ADDIS ABABA UNIVERSITY

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SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

THE EFFECT OF SUBTERRANNEAN TERMITE AND FARMERS TRADITIONAL MANAGEMENT METHOD IN MANASIBU DISTRICT WEST WOLLEGA, OROMIA, ETHIOPIA

BY

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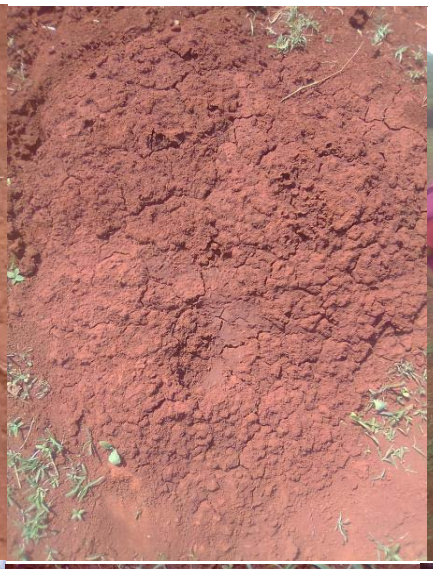






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The Effect of Subterranean Termite and Farmers' Traditional Management Method in Mene sibu District, West Wollega Zone, Oromia, Ethiopia

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AUTHOR'S DECLARATION

The researcher here by declares that the Thesis on the title: "The Effect of Subterranean Termite and Farmers Traditional Management Method", is my original work and that all sources that have been referred to and quoted have been dully indicated and acknowledged with complete references.

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ACRONYMS

ADA	Agricultural Development Agent
BARC	Bacho Agricultural Research Center
DA	Development Agent
FDG	Focal group discussion
MSWAO	ManaSibu Woreda Administrative Office
MSWLMO	ManaSibu Woreda Land Management Office
MSWARDO	ManaSibu Woreda Agriculture and Rural Development Office
UNFP	Unite Nation Food Program

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ABSTRACT

The study of the impacts of subterranean termite on agricultural production and farmers' traditional management methods was carried out in two kebele of mana sibu district (woreda) from September 2022 to August 2024. The data were gathered from farmers, woreda agricultural office, agriculture development agents (ADAs) and kebele elders of the study area. A household survey questionnaire was collected from 150 households selected randomly. Additionally qualitative data/information was collected from 28 informants who were selected purposely for focus group discussion and in depth interviews. Relevant information was collected by using semi-structured interview, field observation, questionnaire and focus group discussion. Descriptive statistics, correlation analysis were used for data analysis. Based on the gathered data, the impacts of subterranean termite have positive significant correlation with farmers' indigenous management practices. After Traditional Termite Management was practiced in the study area, soil erosion and wall destruction were decreased whereas; crop production and availability of forage for animal were increased. Deforestation is the main causing factor for increased termite impacts on agricultural production system in the study area. Based on the findings of the study, the researcher recommends that the district agricultural office and all the concerned bodies should take local fitted measures. In doing so farmers should considered in the planning, management and control measures to halt termite infestation and it's impact on agriculture, and households' income particularly and environmental generally.

***Keywords**: Subterranean termite effect, Farmers' traditional termite management practice, Mana sibu*

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

Termites are social insects which belong to the insect order Isopetra. Termites established society depends on a system of mutual communication; they have no trouble in exchanging information. They are an essential member of the social ecosystem (Glaciela et al., 2006; Tathiane et al., 2009; Abdel and Skai, 2011) found mainly in the tropics between 45^{0} North and 45^{o} South latitudes (Gedeon 2006). The distribution areas of termites cover over two-thirds of the landmass, involving some 100 countries and predominantly distributed in tropical environment, with the highest species richness in equatorial rainforest, and generally declining with increasing latitude (Yanyong *et al*., 2003).

Therefore, their presence is particularly noticeable in tropical and subtropical regions where they represent (10%) of the animal's biomass and the estimate is refined to include only soil insect biomass which value rises to 95% coverage (Donovan *et al*., 2007). There is the high prevalence of termite colony in Africa. Among the negative impact of termite, damage to plant and agricultural crops are notable. Therefore, it requires effort to build coherent principles for termite management (Sileshi .*et al*., 2009). Termites are subterranean in nature and difficult to locate and destroy them (Devendra *et al*., 1998).

Among all termites, with the largest, species, the *Macrotermes* species known to be fungus growing and mound building and build large epigial nests from where they forage outwards to distances up to 50m in galleries (Osipitan and Oseyemi, 2012 Severe yield losses made in East Africa including western Ethiopia by *Macroterms* ranging from 50 to 100% in (Wood *et al*., 1980; Nyeko and Olumbayo, 2005). In other parts of Ethiopia also serious damage occurred, on some trees & crops in highly termite infested areas (OADB, 2001). Particularly the damage of termite is high in central rift valley and western part of Ethiopia (Daniel. and Emana, 2014a; Mulatu. and Emana, 2015). The purpose of this study was to assess and document the impact of subterranean termite on farmers' agricultural practices and farmers traditional management methods to minimize the impact of termite on agricultural practice and related activities in the study area

1.2 Statement of the Problem

Soil erosion is major problem of food insecurity as result of lack of soil fertility management practice due to serious pest of agricultural crops (Abraham, 2008), because of degraded land yield production effectiveness is very low (Brauman, 2ooo). The cause to this route problem termite attack is resulted from land degradation exhibited in the form of soil fertility and pest problem in one factor (Emana and Gure, 2017).termite have been regarded as serous pest that attack a wide range of agriculture land, forest trees and building, in western Ethiopia (Abduraman,2011).

A large numbers insect pests attack crops and pastures in Ethiopia, although few of them cause economic losses (Tilahun, 2018). Some termites are economically important insect pests by eating other insects that cause more destruction to crops, where as some are distractive to agricultural production (Xing et al., 2001). For the management and control of subterranean termites different methods include cultural and biological control, queen removal, plant resistance, natural products, physical barriers and insecticides are still used (Kumawat, 2001; Rana *et al*., 2001). Even plastic barriers and engine oils are applied though not effective solution for different materials and buildings to resist from termite damage (UNEP, 2000; Ahmed and French, 2008). Agricultural yield reduction caused by land degradation has been exacerbated termite attack on a wide range of agricultural crops, forest trees, and building in western Ethiopia (Abdurahaman, 1983; Abraham, 1990).

Guachan *et al*. (1998) described that termites lowered the yield of maize, sorghum, teff, millet, and beans in Mana Sibu district (West Wollega, Ethiopia). Furthermore, it was reported that termite damages growing trees, nursery and young trees in the fields, matured trees in natural habitat, in plantation and specimens in towns or botanical gardens. Abdurahman (1990) reported that in western Ethiopia thatched roof huts are destroyed in less than five years and corrugated iron roof of houses in less than eight years because of the damage of wooden materials supporting corrugated iron Many wooden structures and the wall of the house which is made from mud in the same area require maintenance every year. This undesirable consequence of repeated rebuilding of wood straw thatch houses leads to excessive clearing of native range land, woodland and forests as well as trees. In other way for planting whether native or exotic trees, there are a serious damage of termite on newly planted tree generation in the area. Such

problems primarily affected the rural farming communities who are depending on agriculture for their livelihoods (Bulto and Hirpha, 2016). The productivity of their agricultural production and soil fertility are deteriorated by the effect of termite. Consequently, it leads to soil erosion, environmental degradation, deforestation, destruction of construction, loss of crop productivity, and food insecurity in the study area. Effective and suitable termite management practice is required to combat problems associated with termite. Although various controlling measures have been indicated; ranging from termite mound poisoning (Abdulahi et al., 2010; Bulto and Hirpha, 2016) to botanical control, cultural/traditional, and physical soil and water conservation (Bulto and Hirpha, 2016), this study was conducted to assess the impacts of subterranean termite on the agricultural practice of the local farmers and farmers' traditional control/protection methods against the impacts.

1.3 Objectives of the Study

1.3.1 General objective

The main objective of the study was to investigate the impact of subterranean termite on the agricultural practice of farmers and farmers' traditional management methods against the impacts in the study area.

1.3.2 Specific objectives

- To assess the impact of subterranean termite on the agricultural practice of the local farmers of the study area.
- To examine farmers' traditional methods of management of the impact of subterranean termite on their agricultural practice.
- To assess local institutional support to control the spread and impact of subterranean termite on local agricultural practice.

1.4 Research Questions

The main focus of this study was to investigate the impact of subterranean termite and farmers traditional management methods in two kebeles of Mana Sibu Woreda. The finding of the study would try to answer the following research questions.

- What are the impacts of subterranean termite on agricultural practice of the local farmers in the study area?
- what extent farmers' traditional methods of management reduced the impact of subterranean termite on their agricultural practices?
- How is the local institutional support to control the spread and impact of subterranean termite on local agricultural practice?

1.5 Significance of the Study

The study would have a great contribution for farmer and agriculture investors to prevent their production from defect of termite pest problem during cultivation and harvesting season and also those who deal with plantation activities. It has also used as secondary source of data for individuals and institutions those have interest to continue farther study. The study would also used additionally as supplementary material for individual farmers, agricultural bureau, NGO, policy making, other interesting group, in implementation and achievement of sustainable rural development and poverty reduction program.

1.6 Scope of the Study

The study was conducted in Oromia region, West Wollega zone, ManaSibu Woreda of two kebeles, odoro tobara and Kokora gurati of the study area. The researcher was also conducted this study while he teaching his normal class. Although termite can have both positive and negative impacts in agricultural production system, this study focused on the negative impacts of subterranean termite. A wide range of controlling measures of negative impacts of termites have been recommended ranging from termite mound poisoning to botanical control, cultural /traditional, and physical soil and water conservation, nevertheless this study was focused on traditional methods of subterranean termite management practice of farmers of the study area. Other variables considered by this study included the impact of subterranean termite on local communities' activities, farmers' awareness and training on the impact of termite; traditional

methods of management of the impact of termite; change observed after land management from termite infestation; and determinants of observed outcome.

1.7 limitations

The study would delineate to these kebeles because of shortage of time, and resource constraints for the researcher to cover wide area. The researcher hasn't experience of research working. Inadequate budget and time, access of the source in the study area also hinder the researcher to do more detail.

1.8 Inferential Statistics

Correlation analysis was performed to investigate the effect of subterranean termite and farmers' traditional termite management. Using Pearson correlation with two tailed test of significance, the correlation analysis was made.

1.8.1 Correlation Analysis

According to Field (2005), a coefficient of +1 indicates that the two variables are perfectly positively correlated, so as one variable increases, the other increases by a proportionate amount. Conversely, a coefficient of -1 indicates a perfect negative relationship: if one variable increases, the other decreases by a proportionate amount. A coefficient of zero indicates no linear relationship at all and so if one variable changes, the other stays the same. A commonly used measure of the size of an effect and those values of ±.1 represent a small effect, ±.3 is a medium effect and ±.5 is a large effect.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Definition of termite and food of termite

Termites (*Isopteran*) are truly social insects and the most successful insects to exploit their environment (Clyde *et al*., 2006). Termites possess a complicated spatial and social organization comprising interconnected sites and nest containing variable number of reproductive (Husseneder *et al*., 2003).

Subterranean termites are insects that feed on wood, frequently become pests of home. Termites are small insects that are usually less than half-inch in length (Husseneder *et al*., 2010). Termites are insects that cause damage to building. Termites are may be considered pest because they can destroy homes. Termites live in large social group called colonies (Clyde *et al*., 2009).

The normal food of most termites consists of cellulose (dead wood), fungi or soil. Some termites feed directly on dead plant tissue; others collect plant materials on which to grow fungus gardens in their nests and the rest consume huge amounts of organic matter to derive nutrients. The fungus-growing termites are the most troublesome in agro forestry. They feed on organic material such as crop residues, mulches and soil organic matter (humus). However, when this type of food is not available, they will feed on live plant material including crops such as ground nuts, millet, maize, cassava and trees. Harvester termites' collective green plant material and cause damage to pasture grasses, crops and tree seedlings. They readily attack weak plants that are wilting or damaged. Termite damage in agro forestry and agricultural fields appears to have intensified due to climate change (Philip *et al*..2019)

2.2 The Role of Subterranean Termites in Ecology

Termites are the dominant Macro arthropod decomposers in many tropical soils, and are particularly diverse and abundant in lowland equatorial forests (Eggleton, 2000). Soil of termite mounds is normally nutrient rich, in particular of calcium, magnesium, potassium, sodium and available phosphorus. Also, termite mound soil is characterized by high fractions of clay, silt and

fine sand as well as organic matter. The use of this soil as fertilizer can lead to a three-fold increase in yield (Van Huis, 1996; Fairhead. and Leach, 2003). Termites are abundant and crucial cellulose decomposers in numerous tropical and subtropical ecosystems (Schuurman, 2005) and improve water absorbing and storing capacity (Jude and Ayo, 2008); are a source of vegetation heterogeneity and tree diversity (Traoré*et al.*, 2008; moe*et al*., 2009; Sileshi*et al*., 2010); they are considered as good bio-indicators and real ecosystem engineers in tropical ecosystems and their sensitivity to habitat disturbance causes changes in their species richness, composition and functional characteristics (Eggleton*et al.*, 2002; Dosso *et al*., 2013). Therefore, due to termites playing a key role in the tropical ecosystem evolution, CNF select as an ecological niche of some insect species including termites (Boga*et al*., 2015). On the other hand, many African communities have knowledge of the nutritional and medicinal value of termites and mushrooms associated with termite nests (Nyeko and Olubayo, 2005; Kabasa*et al*., 2006; Opige*et al*., 2006; Sileshi*et al*., 2009)

2.3 More Destructive Period, Areas and Plants by Termites

Susceptibility of crops and trees to termites is governed by several factors. Termite infestation and damage caused by subterranean termite species is greater during o drought than the periods of regular rainfall (Logan *et al*., 1990; Nyeko and Olubayo, 2005; Christopher *et al*., 2013). Damage by termites is greater during dry periods than periods of regular rainfall, in lowland rather than highland areas, and in plants under stress rather than in healthy and vigorous plants and particularly, exotic crops and trees are more susceptible to termite attacks than indigenous crops (Logan *et al*., 1990; Pearce, 1997; UNEP, 2000).

2.4 Impact of termite

2.4.1 Termite Damage to crop and Range Lands vegitation

Termites are associated with severe damages to crops and croplands, range lands vegetation, particularly, in degraded arid and semi-arid ecosystems (Pearce, 1997). They are severe pests in several parts of Ethiopia, particularly in the Western regions of the country (Deressa, 2017).Grass eating termites are often many in tropical and subtropical grass lands where livestock also graze and compete with grazing animals for forage, to actually damage forage resources, and to interrupt soil nutrient cycles (Gauchan et al., 1998). Termites enhance soil

degradation and erosion by reducing the vegetation cover (Demissie et al., 2019); Gauchan et al., 1998). A soil infested with termite mostly resulted in distortion of soil structures and compaction. Hence soil becomes difficult to plough; this in turn results in a reduction of productivity of crops (Gebreslasie and Meressa, 2018).

2.4.2. Effect of Termite Infestation on Household Property

In western Ethiopia thatch roof huts are destroyed in less than five years and corrugates iron roof house in less than eight years (Abdurahman, 1990). Frequently repairing and rebuilding of house within a few years is challenge for subsistence farmers; beside it has negative impact on environment as plants are the major sources for building materials. (Debelo and Degaga, 2014)

2.4.3. Effects of Termite Infestation on Household's Food Security

Termite infestation has negative effects on household food security. They contribute a lot to poor agricultural productivity and poor soil fertility that leads to increasing out migration of the community from their residence to another place (Legesse, et al., 2013).

2.5 Controlling Methods of Termite Pests

2.5.1 Chemical Control

Chemical treatments, such as: liquid termiticides and baiting systems are widely used to control subterranean termites. Soil treated with liquid termiticides, such as fipronil, imidacloprid and chlorantraniliprole, places chemical barriers between termites and wooden structures (Ibrahim *et al*., 2003; Osbrink *et al*., 2005; Parman and Vargo, 2010; Osbrink*et al*., 2011). According to a 2002 survey, liquid termiticides account for three fourths of the market share of termite control (Rust and Su, 2012). Although the effectiveness of liquid termiticides has been proven by laboratory and field studies (Hu, 2005; Mao *et al*., 2011; Vargo and Parman, 2012; Gautam*et al*., 2013), they are not free from shortcomings (Cai Wang, 2010). Soil treatments with liquid termiticides requires the use of large amount of chemical, which does not only increase the cost to homeowners, but also exert non-target effects to soil and aquatic organisms (Mostert, 2002; Clasen*et al*., 2012; Hayasaka*et al*., 2012). Chemical treatments for termite control methods practiced in Ethiopia include aldrin, heptachlor, Diazinon and Chlorpyriphos (BARC, 2004). However, even if organo chlorinated, hydrocarbon insecticides, aldrin and dieldrin 13 are

effective for management of termites in the world, they are harmful effects on human health, other organisms and environmental pollution (Soomro*et al*., 2008). Baiting systems provide another option for long-term control of subterranean termites (Henderson, 2001; Rust and Su, 2012). A baiting system deliver slow-acting pesticides, such as hexaflumuron and noviflumuron, to the whole colony of termites through direct feeding and secondary transfer (Sajap*et al*., 2000; Su, 2005; Getty *et al*., 2007; Hussenede*et al*., 2007; Osbrink and Corneliusm, 2013). Baiting systems decrease environmental exposure of pesticides. However, the present bait stations are very labor intensive for checking and replacement, and thus limit their application for the termite control (Cai Wang, 2010).

2.5.2 Biological/Botanical Control

Biological control constitutes a more environmentally acceptable alternative to traditional chemical control measures. When successfully implemented, it can yield permanent, cost-effective management of pest population with minimal environmental disturbance (Culliney and Grace, 2000). Biological control may provide an environmentally friendly method for termites control that have agents, including nematodes, bacteria, and fungi, have been tested against termites under laboratory conditions (Cai Wang, 2010). According to a review by Chouvenc*et al*., (2011), a total of 227 scientific reports related to termite biological control were published between 1960 and 2011, many of them reported high termite mortality caused by pathogens, such as *Bacillus thuringiensis*, *Serratiamarcescens*, *Pseudomonas fluorescens*, *Beauveriabassiana*, *Paecilomycesfumosoroseus*, and *Metarhiziumanisopliae*, in laboratory bioassays (Connick*et al*., 2001; Castilhos-fortes *et al*., 2002; Sun *et al*., 2003; Wang and Powell, 2004; Meikle*et al*., 2005; Wright *et al*., 2005; Dong *et al*. 2007; Wright *et al*., 2008; Devi and Kothamasi, 2009; Singha*et al*., 2010; Wright and Cornelius, 2012).

Some indigenous plant materials are botanicals which used in insect pest management successfully to control *Macrotermes*spp (Muhammad, 2009). The use of botanicals can be a fundamental component of integrated pest management, but their value in controlling termites has not been well investigated under Ethiopian conditions (Tadele*etal*., 2014).However, seed powder of *Azad rachtaindica* (neem) water extracts were effective against termite (Daniel and Jembere, 2006) and tobacco leaf extract and Birbira seed extract caused greater mortality to subterranean termites (Tadele*et al*., 2014). From the botanicals extracts, seed extracts of

*Azadrachtaindica*are most bio-potent botanicals and caused higher mortality among the remaining botanicals at higher concentration respectively (Addisu, 2014). However, most botanical methods did not provide significant control of the pest (Ahmed and Girma, 2013).

2.5.3 Physical and Cultural/ Traditional Control

Before adopting a chemical means of control, alternative, traditional methods of control should be considered (Gedeon, 2006). Some of these traditional methods of termite control are known in some sub Saharan African countries. Mound (nest) destruction and queen removal (Zhang *et al*., 2000; BARC, 2004), flooding and suffocating (Guachan*et al*., 1998), and improving soil quality (fertility) (Sileshi.and Mafongoya, 2003) are some physical or cultural methods of controlling termite pests. As Mulatu and Emana, (2015) reviewed some studies; several traditional methods of termite management were undertaken in the tropics and subtropics where termites have been a constant threat to crops, buildings, trees and any other materials made of wood. The practices used by smallholder farmers in Ethiopia include flooding mounds, digging mound, removal of the queens, excavating the top parts of the mounds, burning straw to suffocate and kill the colony, mound poisoning (Gauchan*et al.,* 1998). According to Sileshi., *et al*. (2009) management of termites in the future should be built on farmers 'indigenous knowledge and adequate understanding of the ecology of the local termite.

CHAPTER THREE

3. DISCRIPTION OF THE STUDY AREA & MATERIAL AND METHODS

3.1 Description of the Study Area

The study was conducted in two kebeles of Mana Sibu Woreda located in west Wollega Zone, Oromia Regional State, Ethiopia. The study area is found at 616 km west of the Ethiopian capital city, Addis Ababa. The Woreda has 47 administrative rural Kebeles and Mendi is the capital town of the Woreda. The main road from Addis Ababa to Assosa crosses this town as well mana sibu woreda (MSWAO, 2017).

3.1.1 Location

The study area is found in Ethiopia, Oromia regional state, West Wollega Zone, Mana Sibu woreda, (figure 1). map of the study area (MSWAO, 2017)

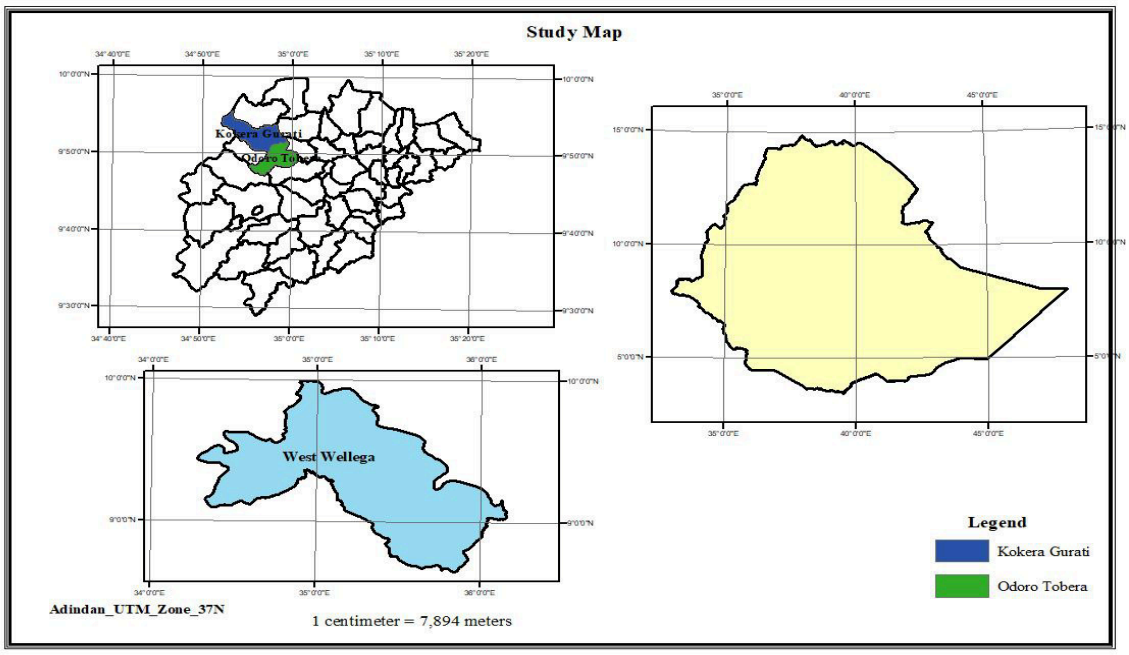

Figure 1 .Location map of the study area (MSWAO, 2017).

Mana Sibu Woreda lies in between $9^0$30'N to $10^0$00'N latitudes and $34^0$55'E to $35^0$20' E, longitudes. This Woreda has a total area of 1668.1Km^2 which is bordered by bildinginu woreda

of Benenshangul gumuz regional state on North direction, Kiltu Kara woreda of oromia regional state on East direction, Babo Gambel Woreda of Oromia regional state on south east direction, kondala woreda of oromia regional state on south west direction, and banbasi woreda of benishangul gumuz regional state on West direction. The study area is 43Km north western of the Woreda town. The Woreda has 47 kebeles where as, Idoro tobara and kokora gurati kebekes were selected randomly for the study from the six (6) more affected Kebeles in the Woreda by the subterranean termites (MSWANCO, 2009). Particularly the study areas are bordered by Gunfi kebele at the North, xayiba kongil kabala on East, Bengu'aa kebele on south and Wanasha dabus kebebe in the west.

3.1.2 Topography and drainage

The relief pattern of the district is characterized by various relief with undulating plateaus, Karra Bonso, Tululami, Gunfi, gara warabessa are some of the major hill in the woreda with average altitude above 1500m above sea level and cala dabus, washo borata, Chafichafi Danbora, karawayu abo,matari birbisa were the lowland area of the woreda with average altitude below 1500m above sea level.

The woreda is generally lies within altitudinal range estimated to be 1250 m –1933m above sea level**.** The woreda has varied land forms. The topography of the area is mainly characterized by gentle slopes (40%), undulating hills steeply slopes (25%) and moderate lowlands/ plain (35%) with many small tributaries. The altitude of the district varies in altitudinal ranges between 1250m and 1933m above sea level and located at 09º 30'N and 35º 06'E (Gemtessa, 2014; Ebissa, 2014)

There are many rivers that drain in the woreda that are mostly used for small scale irrigation and for drinking purpose both for animals and people and other activities carried out in house. They are the main tributary of Dabus River which is tributary of *Abay* River. These rivers include *Hena, Kongil, Kersa, Sechi, Washo, Nanno, Alaltu,yebalo, jirma* and etc. The study woreda has around 41 micro watersheds and 4 macro watersheds.

3.1.3 Climate

The agro-climate zone of the Woreda is classified into high land and low land with the altitudinal range of 1250m to 1933m above having area coverage of 70% and 30% a total area of the Woreda respectively. Specifically, the study area average mean altitude is 1296.67m above the sea level for both of them partially found in low land and partially found in high land. The major rainy season in the Woreda is from June to August and the average annual rain fall of the Woreda is about 900mm to 1500mm; specifically, the study area (two kebeles) average mean annual rain fall is 1050mm and the rainfall distribution of the woreda is unimodal. The average temperature of the study area is 26^0c (M SWAO, 2009).

3.1.4 Geology and Soil

According to the data obtained from the MSWANCO (2009), the soil texture coverage 70% clay, 20% sand and 10% silts; few black stones and marble were recorded in the woreda and the average soil PH acidity was 32.67%.

3.1.5 Land Use, Vegetation and wild Animals

Mana snibu woreda is endowed by varied type wild animals like hyena, monkey, apes, rabbit, crocodile, buffaloes, antelope, ape, etc and different kinds of birds

The major type of natural vegetation observed in the study area in rare was indigenous trees and shrubs. These natural forests were under the protection of kebeles and still there was no reserved area officially for wild life conservation in the Woreda. The total land area of the Woreda as classified by land use/cover is given in Table 1 (MSWLMO, 20019) of which 15.1, 3.5, 3.7 and 10.4 were under cultivation, pasture, forest and protected land respectively.

Table 1: Land use indication in hectare in Mana Sibu Woreda (MSWLMO, 2019).

Landuse cover	Cultivation land	Posture land	Forest land	Protected land	Other	Total
Area (ha)	25,099	5,868	6,250	17,336	112,257	166,810
% of total	15.1	3.5	3.7	10.4	67.3	100

3.1.6 Population and Economic activities

The study was conducted in Idoro tobara and kokora gurati Kebeles of Mana SibuWoreda. The Woreda has a population of 132,895 who are living in an area of 1668.1square kilo meter. The study kebeles populations account 4.66% of residing in an area of 77.73 square kilo meter which making the population density near 78 person per square kilo meter; and the total populations of the study kebeles (study area) were 6072 and the household heads were 874 .(MSWAO, 2017)

The major economic activities practicing in study area is mixed agriculture, plantation agriculture and traditional mining. The economic bases of the communities in this area are rain fed crop cultivation and some traditional irrigation. Mixed agriculture remains the main source of livelihood activity and the major cultivating yields include Maize, Sorghum, Millet, teff, and plantation are mango,banana, sugarcane, Orange,coffee, avocado and Vegetables (Guachan*et al* 1998; MWAO, 2017).

Table 2 population size of the two studied kebeles (MSWAO, 2019)

No	Study area of Kebeles	Total land size in hectare	Total population	House hold
1	Idoro tobara	653	3242	363
2	Kokora gurati	616	2830	371
3	Total	1269	6072	734

3.2 Research Methods

To estimate the impact of subterranean termite on farmers' agricultural practice and its traditional methods of management the researcher use both qualitative and quantitative approaches. To determine the impact of subterranean termite in the study area; semi-structured interview, focus group discussions, questionnaire for households, field observation, have been employed in the selected study area.

3.2.1 Selection of the Study Area

As many studies shown, in Western Ethiopia, the impact of termites is the highest rate (Daniel and Emana, 2014a; Mulatu and Emana, 2015).Mana Sibu woreda is one of the district of West

Wollega zone. The Woreda is challenged by termite impact and as raw data are recorded by Mana SibuWoreda Agricultural Office shown that the impact of subterranean termites in the is high Woreda (MSWANCO, 2017). The Woreda has 47 kebeles, and the (two) kebeles were selected from the six kebeles relatively more affected by termite than the other,. odoro tobara and Kokora gurati were selected randomly from more affected kebeles for the study from Mana SibuWoreda of Oromia region, Ethiopia.

3.3 Sampling Informants

To the study of impact subterranean termite, farmers' household, Development Agents, kebele elders and woreda agricultural office experts were included. Voluntary households of the study area, who volunteers would participate in the responses, complete the consent form prepare by the researcher. Since there was no recent investigation conducted on the similar study in the study area P value of 0.05 would been taken to ensure the sample size large enough to satisfy the precision and confidence constraints. Accordingly, the 95% confidence interval for Z statics which is conventionally 1.96 and 5% precision were used to determine _ n 'using the statistical formula of Kothari (1995).

$$\frac{Z^2 \frac{\alpha}{2} p(1-p)}{d^2}$$

Where

n = Sample size;

Z = Z statics for a level of confidence;

$$\frac{Z^2 \frac{\alpha}{2} p(1-p)}{d^2}$$

d = Precision;

P = Expected effect Based on the formula,

the sample size (n) is calculated:

n = (1.96) (0.65) (0.35)

(0.05^2)

0.4457

0.0025

= 178.36

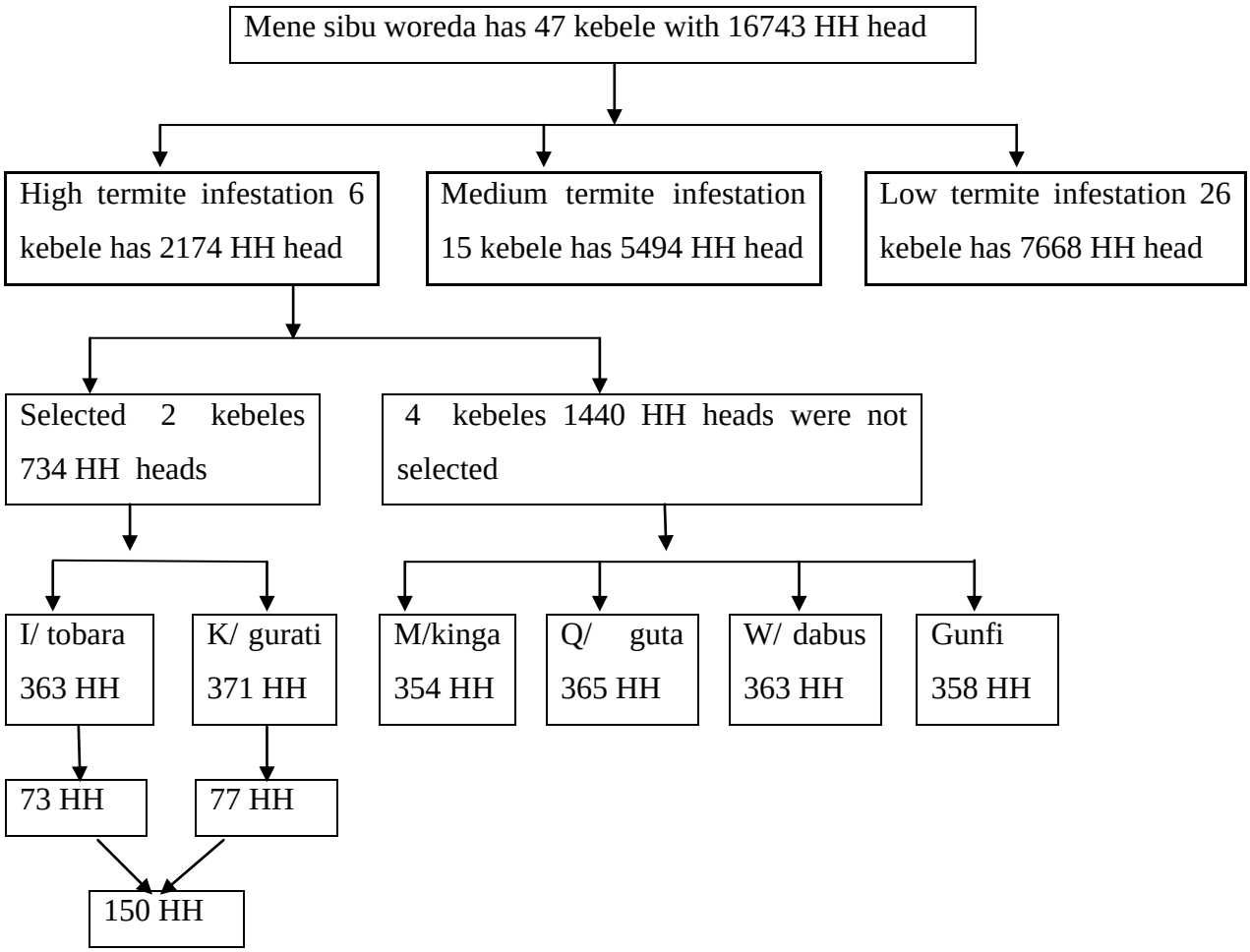

Figure 2 systematic representation of sampling procedure (MSW, 2023)

Table 3: sample frame and sample size of participants in the study area

No	Population of the study area	Number target population	Sampling size	Sampling techniques	Data gathering tools
1	DA of kebele	734	150+28	Purposive sampling	FGD and interview
2	Woreda agricultural office expert				
3	Key informant house hold or elders			Simple random	Questionnaire
4	House hold head				

The study participants were selected using purposive sampling and simple random techniques to attain the intended sample size. The researcher used simple random techniques to select 150 farmers' household heads from the two kebeles; household heads to fill the questionnaire prepared for them. Twenty eight participants were selected purposely; which consists 8 DA from the two kebeles, 8 farmers FGD, 8 woreda agricultural office experts, and 4 elders informant interviewers from two kebeles.

3.4 Data Collection Techniques

Semi-structured interview, focus group discussions, questionnaire and field observations would used to collect data. Informants would interviewed individually in the local language, Afan Oromo. Key Informants for the Semi-structured interview would selected with recommendation of the local elders, DAs and the Kebele leader. The individual Semi-structured interview includes DAs and elder farmers of the study area.

3.4.1 Household Survey

Survey questionnaire was addressed questions regarding the impact of the termite on agriculture production, farmers' traditional termite management and the role of institution in termite impact management in the study area. About 150 questionnaire papers were prepared and distribute to the respondents and fill by them, finally the researcher analysis the suggestion given by the respondents

3.4.2 Key Informant Interview

The Semi-structured interview contains questions on the impact of subterranean termites and farmers traditional management methods. Each informant would listen at least two times during he/she gives his/her response in order to provide real information.

3.4.3 Focus Group Discussion

In order to prove the reliability of the data collection through semi-structured interview, focus group (focus group discussion for the two kebele with average number of 8 participants) and development agent of each kebele as well as woreda agriculture office. The discussions would undertake to gain further information on the occurrence of termite impacts on agriculture, range land, wall of house and farmers' traditional management practices, and associated knowledge of the community toward the impact of termite and its traditional methods of management.

3.4.4 Direct Observation/Field Study

The researcher observed fields several times and documented the effect of termite on agriculture production, construction, and natural vegetation. He also collected information about farmers' traditional termite management methods, termite impact on agricultural activities, and effectiveness of applied management practices.

3.5. Data Analysis

The data was collected through different techniques to verify and check for validity and reliability the study. Collected data edited coded and entered into SPSS software for analysis. Data were analyzed using descriptive statistics of tables, figures, means, percentages and frequency distributions. Furthermore, multinomial logic model was used to analyze the determinant factors that affect agricultural outcomes after management of termite as adaptation measures as presented below

CHAPTER FOUR

4. ANALSIS AND RESULTS

4.1. Socio-economic Characteristics of the Respondents

4.1.1 Social background of the household

The household surveyed sample was consisted of 150 respondents. As observed from table 4 in terms of gender 84.7% of household were males, while 15.3% of respondents were females .The age composition of the respondents were 18.7 % of the sample households were 25-35 years old, 30.7 % the sample households were age from 36-45years old, 40 % the sample households were 46-55 years old and 10.7 % household heads above 55 years old. Educational status of the sampled households shows that 15.3% of respondents were illiterate, 74.6% of the respondents had primary school and 10% respondents had secondary school.

The family size of respondent was 24 % of the sample households had 1-3 family members, 66 % households had 4-6 family members and 10 % had above 6 family members.

Table 4. Sociol Characteristic of the Respondents.

	Characteristics	**Frequency**	**Percent**
Sex of the Respondents	Male	127	84.66
	Female	23	15.33
Age of the Respondents	25-35	28	42.6
	36-45	46	43.5
	46-55	60	7.8
	>55	16	6.1
Family size	1-3	36	24
	4-6	99	66
	>6	15	10
Level of Education	Illiterate	23	15.3
	Primary school	112	74.6
	Secondary school	15	10

Source: Own Survey result, 2023

4.1.2 Economic back ground of the household

The farmers in the studied area had different farming experience based on their age. As indicated in the table 5 about 2% of the respondents had below 15 years farming experience, 19.3% of the households had 16-25 years of farming experience, 22% of households had 26-35 years of farming experience, 45.3% of households had 36-45 years of farming experience and 11.3% of respondents had above 45 years of experience. Generally majority of the respondents 56.6% of them had above 35 years of farming experience farmers in the studied area.

In terms of land size owned by farmers of in the studied area 1.3% of respondents had below 1ha,10% of households had 1ha-2ha, 17.3 of respondents had 2.1ha-3ha, 62 of respondents had 3.1ha-4ha, and 9.3% of respondents had above 4ha of land which used for different purpose. The number tropic of livestock unit possessed by farmers 10.7% of household had below 5 cattle, 30% of household had 6-10 cattle, 34.7% of respondents had 11-15 cattle, 17.3% respondents had 16-20 cattle and 7.3% of respondents had above 20 cattle. Averagely the largest percentage of respondents had 6-15 numbers of livestock.

Table 5. Economic back ground of household

	Characteristics	**Frequency**	**Percent**
Farming experience of household	<15	3	2
	16-25years	29	19.33
	26-36 years	33	22
	36-45 years	68	45.33
	>45 years	17	11.33
Land size	<1ha	2	1.33
	1ha-2ha	15	10
	2ha-3ha	26	17.33
	3ha-4ha	93	62
	>4ha	14	9.33
Tropical Livestock Unit (TLU)	<5	16	10.66
	6-10	45	30
	11-15	52	34.66
	16-20	26	17.33
	>20	11	7.33

Source: Own Survey result, 2023

4.2 The Impacts of subterranean termite on local communities

There were serious termite impacts in the study area. These impacts are:

1. The researcher had seen barren land due to termite effect in the studied kebele (example, Figure 3 presents plot where a grass of grazing land is damaged). Termite causes serious damage which is difficult to recover.

2. All the respondents have agreed upon the negative impact of termite on land productivity of their activities particularly related to their land, and all respondents have agreed that there was serious termite effect in their kebeles as whole. The FGD and key informants also confirmed that termite impact is endemic pest problem to their daily activity particularly their agricultural production and also challenge their daily livelihood activities.

3. Every farmer indicated they worry about the effect of termite throughout the cultivation periods: early cultivation period, cultivation period (from sowing to crop maturity), harvesting, and post harvesting period.

The FGD with experts of woreda agricultural officers and informant elders showed termite impacts had relation with human action. In study area there were great differences in impacts between places, in some places some of the human actions were affected by some degree, whereas in some places human actions were completely restricted to practices. The difference is only on destruction but termite mound can appear on every of the study area. The interviewee farmers also reported that the impact intensity of termites varies, i.e. in area where only few people live and farming is less practices, impact is less, whereas as population settlement became crowded and most of the land is plowed and used for grazing land (Figure 3), termite impact also became intensified. Still now there variation between touched and untouched land, plowed and un plowed land. As whole there were great connection between human activities related to land resource and termite impact because, termites were used vegetative plants as stable source of food for generate its' life. With regard to the question whether the impact of subterranean termite is challenge on local communities' activities or not all respondents responded that it is a common problem to the communities as a whole.

Figure 3. Effect of termite on grazing land where grass is completely damaged/photo taken byResearcher, 2023

Figure 4. District experts and farmer (photo taken by Researcher, 2023)

4.2.1 Degree of Termite Effect

The degree of effect of termite is the rate by which termite damage human activities done on the land. Most of the respondents about 82 (54.7%) and 39 (26%) are agreed that there were very high and high subterranean termite effect in their kebele respectively, 20 (13.3%) of the respondent were consider there was medium while only 5 (3.3%) and 4 (2.7%) were understand low and very low termite effect in their kebele respectively (figure 5). As we understand from the response of respondent's termite effects in their kebele was beyond expected amount and difficult recover.

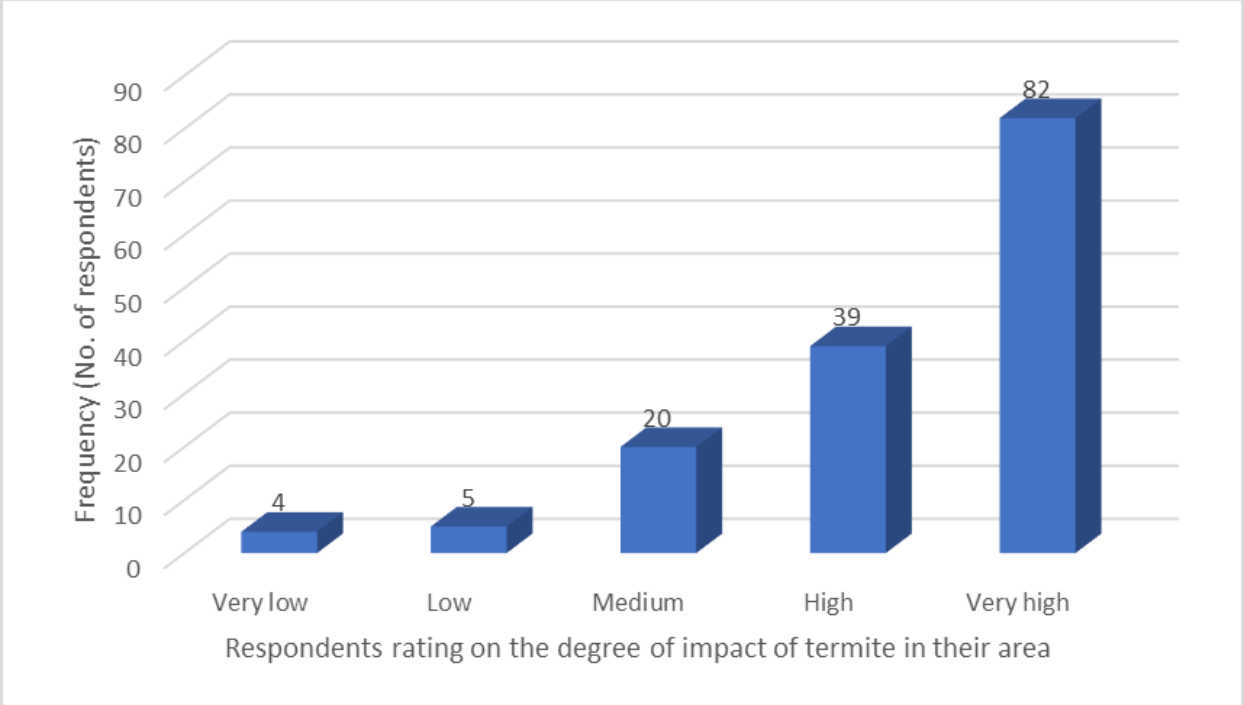

Figure 5. Respondents rating on the degree of the impact of termite in their area (N=150)

4.2.2 More Affected Type of Trees and Area by Termite

As key informant report exotic trees are more vulnerable than endogenous trees and planted trees are more expose than natural trees to termite impact. Tree less area is more susceptible to termite effect than that of area where trees are crowded or areas of under shadow. FGD participants were also discussed susceptibility of plants were vary depend on its kind. In relation to coverage grass lands were more vulnerable to termite action than forest lands.

Grazing land is land that is used for providing animal feeding. According to table 6 indicated 74% of the informants were said that grazing land is seriously affected by the action of subterranean termite, while 26% of the respondents were not confidant to the effect of subterranean termite on grazing land. Subterranean termite was the main cause for scarcity of animal feeding in the study area.

Table 6. The effect subterranean termite on grazing land

Is grazing land in your area affected by termite?				
		Frequency	Valid Percent	Cumulative Percent
Valid	Yes, it is affected	111	74.0	74.0
	Not sure	39	26.0	100.0
	Total	150	100.0	

Source: Own survey result, 2023

4.2.3 Impact of Termite on Soil Productivity

Soil productivity is the capacity of soil to provide fertility for production agricultural product. As stated in table 7 about 89.3% respondents were said that soil productivity is affected by the action of termite, while only 10.6% of respondents were not confidant to termite can affect soil productivity. Thus, soil productivity was seriously affected by termite action as it occasionally create favorable condition for soil erosion. Generally soil productivity loss caused reduction in agricultural product which resulted in food scarcity and food insecurity.

Table 7. Effect of subterranean termite on soil productivity

Is soil productivity affected by termites in your area?			
	Frequency	Valid Percent	Cumulative Percent
Yes, it is affected	134	89.3	89.3
Not sure	16	10.7	100.0
Total	150	100.0	

Source: Own survey result, 2023

4.2.4 Impacts of Termite on Agricultural Product

The effect of subterranean termite on agriculture is the damage caused by subterranean termite on agricultural products and agriculture related activities in the study area. According to Figure 6, indicate about 91 (60.6%) of the respondents were said that there was very high and 42 (28%) of respondents were said high subterranean termite effects in their kebele respectively. Only 3 (2%) and 1 (0.6%) of respondents were consider termite effect is not so much danger to agricultural production. 13 (8.66%) of the respondents were said there was balanced termite effect on agriculture in the study area. Agricultural activities were highly damaged by subterranean termite action in the study area.

Termites were social insects which could cause serious impacts on livelihood human being. As key informant interviewers' farmers were informed their daily activities special agricultural production was damaged by termite invention. They said that to sustain our life we should have straggle with termite invention, ales and otherwise we could not feed our family. Also as FGDs responded termite could cause unexpected amount of losses on agricultural product in their kebele. Additionally, both interviewer and FGD participants were discussed upon the issue of range land and construction made from wood. Now people were facing serious problem of animal forage due the impact of termite. The wall of their house was re-distracted within four to five years. The losses were caused in multi-dimension

1, By causing soil fertility loss which resulted in agricultural production reduction.

2, loss during seedling to maturity

3, loss during harvesting

4, loss in store

5, time consuming of production

The cumulative of these losses agricultural product were beyond half the expected amount of production on their garden. Generally, termite impacts were expressed as weapon less guerrilla fighters which devastate communities' production and leads to migration.

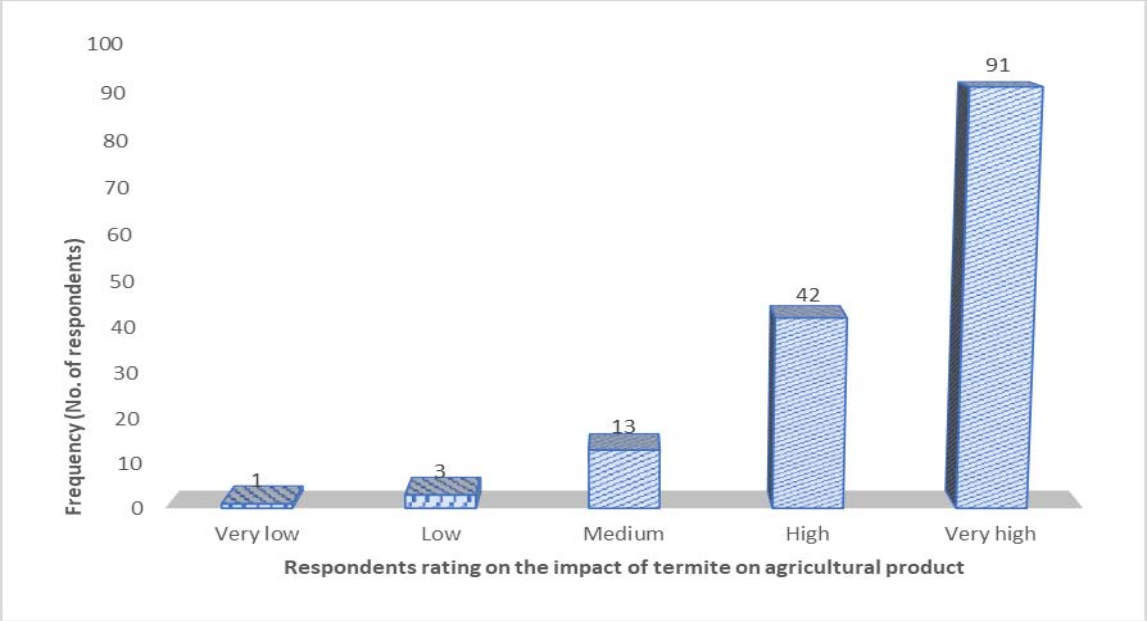

Figure 6. Respondents rating on the impact of termite infestation on agricultural products in their area (N=150)

Figure 7. Elders interview and farmers FDG (photo taken by Researcher, 2023)

4.2.5 Impacts of Termite on Construction

The effect subterranean termite on construction is the destruction caused by subterranean termite on the house, fence, bridge and etc. As we can see from table 8 about 82% of the respondents were said that subterranean termites are highly destruct wall of the house. On the other hand 18% of the respondents were not recognizing the effect of termite on the wall of house. Generally speaking subterranean termites are caused serious damage to the wall of house as we understand from the informant report.

Table 8. Effect of termite on construction

	Frequency	Valid Percent	Cumulative Percent
Yes	123	82.0	82.0
No	27	18.0	100.0
Total	150	100.0	

Source: Own survey result, 2023

4.2.6 Causes for Increasing Termite Impacts

The FGD participants have full understanding concerning to termite impact increment. Farmers were forwarded that deforestation, over grazing, intensive cropping for long period, inadequate alternative source of for termite, over population and etc. Even though all of these factors play role in termite infestation deforestation was more influential factor for termite impacts on human activities because forests were used as source food for termite.

Key informants were also said that deforestation, expansion of farm land, over population, unrest of farm land or absence of fallowing and the like were causes of termite infestation in the studied area. Elders farmers said that prior time when forests were cover many parts of land and population size was minimum we hadn't seen such severe termite problem on our regular activities related to land. Even if termite mood was seen in the forest it did not cause impacts on agriculture product because the main source of food of termite was dead tree. Now a day due to scarcity of dead trees termite start to eat living trees. Thus deforestation is the main causing factor for termite impact increment studied area.

Figure 8. Interviews with Kebele Elders (Photo Taken by Researcher, 2023)

4.2.7 Destructive Period of Termite

As we can see from the Table 9, about 38%, and 35.3% of respondents reported that the impact of termite are more destructive in spring and autumn periods respectively. Generally, spring and autumn were the destructive period of termite because little wet condition of these seasons is comfortable for a higher termite action and activities.

Table 9. Seasonality of termite effect

In what seasons termite effects are more destructive?			
	Frequency	Valid Percent	Cumulative Percent
Summer	11	7.3	7.3
Autumn	53	35.3	42.7
Winter	29	19.3	62.0
Spring	57	38.0	100.0
Total	150	100.0	

Source: Own survey result, 2023

4.3 Farmers Traditional Methods of Management of Termite Effects

4.3.1 Types of Traditional Termite Management

There is different traditional method of managements to control the effect of subterranean termite on human activities. These traditional termite management methods are mound destruction and queen removal, flooding, terracing, smoking hole or suffocation, use of resistant plant, and etc.

According table 10 report 70.7% of respondents were said that mound destruction and queen removal was the best traditional methods of termite management used to control termite effect. Contrary 9.3% of the respondents were said that flooding was best mechanism of termite effect reduction, 8.7% respondents were believed that terracing was preferable means of termite control, 7.3% of respondents were conceived smoking hole or suffocation was appropriate method of termite impact reduction and 4% of respondents were believed the use of resistant plant were used for termite effect management. Generally, queen removal is the best farmers' traditional mechanism of termite effect managements in the study area when it used appropriately.

Table 10. Traditional methods of termite management

Which of these Traditional methods of termite management do you commonly use?			
Type of traditional management	Frequency	Valid Percent	Cumulative Percent
Mound destruction and Queen removal	106	70.7	70.7
Flooding mound	14	9.3	80.0
Terracing	13	8.7	88.7
Smoking hole	11	7.3	96.0
Use of resistant plant	6	4.0	100.0
Total	150	100.0	

Source survey result 2023

Figure 9. Termite mood and termite queen /photeo taken by Researcher, 2023/

Figure 10. Queen Removal procedure /photo taken by researcher, 2023/

4.3.2 Effectiveness of traditional Methods used in the area as reported by the respondent

Effectiveness of traditional termite management method is the productiveness of the methods to controls termites impact. According to Table11 report 91.3% of respondents were said that mound destruction and queen removal was effective traditional termite management method to control termite effect. Only 8.7% of respondents were responded mound destruction and queen removal was not effective traditional termite management method to control termite effect. About 87.3% of the respondents were reported that flooding was effective tradition termite infestation management method to improve termite effect on farmers' agricultural practice; whereas 12.7 were reported that flooding was not effective tradition method to control termite effects on agricultural activities.

Nearly 82% of the respondents indicate that smoking hole or suffocation was effective traditional termite management method to control termite infestation; on the other way 18% of respondents were responds that smoking hole or suffocation was not effective traditional termite management method to overcome termite infestation.

As stated in table 11 about 79.3% of households were indicated that terracing was effective traditional termite management method to manage termite impact on agricultural practice, while 12.7% of respondents were believe that terracing was not effective traditional termite management mechanism to combat termite effect daily activity of the local farmers.

About 66% of the households were reported that use of resistant plant was effective traditional termite management method to improve the effect of termites on farmers' agricultural practice, on the other hand 34% of the respondents were said that used of resistant plant was not effective traditional termite management method to manage to combat the effect of termite on farmers' agricultural activities.

The FDG groups also indicate that the effectiveness traditional termite management method and their level of effectiveness. Mound destruction and queen removal was the best method to control termite infestation because it can be applicable in all season and solely it is productive to manage termite infestation. They also reported that when it cooperate with flooding and suffocation, mound destruction and queen removal is more effective.

Generally traditional termite management methods were effective to control termite action if it used properly and more effective when cooperate one method with the other method (mound destruction and queen removal with flooding hole and suffocation).

Table 11. Effectiveness of traditional termite management method as reported by respondents

How do you rate the effectiveness of traditional termite management method					
	Yes		No		
Traditional methods	Frequency	Percent	Frequency	percent	Total
Mood destruction and Queen removal	137	91.3	13	8.7	150
Flooding mood	131	87.3	19	12.7	150
Terracing	119	79.3	31	20.7	150
Smokinghole or suffocation	123	82	27	18	150
Use of resistant plant	99	66	51	34	150

Source: Own survey result, 2023

4.3.3 The Role of Traditional Termite Management in Soil Fertility improvement

According to table 12 revealed that 85.3% of respondents were proved that farmers' traditional termite management methods were valuable for soil fertility conservation; While 14.7% of the informants were not confidant whether traditional termite managements were used for soil fertility conservation. Almost all farmers believed that traditional mechanism of termite management were valuable for soil fertility conservation.

Table 12. Traditional termite management on soil fertility conservation

Do you think traditional termite management improves soil fertility?			
	Frequency	Valid Percent	Cumulative Percent
Yes	128	85.3	85.3
No	22	14.7	100.0
Total	150	100.0	

Source: Own survey result 2023

4.3.4 Proportion of Management

As table FGD groups indicate every land owned by the farmers were not equally treated from the effect of termite by farmers' traditional means of termite management. They said that there was no balanced treatment of every plot of land owned by farmers of their kebele from termite effect by traditional termite management mechanism. Thus, there was no equal treatment of every plot of land owned by farmer from termite effect. This could create favors condition for termite to live and reproduce in non-treated areas.

The land owned by farmers used for different purpose like farmland, range land, plantation land, bare land. As table 13 depict 52%and 40.7 of respondents were responded farm land and plantation land were more managed respectively. In reverse to this 6% and 1.3% of respondents were indicate range land and stone land were more managed respectively. Generally farmers in the study area were more managed farmland and plantation land from termite effect. The rest lands which are not well managed were used as shelter for termite to conduct their life cycle and take their action human activities.

Table 13. Farmers priority of land use to control the impact of termite by traditional method

To what land use you give priority of managing the impact of termite?

Type of land	Frequency	Valid Percent	Cumulative Percent
Farmland	78	52.0	52.0
Range land	9	6.0	58.0
Plantation land	61	40.7	98.7
Bare land	2	1.3	100.0
Total	150	100.0	

Source: Own survey result 2023

4.3.5 Importance of Collaboration of Farmers

According to table 14 report 87.3% of respondents were believe that collaboration between neighboring farmers were important to control termite effect when traditional termite management method conducted. Contrary 12.7% of respondents were believe working in collaboration with neighboring farmers was not important to overcome the effect of termite by using traditional termite management method. As whole collaborative work of the neighboring

farmers on termite effect management was important when farmers communities were traditionally managed the effect of termite.

Table 14. Importance collaborative work of neighboring farmer on traditional termite management

Importance of collaboration neighboring farmers			
	Frequency	Valid Percent	Cumulative Percent
Yes	131	87.3	87.3
No	19	12.7	100.0
Total	150	100.0	

Source: Own survey result, 2023

4.3.6 Presence Collaboration of Farmers

According to table 15 report 27.3% of respondents were said that there was collaborative work between neighboring farmers on termite effect management. On the other hand 72.7% of respondents were responded that there was no collaboration between farmers on traditionally termite effect management in the study area. Generally, farmers in the study area were lack of collaborative termite management between neighboring farmers as whole of their kebele.

Table 15. Presence of collaborative work of neighboring farmers on traditional termite management

presence of collaboration neighboring farmers			
	Frequency	Valid Percent	Cumulative Percent
Yes	41	27.3	27.3
No	109	72.7	100.0
Total	150	100.0	

Source: survey result, 2023

4.3.7 Importance of Continuous Work on Traditional Management

As table 16 revealed 84% of respondents were responded that termite management need continuous work of traditional management. While 16% of the respondents were said that no need of continuous work of traditionally termite management method to overcome the problem termite in the study area. Generally as farmers in study area stated that termite management need readiness of every day to fight with it and create as cultural farming component.

Table 16. The importance of continuous work traditional termite management

Need of continuous work termite management			
	Frequency	Valid Percent	Cumulative Percent
Yes	126	84.0	84.0
No	24	16.0	100.0
Total	150	100.0	

Source: Own survey result, 2023

4.3.8 Presence of Continuous Work Traditional Management

According to table 17 show 68.7% respondents were said that even though continuous work termite management was important there wasn't performed by farmers in the study area. While 31.33% of respondents were responded there was continuous work of termite management method. Most the farmers in the study area were concluded there wasn't days to day performance of termite management like that of their daily activities.

Table 17. Presence of continuous work traditional termite management

Presence of continuous work termite management			
	Frequency	Valid Percent	Cumulative Percent
Yes	103	68.7	68.7
No	47	31.3	100.0
Total	150	100.0	

Source: Own survey result, 2023

4.3.9 Traditional Termite Management additional Benefit

As idea from gained FDG and key interviewer traditional termite management was not only used for controlling termite impact but also used for hen feeding (figure 11) and ox fatten. The traditional management method used for this activities mood destruction and queen removal. When this action is taken, the removed queen was used for ox fatten and workers and solders were used for hen feeding. Thus people were gained doubled benefit when they conduct traditional termite management termite impact control and feeding their animals specially queen removal. Terracing which conducted to control termite impact was also used to maintain soil fertility simultaneously. Thus peoples should have known the multipurpose of traditional termite management and adopt it as routine activities.

Figure 11. Termite Queen and Hen feeding / Photo Taken by Researcher 2023/

4.4 Institutional Support towards Termite Effect and Management

Institutional support is important in termite effect management. According to figure 12, report 50.7% of respondents were responded there was good relation between institution (district agricultural office and different development organizations, and agricultural development agents) and farmers of in the study area. About 26.7% of respondents were said that there was medium relation between institution and farmers in the study area. Nearly 15.3% of respondents were

forwarded their idea there was very good relation between institution and farmers. Only 5.3% and 2% respondents indicate that the relation between institution and farmers of the study area on the management of termite was low and very low respectively. Generally over 92% of the respondents rated the relationship between institutions and farmers of the study area in termite management was medium to very good.

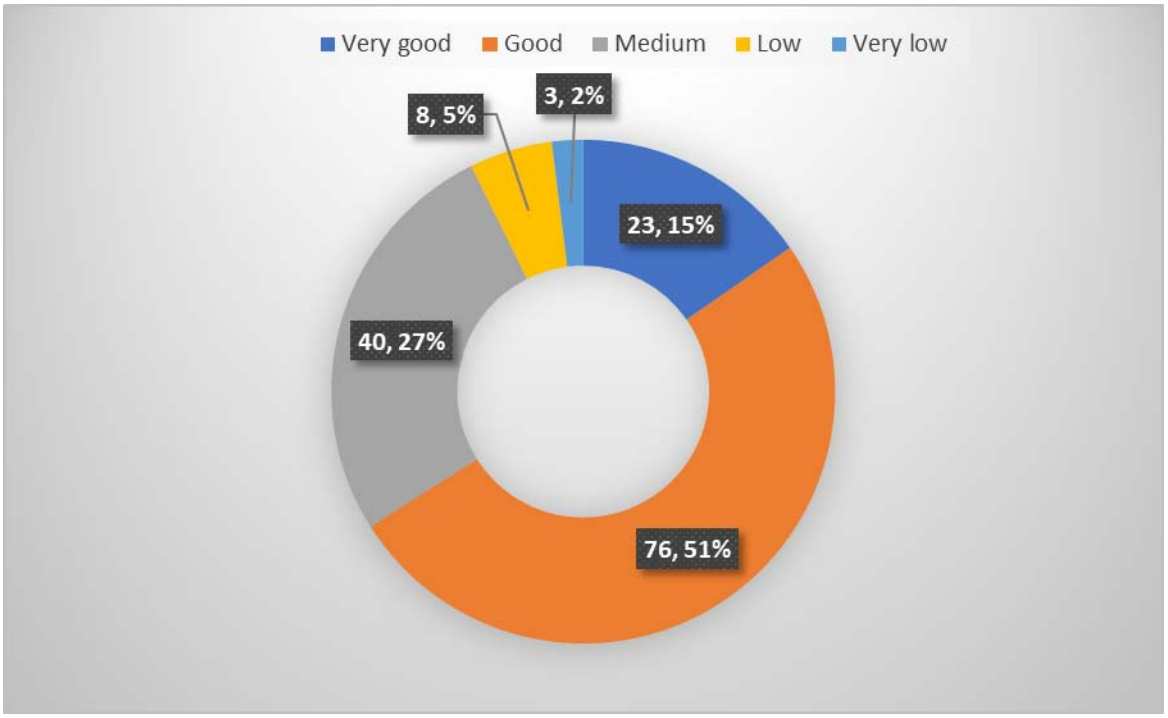

Figure12. Respondents rating on institutions relation with farmers on termite management (N=150)

4.4.1 The Role of Development Agent (DA)

According to table 18 the largest percentage of informant accounts 84.7% were said that the role of development agent /DA/ was important in termite effect management traditionally. On the other hand 15% of respondents were responded no need of DAs involvement in traditional termite management activities. As whole the involvement of DA in traditional termite management was decisive to overcome the problem of termite on farmers' activities.

Table 18. The role of development agent (DA) in termite effect management

Is there any role of DA in the management of termite?			
	Frequency	Valid Percent	Cumulative Percent
Yes	127	84.7	84.7
No	23	15.3	100.0
Total	150	100.0	

Source: Own survey result, 2023

4.4.2 Attention of Development Agent

According to Figure 13 showed 62 (41.3%) of respondents were said that the attention given by development agent /DA/ on termite effect and traditional management method was medium level. About 56 (37.3%) and 22 (14.7%) respondents were suggested the attention given by DA on subterranean termite effect and traditional management method was good and very good respectively. Only 6 (4%) and 4 (2.7%) respondents were responded the attention was bad and very successively. It can be concluded as not so much enough attention was given by development agent /DA/ on termite effect and traditional management method to over the problem caused by termite on farmers daily activities.

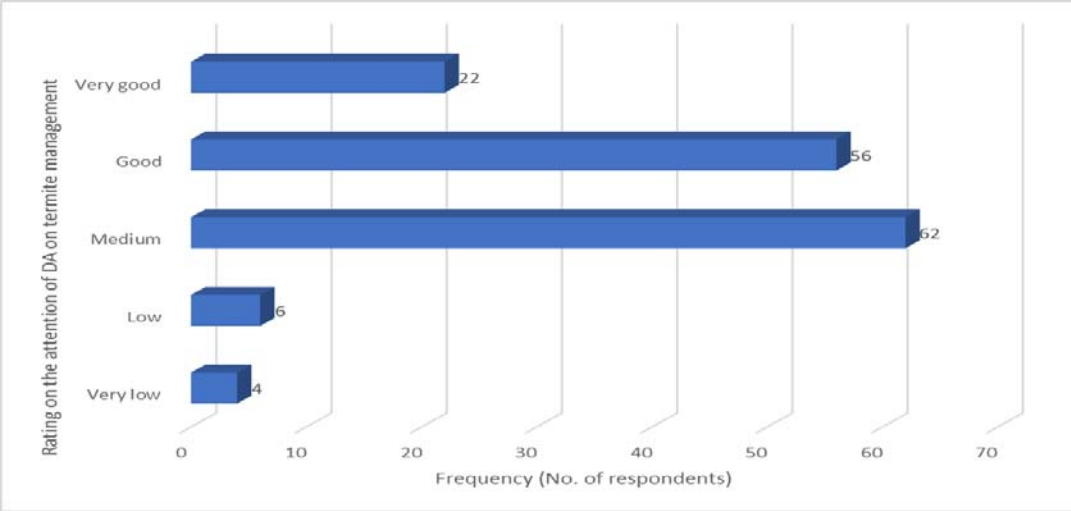

Figure 13. Respondents rating on the attention of development agents (DA) to termite management (N=150*)*

4.4.3 Interest of Development Agent

As Figure 14 revealed that 39.3% and 35.3% respondents were responded the interest of DA to support farmers on traditional termite management was medium and good respectively. About 12.7% respondents were suggested the interest of DA to support farmers on traditional termite management was very high. Nearly 7.3% and 5.3% of respondents were respectively said that there was low and very low interest of DA on supporting farmers to manage termite effect traditionally. To sum up development agents /DA$_S$/ had good attitude to stand with farmers on termite management traditionally.

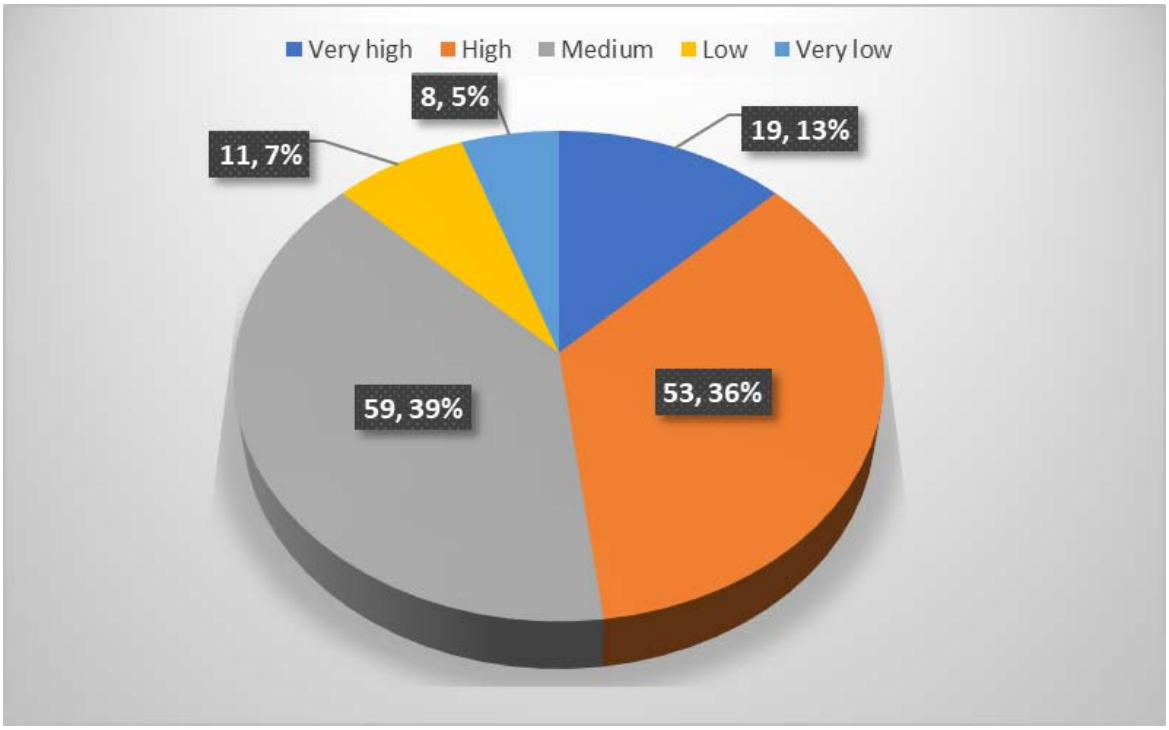

Figure 14. Farmers rating on the interest of agricultural development agents on traditional termite management (N=150)

4.4.4 Integration of Development Agent with Local Farmers

As reported in figure 15 about 62 (41.3%) of house hold responded they have doubt on their integration with agricultural experts. Nearly 30 (20%) of house hold responded we had strong integration with experts. About 27 (18%) of house hold responded there was week integration between them and experts. 15 (10.6%) of respondents were said that the connection between farmers and experts were very week. Similarly 15 (10%) of households were responded there

were very strong integration farmers and experts. To conclude the integration between experts and farmers was not much with amount needed to control termite impact.

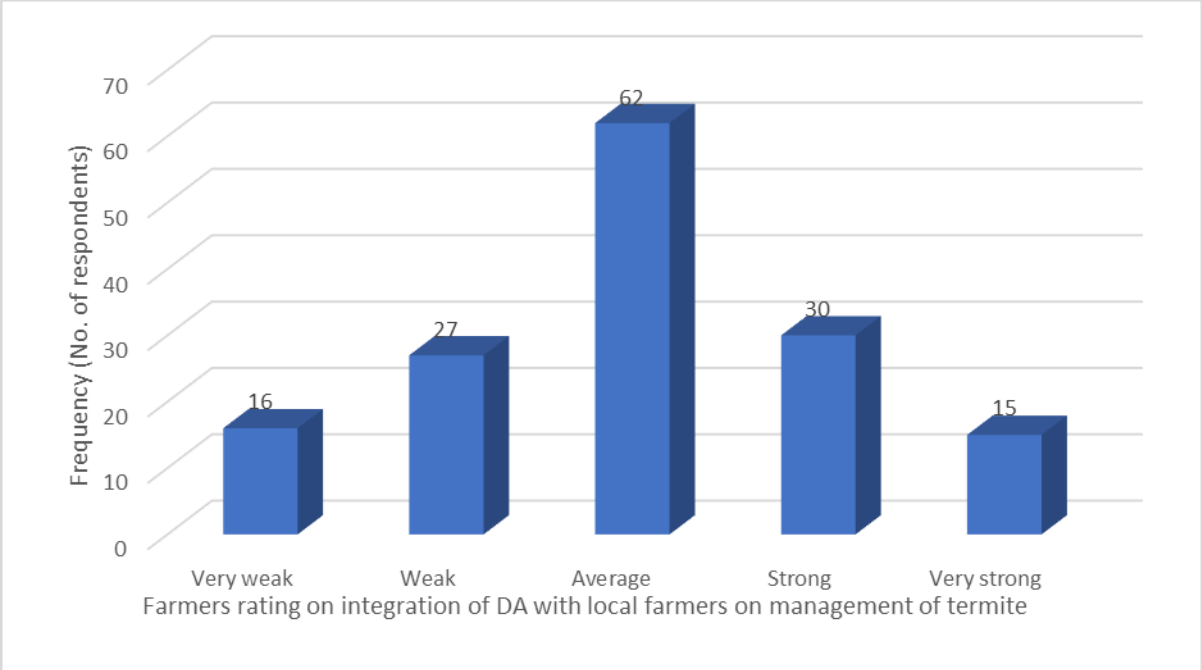

Figure 15. Famers rating on integration of agricultural development agents (DA) with local farmers on management of the impacts of termite (N=150)

4.4.5 Reason for Termite Impact to Stay Severe

As FGD Participant discussed there were different factors that hinder traditional termite management methods not were more effective in the studied area. The factors that affect effectiveness of the methods are lack of collaborative work of neighboring farmers, absence regular use of traditional methods, lack of interest of some farmers to use the methods, attitude of some farmers toward traditional methods, week institutional support, unbalanced ability to manage impact of termite and land owned by some farmers and etc. Collaborative could have been seen in two ways working together as regular campaign and every farmers should work on the land owned by him. But what tangibly seen ground was when active farmers practice on their land the rest neighboring farmers were not stay silent. Concerning to campaign there was no traditional termite management campaign conducted in our kebele until today.

4.5. Change observed after land management from termite infestation

As indicated in Figure 16 about 97(64.7%) of households reported that after used of traditional termite management practices, soil erosion decreased in their kebele, while 53 (35.3%) of households reported that termite management practices had no effect on soil erosion control. About 103 (68.7%) of households reported that termite control practices helped them to maintain improved forages for animal (Figure 17), Contrary 47 (31.3%) of households were responded termite management activities had no contribution to improve forage production. Nearly 88 (58.7%) of households reported termite management practices have helped their houses not to be distracted a short period of time while 62 (41.3%) respondents were reported that termite management practice were not brought change on house wall damage. About 111 (74%) of respondents highlighted that termite management practices have improved crop yield, on the other hand 39 (26%) of households were revealed that termite management practices were not value to crop production. In general, these responses and FGD suggested that termite management practices have improved local farmers livelihood and bring changes in agriculture production.

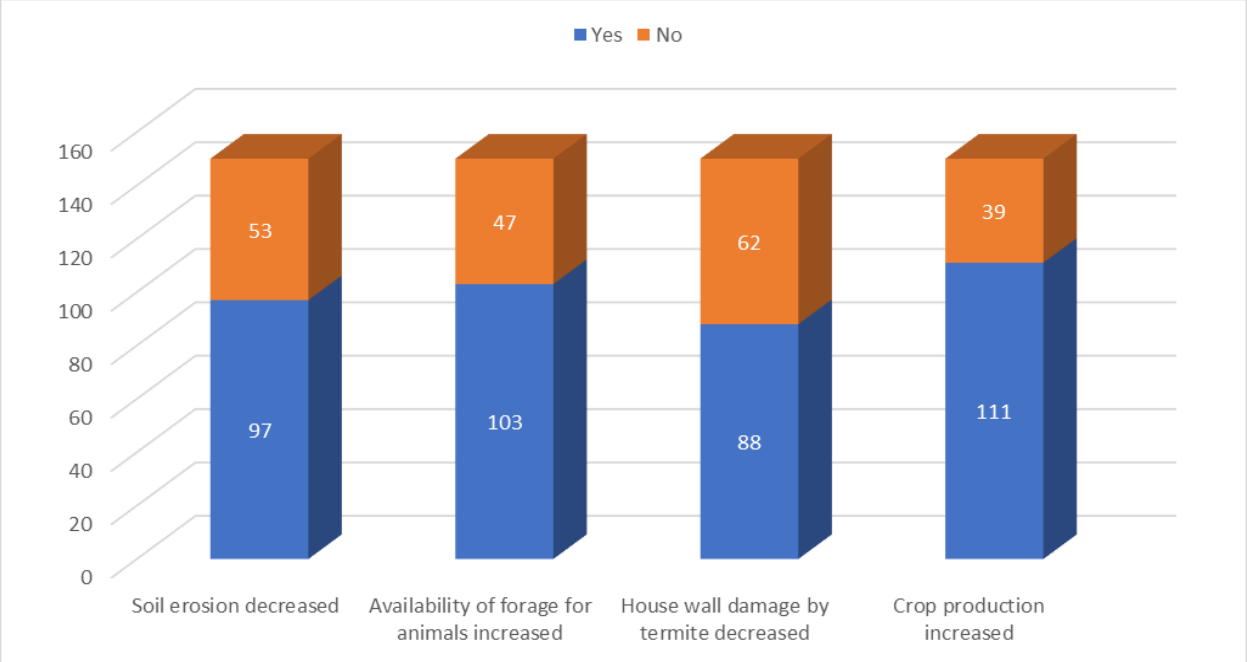

Figure 16. Respondents response on changes observed after termite management on their land (N=150)

Figure 17. The previous (A) and newly (B) terracing on range land (photo taken by Researcher 2015)

4.6 Determinants of observed agricultural outcome after land management from termite infestation

Table 19. Definition of dependent and independent variable for bivariate correlation

Independent Variables		Frequency	Valid Percent	Cumulative Percent
Awareness of farmers on traditional methods of termite management	very unaware	67	44.7	44.7
	unaware	55	36.7	81.3
	uncertain	13	8.7	90.0
	aware	9	6.0	96.0
	Very aware	6	4.0	100.0
Integration of agricultural experts and farmers on traditional method of termite management	very weak	16	10.7	10.7
	Weak	29	19.3	30.0
	Average	62	41.3	71.3
	Strong	30	20.0	91.3
	Very Strong	13	8.7	100.0
Interest of agricultural development agents (DA) to support farmers on traditional termite management on soil fertility	very low	8	5.3	5.3
	low	11	7.3	12.7
	medium	59	39.3	52.0
	high	63	42.0	94.0
	Very High	9	6.0	100.0

Table 20. Changes Observed After Land Management Practice

What Change You See After Traditional Termite Management Practiced in Your Kebele?				
Dependent Variables		Frequency	Valid Percent	Cumulative Percent
Soil erosion decreased	Yes	97	64.7	64.7
	No	53	35.3	100.0
	Total	150	100.0	
Availability of forage for animal increased	Yes	103	68.7	68.7
	No	47	31.3	100.0
	Total	150	100.0	
House's wall destruction by termite decreased	Yes	88	58.7	58.7
	No	62	41.3	100.0
	Total	150	100.0	
Crop production increased	Yes	111	74.0	74.0
	No	39	26.0	100.0
	Total	150	100.0	

Source: Own survey result, 2023

4.7 Correlation Analysis

Stronger relationships between variables are represented by larger numerical values. As a rule of thumb, values between 0.10 and 0.30 are usually described in words as being low and indicating a small or weak relationship. Values between 0.40 and 0.60 are described as indicating a modest or moderate relationship. Values between 0.70 and 0.90 or larger are described as being high and indicating a large or strong relationship (Dennis & Duncan, 2000).

According to Cohen (1988), coefficient of correlation (r) stretching from 0.10 to 0.29 may be considered as showing a low level of relationship, coefficient of correlation (r) stretching from 0.30to 0.49 may be considered as a modest level of relationship, coefficient of correlation (r) extending from 0.50 to 1.00 may be considered as a high level of /relationship.

To describe the linear relationship between two variables of the study, we used here Pearson product-moment correlation coefficient (Pearson correlation coefficient) statistical indices and the decision rule for interpretation of the effect size was based on the above credible sources

cited. Accordingly, Pearson correlation analysis result of the study was presented in Table 22 below.

Table 21. Pearson Correlation between Factors of management practice and independent variables (soil erosion, availability of forage, wall distraction and crop production N=150)

Correlations					
Farmers' Management Practices		Soil erosion decreased	*Availabilityof forage enhanced*	Wall destruction reduced	Crop production increased
Effectiveness of traditional termite management method	Pearson Correlation	.434**	*.475***	.382**	.541**
Traditional method of termite management	Pearson Correlation	.761**	*.833***	.670**	.883**
Traditional termite management on soil fertility	Pearson Correlation	.561**	*.614***	.494**	.699**
***. Correlation is significant at the 0.01 level (2-tailed).*					
**. Correlation is significant at the 0.05 level (2-tailed).*					

4.7.1 Correlation between Effectiveness traditional termite management method and independent variables

As per Cohen (1988) effect size standard, Effectiveness traditional termite management method positively correlated with soil erosion, Availability of forage for animal, wall destruction and Crop production by (r = 0.434, p-value of 0.000, r= 0.475. p-value of 0.000, r=0.382, p-value=0.000 and r=0.541, p-value= 0.000) respectively. The correlation between them shows moderate level of association except crop production which has high level of association.

4.7.2 Traditional method of termite management and independent variables

As per Cohen (1988) effect size standard, Traditional method of termite management was positively correlated with soil erosion, Availability of forage for animal, wall destruction and Crop production by (r = 0.761, p-value of 0.000, r= 0.833. p-value of 0.000, r=0.670, p-value=0.000 and r=0.883, p-value= 0.000) respectively. The correlation between them shows high level of association or strong correlation.

4.7.3 Traditional method of termite management on soil fertility and independent variables

Traditional termite management on soil fertility was positively correlated with soil erosion, Availability of forage for animal, wall destruction and Crop production by ($r = 0.561$, p-value of 0.000, $r= 0.614$. p-value of 0.000, $r=0.494$, p-value=0.000 and $r=0.699$, p-value= 0.000) respectively. The correlation between them shows high level of association or strong correlation.

4.8 Reliability Test

The criteria of Cronbach's alpha for establishing the internal consistency reliability is: **Excellent** ($\alpha>0.9$), Very good ($0.9< \alpha<\alpha<0.7$), Good ($0.7<\alpha<\alpha<\alpha<0.5$), Acceptable ($0.6<\alpha<\alpha<0.5$), Unacceptable ($\alpha<0.5$).

Table 22. Reliability statistics

Reliability Statistics		
Management practices	Cronbach's Alpha	N of Items
Overall	.959	19
Cooperation of traditional termite management method	.792	5
Changes after land management practices	.951	4
Traditionaltermite management on soil fertility	.939	5

Based on the Table 22, the overall Cronbach's alpha value is 0.959. This shows that data have a high reliability in internal consistency. Changes after land management practices have the highest Cronbach's alpha value (0.951). This shows the first high reliability in internal consistency of 3 questions. Traditional termite management on soil fertility has the higher Cronbach's alpha value (0.939) which means that the data is second high reliable in internal consistency of 3 questions. Cooperation of traditional termite management method has the third high Cronbach's alpha value (0.792) which shows the data has higher reliability in internal consistency of 3 items. All styles have alpha values >0.9, this shows the internal consistency reliabilities are: ***Excellent***

CHAPTER FIVE

5. DISCUSION, CONCULUTION AND RECOMMENDATION

5.1 Discussion

All of the respondents have agreed upon the negative impact of termite on land productivity and their activities particularly related to their land, and all respondents have agreed as that there was serious termite effect in their kebeles whole. The damage of termite is high in central rift valley and western part of Ethiopia (Daniel. and Emana, 2014a; Mulatu. and Emana, 2015).

Most of the respondents about 82 (54.7%) and 39 (26%) are agreed that there were very high and high subterranean termite effect in their kebele respectively. Termite contributed a lot to poor agricultural productivity and poor soil fertility that leads to increasing of the out migration of the community from their residence to another place (Legesse, et al., 2013).

In this study as key informant report exotic trees are more vulnerable than endogenous trees and planted trees are more expose than natural trees to termite impact. Spring and autumn were the destructive period of termite because little wet condition of these seasons is comfortable for a higher termite action and activities. Susceptibility of crops and trees to termites is governed by several factors mean that termite infestation and damage caused by subterranean termite species is greater during periods of drought season than the periods of regular rainfall (Logan *et al*., 1990; Nyeko and Olubayo, 2005; Christopher *et al*., 2013).

In this study 60.66% of the respondents were said that there was very high and 28% of respondents were said high subterranean termite effects on agricultural product in their kebele respectively. Guachan *et al*. (1998) described that termites lowered the yield of maize, sorghum, teff, millet, and beans in Mana Sibu district (West Wollega, Ethiopia).

In this study 89.3% respondents were said that soil productivity is affected by the action of termite. Termites enhance soil degradation and erosion by reducing the vegetation cover (Demissie et al., 2019)

In current study 74% of the informants were said that grazing land is seriously affected by the action of subterranean termite. Termites are occasionally associated with severe damage to range

land vegetation, particularly, in degraded arid and semi-arid ecosystems (Pearce, 1997). About 82% of the respondents were said that subterranean termites are highly destruct wall of the house. Frequently repairing and rebuilding of house within a few years is uneconomical for subsistence farmers; beside it has negative impact on environment as plants are the major sources for building materials. (Debelo and Degaga, 2014)

There are different traditional method of managements to control the effect of subterranean termite on human activities which is related to land. These traditional termite management methods are mound destruction and queen removal, flooding, terracing, smoking hole or suffocation, use of resistant tree, and etc. The practices used by smallholder farmers in Ethiopia include flooding mounds, digging mound, removal of the queens, excavating the top parts of the mounds, burning straw to suffocate and kill the colony, placing the harvest of different crops on wooden beds raised a few centimeters above ground, (Gauchan*et al.,* 1998).

About 85.3% of respondents were proved that farmers' traditional termite management methods were valuable for soil fertility conservation. Reports of 70.7% of respondents were said that mound destruction and queen removal was the best traditional methods of termite management used to control termite effect. According to Sileshi., *et al*. (2009) management of termites in the future should be built on farmers 'indigenous knowledge and adequate understanding of the ecology of the local termite.

Large numbers of respondents, 84% of them were responded that termite management needs continuous work of traditional termite management methods. 68.7% respondents were said that even though continuous work termite management was important, there wasn't performed by farmers in the study area. 87.3% of respondents were believe that collaboration between neighboring farmers were important to control termite effect when traditional termite management method conducted. 72.7% of respondents were responded that there was no collaboration between farmers on traditionally termite effect management in the study area.

In this study the responses household and FGD suggested that termite management practices have improved local farmers' livelihood and bring changes in agriculture production. According to Sileshi, *et al*. (2009) management of termites in the future should be built on farmers' indigenous knowledge and adequate understanding of the ecology of the local termite.

5.2 Conclusion

The study identified that there was serious termite effect in study area . Farmers termed, “termite impact is endemic disease to our production and headache to our daily livelihood”. Termite effects in their kebele was beyond expected amount and difficult to recover. Relatively exogenous trees were more exposed to termite damage than endogenous trees. Grass lands were more vulnerable to termite action than forest lands. Termite impacts are guerrilla fighters which devastate communities’ production and leads to migration. Generally, because of the effects of subterranean termite, soil loss caused reduction of agricultural products which resulted in food scarcity and food insecurity.

The effects of termite vary based on season: Spring and autumn were the destructive period of termite because little wet condition is comfortable for termite action on human activities.

Agricultural activities were highly damaged by subterranean termite action in the study area that caused serious damage of the soil fertility. As a whole there was a great connection between human activities related to land resource and termite impact because termites were used plants as stable source of food to generate its life. In the recent day, due to scarcity of dead trees termite start to eat living trees. Thus deforestation is the main causing factor for termite impact increment studied area. Therefore, farmers in the study area have good understanding of subterranean termite effect human activities.

Farmers of in the study area have taken training which have no continuity. Despite almost all of the farmers in the study area was familiar with traditional termite management methods which were effective to control termite action, farmers could not use properly. Traditional termite management methods are queen removal and mound destruction, flooding, suffocation, terracing and use of resistant plant. Queen removal and mound destruction is the best farmers’ traditional mechanism of termite effect managements in the study area when it is used appropriately because, it is valuable solely and more effective when it used cooperatively with suffocation and flooding to control termite infestation.

Another important land management practice in the study area was terracing which was conducted to control termite impact and maintain soil fertility simultaneously. Thus, one can conclude that it is better to know the multipurpose of traditional termite management and adopt it

as routine activities. The result of the study also reveals that land management practice change degraded land into productive land and livelihood of local community.

Almost all farmers believed that traditional mechanism of termite management were valuable for soil fertility conservation. Some farmers in the study area were more managed their farmland and plantation land from termite effect. The rest lands which are not well managed were used as shelter for termite to conduct their life cycle and take their action on human activities. Generally, farmers in the study area were lack of collaborative termite management between neighboring farmers as whole of their kebele.

It can be concluded as not so much enough attention was given by development agent /DA/ on termite effect and traditional management method to over the problem caused by termite on farmers' daily activities. To sum up development agents /DA_S/ had good attitude to stand with farmers on termite management traditionally. Generally there was good relationship between institution and farmers of the study area. As whole the involvement of DA in traditional termite management was decisive to overcome the problem of termite on farmers' activities. Termite management practice requires effort to build coherent principles for termite management (Sileshi .*et al*., 2009).

The correlation between independent variables and dependent variables show high level of association or moderate level of association. The criteria of Cronbach's alpha for establishing the internal consistency reliability of our data was highest level. It tells us how our data was reliable or not. In the case the overall data was found to be the highest internal consistence reliability.

5.3 Recommendation

- Further research is required to identify another unidentified effect of subterranean termite on agriculture and on living plants.
- Government and societies have to better take actions to measure and estimate the burden of subterranean termite so that adequate planning, management and control measures should be taken against the problem.
- Furthermore, awareness creation activities by stakeholder especially on continuous use of traditional termite management and collaborative work of neighboring farmers in the study area, because most of farmers were not actively participate in termite mitigating program even though they know severity the problem.
- Cooperation and coordination of farmers should better increase in order to advance the use traditional termite management method and modernize way of controlling which may help to employ better ways to control the termite infestation in the study area.
- To attain better control of termite impact, using integrated traditional termite management methods is more valuable because, it is more effective when one method is cooperate with the other method i.e. queen removal and mound destruction with hole smoking/suffocation and flooding or apply all methods at the same time on farming land

REFERENCES

Abdel, G. and Skai, E. 2011.Termite Damage to Buildings: Nature of attacks and preventive construction methods. Am. G. Eng. Appl. Sci. 4(2):187- 200

Abdulahi, A., Tadesse, A., & ohammed Dawd, M, (2010). The importance and management of termite in Ethiopia: A review. Pest management journal of Ethiopia, 14, 1-20

Abdurahaman, A. 1983.Termite control campagn in Wollega.Committee of Ethiopian *Entomologis(CEE) Newsletter 3(2*): 6-7.

Abdurahman, A.1990. Foraging Activity and Control of Termites in Western Ethiopia.Ph.D.Thesis, University of London. Pp. 277

Abraham. 2008. Increasing Crop Production through Improved Plant Protection. Annual Conference of Plant Protection Society of Ethiopia (PPSE)and EIAR, Addis Ababa, Ethiopia Pp.598

Addisu , Mohamed, D and Waktole.2014.Efficacy of Botanical Extracts against Termites, *Macrotermes*spp., (Isoptera: Termitidae) under Laboratory Condition*International Journal of Agricultural Research*, 9: 60-73

Addisu ,Waktole, and Mohamed, D. 2013. Laboratory Evaluation of Entomopathogenic Fungi *Metarhiziumanisophilae*and *Beauveriabassiana* Against Termite, *Macrotermes*(Isoptera: Termitidae). *Asian Journal of PlantSciences*.12: 1-10

Ahmed and Girma. 2013. Evaluation of some botanicals against termites'damageon hot pepperBako, Western Ethiopia. BARC .1(2): 048-052

Ahmed, BM. and French, JR. 2008. An over Review of Termite Control methods in Australia AndTheir Link to Aspects of Termite Biology and Ecology. *Pak Entomol*30 (2):101-108

BARC. 1998. Chemical Control of Termite. Baako Agricultural Research Center Progress Report

BARC. 2004. Crop Protection Division Progress Report for the Year 2004.

Brauman, A.2000. Effect of gut transit and mound deposit on soil organic matter transformations in the soil feeding termite Pp 36:117–125

Cai Wang. 2010. Biological control of the formosan subterranean termite. Louisiana State University and Agricultural and Mechanical College Pp. 16

Castilhos-fortes, R.,T. S. Matsumura, E. Diehl and L. M. Fiuza. 2002. Susceptibilityof*Nasutitermesehrhardti*(Isoptera: Termitidae) to *Bacillus thuringiensis*subspecies. Braz. J. Microbi33:219-222.

Changlu, W., Xugao, Z., Shujuan, L., Magaret, S., Michael, E., Grzegorz, B. and Gary, W.2009. Survey and identification of Termites (Isoptera: Rhinotermitidae) in Indiana. *Entomol.Soc. Am.*102(6):1029 – 1036

Chouvenc, T., N-Y.Su and J. K. Grace. 2011. Fifty years of attempted biological control of termites–Analysis of a failure. *Biol. Control*59: 69-82.

Christopher, M., Jacobm, Y. and Bruno, N. 2013.Damage caused by termites (*Isoptera: Termitidae*in coconut nurseries of Rufiji District, Tanzania Pp228-23

Claybourne and Anna.2013. Colony of Ants and other insect groups, Chicago III: Heinemann Library. Pp. 38

Clyde, L., Ogg Barbara, P., Shripat, T., Kamble Dennis F. 2006. ―Subterranean Termites A handbook for Homeowners‖ University of Nebraska -Lincoln Workshops on a common senseapproach to dealing with termites and termite control.

Cohen, J.W. (1988) .Analysis for the behavioral sciences (2nd ed.).Hillsdale, NJ :Lawrance

Cost Leonardo, A. and M. Haifig, I. 2010. ―Pheromones and exocrine glands in Isoptera:

Daniel and Emana. 2014b. Preliminary studies on termite damage on rural houses in the Centeral Rift Valley of Ethiopia. Pp. 2902 – 2910

Daniel and Emana.2014a.Termite species composition in the central rift valley ofEthiopia.Pp.2151-7517

Daniel and Jembere. 2006. Evaluation of toxicity of crude extracts of some botanicals on different castes of macroterms termites. *Pest Management Journal ofEthiopia*8: 16.

Debelo and Degaga, 2014. Preliminary studies on termite damage on rural house in the central rift valley of Ethiopia: Africa Journal of Agriculture.

Dennis, H., & Duncan, C. (2000). First Steps in Research and Statistics-A Practical Workbook

Devendra, G., Ayo- Odongo, J. Kit, V., Lemma G., Mulugeta Negeri.1998. A Participatory systems analysis of the termite situation in west Wollega, Oromia Region, Ethiopia.

Devi, K. K.,and D. Kothamasi. 2009. *Pseudomonas fluorescens* CHAO can kill subterranean termite *Odontotermesobesus* by inhibiting cytochrome c oxidase of the termite respiratory chain. *FEMS Microbial. Lett*.300: 195-200

Dong,C., J. Zhang, W. Chen, H. Huang and Y. Hu. 2007. Characterization of a newly discovered China variety of *Metarhiziumanisopliae*(*M. anisopliae*var*dcjhyium*) for virulence to termites, isoenzyme, and phylogenic analysis. *Microbiol. Res.*162: 53-61.

Donovan, S.E., G.J.K. Griffiths, R. Homathevi and L.,Winder., 2007. The spatial pattern of soil dwelling termites in primary and logged forest in Sabah, Malaysia Ecol. Entomol.32:1-10.

Dosso, K., Deligne, J., Yéo, K., Konaté, S. and Linsenmair, K.E. 2013. Changes in the termite assemblage across a sequence of land-use systems in 257 the rural area around Lamto Reserve in central Côte d'Ivoire (17): pp 1047-1057

Dronnet, S., M., Chapuisat, E. L.,Vargo, C., Lohou and A. G. Bagnères. 2005. Genetic analysis of the breeding system of an invasive subterranean termite, *Reticulitermessantonensis*in urbanand natural habitats *Molecular Ecology.*

Earlbaum Associates.

Eggleton, P. 2000. Global patterns of termite diversity. In Termites Evolution, Sociality, Symbiosis,Ecology, Abe T., D. E. and Bignell M. Higashi (Eds), Kluwer Academic Press, Dordrecht, pp:25-51.

Eggleton, P. and Tayasu, I. 2001. Feeding groups, life types and the global ecology of termites, *Ecol. Res*., 16(5), 941−960

Eggleton, P., Bignell, d.E., Hauser, S., Dibog, L., Norgrove, L. and Madong, B. 2002.Termite diversityacross an anthropogenic disturbance gradient in the humid forest zone of West Africa.*Agriculture, Ecosystems andEnvironment*9:189-202.

Emana and Gure. 1997. A Strategy for a Sustainable Control of Termite in ManasibuWereda(West Wellega) a Document Prepared by B & M Development Consultants PLC for the Ethiopian Evangelical Church MekaneYesus-Western Snod.

Emana, K., and Tazawa, S. 2004. The development of the eco-engineering insect control technology—physical control of insect behavior using artificial lights.Eco-engineering 16:237–240

Fairhead, J. and Leach, M. 2003. Termites‘ society and ecology: Perspective from West Africa: Pp. 197-219

for Psychology Students. London and Philadelphia: Routledge Taylor & Francis Group.

Gauchan, D., Ayo-Odongo, J., Vaughan, K., Lemma Gudeta and MulugetaNageri. 1998. A participatory systems analysis of the termite situation in West Wellega, Oromia region, Ethiopia: Working Document Series 68, ICRA, Wageningen, The Netherlan

Gedeon, 2006. Evaluation of Termite Resistant Plant Attributes for Their Bioactivities against *Macro terms termite*. Addis Ababa University: 46-50

Glaciela, K., Julio, C. P., Jaime, A. A., Deise, C. S., João, F.B. 2006. Termite Activity in Relation to Natural Grassland Soil Attributes. *Sci. Agric.* 63 (6):583-588

Harun, Y. 2007. The Miracle of Termites, Global Publishing, TalatpasaMah: A Blok Kat 4 Okmeydani - Istanbul / Turkey Pp. 59 – 60

Hayasaka, D., T. Korenaga, K. Suzuki, Fuki Saito, F. Sánchez-Bayo and K. Goka. 2012. Cumulative ecological impacts of two successive annual treatments of imidacloprid and fipronil on aquatic communities of paddy mesocosms. Ecotox. Environ. 80:355-362

Henderson, G. 2001. Practical considerations of the Formosan subterranean termite in Louisiana: a 50-year-old problem. *Sociobiology*37:281-393.

Hirpha, K., & Bulto,T. (2016). Effect of different termite management practice on the maize production in Assosa district, Benushangul Gumuz Region, Western Ethiopia Journal of Biology, Agriculture and Healthcare, 6, 23.

Hu, X. P. 2005. Evaluation of efficacy and non-repellency of indoxacarb and fipronil-treated soil atvarious concentrations and thicknesses against two subterranean termites (Isoptera: Rhinotermitidae). J. *Econ. Entomol98*:509-517.

Husseneder, C., J. M., Berestecky, J. K. Grace. 2009. Changes in composition of culturable bacteria community in the gut of the Formosan subterranean termite depending on rearing conditions of the host, Ann. *Entomol. 102*:498-507

Husseneder, C.,D. M.Simms and C. Riegel. 2007. Evaluation of treatment success and patterns of Re-infestation of the Formosan subterranean termite (Isoptera: Rhinotermitidae). J. *Econ.Entomol.*100:1370-1380.

Kabasa J. D., D. Olila, D. Okethwangu, P. K. T. Munishi, and I. Kisovi. 2006. Nutritive and nutriceutic potential of indigenous Bubaala mushrooms Termitomycesmicrocarpus from the Lake Victoria basin. 1:92–96.

Kothari, C.R., 1995. Research Methedology, Methods and Techniques.Wishwaparksna. New Delhi.

Kumawat, K.C. 2001. Evaluation of some insecticides against field termites, *Odontotermesobesus* and *Microtermesobesi* in wheat, *Triticumaestivum. Ann. Pl. Protect.Sci*9: 51–53.

Meikle, W. G., G. Mercadier, R. B. Rosengaus, A. A. Kirk, F. Derouane, and P. C. Quimby. 2005. Evaluation of an entomopathogenic fungus, *Paecilomycesfumosoroseus*(Wize) Brown and Smith (Deuteromycota: Hyphomycetes) obtained from Formosan subterranean termites (Isop.,Rhinotermitidae). J. Appl. *Entomol*.129:*315-322.*

Messenger, MT. and Su, N-Y., 2005. Colony characteristics and seasonal activity of the Formosan subterranean termite (Isoptera: Rhinotermitidae) in Louis Armstrong Park, New Orleans, Louisiana. *J Entomol Sci*40:268–279.

MSWANCO. 2009. Mana -SibuWoreda Annual Report of Agricultural and Natural ConservationOffice (Unpublished.)

MSWAO, 2009.Mana -SibuWoreda Administration. Annual report (Unpublished)

MSWLMO, 2009.Mana- SibuWoreda Land Management Office. Annual report (Unpublished)

Mugerwa, S., Mpairwe, D., Zziwa, E., Swaans, K. and Peden, D. 2014. Integrated termite management for improved rainwater management: A synthesis of selected African experiences. Nairobi, Kenya

Muhammad, A. 2009.Antixenotic and antibiotic impact of botanicals for organic management of stored wheat pest insects.Ph.D. Thesis, University of Agriculture, Faisalabad Pakistan.

Mulatu andEmana. 2015. Effect of Integration of Cultural, Botanical, and Chemical Methods of Mound Treatment on Termites (Macro terms sub hyalinesRampur) Colonies in Ghimbi District of Western Ethiopia.

Nyeko, N. and Olubayo, FM. 2005. Participatory assessment of farmers‘ experience of termite problems in Agroforestry in Tororo district, Agriculture Research and Extension Network paper No 143.

Opige, M., E. Kateyo, J. D. Kabasa, and D. Olila. 2006. Comparative chemical composition of two indigenous edible mushrooms from the Teso region of Uganda. 1:1–6.

Osbrink, W. L. A., M. L. Cornelius and A. R. Lax. 2005. Effect of imidacloprid soil treatments on occurrence of Formosan subterranean termites (Isoptera: Rhinotermitidae) in independentmonitors. *J. Econ. Entomol*.98:2160-2168.

Osbrink, Weste, and Mary Cornelius. 2013. Acoustic evaluation of trees for *Coptotermesformosanus* Shiraki (Isoptera: Rhinotermitidae) treated with imidacloprid

and noviflumuronin Historic Jackson Square, NewOrleans,Louisiana.Sociobiology60:77-95.

Osipitan, A.A. and A.E. Oseyemi. 2012. Evaluation of the Bio-insecticidal potential of some tropical plant extracts against termite Termitidae: Isoptera) in Ogun state, Nigeria. J. *Entomol*., 9: 257-265

Parman, V., and E.L. Vargo. 2010. Colony-level effects of imidacloprid in subterranean termites(Isoptera: Rhinotermitidae). *J. Econ. Entomol.*103: 791-798.

Pearce, MJ.1997. Termites Biology and Pest Management.CAB International, New York.P.172.

Potter, M. F. 1997.*Mallis Handbook of Pest Control.* Hand book and Technical Training Company. Pp.232-333

Rana, J.S., Ombir, K.K. Dahiya. 2001. Management of termite, *Microtermesobesi*(Holmgren) in wheat, *Triticumaestivum* through seed treatment. *Ann. Biol*., 17:207–209

Rust, M. K. and N.Y. Su. 2012. Managing social insects of urban importance, Annu. Rev. *Entomol.* 57:355-375

Sajap, A. S., S. Amit, and J.Welker. 2000. Evaluation of hexaflumuron for controlling the subterranean termite *Coptotermescurvignathus*(Isoptera: Rhinotermitidae) in Malaysia. J.*Econ. Entomol.*93: 429-433.

Sileshi, Arshad, M.A., Konaté, S. and Nkunika, P.O.Y. 2010. Termite-induced heterogeneity in African savanna vegetation: *Ecology and Society:*21(5): 923-937

Sileshi,Nyeko, P., Nkunika, P.O.Y., Sekematte, B.M., Akinnifesi, F.K. and Ajayi, O.C. 2009. Integrating ethno-ecological and scientific knowledge of termites for sustainable termite management and human welfare in Africa: *Ecology and Society*: 14(1):48-55

Soomro, A.M., G.M. Seehar, M.I. Bhangar and N.A. Channa. 2008. Pesticides in the blood samplesof spray-workers at agriculture environment: The toxicological evaluation. Pak.J. Anal. Environ. *Chem.* 9:32-37.

Springer and Verlag. 2005. Indirect test of inbreeding depression in the termites *Reticulitermesflavipes and Reticulitermesvirginicus*

Su, N.-Y. 2005. Response of the Formosan subterranean termites (Isoptera: Rhinotermitidae)to baits or nonrepellenttermiticides in extended foraging arenas. J. Econ. *Entomol.*98:2143-2152.

Su, NY. 2003. Overview of the global distribution and control of the Formosan subterranean ermite, *Sociobiology*41:7–16

Sun, J., J. R. Fuxa and G. Henderson. 2003. Effects of virulence, sporulation, and temperature on *Metarhiziumanisopliae*and *Beauveriabassiana*laboratory transmission in *Coptotermesformosanus*. J. Invertebr. *Pathol*. 84:38-46.

T.W. Culliney and J.K. Grace. 2000. Prospects for the biological control of subterranean termites.Bulletin of Entomological Research, USA.90: 9-21

Tadele ,Habtamu A and Mulugetai. 2014. Effect of Some Botanicals against Termites, Macroterms Spp. (Isoptera: Termitide) Under Laboratory Conditions. Department of Plant Sciences, College of Agriculture and Veterinary science, Ambo University, Ethiopia.1 (2) 52-55

Tathiane, S.S., Carlos, E.G., Leila, S.L, Helga, D.A., Joao, H.M., Manoel, R.A. and Teresa, T.G.2009. Chemical, physical and micro morphological properties of termite mounds and adjacent soils along a top of sequence in Zona da Mata, Minas Gerais State, Brazil Catena76: 107–113

Thorne, B. L., Traniello, J. F. A., Adams, E. S. and Bulmer, M. 1999. Reproductive dynamics and colony structure of subterranean termites of the genus Reticulitermes (Isoptera).

Thrusfield, M.V., Kitching,R.P. and Hutber,A.M. 2005.Areveiw of foot and mouth disease with special consideration for the clinical and epidemiological factors relevant to predictingmodeling of the disease. *The veterinary Jornal*, 169(2): 197-209.

Tilahun, M, (2018). Subterranean termites management using different legume crops and chomo grass (Brachiaria humidicola) as green manure on teff under acidic soil condition at Nejo West Wollega Ethiopia. International Juornal of Agriculture and Bioscience, 7(4), 200-206.

Traoré, S., Nygard, R., Guinko, S. and Lepage, M. 2008.Impact of termitaria as a source of heterogeneity on tree density and structure in a soudanian savannah under controlledgrazing and annual prescribed fire (Burkina Faso). 255: 2337-2346

UNEP/FAO/ Global IPM Facility Expert Group.2000.Finding alternatives to PersistentOrganic Pollutants (POPs) for termite management.

V. R. Lewis,A. M. Sutherland and M. I. Haverty. 2014.IPM in and around the home, Agriculture andNatural Resources. University of California Pub, 7415, Pp1-6

Van Huis, A. 1996. Traditional use of arthropods in Sub Saharan Africa: *ProcExpEntomol(NEV Amsterdam*) 7: 3-20

Vargo, E. L. and Husseneder, C. 2009. Biology of subterranean termites: insights from molecularstudies of Reticulitermes and Coptotermes.Ann. *Rev. Entomol.*(54)379–403

Vitaminsand Hormones.83:521-549

Wang, C.-L., and J. E. Powell. 2004. Cellulose bait improves the effectiveness of *Metarhiziumanisopliae*as a microbial control of termites (Isoptera: Rhinotermitidae). *Biol.Control*30:523-529.

Wood, T.G. 1986. Assessment of termite damage in Ethiopia and recommendation for short term control and development of long termpest management practices. Report for the World Bank, TRIODA, London.

Wood, T.G., R.A. Johnson and C.E. Ohiagu. 1980. Termite damage and crop loss studies in Nigeria. *Tropical Pest Management*26:241–253

Wright, M. S., A. K. Raina and A. R. Lax. 2005. A strain of the fungus *Metarhiziumanisopliae*for controlling subterranean termites*. J. Econ.Entomol.98*:.

Wright, M. S., and M. L. Cornelius. 2012. Mortality and repellent effects of microbial pathogenson *Coptotermesformosanus*(Isoptera:Rhinotermitidae). BMC Microbiol.12: doi: 10. 1186/1471-2180-12-291.

Wright, M. S., W. J. Connick and M. A. Jackson. 2008. Use of *Paecilomyces*spp. as pathogenicagents against subterranean termites. U.S. Patent.Pp: 7,390,480.

Yanyong, C., Ouab, S. and Nit, K. 2003. Belt-Transect: A sampling Device for TermiteCommunities Study *Kasetsart J*. 37:150 – 156

Appendix

Appendix 1

Addis Ababa University

College Social Science and Humanity

Department Geography and Environmental Studies

A, questionnaires for sample house hold farmers and stakeholder in the kebele

Dear respondent, this questionnaire are aimed to get the required information regarding to the contribution of effect of subterranean termite and farmers traditional method of management toward soil degradation and decline of production. The researcher would like to assure you that your response will be required only for academic research purpose and aims to forward valuable possible solution for the challenge related effect of subterranean termite and farmers traditional method of management in your kebele. I would like to say thank you in advance for your valuable time, practice and genuine answer.

Remark:no need of writing your name

General direction:please indicate your correct response by using **X**mark (**X**) inside the box provided in front each question and state if any other factor

Part1: farmers community awareness toward effect of termite on soil degradation , reduction of product, wall distiructio,on people's livelihood and challenge of implementationof traditional termite management.

1 The effect of subterranean termite on local community related questions

1.1Is there the effect of termite in your kebele? A. yes ☐ B, no ☐

1.2 f yes for question NO 1.1 how much the effect of termite in your kebele?

A, Very high ☐ B, high ☐C, medium ☐D, low ☐, very low ☐

1.3 Is termite affect agricultural product in your area? A. yes ☐ B, no ☐

1.4 Is termite damage grazing land in studied area A, yes ☐ No ☐

1.5 Is termite damage wooden parts of construction study area A, yes ☐ No ☐

1.6The farmers of your kebele were aware on the degree of effect of termite.

A, strongly agree ☐ B, agree ☐C, uncertain ☐D, strongly disagree ☐ E, disagree ☐

1.7 How often farmers community in your kebele theoretically and practically trained regarding to the effect of termite? A,always ☐ B, sometimes ☐ C, uncertain ☐ D , never ☐

1.9 In what season termite effect is high in your kebele**?**

A, summer ☐ B, winter ☐C, Autumn ☐D, spring ☐

2, Questions related to traditional management of the effect of subterranean termite by local farmers

2.1 Is farmer of your kebele were have awareness on the importance termite

Management? A yes ☐ B No ☐

2.2 Is traditional termite management practice is effective to control termite impact?

A yes ☐ B No ☐

2.3 is traditional termite management practices play roles in improve soil fertility of local community? A, Yes ☐ B, No ☐

2.4 which traditional method of termite management mostly used by farmers of your kebele?

A, queen removal ☐ B, flooding ☐ C, terracing ☐ D, smoking hole ☐

2.5 Is continuous work traditional termite management is important to control impact of termite?

A, Yes ☐ B, No ☐

2.6 Is there continuous work of traditional termite management practices in your kebele?

A, Yes ☐ B, No ☐

2.7 Is traditional termite management need collaborative work between neighboring farmers?

A, Yes ☐ B, No ☐

2.8 Is there collaboration on termite management between farmers community in your kebele?

A, Yes ☐ B, No ☐

3, Question related to institutional support toward termite management

3.1 The relation of institution with the kebele farmers for the implementation termite management A, very good ☐ B, good ☐ C, medium ☐ D. bad ☐ E,very bad ☐

3.4 The attention given by development agent (DA) to effect of termite and traditional management in your kebele.

A, very good ☐ B, good ☐ C, medium ☐ D. bad ☐ E,very bad ☐

3.5 The interest of development agent (AD) to support farmer on traditional method of termite management in your kebele.

A, very high ☐ B, high ☐ C, medium ☐ D, low ☐ E, very low ☐

3.6.is there support from your woreda agricultural office on termite effect?

A, Yes ☐ B, No ☐

Appendex 2

Addis Ababa University

College Social Science and Humanity

Department Geography and Environmental Studies

A, Focus group discussion for sample house hold heads and stake holders of Study kebele

Dear the respondent, this questionnaire are aimed to get the required information regarding the contribution of effect of subterranean termite traditional management method toward soil degradation of termite on local community. The research would like to assure you that your response will be required only for the challenge related to effect of termite subterranean termite and management method in your kebele, The researcher would like to say thank you in advance for your valuable time, practice in genuine answer.

1, when the effect of termite is high in your kebele?

_____

2, How long termite effect in your kebele?

_____

3, can you mention special impact of termite on human activities in your kebele?

_____

4, what is your general idea concerning to termite impact in your kebele?

_____

5, which traditional method of management is best preferable to control effect of termite in your kebele?

_____

6, if you mention best controlling method , why termite effect is highest in your kebele?

_____

7, what suggestion you give the researcher man who studying the effect of subterranean termite and traditional method of management in your kebele?

_____

Thank you

Appendix 3

Addis Ababa University

College Social Science and Humanity

Department Geography and Environmental Studies

A, Focus group discussion forworeda stake holders of study where study area kebele located in

Dear the respondent, this questionnaire are aimed to get the required information regarding the contribution of effect of subterranean termite traditional management method toward soil degradation of termite on local community. The research would like to assure you that your response will be required only for the challenge related to effect of termite subterranean termite and management method in your kebele, The researcher would like to say thank you in advance for your valuable time, practice in genuine answer.

1, what is attention of your office on effect of termite inidorotobara and kokora gurrati kebele where the effect of termite in your warada?

_____

2, how can you explain the effect of termite in idoro tobara and kokora gurati?

_____

3, How long termite effect in your woreda specially idoro tobara and kokora gurati kebele?

_____

4,Can you mention special impacts of termites in idoro tobara and kokora gurati kebeles of your woreda?_____

5, Which traditional method of management is best preferable to control termite impact in your woreda especially Idoro tobara and kokora gurati kebele?

_____

6,If you mention best controling method,why termite effect is still the highestin your woreda

_____

7,As expert what kind of support you have provided those farmers of your woreda especially Idoro tobara and kokora gurati kebele where there is highest impact of termite?

_____

8, Is there any NGO support on termite impact management in your kebele?

_____

Appendix 4

Addis Ababa University

College Social Science and Humanity

Department Geography and Environmental Studies

A, Focus group discussion forworeda stake holders of study where study area kebele located in

Dear the respondent, this questionnaire are aimed to get the required information regarding the contribution of effect of subterranean termite traditional management method toward soil degradation of termite on local community. The research would like to assure you that your response will be required only for the challenge related to effect of termite subterranean termite and management method in your kebele, The researcher would like to say thank you in advance for your valuable time, practice in genuine answer.

1, As you thought, how you see the effect of termite in your kebele?

_____

2, how you can explain the change of termite impact from time to time in your kebele?

_____

3, how you can explain the impact of termite on your production and other relented activities in your kebele?

_____

4, Which traditional method of management is best preferable to control termite impact in your kebele?

_____

5, have you gained any support from other institution to control termite impact?

_____

6, Is there any NGO support on termite impact management in your kebele?

_____