Nigeria: A review of termite (Isoptera) damage to maize and estimation of damage, loss in yieldand termite (Microtermes) abundance at Mokwa, *Tropical Pest Management*, 26(3) (1980), 241-253.
[38] T.G. Wood, R.W. Smith, R.A. Johnson and P.O. Komolafe, Termite damage and crop loss studies in Nigeria: Pre-harvest losses to yams due to termites and other soil pests, *International Journal of Pest Management*, 26(4) (1980), 355-370.
[39] T.G. Wood, The hototermitid havester termite of South Africa, Union of South Africa, Department of Agriculture, *Entomological Series*, 43(1958), 375.
[40] T.G. Wood and W.A. Sands, The role of termites in ecosystems, In M.V. Brian (Ed.), Production Ecology of Ants and Termites, Cambridge University Press, Cambridge, UK, (1978), 245-292.