A PARTICIPATORY SYSTEMS ANALYSIS OF THE TERMITE SITUATION IN WEST WOLLEGA, ETHIOPIA

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A Participatory systems analysis of the termite situation in West Wollega, Oromia region, Ethiopia

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DEDICATION

This report is dedicated to resource poor farmers of West Wollega, Ethiopia.
ACKNOWLEDGMENTS

This report on West Wollega (Ethiopia) is a product of interdisciplinary and participatory. Without the support of each other, various organizations, institutions, and individuals, it would not have been completed.

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Bako, July 1998
ABSTRACT

Termites have been regarded as serious pests of agricultural crops, forest trees, and buildings in West Wollega, Ethiopia, contributing to severe soil degradation problems by reducing vegetation and leaving the soil surface barren and exposed to the elements of erosion. A multidisciplinary team of five scientists carried out a participatory systems analysis of the termite situation, farming systems and broader agro-environment of West Wollega zone from April to July 1998. The main objective of the study was to analyse the termite problem from a dynamic systems perspective so as to better understand the cause-effect relationships and to propose a systems-oriented, integrated and participatory way of managing the pest and the damage caused by it. The methodology involved a participatory systems analysis of the problem situation involving all relevant stakeholders at different levels of hierarchies. A sampling framework was developed to enable the systematic analysis and classification of the zone, farm systems, field types and farmers. The systems analysis demonstrated that a diversity of different but interrelated factors interact with, and influence each other resulting in what is manifested as the termite problem. Ecological changes resulting from increasing human activities, unsustainable land use practices and mismanagement of natural resources are identified as the major cause of the recent spread and intensification of the termite problems. The consequences of termite infestation are reduced farm productivity, land degradation and increased vulnerability of resource poor farmers. It is noted that past interventions focused on termite control with chemicals without incorporating farmers' indigenous coping strategies and therefore had little impact.

The study concludes that the termite situation is complex and diverse with numerous different linkages and influencing factors, and suggests holistic interventions that incorporate stakeholders' priorities and needs in the management of the problem. Recommendations are thus made for systems oriented and integrated approaches to minimise the termite situation by strengthening farmer participation in research and development and establishing a working group of relevant stakeholders (farmers, extensionists, researchers, NGOs etc.) to systematically co-ordinate research and development activities.
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Glossary

Bone land A local term used to valley bottom fields that grown to crops using residual moisture in the dry season.
Waldigessa Small animal that bore a number of holes into termite nests for search of termite to feed on.
Dugda Baasu Traditional arrangement for sharing labour for different farm operations.
Kite kotu Share cropping
Ya’á Rain water run-off diverting furrows made using oxen plough in crop fields.
Ganda Administrative structure below a district (at village level).
Derg Collective term used to refer to military led government.
Stakeholder Individuals, community organizations or institutions who affect or be affected by a given research and development change.
**Acronyms and Abbreviations**

<table>
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<th>Acronym</th>
<th>Description</th>
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<tr>
<td>AERO</td>
<td>Ethiopian agricultural research organization</td>
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<tr>
<td>AISCO</td>
<td>Agricultural inputs supply corporation</td>
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<tr>
<td>AKIS</td>
<td>Agricultural knowledge and information system</td>
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<tr>
<td>BRC</td>
<td>Bako research centre</td>
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<tr>
<td>CPR</td>
<td>Common property resources</td>
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<tr>
<td>DA</td>
<td>Development age</td>
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<td>DAP</td>
<td>Di-ammonium phosphate fertilizer</td>
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<tr>
<td>DFID</td>
<td>Department for international development</td>
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<td>DORA</td>
<td>Development oriented research in agriculture</td>
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<tr>
<td>EECMY-WS</td>
<td>Ethiopian evangelical church Mekane Yesus-Western Synod</td>
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<td>OADB</td>
<td>Oromia agricultural development bureau</td>
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<tr>
<td>GDP</td>
<td>Gross domestic product</td>
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<tr>
<td>IAR</td>
<td>Institute of agricultural research</td>
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<tr>
<td>ICRA</td>
<td>International centre for development oriented research in agriculture</td>
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<tr>
<td>KIT</td>
<td>Royal tropical institute</td>
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<tr>
<td>MOA</td>
<td>Ministry of agriculture</td>
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<tr>
<td>NGO</td>
<td>Non governmental organization</td>
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<td>NRI</td>
<td>Natural resource institute</td>
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<td>PA</td>
<td>Peasant association</td>
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<tr>
<td>PPRC</td>
<td>Plant protection research centre</td>
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<td>PRA</td>
<td>Participatory rural appraisal</td>
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<tr>
<td>R &amp; D</td>
<td>Research and development</td>
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<tr>
<td>RRA</td>
<td>Rapid rural appraisal</td>
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<tr>
<td>T &amp; V</td>
<td>Training and visit</td>
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<td>TOR</td>
<td>Term of reference</td>
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<td>USD</td>
<td>United State dollar</td>
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EXECUTIVE SUMMARY

Introduction

Background information

This study is the result of a joint collaborative project between the Ethiopian agricultural research organisation (EARO); Oromia agricultural development bureau (OADB), Ethiopia and the international centre for development oriented research in agriculture (ICRA) of The Netherlands. A multidisciplinary team of five agricultural research professionals conducted a participatory systems analysis of the termite situation from April to July 1998. The focus of the study was the West Wollega zone of Oromia region where the termite problem has been known for about 30 years but has intensified in recent years. Termite activity was reportedly causing damage to crops, rangeland, exotic forest trees, and buildings and contributing to severe soil degradation problems by reducing vegetation and leaving the soil surface barren and exposed to the weather elements. Both the regional and zonal agricultural development bureau (ADB) and Bako research centre (BRC) consider the recent spread and intensification of termite damage as a high priority problem and recognise that there is a lack of clear understanding of the causes of the problems.

Study purpose and objective

The purpose of the study was to promote farmer participatory problem solving research and development activities to reduce termite infestation and its effects on crops, soils and the livelihood of farmers in Nedjo district and surroundings.

The main objective of the study was to analyze the termite problem from a dynamic systems perspective so as to better understand the cause-effect relationships and to propose a systems oriented, integrated and participatory way of managing the pest and the damage caused by it.

Methodology

The study undertook a diagnostic, participatory and systems oriented approach and analysis of the farming systems, broader agro-environment and termite situation by involving all relevant stakeholders at different hierarchies, including politicians, researchers, extension workers and farmers. A sampling framework was developed to enable the systems analysis and classification of the zone, farm systems, field types and farm households. The study area was first zoned using agro-ecological and farming systems characteristics and then within the zones the villages were selected based on the level of termite infestation. At a field level in all zones and farm systems, five distinct field types were identified based on the toposequence and farmers’ management practices. Finally a farm / household typology was developed to focus further in-depth study on the termite situation, and targeting future
interventions based on farmers' own major wealth ranking criteria. A problem-causal diagram was developed and analysed by integrating the diverse perspectives and expertise of the team members to identify potential gaps and areas for intervention. The problems and priorities identified and ranked by different stakeholders (e.g. farmers, research and extension staff) during the fieldwork were used as the basis for screening options and prioritizing interventions. Mid-term and final workshops were conducted to present findings, get feed back and develop framework for interaction, coalition building and future collaboration with different stakeholders. In addition, farmers' workshops were conducted in each village to present findings, verify collected information and to get feed back on the priorities and the possible opportunities.

Findings

Zonation and farm typology

The purpose of the zonation was to delineate homogenous geographical areas for targeting research and development interventions. Three broad zones are identified based on major agro-ecological and farming systems characteristics and the level of termite infestation.

- **Zone I**: rolling topography, natural savanna woodlands vegetation, dominated by coffee based systems and high level of termite infestation
- **Zone II** has undulating topography, sparse vegetation dominated by cereal based farming system and high level of termite infestation.
- **Zone III**, rolling topography, natural savanna woodland vegetation, cereal dominated mixed farming systems, new settlement pattern and less termite incidence.

Within each zone, five field types (micro-zones) were identified: homestead fields, cereal fields, degraded sloppy fields, coffee fields (lower slopes), and valley bottoms which differ in terms of toposequence, termite problems, farming systems constraints, productivity, research and development interventions and opportunities.

In addition to zonation of geographic area and field types, farm household typology was also developed to classify farm households into different homogenous groups for targeting research and development interventions. The major criteria used in this study for differentiating farm household groups were availability or absence of land, size of land holding, ownership of oxen and gender. Based on the farmers' participatory wealth ranking exercise, the following four farm typologies were identified for future interventions;

- Resource rich (with land and oxen)
- Medium resource (with land but no ox)
- Resource poor (with no land and ox)
- Women and women headed household (with or without land or/ oxen)
Termite effects in relation to seasonality and field types

- Termite damage is observed more in early and post rainy season on crops, pastures and tree seedlings. However, damage in teff is observed in mid-rainy season. Dry season damages are seen mainly on pastures and young seedlings.
- More termite damage is observed in dry hilly and sloping areas than moist flat and valley bottoms.
- Greater damage is seen in cereal fields than homestead gardens.
- Greater in heavily grazed and denuded fields than well managed fields.
- Higher incidence of termite damage is reported in rainfed fields than irrigated areas.

Coping strategy and vulnerability to termite situation

Over the years farmers have developed several strategies and indigenous techniques to cope with increasing vulnerability to the termite problem and hungry period. There is a gradual change in crops grown over the years due to decline in soil fertility and termite incidence. The shift towards stress and termite tolerant crops such as finger millet from teff and maize appears to be high in termite affected zones. An increasing number of farmers are gradually shifting towards root and tuber crops in the homesteads and spring (bone) maize in valley bottoms to cope with hungry period as they are fairly tolerant to termite attack. Other strategies adopted to minimise termite problems are use of high seed rates during planting, clean weeding, use of high amount of fertilisers and manure, rotating the lands for different crops, burning crop residues, mulching and flooding.

Farmers without oxen (resource poor) and women headed households are the most vulnerable groups to termite attack. Lack of access to oxen (draught power) affects timely planting and management of farmlands. This results in poor and stressful growth of crops where the incidence of termite damage is high resulting in poor productivity and high vulnerability of these farm households. These farm groups also have less resilience to cope with hungry period due to lack of adequate cash resource and less access to valley bottom lands.

Stakeholders’ problem ranking and analysis

Various stakeholders viz.: groups of farmers (resource rich, poor, women), extension workers and researchers identified several problems related to agriculture and termite situation in the study area. These problems were prioritized into ten key problems, which were finally used for participatory ranking by different stakeholders e.g. different group of farmers, extension workers and researchers. Participatory ranking analysis revealed that:

- Termite damage is a predominant problem ranked by all groups (typology) of farmers (resource rich, resource poor and women) in the termite-infested
zones I and II. Wild animal attack, high fertilizer price, and lack of draught power (oxen) were the other major problems identified by them.

- Researchers and extension workers also identified termite as the number one problem followed by land degradation and overgrazing.

**Systems analysis of the termite situation**

The analysis of the agroecosystem from a broader systems perspective revealed that the termite situation is complicated due to its complex interaction and interrelationship with various factors in the farming systems, agro-ecological and socio-economic environment. The analysis also demonstrated the diversity of interrelated factors influencing the termite situation. The recent spread and intensification of termite damage are largely a result of changes in the balances within the agroecosystems following human interference, poor land use practices and mismanagement of natural resources. Termites have always been present in the study areas and had previously not caused adverse effects. However, systems changes and more specifically ecological change, resulting from interference caused by an expanding human and livestock population has prompted a change in termite survival strategies, resulting in increased reports of damage to crops, range land and buildings. Among them, the most prominent ones are overgrazing, depletion of soil fertility and soil erosion that are directly responsible for aggravating termite infestation and damage.

The past research and extension interventions were focused mainly on symptoms of the problem rather than focusing on the underlying root causes which have caused the systems change and subsequent rise in termite related problems. Analysis of the research and extension services identified that farmer participation in the design and diffusion of information and technology is weak. There is lack of an integrated and participatory approach to research and extension interventions available to farmers to manage termite infestation. Farmers also lack access to resources, other sources of information and technology support, although a number of social and informal institutions and organisations exist.

**Recommendations and research proposal**

The study suggests recommendations for research and development on various research themes emphasizing holistic interventions that incorporate stakeholders’ priorities and needs in the management of the environment and the termite situation. An outline of a project proposal on integrated soil and water conservation for the regeneration of degraded lands in termite affected areas is put forward as a starter program to minimize the effects of the termite situation. The proposal suggests a framework to be adopted, firstly by strengthening farmer participation in research and development, and secondly through the establishment of a coordinated working group, to collectively and systematically manage all research and development activities connected to the termite situation.
CHAPTER ONE

INTRODUCTION

Aim and institutional setting

This report is the product of a diagnostic, participatory and systems oriented study of the farming systems, broader agro-environment and termite situation in West Wollega, Oromiya region, Ethiopia. The study was carried out by a multi-disciplinary team of agricultural scientists from the International Centre for development orientated Research in Agriculture (ICRA) in the Netherlands. The study is a joint collaborative effort between ICRA, Oromiya Agriculture Development Bureau (OADB), and Ethiopian Agricultural Research Organization (EARO) and Bako Research Centre (BRC), Ethiopia. The team consisted of two Ethiopian researchers, an entomologist and agronomist, a Nepali socio-economist, Ugandan livestock specialist and a British agro-ecologist. The team was based in Nedjo district for the duration of the three-month study from April 10th until July 11th 1998.

ICRA provides training to international agricultural scientists and equips them with the necessary knowledge and skills to work in interdisciplinary teams. The training’s focus is on developing methods of description, diagnosis and analysis of constraints for agricultural production, together with the ability to formulate appropriate extension, policy and research programmes. ICRA promotes a systems led and participatory approach to Development Oriented Research in Agriculture (DORA), that promotes economic competitiveness, social equity and environmental sustainability, through research carried out by interdisciplinary teams utilising system approaches and farmers participation. A core component of the ICRA programme is three months of intensive field study with partner host institutes in rural areas of developing countries.

Study Background and Objectives

The far West Wollega zone of Oromia region suffers from a serious and increasing problem of termite infestation. The problem has been known for about 20 years, but has intensified in recent years and is reportedly spreading rapidly in an easterly direction from affected districts in the West. Mendi, Nedjo, Jarso and Boji district are among the most affected. The termites cause serious damage to crops, coffee, Eucalyptus trees, pasture grasses and buildings. Termites are believed to contribute to serious soil degradation problems, by reducing vegetation and leaving the soil surface barren and exposed to soil erosion.

In the 1980s, the Ministry of Agriculture (MOA) organised termite control campaigns using chemical control measures. These were only partially successful. Smaller scale campaigns are still being organised by the OADB, using indigenous control methods and in some cases chemical methods. However, these methods have not proved effective enough to control the problem.

Limited in country research has been conducted on termite control and was scattered amongst various institutes overtime often consisting of specifically focused individual research projects. There is limited knowledge of the variety of causes and interlinkages relating to the recent intensification of the termite problem. There has been no concerted research effort to
approach the termite problem from a dynamic systems perspective and to propose systems-oriented, integrated and participatory ways of managing the pest.

Both the Regional and the Zonal ADB and BRC thus considered the intensification and spread of the termite problem and lack of appropriate research as a high priority for forthcoming R&D activities in Western Wollega. In light of the above factors the Joint ICRA, EARO and OADB study initiative was recognised. The field study was based on a jointly developed Terms of Reference and undertaken by the multidisciplinary ICRA team from April to July 1998.

Study purpose

Promoting farmer-participatory problem-solving R&D (research and development) activities to reduce termite infestation and its effects on crops, soils and the livelihood of farmers in Nedjo district and its surroundings

Primary objective

"To analyse the termite problem from a dynamic systems perspective, so as to better understand the cause-effect relationship and to propose a systems-orientated, integrated and participatory way of managing termite and the damage caused by it."

Specific objectives

1. To identify and analyse relevant stakeholders and knowledge and information systems, and suggest areas for improvement.
2. To identify characteristics of farms and their production systems and factors affecting their vulnerability to termite damage.
3. To categorise farms in the study area into a farm typology
4. To identify and indicate leverage points for preventative and curative interventions
5. To identify and indicate areas for improvements and interventions based on lessons learnt from previous R&D experience.
6. To make recommendations for systems-oriented, integrated and participatory ways of managing the pest and to prioritize potential R&D options.

Another objective was to provide ICRA team members and local staff associated with the study, experience in participatory and systems methods of diagnosis and design for agricultural research.

Study outputs

- Copies of the final report, produced and distributed to relevant stakeholders.
- Recommendations developed for potential research for BRC and EARO
- Prioritized recommendations for strengthening farmer involvement in R and D
• Prioritised proposals developed for R &D
• Secondary information resulting from field study, e.g. reports diagrams etc.
• Three workshops conducted.

Organisation of the report

Chapter two of the report provides an overview of the Ethiopian environment and then focuses in on the West Wollega context. A background is provided of the termite situation and a literature review is given of past research experiences on termites in the tropics and Ethiopia. Chapter three describes the stepwise methodology and phases of the fieldwork throughout the entire study. Chapter four presents the zonation and typology criteria and processes for the field study area, it then presents an analysis of the different field types, household typology groups. In chapter five the main characteristics of the farming systems are described, under themes of cropping systems, livestock, natural resources and socio-economic factors, notable differences between farming systems and zones are also highlighted. Chapter six presents a descriptive analysis of the agricultural knowledge information and technology support system, and presents perspectives of key stakeholders on knowledge, information and technology flows. Chapter seven then presents an overview of the termite situation and factors relating to its management and control. Chapter eight presents a systems analysis of termite effects and factors influencing the situation. Discussion is given too drawing out the key themes from the report and analysing and highlighting the variety of interrelationships. Chapter nine presents an overview of vulnerability to termite situation and analysis of farmers, researchers, and extension strategies to cope with termites. Problem opportunities and interventions are discussed in chapter ten. Recommendations and prioritised research proposals list to manage the termite situation are presented in chapter eleven. Finally, chapter twelve provides the major conclusions of the study and the termite situation.
CHAPTER TWO

BACKGROUND INFORMATION ON ETHIOPIA, WOLLEGA AND TERMITES

Ethiopia: General background

Ethiopia is a landlocked country located in Eastern Africa bordered by The Sudan, Eritrea, Djibouti, Somalia and Kenya. It is the third most populous nation in Africa after Nigeria and Egypt with about 54 million people (Oxfam, 1995). Agriculture is the mainstay of the Ethiopian national economy accounting for over 48% of the gross domestic product (GDP) and over 90% of the national foreign exchange earnings (World Bank, 1994). Ethiopia’s exports are heavily dependent on agriculture, the main commodities traded being coffee and hides and skins. About 40% of the agricultural production is made up of animal products: meat, dairy products, and skins.

Agriculture in Ethiopia remains less productive despite its over all importance in national economy and potential for future growth. Although a host of factors account for low agricultural productivity, the availability and use of improved agricultural technologies constitute the major limitations. The combination of continuing high human population increase, at some 3.1% per year, degradation of natural resources (forests and soils), and Ethiopia’s low level of adoption of agricultural technology had placed the country in a state of structural deficit of food until 1994 (NRI, 1996). However (after the change of new government in 1992), Ethiopia’s economy grew at an annual average rate of 7% between 1993 and 1997, while inflation was brought down from 20% to single figures. The greatest impact has been in the agricultural sector, accounting for about 48% of GDP and responsible for the country’s main export—coffee, which brings in two-thirds of foreign exchange earnings (Financial Times, 1998).

National policy Environment

Until 1992, Ethiopia was under socialist rule where everything was under state control. Farmers had little incentive to produce more and market more. Participation of private sectors was virtually absent. The policy was the large-scale biased approach for the socialists transformation of the rural sector where large-scale farms were promoted through the formation of state farms and farmers, producers’ cooperatives (Clapham, 1988 and Workneh Negatu, 1996).

However, after the change of new government in 1992, the country followed a market oriented new economic policy. The objective of the new development policy was transformation of the traditional economy under the perspective of market oriented socio-economic liberalization (TGE, 1994). In order to alleviate poverty, government also introduced agricultural development led industrialization (ADLI) strategy which on the one hand embodies the principles of making the agriculture sector more productive; and, on the other hand, promotes the productive use of poor’s most important asset, labour by promoting labour intensive technology in industry (The Ethiopian Herald, 1998). Indeed the success of the government’s broad economic strategy of ‘agricultural development led industrialisation” (ADLI) is dependent on attracting private investment into regional agricultural processing. However, there is no change in land use policy after the revolution where, land still belongs to the state and farmers legally do not have ownership right for the sale and purchase. Many
argue that there has been little incentive to change, given agricultural policies and the land
tenure structure both before and after revolution (Stroud and Mekuria, 1992).

With regard to sectoral agricultural policy, the ministry of agriculture has responsibility
through, agencies for extension and research. The extension services of the different
departments (crop, livestock, coffee and forestry) are being integrated under a single agency.
Extension services are moving to a system which provides farmers with complete ‘package’
comprising inputs, technologies and credit. Some concerns have been raised recently
regarding the wider relevance of this approach. Because, this package is not well linked with
farmers’ important farm activities such as livestock, horticulture, pest management (termite)
and soil conservation aspects to improve the livelihood of the poor farmers. The policy on
package has also no provision for the delivery of inputs and technology package to share
croppers who lack oxen and/ or lands (though, it is learned that recently provision has been
made for 10% of the poorer population, who can have this access if peasant association
provides recommendation for this).

Oromia and West Wollega background

Oromia is one of the nine regional states of Ethiopia, located in central-West Ethiopia. It is
characterized by diverse ecological conditions which make the areas particularly suitable for
growing different crops. Its landscape includes high and rugged mountain ranges, undulating
to rolling plateau, panoramic gorges and deep encised river valleys. Ethiopia’s largest ethnic
group, the Oromo, lives in this region. West Wollega is one of the 12 administrative zones
in Oromia which is situated in the West most part of the region. The zone consists of three
types of altitude based agroecologies namely highland, mid-land, and lowland. Of the 17
districts in this zone, majority of them lie in medium elevation. Manasibu, Nedjo, Jarso and
Boji are the four districts in this zone which are seriously affected by termite problems.

Background to the study area

The field study is located in West Wollega administrative zone of Oromia region. The field
study area stretches from the coffee growing areas of East Manasibu district to cereal-based
south West part of Boji, Nejo and Jarso districts. (Map 1 and 2). It is situated at 9° altitude
North and 35° longitude West. Physiographically the study area falls within the Western
highlands of Oromia and has an elevation that ranges from about 1600 to over 1800 m asl..
The landscape varies from gently undulating plains and plateaus to rolling plateaus of wider
valley bottoms. The climate of the area is mild hot with mean annual rainfall varies from
1200-2000 mm. The dominant soils belong to District Nitosols series.

All districts experience a serious land degradation problem. From the recent statistics,
Manasibu district had the highest livestock population, termite mound counts and abandoned
land, followed by Jarso, Nejo and Boji districts. Land use mainly comprises cropland
(coffee and/or annual crops), range and forest lands. Detail statistics of termite mound
distribution, demography, land uses, livestock population, indigenous trees and crops are
given in Figure 1, 2, Appendix XIII and XVII.
Map 1. Western Wollega administrative region and study area

Map 2. Regional state of Oromia's administrative divisions
Fig. 1 Three years (995-97) Total Human Population of four districts in western Wollega, Ethiopia 1998

Source: Western Wollega Zonal cooperative promotion department, Yearly report by Belete Wakbeka (unpublished)

Fig. 2 Present land use (%) system in four districts of western Wollega, Ethiopia, 1998

Source: Western Wollega Agricultural office, land use planning and environmental protection section, by Wega Duguma (unpublished)
CHAPTER THREE

METHODOLOGY

The major methodological steps and outputs relating to the study are outlined in Fig 3. A list of key informants and secondary data can be found at the back of the report. The fieldwork was divided into three main phases as outlined below.

Phase One

Pre departure planning-TOR review and field study plan

Prior to departure from The Netherlands the TOR was reviewed and a detailed field study plan developed indicating stepwise activities and outputs. The plan was presented to other ICRA trainees and staff for comment, and finalised after discussion with the team reviewer. The plan was iterative and reviewed throughout the study period to ensure smooth implementation.

Secondary data review

Prior to arrival in Ethiopia, the team undertook a major literature review of relevant articles carried to The Netherlands by Ethiopian team members. A comprehensive literature search was undertaken in the ICRA, University of Wageningen and Royal Tropical Institute (KIT) libraries in the Netherlands and the Department for International Development (DFID) and Natural Resources Institute (NRI) libraries in the UK. Several European key informants were interviewed. These activities provided an overview of the ecological and socio-economic environment and farming systems of the region. This helped to refine the TOR and focus and conceptualise the termite situation and environment of the study area.

Problem conceptualisation: A systems approach, rich pictures and stakeholder analysis.

A major thrust of ICRA’s training is the use of a participatory systems approach to agricultural research. After reviewing the TOR, secondary information and discussing with Ethiopian counterparts, a systems diagram was drawn using the rich picture methodology. Rich picture methodology is a component of a soft systems approach that aims to represent a systems view of all the relevant actors, system components and their respective linkages. The methodology combines the diverse multidisciplinary perspectives of those involved in the research. Individual team members drew visual diagrams of the problem situation from their own perspectives and then came together to share and analyse each others rich pictures, to then make one synthesised picture of the teams' perspectives of the problem. This helped team members reach a common understanding of the problem to orient the field study planning, check the focus of TORs and to develop specific objectives and research questions. A stakeholder analysis was undertaken to identify all key stakeholders and their objectives and levels of interest and influence. This enabled the team to clarify the TOR and identify the diversity of different factors affecting the research. It also

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1 A system can be defined in various ways, but all systems involve an arrangement of parts, components or subsystems, that interact according to some process, transforming inputs into outputs. A systems approach considers all the component parts of a system and their dynamic interrelationships in relation to the whole (ICRA, 1998).

2 Stakeholder analysis is the identification of projects key individuals, groups or institutions and their interest and influence relating to a project and the final success of the research project and proposals. (Department for International Development, 1995)
helped the research to be focused to the correct actors and made sure no important stakeholders and institutions were omitted from the research. This approach was considered iterative and updated throughout the field study period.

**Arrival in Ethiopia and introductory workshop**

Upon arrival in Addis Ababa, Ethiopia, four days were spent interviewing key informants and important stakeholders (Appendix XIV). The team then proceeded to Bako research centre and gave an introductory seminar on the study plan, objectives and schedule. Both activities helped to refine the research focus and outputs and drew upon a wealth of local knowledge. This enabled an understanding of the entire system and further identification of stakeholders and resource persons. It also helped to focus the group’s direction for the reconnaissance survey and field activities.

**Phase two**

On arrival in Nedjo district, the team undertook a reconnaissance survey with the help of local key informants to gain a sound overview of the study area. Before arrival in the study area, the team had developed tentative criteria for zonation. After the reconnaissance survey these criteria were further developed and verified. Criteria were based on farming systems, agro-ecological factors and levels of termite infestation (See chapter 4). Utilising well experienced local extension staff and ICRA in country representative, the team took two full days to tour the four districts of Nedjo, Manisibu, Jarso and Boji. The team utilised RRA and PRA techniques (see field data collection section below) to interview key informants, to develop and validate the zonation criteria and gain valuable insights into the termite situation and farming systems of the area. Two days were then spent analysing data and reviewing zonation criteria. The team then returned to the field for a further two days to verify the zonation and select suitably representative sites for the fieldwork.

Use was also made of direct observation and discussion techniques amongst the group throughout the field study, especially of termite species and damage, overgrazing and land degradation etc.

Three translators were identified from the Nedjo agricultural development office and agricultural training centre. Time was spent orienting them about the study and training them in the use of PRA field techniques during the field survey phase and throughout the whole study period.

After interviewing local extension staff and researchers and reviewing the fieldwork, the stakeholder analysis was updated, this enabled the identification of several new key stakeholders and areas of interest, which might otherwise have been overlooked. The TOR was reviewed and necessary changes to the objectives and outputs incorporated.
Fig 3 Methodology for ICRA TEAM Termite Study

Phase One-secondary data and key informant review → Summary of background Information

Preliminary planning Workshop → Comments on study focus and methodology

Reconnaissance survey & Key informant interviews → Agro-ecological Zoning selection of proposed study sites

Phase Two Data collection & Analysis RRA and PRA → Information on Agro ecological conditions, farming systems characteristics & field types, farmers problems and constraints, socio-economic target groups, Termite problems cause-effect, stakeholder analysis

Mid Term Workshop, all stakeholders → Comments on methodology, Zonation and Farm System characteristics, Debate key issues, prioritise problems & opportunities and refine study focus.

Phase Three Data collection and Analysis PRA, in representative villages → Identification of: farmers coping strategies, external interventions, leverage points, flow chart, farm typology and potential recommendations

Priority setting, all stakeholders → Prioritised list of potential interventions, based on farmers needs, extension and researchers resources

Preparation of collaborative research, extension & farmer orientated proposals and recommendations → Outlines of research proposals and Recommendations

Report preparation → Draft report produced

Final Workshop, all stakeholders → Comments and analysis of proposals and recommendations

Incorporate workshop comments → Produce final report, Disseminate results

Bako Research Centre, IAR and OADB uptake & incorporation into 1999 workplan
Study area: Zonation, farming systems, field types and household typology

On completion of the first field work phase, zonation criteria were reviewed and data analysed from the key informants and secondary information, relating to zonation, farming systems and the termite situation. In discussion two agro-ecological zones and three farming systems were identified within the study area (Fig 4). This was further verified with researchers, extension agents, OADB staff and farmers at the mid term workshop. Further fieldwork utilising PRA techniques identified five distinct field types and four household typology groups. For further in depth details see the following chapter.

Data collection and analysis: Participatory rural appraisal

During phase two, data collection focused on using PRA techniques. PRA can be described as a suite of research techniques that aim to allow the informants an interactive role in developing solutions to their own problems (Mikkelsen, 1995). Past research has often focused more on a top down approach of researchers aiming to find answers to pre-set questions in a structured and formal manner. These processes were commonly biased towards researcher interests and important factors and perceptions were often overlooked. To avoid this the team used a number of different PRA techniques, including focus group discussions, semi-structured interviews, key informant interviews, wealth and problem ranking, transect walks, flow and systems diagrams, mapping and other visual techniques. This enabled interviewee’s freedom to express their ideas and problems relating to the research and facilitated a solid rapport between farmers and researchers.

Semi-structured interviews

Semi-structured interview techniques were used throughout the fieldwork, including key informant’s interviews and focus group discussions. Questioning was informal and conversational. Researchers divide into five teams depending on their specialization and task. Before the fieldwork, a checklist (Appendix XVII) of key themes (see below) and sub questions were developed as a guide. Use was made of the individual researcher specialization and key themes were explored and cross-checked by rotating researchers, respondents and themes. Questions were open ended and not directive, with researchers allowing participants to speak freely about all topics, whilst probing deep into the relevant areas. This resulted in information of systems nature that went beyond standard answers. New avenues of investigation were always allowed to develop and if relevant were fed into the iterative checklist development process.

Research themes, interviews, interactive mapping and ranking tools and termite methodology

After analysing and reviewing secondary data, and data from the first phase, key research themes were developed for the field study. Specific field methodology was reviewed and selected depending upon time, availability and type of farmers and to meet specific research objectives and questions.
Historical trends

Due to the reported increase in the intensity and evolution of the termite problem over many years, together with an awareness of the constantly changing dynamics affecting farming systems, the ecological and the socio-economic environment, it was decided that a historical analysis of change was vital to unravelling the termite situation. Farmers were organised into homogenous groups based only on either age or gender and discussed freely in focus group discussions on issues of change relating to termites, socio-economic, ecological, political and agriculture related issues. Discussions in conjunction with a PRA timeline technique enabled elderly farmers to actively draw a timeline of major historical events relating to issues of change. Farmers used traditional walking stick spears to draw a line in the dirt and indicated at different stages throughout the discussion various historical events and changes.

Termites

As the focus of the study was to find ways to manage the termite situation, a major theme was termite; history, damage and intensification. Interviews focused on a broad array of termite related information. Emphasis was given to lift up the study to a systems level and all factors contributing to termite infestation and damage were considered. A timeline (Table 6) of the termite history was developed from discussion and review of secondary data.

In all study site zones termite species samples were collected from cultivated land, woodland, grass lands and termite mounds. Termites found foraging in cereal fields and coffee fields on crop residues were collected at 10 metre intervals across the fields. Efforts were made to include soldiers, workers, queens and alate (swarming) caste and newly deposited eggs. The samples were preserved in pure alcohol and are kept for further identification. Nesting behaviour was also studied by looking the presence or absence of mounds in an area. Farmers and PA heads were interviewed in order to know the density of termite mounds on each site from their own records. The team also counted the number of mounds per hectare in cultivated and grassland areas. The density of termite species foraging holes was determined for grassland and abandoned land. In each field study locality, five sites were selected at 10 metre intervals diagonally. The density of foraging holes was recorded in an area of one square metre at a distance of five meters either side of the five study sites.

Agricultural knowledge and information system (AKIS)

An AKIS analysis enables the identification of information and communication gaps and opportunities for improvement. It also enables identification of the perceptions of individuals and various institutions especially those outside of direct community involvement e.g. OADB extension service, yet who affect the study. Special attention was given to identifying the functioning and perceptions of the extension and research systems, and their role relating to agricultural activity and termite control. Consideration was given to other institutions and individuals including the peasants association and private agricultural input supplier’s etc. The AKIS evaluation was achieved by extensive interviews, utilising both key informant and focus group discussions with all actors involved. Systems spray diagrams were developed by the group, enabling a systems perspective of the AKIS to be developed.
Farming systems and agro-ecological environment, farming systems resource map, seasonal calendar and transects

The interrelationship of the termite problem and farming systems, together with the higher objectives of the study, necessitated a systematic in-depth study of the farming systems. This was the core foundation of the study, around which other themes and topics revolved. The analysis of the farming systems enabled a solid description of the functioning of the various differing components of the farm system and their respective problems and opportunities. It enabled identification of typology of farm systems, field types and target groups relevant for recommended focused interventions.

A variety of farmers, men and women, young and old, rich and poor were interviewed from the three different zones and farming system. Interviews were conducted with key informants and focus group discussions utilising themes and questions from the checklist.

Transect walks (Fig 5 and 6) were undertaken with farmers, enabling farmers and researchers to walk across various topographic sequences and farm systems, discussing various farm practices, natural resources, crop and livestock patterns, and problems and opportunities. An agro-ecosystem transect (Fig 5 and 6) was then drawn based on the farmers comments and direct observation. This technique was vital in differentiating the variety of farming systems practices and problems by topographic sequence. It allowed researchers and farmers to identify common field types across various farm systems and topographic sequences.

Farming systems resource flow diagrams (Fig 7) were drawn by a number of different farmers e.g. wealthy head of PA and disadvantaged resource poor female household head. These diagrams were drawn in the farmer’s home by the farmers’ themselves. Care was taken by the researchers not to bias the farmers. Farmers identified the variety of resources available on their farms and external resources relating to the farm system and indicated resource flows by gender e.g. goods to and from the market by male/female. Diagrams quickly helped in the identification of the various components interacting together to form the farm system. Diagrams demonstrated the different resources available to the household, and provided an indication of the diversity of resource endowments between households within one supposed farm system type e.g. coffee based. During drawing, notes were taken recording additional information not represented on the diagram, such as reasoning for choices. The diagrams and supplementary notes were analysed, and the information cross checked with other interview data and transects, and then compiled to make descriptive farming systems spray diagrams.

Socio economics

For the socio-economic data collection stages, a variety of data was collected under certain sub themes including:

- Gender
- Land tenure, share cropping, labour sharing and hiring mechanisms,
- Resource access and decision making.
- Cost of production
- Off farm employment
- Social institutions including credit input and supply
- Markets and policy effects
- Livelihood systems and household economy
Care was taken to utilise a systems approach and to interview a broad cross section of the households: men and women, old and young, rich and poor.

Soil analysis

During the field study period, farmers reported different levels of termite incidences and crop productivity for different field types and physiographic position on the landscape. To correlate this observation with empirical data and to see whether there is some relationship between the soil physico-chemical properties and termite incidence, or crop susceptibility to termite attack, soil samples were taken from selected landscape and field types.

For all zones, three to five sub samples were taken from homestead (gentle slopes or plateau’s), crop fields, degraded/abandoned lands (gentle to steep slopes), and valley bottoms at a soil depth of 30 cm using an auger. In some zones, soil samples were also taken from coffee fields and termite mound. Soil sub samples from each zone were then pooled across field types. The soil samples were analysed in the National Soil Laboratory (Addis Ababa) available phosphorus, exchangeable cations, cation exchange capacity (CEC), soil pH, and texture classes. Discussion on the results is presented in chapter five and data showing the physico-chemical properties of the soils at different zones and field types are given in Table 2 and Appendix IX, X, XI and XII.

Mid-term work shop

At the end of phase two a mid term workshop was held at Nedjo by the ICRA team, researchers, extension staff, farmers and other stakeholders. The purpose of the workshop was to present preliminary findings, bring together the key stakeholders involved in the termite situation and to exchange views and information on how to best manage the termite situation in Western Wollega.

The workshop objectives were:
1. To verify and confirm the zonation adopted for the field study
2. To get feed back from participants on initial findings
3. To update stakeholders on progress of the study
4. To identify and prioritise problems and opportunities
5. To identify key issues for in-depth study in phase III of the study
6. To promote interaction amongst farmers, extensionists, researchers and other stakeholders.
7. To promote a participatory and systems-oriented approach in handling the termite situation.

Time was given for presentation of findings, verification of diagrams, a farmer’s forum discussion, working groups on key issues and plenary and general discussion. Attendance was high and active participation by all participants, with farmers taking a vocal role in relating their problems to extensionists and researchers. At the end of the workshop extensionists and researchers were asked to rank a series of ten problems identified by farmers’ (Appendix II). The results were then analysed and compared with those of farmers for the same problems.
On completion of the workshop the team spent one week writing up and identifying other key issues and gaps to be researched in the next phase of the study.

**Phase three-in depth study of farming households and key areas**

After completion of the workshop the team went into an in-depth field study of selected sites and themes within the study area. Diagrams and initial findings were then verified with farmers groups at each site.

**Wealth ranking**

A wealth ranking exercise was conducted with key informants to identify a farmer typology. A tentative typology was developed based on land ownership, gender, access to oxen and numbers of cattle (Table 1). The typology was compared with those developed by different socio-economic groups e.g. landless versus big land owners, male female, literate, illiterate and cattle or no cattle, through a PRA wealth ranking exercise. This technique utilised three to five key informants farmers to identify 50 households in the locality and to write the household heads name on a piece of paper, either by themselves or with the assistance of a translator. Through discussion the group where asked to categorise and rank households into homogenous groups depending on whatever criteria they thought most relevant. The criteria developed by the farmers and researchers were strikingly similar. The classification was a sensitive issue, therefore, care was taken to respect the privacy and nature of the classifications and the ranking exercise proved most successful in the last phase as a good rapport and trust was established.

**Problem ranking**

In earlier fieldwork phases the team had identified farmers problems through PRA techniques. As the team was aware that different farmers in different areas have different problems and order of importance, it was decided to rank a series of ten common problems identified by all farmers in all zones. Farmers were selected from different typologies and zones and asked to rank the problems in order of importance. Ten of these problems were then ranked using 55 bean seeds or small stones. Large visual charts with either pictures or representative symbols e.g. termites for the termite problem, were laid on the ground and a discussion held of the various problem. Participants then individually and in group ranked their problems with ten stones for the most important problem, then next with nine and so on (Appendix II and III).

PRA techniques, including focus group discussions and farmers workshops were utilised to identify farmers solutions to the identified problems. Those potential farmers’ solutions which fall within the mandate of the studies were incorporated into the development of potential interventions and research proposals.

By the end of the third phase the team had a verified zonation of the study area and verified farm typology developed with the farmers’ themselves. A series of ranked problems by farmer typology group and zonation area was collected together with potential priorities for intervention.

**Researcher and extension interviews**

Throughout the study numerous interviews were held with extension and research staff. However, interviewing researchers was conducted at Bako at the end of the third phase.
Interviews were conducted with researchers, extensionists, planners and input suppliers in Bako and Addis Ababa, respectively. The interviews at this stage enabled the team to identify past and present research and extension priorities and linkages and to further develop their understanding of the research and extension organisations so as to assist in identify potential areas for recommendation.

Data analysis

After each day in the field, time was given to draw up all diagrams, assimilate notes, and exchange information among the team members. The team then synthesised spray diagrams relating to the study themes. Individual key points, differences and similarities within sites and systems were noted. The similarities allowed for triangulation of findings and the making of composite spray diagrams. Differences and key points were fed back into the study process for further validation.

Problem-causal trees

A causal diagram is simply a way of representing the interrelationships between different factors affecting a situation. Other terms used to describe this type of analysis are “problem analysis or constraints analysis”, with the result being called “problem trees or causal models” (ICRA 1997 course note). Casual diagrams are used in a thorough and analytical way. In applied agricultural research, causal diagrams represent a valuable way to integrate the analyses of different disciplines. The identification of a number of problems and the analysis in the form of a causal diagram, enables the interrelationships of the various constraints to be seen more clearly. The interrelationships show which problems need to be addressed together with others. In addition, problems which have many interrelationships and hence are critical for the solution of “higher level” problems can be identified.

The team worked together to develop problem-causal trees (Fig 27 and 28) starting with a macro and general tree of the whole termite situation. This process proved extremely useful in developing research themes and highlighting research gaps and for developing hypothesis. The problem causal tree systematically outlined the complexity of the termite situation from a systems perspective and was utilised to develop areas for potential intervention. The causal trees proved invaluable for developing a multidisciplinary and systems approach to the study.

Screening options and prioritisation of proposals

The fieldwork identified the termite problem as being more complicated than originally thought of by local counterparts. The systems analysis demonstrated the diversity of complex interlinkages. From this analysis, it became apparent that a variety of integrated and systems oriented interventions were needed.

An overarching and priority objective of the screening and prioritising process was for recommendations that:

- “Are most likely to meet the study objectives and effectively target the termite situation”

In phase three the identification of interventions was undertaken in collaboration with all stakeholders, incorporating a review of past and present interventions and drawing upon the extensive multidisciplinary knowledge of team members. The problem-causal diagram in Fig 27
was analysed to identify potential areas for intervention, together with a comprehensive review of secondary data. The problems and priorities identified and ranked by farmers, research and extension staff during the fieldwork, were used to screen and prioritise recommendations in the first phase of development. This ensured recommendations fitted the objectives and priorities of all stakeholders.

In the third phase all recommendations were screened on the basis of the following three criteria:

- Environmental sustainability- long term versus short-term impact.
- Economic competitiveness- viability, ease of adoption
- Social equity- gender, farm typology, stakeholder participation and benefit distribution

This ensured that all unsuitable recommendations were eliminated. Due to resource constraints, it would be impractical for BRC or EARO to adopt all of the recommendations, also some of the proposals although relevant are outside of BRC’s remit, but are recommended for other agencies adoption. It was thus necessary to prioritise the recommendations to increase the efficiency of research and potential impact on the termite situation. Recommendations were prioritised using the following criteria and then developed into outline proposals.

- Resource availability- financial and human
- Likelihood of success- ease of adoption, appropriateness and system compatibility
- Timeframe- technology development, interventions and expected output
- National, regional and organisational priorities-policy and objectives

The proposal outline is presented in chapter 11.

*Final report and workshop*

The draft report was circulated at the final workshop to allow for comments from different stakeholders. A final workshop was held at Bako research centre. Its purpose was to present the main findings of the study to farmers, researchers and extensionists and other interested stakeholders and to seek their comments on improvements to the proposed interventions and research proposals. The workshop lasted for one full day, with the morning spent on presenting the findings and the afternoon in small discussion groups reviewing the recommendations. Comments were then presented in a plenary and useful suggestions incorporated into the report. The report was then finalised in Addis Ababa and published in the Netherlands with 50 copies being issued to relevant stakeholders in Ethiopia by the Ethiopian team members and distributed to other interested parties and organisations within Europe.

*Comments on methodology*

Seasonality posed a problem for transport with the team getting stuck in several difficult places in their search to get representative village sites away from the road. Seasonality was also a problem in verifying termite damage as most occurred in the months when the team was not in the field. Difficulty was experienced in quantifying the level of termite infestation and damage due to Seasonality and the difficulties in accurately counting termite populations and identifying subterranean galleries. This was made more difficult by the lack of quality data on baseline figures for numbers of termites in an area with and without reported termite damage. Difficulty was also experienced in accurately attributing the extent of environmental degradation caused by
termites. It was difficult to state with certainty whether the barren hill slopes and scarce vegetation were a result of termite damage, livestock overgrazing or surface soil crusting and low infiltration. Many respondents and research and extension staff simply viewed a degraded area and attributed it solely to termites and ignored the complex systems interrelationships of inappropriate cropping practices and livestock pressure etc. This made it very hard for qualitative studies to fully unravel the complexity of the termite situation and further quantitative studies are needed to verify some of the findings.

The team felt that the PRA methodology proved an invaluable tool for data collection and for promoting active participation of farmers, men and women alike. Some of the historical data collected was difficult to verify, with many farmers having different perceptions of time periods and a sometimes more optimistic and rosy picture of the past. PRA is often criticised for not providing concrete statistical data. However, this is often unfounded, as the field data confirmed knowledge held by the two Ethiopian team members and other key informants. From the teams own experience it appears that the information provided through the PRAs with farmers and key informants is much closer to the situation than that of the limited published data. The use of PRA enables farmers themselves, the ultimate beneficiaries of agricultural R and D to be involved in the whole research process and empowered by identifying their constraints and problems, and making suggestions for improvement. Ultimately the PRA process enabled the farmers a voice and a fair stake in the research process.
CHAPTER FOUR

STUDY AREA: ZONATION, FIELD TYPES AND HOUSEHOLD TYPOLOGY

Sampling framework

All too often research and development has recommended blanket technologies and interventions for target areas and groups. However, there is a growing awareness that within a zone numerous different factors contribute, to influence differences between agro-ecological and socio-economic factors within farming systems. In short different farming systems and household groups, need different types of interventions, technologies and information. To effectively target interventions there is a need for the classification of agro-ecological zones, farming systems, field types and household groups.

A sampling framework was developed to analyse and classify the diversity of different farm systems and households, investigate the influencing environmental and socio-economic factors and to be able make recommendations for specific domains and target groups (Table 1). The sampling framework enabled the characterisation and classification of the study area and target groups into representative and relatively homogenous zones, farming systems, field types and households.

Zonation and farming systems

The reconnaissance survey and key informant interviews, enabled the team to identify, three distinct zones and two distinct farming systems within the of the four designated districts of the study area. Criteria for classification were:

1. Agro-ecological factors
   - Slope
   - Altitude
   - Topography
   - Soils fertility, degree of soil erosion and depth and colour of top soil
   - Temperature and rainfall
   - Vegetation

2. Farming systems
   - History of settlement
   - Dominant crops and cropping practices

3. Termites
   - Level and type of damage and infestation
   - History of problem

4. Land holding and tenure

5. Human population
   - Migration

6. Access to infrastructure
   - Roads
   - Markets and off farm employment
Description of zones and farming systems

Zone I - Coffee based Bafano Koreche and Dandi Gudi
This zone is characterized by rolling topography and a higher forested area, particularly in sloping fields with coffee as an under-storey cash crop (Fig 5). It is a predominantly coffee growing area, this is due to the good water holding capacity of the clay to clay loam textured soils. Coffee is cultivated on all levels of the topographic sequence, except for the wetter and poorly drained valley bottom fields. The valley bottom fields are wider than in other zones and are utilized for growing off-season bone maize, using the residual moisture and high fertility resulting from alluvial deposits from up slopes during the rainy season. Roots, tubers and fruit (e.g. banana and mangoes) and maize are grown homestead fields. Areas of hillsides and plateaus have barely any vegetation and are under continued threat of serious land degradation. The ecological and sociological implications of termites have a root here, and are considered as the major problem by farmers and extension workers.

Zone II - Cereal based (Oda Ganka and Gute Michael)
Farming system within this zone is predominantly cereal based (Fig 6). Coffee is a minority crop and its cultivation is not widespread. The topography is gently undulating with less forested and vegetation cover than Zone I. Valley bottoms are very narrow and more utilized for livestock grazing and thatch grass production than bone maize. Oda Ganka has high land degradation problem and high termite activity, whilst Gute Michael has less of a termite problem, even though it has similar farming systems.

Zone III - (Abono Dilla)
The area is newly settled, with recently cleared forest land for cultivation. Almost all the inhabitants are immigrants from other areas, who have migrated either as a result of population pressure, termite incidence or land tenure problems. Land is abundant and termites are not a problem. This zone has similar physiographic features with Zone I. It is a crop-livestock mixed farming system with a very diverse crop mix. The production of root and tuber crops and bone maize is less common. The soil is relatively fertile and black due to a high organic matter content.

In terms of vegetation diversity and extent of cover, Zone I and III are better endowed than Zone II. The reason for more vegetation in Zone III is that it had previously been a forested and unsettled area. Whilst in Zone I preservation of trees is mainly for the shade needs of coffee plantations.

Field types
Different field types were identified within the farming systems. This was achieved by using the criteria below and by participatory transect development with farmers. Five different fields were identified and classified. The classification was verified by farmers within all zones, and was applicable for both the cereal and coffee based farming systems.
Figure 4. Hierachial steps for zonation, farming systems, field types and household typology

Hierachial steps for classification

Criteria for selection and classification

Classification

Agro-ecology and farming systems

Slope, topography, soils, climate, vegetation, FS practices and infrastructure

Zone 1-Rolling topography, steep slopes, coffee based FS, more vegetation and wider valley bottoms

Zone 2- Undulating topography gentle slopes, sparse vegetation, cereal based FS and narrow valley bottoms

Zone 3-Rolling topography more vegetation and diverse crop mixture and newly settled

Intensity of termite damage

Farmers problem ranking, field observation, key informants, representativeness, level of damage and infestation

Less affected- Gute-Michael Zone 2 and Abono-Dilla Zone 3

Most affected- Bafano-Koreche and Dandi-Gudi-Zone 1 Oda-Ganka-Zone 2

Field types

Topography, soil type & fertility crop/livestock practices and representativeness

Arable fields & fallows

Degraded steep slopes

Homestead

Hill sides & plateaus

Valley bottoms

Resource rich Oxen and land

Medium resource Land no oxen

Resource poor no oxen or land

Farm/ Household Typology

Participatory wealth ranking, land owners-land less, oxen owner, no oxen, Gender

Women headed households

FS=Farm Sytems
Criteria for identifying and classifying different field types are:

- Topography
- Soil fertility
- Farmers' management practices

1. **Homestead fields**

These fields are located around the house itself and are found on the higher plateau areas and flatter areas of the toposequence. Invariably, the homestead fields in all zones are well managed and have favourable soil physico-chemical properties. As the soils are relatively rich in organic matter and have plant cover for almost the entire year, they are less exposed to soil erosion. Termite damage is reported to be low. The size of the homestead field type is largely determined by the amount of manure a household can access.

2. **Coffee fields**

Coffee is mostly located on the lower steeper parts of the toposequence. Formerly these areas were under natural forest. The natural trees are still used to shade the coffee plantation, the general appearance of coffee fields still resembles small pieces of natural forest. Partly due to the high level of management associated with it and protection of the soil to direct effects of sunshine and rainfall, coffee fields are prone to land degradation and termite damage. All farmers within Zone I, have coffee trees (at least 500 trees/person).

3. **Cereal fields**

In cereal crop fields, low soil pH and inadequate nutrient inputs, make crop production very difficult. Such characteristics do not apply to similar soils in Zone III. These field types are often situated on steeper slopes and are prone to heavy erosion and subsequent land degradation. The less nutrient demanding crops like teff, finger millet and noug are planted here. Crop damage by termites is high in these field types.

**Degraded fields**

Most degraded lands lie on the steepest slopes of the toposequence. These fields have formerly been under cereal cropping. Intensive cultivation, shortened fallow and removal of crop residues has resulted in the loss of top soil and soil fertility. Soil surface crusting and gully erosion are common features. The soils in these fields are low in pH, CEC and essential plant nutrients (Table 2 and Fig. IX, X, XI and XII). Termite activity is reportedly higher in these fields. The fields are now only used for grazing, but biomass production is very low.

4. **Valley bottoms**

Valley bottoms are seasonally flooded from water run-off coming from surrounding hills and plateaus, and are not planted to traditionally grown crops in the wet season. During the dry
Figure 5. Transect diagram of Zone I coffee based farming system, Bafano Koreche, Manasibu district

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<tr>
<th>Landscapes</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Types</td>
<td>Gentle slopes</td>
<td>Moderate slopes</td>
<td>Moderate to steep slopes</td>
<td>Steep slopes</td>
<td>Flat land</td>
</tr>
<tr>
<td>Field Types</td>
<td>Homesteads scattered, Eucalyptus trees</td>
<td>Arable &amp; Pasture land</td>
<td>Degraded Field: crop, fallow or abandoned</td>
<td>Mixed natural vegetation with coffee trees</td>
<td>Valley bottoms</td>
</tr>
<tr>
<td>Farming Systems: Major crops</td>
<td>Home gardens e.g. maize, sorghum, yam &amp; plantation crops &amp; Livestock</td>
<td>Main season Cereal: finger millet less tef</td>
<td>Bare land: fallow/crops/ grasses/ grazing</td>
<td>Coffee under natural shade trees</td>
<td>Maize, Colocassia and lightly grazed</td>
</tr>
<tr>
<td>Problems</td>
<td>Termite, pests, Livestock and crop disease</td>
<td>Termite, teff rust, soil fertility, sheet erosion, Feed scarcity</td>
<td>Termite damage, Soil fertility, no top soils &amp; gully erosion, Feed scarcity, Over grazing</td>
<td>Coffee berry disease, Wild animal damage</td>
<td>Stalk borer, Wild animal damage, Drainage problems</td>
</tr>
</tbody>
</table>

ZONE 1: Coffee Based Farm System (Bafano korechi & Dandigudi, Manasibu District)
Figure 6. Transect diagramme of Zone II showing agro-ecological features and major agricultural constraints

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<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Landscape</strong></td>
<td>Gentle slopes</td>
<td>Gentle slopes</td>
<td>Moderate to steep slopes</td>
<td>Steep slopes</td>
</tr>
<tr>
<td><strong>Field Types</strong></td>
<td>Homesteads with scattered Eucalyptus trees</td>
<td>Arable &amp; Pasture land</td>
<td>Degraded Field:crop, fallow or abandoned</td>
<td>Mixed natural vegetation</td>
</tr>
<tr>
<td><strong>Soil Types</strong></td>
<td>Dark black soils, high organic matter</td>
<td>Shallow reddish-brown soils(xose)</td>
<td>Red eroded soils</td>
<td>Brown/black soils</td>
</tr>
<tr>
<td><strong>Farming Systems: major crops</strong></td>
<td>Home gardens, maize, sorghum less root crops, plantation crops &amp; livestock</td>
<td>Main season Cereal (tef, fingermillet) crops</td>
<td>Bare land:fallow/crops/grasses/ grazing</td>
<td>Forests trees</td>
</tr>
<tr>
<td><strong>Problems</strong></td>
<td>Insect Pests, Termite, Livestock &amp;crop disease,</td>
<td>Termite, soil fertility, Feed scarcity, sheet erosion, less top soils</td>
<td>Termite, Soil fertility, no top soils &amp; gully erosion, feed scarcity, Over grazing</td>
<td>Decreasing forest reserves</td>
</tr>
</tbody>
</table>

ZONE II: Cereal Based Farm System (Odaganka & Gutemichael, Jarso District)
season, however, they are used for coffee nurseries and growing bone maize, taro and thatch grass and livestock grazing. “Bone” is a local term used for valley bottom fields that cultivated to crops in the off-season using residual moisture. Termite attack on bone maize is minimal.

**Farm and household typology**

The team developed initial typological groups based on field data, these groups were then compared with those developed by farmers and found to be identical. Wealth ranking exercises were conducted within each zone with farmers and other key informants, care was taken to utilise the perspectives of different groups including, landless and resource rich groups All groups identified the following criteria for differentiating households into different typological groups.

1. Ownership of oxen for draught power
2. Number of cattle and other livestock
3. Farm size e.g. large and small and land availability
4. Ownership of different field types e.g. homesteads, valley bottoms, coffee field etc.
5. Household head e.g. male and female headed, young couples
6. Food sufficiency level for household

Table 1. Criteria used by farmers during wealth ranking for target grouping

<table>
<thead>
<tr>
<th>Farmers criteria</th>
<th>Resource rich Land &amp; ox-owner</th>
<th>Medium Land but No oxen</th>
<th>Resource poor no land or oxen</th>
<th>Women headed &amp; women headed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land holding</td>
<td>+ +</td>
<td>+</td>
<td>-</td>
<td>-/+</td>
</tr>
<tr>
<td>Oxen</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-/+</td>
</tr>
<tr>
<td>Cattle</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-/+</td>
</tr>
<tr>
<td>Food Sufficiency</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-/+</td>
</tr>
<tr>
<td>Cash</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Share cropping</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>Donkeys</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+/-</td>
</tr>
<tr>
<td>Large assets</td>
<td>+/-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Valley bottom</td>
<td>+</td>
<td>+/-</td>
<td>-</td>
<td>-/+</td>
</tr>
<tr>
<td>Coffee trees*</td>
<td>+</td>
<td>+/-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Life cycle of the households</td>
<td>Mature households</td>
<td>Young/ matured</td>
<td>Young households</td>
<td>Matured/ young</td>
</tr>
<tr>
<td>Gender</td>
<td>M+W</td>
<td>M+W</td>
<td>M+W</td>
<td>W</td>
</tr>
</tbody>
</table>

+ = Presence, - = Absence, +/- = Presence or Absence
M= Men, W= Women
++ = Presence of large size
*Coffee trees applicable only in Zone I
For future intervention purposes the team verified farmer's criteria in farmers' workshops, and decided upon the following major criteria for a typology for target grouping of farm households.

- Landowners and landless
- Oxen owners and no oxen
- Gender eg. women headed households

**Group I: Resource rich households (with land and oxen)**

These farm households have adequate farmlands, oxen and other animals, greater access to bone maize and adequate food availability for the family. In Zone I (Baffano), these farmers have more productive coffee lands at lower slopes (near valley bottoms) than other groups. Because of endowment of resources, they have more access to technological package and extension services than that of resource poor groups.

**Group II: Medium resource households (with land but no oxen)**

These households have small piece of lands not adequate for producing food for the family. Many of the young households also fall in this group as they do not inherit enough land from their parents. Since they lack oxen they are involved in share cropping by exchanging their labor with oxen owning households. Lack of timely access to oxen seriously affects crop planting times of these non-ox owning households and subsequently reducing agricultural productivity and vulnerability.

**Groups III: Resource poor households (with no land and oxen)**

Households with no land and oxen constitute significant proportion in the study areas. They normally survive through wage labour in farm and off-farm works within the village and in surrounding areas.

**Group IV: Women and women headed households (with and/or without land and oxen)**

Women constitute more than half of the population in the study areas. In most of the cases women appeared to be more vulnerable to productivity decline and termite effects as they have less access and control of household resources. The proportion of women headed households who are at the edge of survival are found high in zone I (Baffano Koreche).
CHAPTER FIVE

FARMING SYSTEMS AND NATURAL RESOURCE MANAGEMENT

Introduction

The farming system around Zone I is predominantly based on coffee whereas those of Zone II and III are cereals based mixed farming systems (Fig. 5 and 6). In all sites, livestock and common property resources (CPR) are important components of the system (Fig. 7).

Figure 7. Inter-relationships among different components of the farming system

Although it is difficult to give a figure, larger parts of coffee fields lie in well-drained foothills and steep slopes. Some farmers grow ginger under less dense coffee stand. Coffee plantations are situated around homesteads, foothills and well-drained valley bottoms. Coffee
trees in the valleys give higher berry yields owing to favorable moisture and soil fertility regimes. But yield losses due to coffee berry disease was reported to be higher in the valleys than hillsides or plateaus. Within the cereal based farming systems (Zones II and III), distinctions can be made in terms of cultivable area put to a given crop species and diversity of the crop mix. In Zone II, the crop species grown by farmers are very much limited. Here, finger millet is the major staple and occupy more than half of cultivable land. On the contrary, in Zone III there is high crop diversity and larger cultivable land is allocated to sorghum, maize, barley, and pulses than finger millet.

**Historical perspective.**

According to the elderly farmers, 70 years ago Zone I was covered with a luxuriant savanna woodland. The major tree and herbaceous species at that time were *Trifolium* species, *Hyperrhenia* spp., *Croton macrostachyus*, *Syzygium guineense*, *Guizotia scabra* and *Ekebergia capensis*. Land was quite abundant and farmers could afford long fallow periods some time lasting up to five years. Crop and livestock productivity were both high and were in excess of the requirements to sustain the human population occupying the area at that time. Valley bottoms were reserved for livestock grazing. Some of the indigenous tree species of the zone are, however, are still maintained to date and provide shade to coffee plantation, but are more patchy than previously. When the productivity on the hill slopes and plateaus declined and termite become a problem, farmers started encroaching on the valley bottom fields for crop production.

Productivity of teff was good and it was the staple food. Faba bean and peas were widely grown while sorghum and finger millet were grown in small plots and used mainly for local brew. However, teff has since become very susceptible to termites, rust and other insect pest damage. Today areas under finger millet but only a few farmers managed to obtain enough grain yield in a season to satisfy their household requirement for the year. This is a result of declining soil fertility. One elderly farmer from Zone II (Oda Ganka) summarized the changes that have taken place over the last 30 - 40 years as below:

"In olden days, our fathers used to tell us not to eat sorghum because they say it would fill our stomach with worms. In those days teff gave good yield and was the staple food. Peas and faba beans were widely grown. Cultivation of pea and faba bean has been abandoned as they are susceptible to termite and also damaged by aphids, leaf shriveling and pod boring insects. But now we have to depend on finger millet and sorghum because termite and diseases have affected our staple teff badly."

The cultivation of maize and sorghum is now confined to homestead fields whose pH and fertility levels are moderately high. Historical changes of cropping pattern of the termite-affected areas are presented in Fig. 8. These percentage figures were established from a farmers group interviews and show the percentage of cultivated land a modal farmer allocate to different crops today and before 30-40 years. The magnitude of increase is particularly high for finger millet, roots and tubers. Rangeland deterioration and land degradation that followed overgrazing and termite attack on rangeland litters and standing grasses have reduced range productivity and the available feed for animals. This is said to have resulted in a decline in livestock populations in the last three decades. Many farmers now only use portions of their land where they can afford to apply chemical fertilizers. High termite
Infestation has also limited use of cereal fields, some of which have been partially abandoned. The termite problem reported to have been increased and intensified over the years. In response to farmer's complaints, chemical control campaigns against termites started in the late 1960s using Aldrin. Further campaigns were undertaken in 1983 and 1988 (Abdurhaman, 1990).

Figure 8 Historical change in cropping pattern of termite affected area (percent cultivated land allocated to different crops)
Crop production

Cropping system

In all Zones, multiple cropping is practiced around the homestead fields. Multiple cropping is a land use system that maintains favorable microclimate and makes the best use of solar energy, moisture and plant nutrients at various depths of the soil profile. The crop mix in the multiple cropping system includes orange, lemon, chat (*Catha edulis*), mango, coffee, pepper, hops, pumpkin, yam, taro, anchote (*Coccinia abssynica*) Oromo potato, Irish potato, tobacco, pulses, banana sorghum and maize. Many farmers intercrop maize with pulses, cabbage and pumpkin. Due to diseases and low fruit yield, pumpkin production is declining. In cereal fields further away from the homestead monocropping is the common practice. In valley bottom fields monocropping of maize prevails.

Irrespective of the duration of the rainfall and/or available residual moisture, farmers in Zones I and II do not practice double cropping or rely on two or more crops in a season. The only exception is in Zone III. Privileged partly by the diverse cropping experience that these migrant farmers brought along with them, and the fairly high soil fertility in the virgin land, many migrant farmers practice double cropping. Crops that are cultivated twice a year include pulses (bushy types), faba bean and barley. These crops demand fertile soils and are grown around the homestead. The commonly followed cropping patterns are:

- Faba bean → Barley
- Barley → Pulses
- Pulses → Faba bean

Crop management

In this section the intention is not to exhaustively describe the diverse and complex management practices followed by farmers. It is only intended to outline those practices that have some implication to the household food security, soil erosion and termite management in the field types identified in this study.

Coffee field. In Zone I, coffee being the main cash source especially in Zone I receives comparatively high management attention. As a result termite mounds are spotted and destroyed as early as possible. Following queen removal, the underground nests of the colony is inundated by directing run-off. To date, no fertilizer is applied to coffee crop although some farmers undersow noug in young coffee plantations and underplough the noug crop at flowering stage to raise the fertility of the soil. Soil fertility in mature coffee tree fields is maintained by keeping cattle in wider kraals within the coffee plantations to deposit manure.

Cereal field. Land preparation is undertaken by oxen plough. The implement used for ploughing purpose is called *maresha* and it tears the soil than inverting it. The number of times the field is cultivated depends on the type of field and crop species. Newly opened land require more frequent cultivation than fields under crop the previous year. For small seeded cereals like finger millet and teff land preparation takes longer time and is repeated three or four times in order to obtain a good seed bed. As these excessive ploughings take place in the rainy season and extends for a month or so, teff and finger millet fields are predisposed to
loss of organic matter and other soil components by erosion. The extent of overgrazing, termite activities and land degradation is also more prevalent in cereal fields.

Homestead fields. Among annual crops, maize, sorghum, roots and tubers being close to homestead (Zones I and II) are commonly better managed. The highest family labour around homestead is spent on management of weeds. Weeds are more serious on manured plots. They are entirely controlled manually using family labour. Weeds are particularly important crop production constraints in more fertile soils of Zone III. Here, the most abundant and dominant weed species include *Snowdenia polytachia* and *Guizotia scabra*. Weeding is considered a woman’s job whilst harvesting and stacking is done jointly by both men and women.

Figure 9. Cropping calendar of major annual crops grown in Zones I, II and/or III

<table>
<thead>
<tr>
<th>Crops</th>
<th>A</th>
<th>M</th>
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<tbody>
<tr>
<td>Maize</td>
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<td>Sorghum</td>
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<td>Faba bean</td>
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<td>Yam</td>
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<td>Anchote</td>
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Legend

- Seed bed preparation & sowing
- Weeding
- Harvesting

There is an overlap of farm activities at planting and harvest (Fig.9). Labour demand particularly is at its peak in the middle of the dry season. To minimize termite attack on matured crops, harvesting, stacking and processing of most of main season crops are completed within a short time span during this period.

Because of their tolerance to termite attack and potential to bridge food deficit period, over years farmers have managed to grow and harvest root and tuber crops more flexibly throughout the year. The production of root and tuber crops, however, is confined to homestead fields. As long as there is no rain, for instance, the harvest of anchote that planted in May can be extended from September to March. Rain after maturity, however, makes it difficult to cook. Around the homestead, taro is planted in December/January on two or more rows along
with wider alternative strips of yam and matures after one year. In the valley bottom fields, it is planted during the same period but reach maturity after two year. Yam is grown in fenced plots that has been kept under livestock kraal. The extent of yam production is determined by the availability of oxen, manure and labour. Sweet potato intended for June harvest is planted in December/January. In seasons with excessive rainfall and low sunshine hours, root yield of this crop is less. Normally, sweet potato harvest from the first crop is low. The main season sweet potato crop is planted in June and harvested in January the following year. Root yield harvest from the second crop is often high. Sweet potato thrives well on less fertile soils but on soils with high organic matter it largely grow vegetatively.

**Crop Rotation.**

The rotation sequences followed for the different crops are similar for all study sites but only differ between field types. The rotation sequence particularly in homestead fields is tied to the rotation of livestock kraals as a major source of fertility replenishment. The most modal rotation sequences are indicated below.

1. **Homesteads:** Livestock kraal —► Yam/maize —► Sorghum —► Livestock kraal or Livestock kraal —► Maize —► Sorghum —► Faba bean/pulses —► Sorghum

2. **Cereal field:** Fallow —► Teff —► Finger millet —► Noug —► Finger millet

3. **Valley lands:** Maize continuous

Fallow period ranges between two to five years, the longest being for Zone III. In the cereal crop fields, leguminous crop such as peas, faba beans and pulses are included in the traditional crop rotation sequence of all study sites as a means of maintaining soil fertility.

**Criteria to determine crop rotation sequence.**

The criteria used by farmers in all zones to decide which crops to come first or last in the rotation and the order of rotation are more or less similar and cut across the three zones of the study area. Major ones are listed below.

- **Nutrient demand of the crop.** Maize and yam come first, followed by less nutrient demanding crops like sorghum, teff, finger millet and noug. This is also related to whether or not the crop can be grown with or without a fertilizer.

- **Lodging tolerance.** Teff and finger millet lodge if put first in the rotation sequence. They require fields with relatively less organic matter. Therefore, teff and finger millet appear farther in the sequence if they are to be planted in soils of high organic matter.

- **Tolerance to weed.** On fertile soil the weed management for teff and finger millet is difficult. Therefore, farmers assign fertile soils to relatively more weed competitive crops like maize, roots and tubers.

**Criteria for which crops to grow in a season.**

Like the rotation sequence, the type of crop to grow in a given season by its own right is weighted against multiple needs of the household. Subject to resource endowment, farmers
consider some or all of the following issues to arrive at the type of crop grown in a given season.

- Tolerance to major insect pest and diseases. In Zones I and II, for instance, tolerance to termite attack and ability to grow under low fertility conditions, are major factors governing the choice of crops to be grown.

- Labour availability. Less labour intensive crops are grown by smallholders where there is no adequate household labour.

- Household food need and crop productivity. Although maize and teff are preferred to sorghum and finger millet in terms of quality for household consumption, households with bigger family sizes will grow the more reliable and better yielding sorghum and finger millet crops under low input situation.

- Complementarity to main staple. Root crop e.g. sweet potatoes are grown to postpone the consumption of cereals for later parts of the year (consumed in the early part of the dry season). Root crops are also grown as security against crop failures.

- Strategic off-season production. The possibility of production of crops like bone maize, taro, sweet potato and yam that grow and mature during the off-season periods provide a good remedy for food deficit (May and June).

- Other household needs e.g. teff straw for plastering mud walls and dry season livestock feeding.

- Marketable produce. Tobacco, teff, faba bean and ginger are specifically grown for sale. This is more common in Zones II and III where there is no single crop grown exclusively for cash income. Whether or not they grown, however, depend on the availability of adequate land to the household and other resource endowment factors.

- Suitability for sauce. Cabbage and pulses are grown for this purpose.

- Fertility restoring ability of the crop. To restore soil fertility farmers grow noug and other leguminous crops on worn out lands.

**Constraints to crop production**

- Insect pests and diseases. Termites are considered as serious threats to crop production in Zone I and part of Zone II (Oda Ganka) but is also gradually becoming an important pest in the rest of study areas. It causes damage on most annual crops, pastures, young seedlings of many plantation crops and tree species and wooden structures (fences, trellises and houses). Rust on teff, coffee berry disease on coffee, rotting on Oromo potato and finger millet, blight on Irish potato and maize, smut on sorghum are the common crop diseases of the area. The major insect pests of crops other than termite are stalk borers on maize, shoot fly on teff, aphids and beetles on yam and beans. Maize is grown twice in a year; under rainfed condition between April to October and on residual moisture in valleys from January to June. This pattern of cropping provides a continuous breeding
ground and favorable environment for the build up of maize stalkborer.

- Decline in soil fertility and high fertilizer prices are the most important constraints to increased crop yield and crops vulnerability to termite attack. Because of the steepness of the hillsides, the rate and extent of soil erosion and land degradation are particularly high in Zone I.
- Lack of oxen is an important constraint to majority of farmers across all the study areas. Oxen are used for land preparation and weeding of maize and sorghum and their absence drastically affect crop production.
- Wild animals are serious threat to cereals plantation and root crops, poultry and small ruminants.

**Livestock production**

**Livestock types**

Livestock comprise a major and integral component of the farming system in the study area. The major livestock types are cattle, donkeys, mules, goats, sheep and poultry. Livestock holding ranges from 70% of the peasant association in Zone II (highly infested-Oda-Ganka), 45% in Zone II less infested (GuteMichael), to 40% in Zone III (Abono Dilla) and 30% in Zone I (Bafano Koreche). Livestock numbers per household as well as in the peasant association as a whole are said to have declined in all zones over the past decade mainly as a result of diseases and feed shortage.

**Cattle**

Cattle are kept mainly for draught power, for meat and domestic milk production. They are also a source of economic security, cash income and manure and have important socio-cultural value. The average age of heifers at first mating is four years and first calving is frequently after more than five years. The calving intervals are long (up to three years); therefore the reproductive life of the cow is short. This also affects the availability of replacement stock for oxen, which is done on average, every four to five years. Most farmers are therefore compelled to buy replacements from the markets usually without much choice for good quality characteristics for draught purposes. The oxen are generally small weighing between 180–230 kg. The Horro, the predominant cattle breed in the area is genetically a poor milker. The current levels of milk production consequently falls far short of the demand in the area. Whole milk is never drunk except by babies and occasionally disabled people. It is reserved for production of butter, which is usually sold, or for making cheese for domestic consumption.

**Donkeys and mules**

Donkeys are the main means of farm transport especially for off-farm transport of farm produce to the markets and processing centers. They are also used for transportation of produce within farm especially at the peak of harvest when crops have to be quickly removed from fields to avoid termite damage. For the land-less who operate as wage laborers on other people's farms, donkeys provide a source of employment for petty businesses in produce trading. Crops are bought cheaply from distant places at the peak of harvest and hoarded till the hungry period when they fetch a better price. The initial capital and the donkeys
sometimes belong to the wealthier farmers of the community. The laborers then get paid a small proportion of the proceeds. Donkeys are used almost exclusively as pack animals. Animal powered transport equipment such as carts which would greatly increase carrying capacity are very occasionally seen. About 25% to 30% of households are reported to own at least one donkey. Mules are used more for human transportation to and from the markets and small townships as well as to the health centers and clinics.

Small ruminants (goats and sheep)

Sheep and goats are found in almost every household. The numbers range from two to five although poorer households may have none or as few as one, while some households have as many as 10 and beyond. They are mainly used as a food source during major events in the year such as Easter. Sheep meat (mutton) is particularly a favorite dish in Ethiopia during festive seasons. In times of difficulty, they are sold to meet various household needs. They are also considered a security for immediate financial aid to fall back to in times of need such as payment of credit for fertilizer in bad crop years.

Poultry

Poultry are mainly kept to satisfy the immediate small cash needs of the family in addition to being a source of meat. Backyard system of husbandry is the common practice and no exotic commercial production of any sort is practiced in the area. Poultry products like eggs are scarcely available.

Except for calves, poultry, small ruminants and equines that are housed in some cases, animals are kept kraaled at night.

Draught power from oxen

Animal draught power is the major source of farm power being almost exclusively depended on for ploughing/land preparation, secondary tillage and weeding of maize and sorghum. No single household reportedly carries out the entire farming activities during a particular season without the use of draught power. Hand hoeing is only done around homesteads for small plots, and usually at the time of weeding. Shortage of oxen however was noted as a major constraint in the different zones. In Oda Ganka for instance, only 40% of farmers in the peasant association were said to own oxen, 20% in Abono Dilla, 20% in Bafano Koreche, and about 30% in Gute Michael. Of these, some have two or more oxen while others have only one.

Different strategies are used to manage land preparation. Of the farmers without oxen, some use those of other farmers in exchange for labor, while others hire oxen at an average price of 110 Birr per ox per crop season. Where it is not possible to make cash payment at the beginning of the season, the farmer is expected to pay two quintals of maize or sorghum per ox after the harvest. One-ox owners frequently pair up and use their oxen together on each other’s fields. Some farmers reported borrowing oxen from relatives, neighbors or other wealthier members of the peasant associations. Other non oxen owners use a share cropping arrangement whereby the ox owner and non-ox owner with land provide either one or other of land, oxen, inputs labor and the resulting produce is equally shared between the two families. Poorer members of the community, especially the elderly, women headed households and the disabled are assisted by other members of the community, but only after
the oxen owners themselves have finished their land preparation and planting. The presence or absence of oxen in a farm household therefore greatly influences the timeliness of farm activity, subsequent yields and vulnerability of a household to food insecurity.

**Grazing lands and their management**

The different livestock species are grazed together under an open grazing system around the homesteads, in the crop stables, fallow lands, lowlands, valley bottoms, riverbanks and wooded areas (Zone III-Abono Dilla). A feeding calendar showing feeding resource profile is presented in a given in Fig 10. Frequently grazing is communal especially in the common property resources, which are common in the villages (ganda), while herding is either communal or individual. Almost all peasant associations have a common property resource (CPR), managed by an appointed committee but accessible to all members of the association. Availability of adequate grazing is seasonal following the rainfall pattern. Year round grazing is done around the homesteads, fallow lands and harvested cereal fields. Dry season grazing is concentrated around valley bottoms and riverbanks. At the peak of the dry season livestock in some ganda are transferred to communal grazing grounds in Dabus valley, a river basin in Mendi district and only driven back after the onset of the rains. Sometimes the menfolk migrate with the livestock during the periods of feed scarcity especially during the long dry season extending from December to April/May. However the high prevalence of contagious diseases and endoparasites picked by animals from the communal grazing grounds is beginning to discourage farmers from taking their animals to Dabus.

Until recently large populations of livestock were reportedly concentrated in one peasant association resulting in overgrazing and only moved to another after the resources in the previous one was seriously degraded. The natural ability of the area to regenerate would be severely impaired and this is believed to have contributed to the exacerbation of the termite problem.

**Supplementary feeding and seasonal livestock migration**

Dry season feed shortage affects most of the farmers between January/February to May. Because of the shortage of grazing land and pressure on croplands, farmers are forced to seasonally migrate with their livestock to lowlands and other less populated areas where ample forage is still available. Only draught oxen and the milking cows totaling five to ten heads of cattle are left and tended around the homesteads. Supplements consisting of crop residues from teff and finger millet, fodder tree leaves and mineral licks are fed. Occasionally brewery by products and finger millet "injera", the traditional pancake, are also fed to oxen. No organized stall-feeding is, however done. Overall, the use of crop residues for homestead feeding of all livestock types is minimal. Crop residues are fed in two forms during the year: during the early post-harvest periods, livestock are grazed freely in crop fields of maize, sorghum, finger millet etc (Zone II, Oda Ganka). At the peak of the dry season livestock especially oxen are fed on straw (teff mainly) specially preserved on raised wooden platforms close to the homesteads. Stacking on the raised platform protects the straw from termite damage and spoilage in case of rains. Sometimes a fence is constructed around to protect it from other straying animals, this being the only reliable source of feed around the homestead during this period. It is also the only form of conserved feed in the area. During this period teff straw is also exchanged amongst farmers at a small fee of 8-10 birr per sack.
Figure 10. Livestock feed calendar

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Livestock-termite relationship

Where livestock numbers are high as observed and reported by farmers and from bureau of agriculture statistics, the incidence of termite damage is evidently higher. Manasibu district, which has the highest livestock population (Appendix XVII), is the worst hit by the termite. Wood (1986a, 1986b) reported that on a rangeland with an estimated grass production of 2000 kg/ha stocking rates were 4.7 TLU/ha compared with recommended rates of 1 TLU/ha. Farmers reported that continuous grazing of an area for more than three to four days results in an increase in the presence of termite and consequently damage on pastures. Livestock are resident during the wet season and graze green grass down to ground level. The high
population of donkeys and mules, which are naturally low grazers, aggravates this. On overgrazed land in the study area, especially during the dry season, termites remove the remaining dry grass and grass litter leaving the soil bare and giving the false impression that they are the primary cause of denudation. This situation is not experienced in less grazed areas like the valley bottoms fields. Farmers and government officials are however reluctant to accept the significant role of overgrazing in the termite problem. *

Quote from an elderly farmer in Bafano Koreche (Zone I)

“The problem on our land is not livestock, but termites. If termites did not eat up all the grass this land could support even twice the current number of livestock. Livestock is our source of livelihood. Before termites became a problem this land supported us adequately, we had enough food to eat and our livestock had enough grass to feed on. Now we don’t have enough food and our livestock are starving as well”

Animal health

The major causes of animal deaths and reduction in numbers are diseases, lack of feed and wild animals (Zones II and III, Oda Ganka and Abono Dilla). Domestic animals are plagued with both endemic and epidemic diseases, which are common to all zones of the study area. The major diseases reported are: contagious bovine pleuropneumonia, trypanosomiasis, anthrax, helminthoses, mange, fascioliasis, blackleg, east coast fever, heartwater and Newcastle disease in poultry. Disease incidence follows a regular seasonal pattern with the greatest being experienced following the onset of the rains. Control of major epidemic animal diseases has until lately been undertaken regularly by government through mass vaccinations, however this is reported to have become irregular or non-existent over the past 2-3 years. The yearly migration of livestock to Dabus in search of feed also has serious implications on the control of epidemic disease. Many farmers reported cattle breaking down with contagious diseases upon return from the grazing lands in Dabus. Infestation with fascioliasis is also a common complaint. Tick borne diseases are not a major problem although tick populations are very high on cattle. Other ectoparasites such as lice and leeches are also common. Animals are in general poor bodily condition most of the dry season to the middle of the rainy season.

The infrastructure of the veterinary service is not well developed and is poorly supported logistically. Veterinary drugs and other inputs are difficult to obtain (Zones II and I-Oda Ganka and Bafano Koreche). Sick animals have to walk long distances to the service centres and consequently herbal treatment and use of other indigenous animal health management techniques are common practices. The common extension package currently being promoted to boost productivity has no provisions for both animal health and production.

Constraints to livestock production

The major constraints to livestock production in the area fall under the following categories:
1) Diseases
2) Shortage of grazing lands/high livestock populations
3) Dry season feed shortage
4) Lack of alternative feed sources
5) Lack of improved livestock breeds/ low genetic potential of local breeds
6) Culturally biased husbandry practices
7) Absence of alternative livestock management techniques
8) High cost of drugs and other veterinary inputs.
9) Poor veterinary service and difficulty in accessing animal health facilities.
10) Wild animal predators

Natural resources and their management

West Wollega region is highly productive area with predominantly rich fertile soils, scattered natural forests and high rainfall. It is classified by the FAO and NRI as productive highland and is one of Ethiopia’s currently underdeveloped areas with a high agricultural productivity potential (FAO, 1995: NRI, 1995).

Forest resources

Despite over-exploitation by people and livestock, remnants of shrubs, small and big trees of tropical Savannah forest are still found in the valley bottom and coffee fields of all the study zones. A comprehensive list of forest tree species identified by farmers is given in Appendix XIII.

The most commonly found and valuable tree species in all zones was Eucalyptus. Although farmers complain it’s susceptible to termite attack and recognize the negative effect of this tree on crops grown under it, they continue growing Eucalyptus because of its construction suitability and fast growth. Indigenous trees are also used for timber, firewood, coffee shade and as a trellises for climbing beans and yam. Farmers who have no access to animal manure, collect tree leaves, burn and distribute ash on their home gardens. A wide range of wild fruit trees and shrub species are available for human consumption. Among the indigenous tree species, Albizia schimperiana, Acacia species and Syzygium guineense are the most preferred for coffee shade. The Syzygium guineense population is declining as it is highly suitable for construction. Trees and shrubs provide valuable survival dry season feed to livestock. Trees and shrubs are also used as livestock feed includes Albizia schimperiana, Acacia species, Syzygium species, Vernonia amygdalina, Sapium ellipticum, Carissa edulis, Combretum molle, Acanthus arboreus, Ficus avata,F.vasta, Faurea rochetina and Comberetum shasalense.

Forest nurseries of soil and water conservation units in district agricultural offices raise and distribute tree seedlings to farmers and other organisations. The decision to what type of tree species to raise on nurseries is entirely upto the soil and water personnel placed at zonal or regional higher level. There is no system in place to involve farmers in the identification of tree species of their particular interest and follow-up the fate of distributed tree seedlings.
"In my lifetime the environment has changed, I can remember the differences from my childhood, now the trees are gone, the birds are less and the soil is exhausted"

(Male farmer at Oda Ganka, Zone II)

Historical factors have had a major impact on natural resource management practices and have implications for the sustainable management of common property resources and soil and water conservation interventions. Under the Derg government regime 1974 -1993, there were massive changes in land tenure with land being nationalised from wealthy landlords and redistributed to farmers. The rural social environment underwent major change as people were forced into collectivisation schemes and village groups, farmers were forced into new forms of social structures and new rights to changing resource access developed. Many farmers resented moving from their traditionally managed homestead areas, to new sites and then having to establish new livelihood strategies and farming systems. Many farmers and respondents reported massive deforestation during that period, as old systems of resource ownership fell apart and a free for all ensued as people gained new rights to land and resources. Previously farmers were forced to undertake soil and water conservation practices, often many kilometres from their own areas, without any payment for their labour or time and were punished if they did not co-operate. These historical actions have left many farmers wary of current government initiatives and possible future land policies.

The present government’s current policy of owning all land, means farmers lease land, pay taxes and have no direct security of tenure, or ability to sell or buy land. This situation is a major disincentive to sustainable land management and promotes minimal investment in practices to increase land quality. Farmers said they felt no direct ownership over the land and fear that the land might again be repossessed by the state. The present policy of land ownership means that for common property resources such as grazing land and forest areas, there is a distinct lack of clear regulations and enforcement over access and usage rights. In areas where community organisations reportedly manage CPRs, the power of the groups to enforce inadequate laws and undertake punishment is limited. The pressure of poverty forces many rural households into unsustainable utilisation of their limited natural resources.

Increased population pressure, reduction in land availability and a decline in average farm size has resulted in increased pressure on natural resources and a decrease in the fallow period, with a subsequent degradation of the ecological environment. The above factors, together with a historical predominance for shifting cultivation and previous abundance of available land, has given limited incentives to promote sustainable land management practices.

The failure in the sustainable management of the natural resource base has important implications for: fuelwood availability; use of dung for fertiliser; soil fertility; soil organic matter content; soil structure/ infiltration and soil erosion. The degree of environmental degradation resulting from natural process compared to how much is a result of human interference would take further comprehensive studies to quantify. However, environmental degradation has certainly been accelerated by the pressures of a growing human and livestock population, inappropriate agricultural practices and lack of institutional support for context appropriate sustainable natural resource management practices and policies.
Common property resource management

A variety of CPRs and management institutions were found throughout the study sites. All zones had different institutions, resources and access rights. There was confusion as to the rights of ownership and access over the resources in many areas.

Forest management

Farmers in all zones utilise timber and fuel wood from state forests and have free grazing access regimes on their own farm land and state owned forest and pasture land. The management and availability of common property resources (CPRs) varied between Zones. The systems of management and rights of access and usage were hard to define, with different respondents often giving different answers. There seems to be much confusion over ownership and systems of management.

As compared to zone III (Abono Dilla), zone I and II have less vegetation coverage because available biomass is utilised for livestock feed and household fuel demand. These factors together with a decline in other forms of available plant biomass for termite food, must be a contributing factor to the increase in termite attacks on crop plants. As the grasses in the rangeland have almost lost because of livestock overgrazing and grass feeding termites, the pressure on trees for foliage as alternative fodder source is growing. Again this reduces the availability of feed sources for termites.

Both individual and community managed forests are prevalent in the study areas. Individual managed forests are located near homestead fields and dominated by Eucalyptus tree. Community managed ones are natural forests and found in lower slopes and hillsides. Selected committees of local peasant associations (PAs) viz; social development committee or forest committee have been formed to look after and manage forests. The PA in each of the zones has formulated special rules and regulations and delegated power to the committee accordingly, to monitor and manage forests. Those who violate the rules and regulations are punished, either by imprisonment or fines. However, the difficulties of managing such a complex and open access resource means, that in reality the committee has limited resources and authority, and is not able to oversee the sustainable management of the forests.

Grazing land

Unlike forests, grazing lands are accessed freely and not managed by committees. In Zone I and II there are no specifically delineated communal grazing areas except individually owned fallow or abandoned cropping lands. However, in Zone III (Abono Dilla an area with more available forest land), separate grazing lands are found where livestock from other areas access local grazing land. As Zone III has good pastures and water sources, livestock from distant places are brought during the dry season (Dec-May). The resource rich environment (pastures and water resources) and higher availability of common property resources in zone III makes it easier for the social linkage and formation of pooled livestock grazing groups. Farmers were not interested in managing open grazing land, as they feel that the land does not belong to them. Farmers reported that the government should be responsible for managing such common lands. However, farmers recognised the steady degradation of such lands by open access use and the possibilities of further degradation for the future, if there is no collective responsibility for CPR management.
The institutional systems of the CPRs in the study zones are complex and diverse varying by resource and zone. A full analysis of their functioning and ability to sustainably manage CPR resources would need comprehensive studies. It was thus decided not to adopt CPR management as a major analysis, as enough information was not collected to make an analysis and draw relevant conclusions.

Soil characteristics and fertility management

Data showing physical and chemical characteristics of sampled soils from different zones and field types is given in Table 2 and Appendix IX, X, XI and XII.

The predominant soil type of all zones is Dystric Nitosols. As these soils are deep and high in weatherable minerals, they have high potential for agricultural uses. The soil reaction is grossly acidic in Zone I and II and specifically low in cereal fields and degraded sites. Conversely, the soil pH (as determined in water) in Zone III ranges from slightly acidic to neutral. In soils with pH of less than 5.6, aluminum poses toxicity, interferes with absorption of calcium, magnesium and the availability of molybdenum and phosphorous (Tsedale et al., 1990). In relative terms, available phosphorous contents of the soils are least in Zone I, highest in Zone III and intermediate in Zone II. Homestead and valley bottom fields generally had relatively higher CEC (cation exchange capacity), exchangeable cations and available phosphorous and low crop damage by termite than cereal crop fields. This was confirmed during field observation and farmers interview.

Table 2. Chemical properties of soils in different zones and field types of the study areas

<table>
<thead>
<tr>
<th>Items</th>
<th>Zone I (Koreche)</th>
<th>Zone II (Oda Ganka)</th>
<th>Zone II (Abono Dilla)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HS</td>
<td>CCF</td>
<td>DL</td>
</tr>
<tr>
<td>pH</td>
<td>5.68</td>
<td>5.61</td>
<td>5.39</td>
</tr>
<tr>
<td>CEC</td>
<td>39.0</td>
<td>15.5</td>
<td>16.20</td>
</tr>
<tr>
<td>Available P</td>
<td>5.26</td>
<td>0.32</td>
<td>3.08</td>
</tr>
</tbody>
</table>

1 HS = homestead, CCF = cereal crop fields, DL = degraded land

Manuring is critical for soil fertility management and livestock contribute greatly to the maintenance of soil fertility. Cattle kraals are located within the homestead fields and are rotated systematically every three to four days to spread the manure in the fields. Rotations are more frequent (every three days) during the wet season because of more manure output put and to avoid the build up of smack, while four to five days elapse before rotations during the dry season to allow sufficient manure to build up. Dry manure is also frequently collected from the kraals and donkey/mule stables and spread out into other fields farther away from the homesteads before the rains. Manuring is mainly done for homestead crops like maize, sorghum, pepper, pulses and yam (kocho). The decision as to which fields should be manured next is determined by the crops to be grown the following season. The kraal size ranges from about 16 m² to about 80 m² for a herd size of 4 to 20. Farmers who do not own livestock either migrate to farm in other areas leaving their exhausted land to fallow for one to three years, or take animals in trust from relatives or neighbours and use them for manuring their fields for two to three months. Animals are borrowed for manure use alone while the right to all other uses is reserved for the owner. Termites mobilize a substantial
amount of manure, but manured plots still support better crop growth and gives higher grain yield than fields not receiving similar treatment. No crop residue is put in the kraal because of the fear it attracts termites that feed on manure and reduce the amount of manure incorporation into the soil. In the rainy season part of the manure is washed away by run-off and kraals are rotated more frequently to reduce this.

Loss of soil fertility, and soil erosion is a major threat to the sustainability of Ethiopia’s resource base (NRI, 1995). Serious soil erosion with sheet erosion, severe gullying and loss of topsoil was clearly visible in all zones, but less apparent in the highly fertile and newly settled Zone III. Within the topographic sequence and farm system, soil erosion was found to be severe on cereal fields and abandoned fields farthest from the homestead fields. In some areas gullying could clearly be seen on farmers fields where plough furrows made to direct runoff transforming into big gullies.

"The soil is exhausted, there is no grass for cattle, if no grass then no cattle, no cattle then no dung, then the soil will die"
(Elderly farmer from Buffano Koreche, Zone I)

In Zones I and II, nutrients have been drained from the soil by intensive monocropping, biomass removal and soil erosion above and beyond replaceable levels by the current low rates of manure or fertilizer application. A farmer from Zone II (Oda Ganka) has described the crop yield changes occurring over the years as follow:

"Crop fields that have been under the kraal in the remote past, used to give a good harvest for three years continuously; ten years back manured fields sustained cropping for two consecutive years; and today the restored fertility last only for one season".

Farmers attribute this decline to the mobilization of manure by termites and steady decline of soil fertility. Unless constrained by lack of cash, farmers in Zone I and II apply DAP fertilizer at the rate of 40-80 kg/ha to teff and finger millet (cereal crop fields). In Zone III, the soil is relatively fertile and cropping is done without chemical fertilizer. The only time farmers use fertilizer is for improved maize varieties that are normally supplied as a full package, as access is restricted and the cost is high.

Soil erosion and soil and water conservation

Farmers perspectives

"We don’t have any promises from our land because it is eroded, how will our soil be improved? This is what we want from our government- we want our fertility back!!" (Farmer at Oda Ganka, Zone II)
Local indigenous soil and water conservation practices called "yaa" were noted within all study areas. The location and frequency of practices depended upon the field type, the topography and cropping pattern. Farmers plough diagonally across the contour to make a ridge and furrow with the soil tipped down the slope, the runoff rainwater then enlarges the furrow. This practice is to speed the water runoff from the fields and not to increase infiltration. At the times of heavy rains the clay soils become fully saturated. When ploughing the "yaa" furrow, farmers go deeper than normal and do it two times, during July and August, before and during the heavy rain period. The "yaa" ploughing is undertaken immediately after sowing and only for teff and finger millet crop fields distant from the homestead. Farmers said they plough diagonally across the contour otherwise the soil and seeds would be totally washed away. This ploughing method in conjunction with the "yaa" method aims to help water run off and maintain soil, whilst helping to stabilise the very small teff and finger millet seeds. If farmers have no oxen they are forced to borrow oxen to undertake the "yaa" ploughing. Farmers reported undertaking minor soil and water conservation practices around homesteads, digging channels and directing runoff and planting trees and shrubs around their home.

Factors influencing soil erosion and soil and water conservation

Although farmers don't directly own their land and have no security to invest or sell land, they still reported that the land was theirs as it was their fathers before. However, under further questioning farmers said they were reluctant to invest in land when it brought them no immediate short term benefit and that they feared possible future land reallocation by the state.

"Security of ownership of land for our families might make us initiate to maintain soil fertility" (Elderly farmer at Baffano Koreche, Zone I)

Farmers reported a land shortage in all areas and stated that this and an increase in the human population had lead to an overuse of the land. There had been reportedly no new land distribution since 1976.

Farmers identified many problems for implementing successful soil and water conservation practices (Fig 11). They added that due to the free grazing nature of livestock management they were unable to fence areas off, and if a neighbour didn't keep his animals away, then they could not plant and maintain their vegetation strips to stabilise the soil and reduce soil runoff. Farmers also stated that it was of no use if only one person undertook soil and water conservation, as ownership of the fields was scattered, and a combined effort through a strong community institution was needed for any interventions to succeed. For sharecropped land, this could be difficult to conserve as leases were often for only one year and sharecroppers don't want to contribute additional labour and time.

Farmers were worried about the width of the terraces and said that the present ones occupy to much space and reduce their cropping area. It was also stated that the vegetative strips might be a home for plant pests and monkeys to hide in, which might then damage their crops. Discussions stated that any vegetative plant species to stabilise the bunds would have to have, a utility value, for instance feed for livestock, tolerance to termite, less shading effect on the crops, take little space or reduce erosion and improve soil fertility. Through discussion farmers identified a number of promising plant species that they said had not been tried for
soil and water conservation vegetative strips, including: *Henna*, sisal, *Hypprrenia* spp. and *Chomo* grass, *gosu*, *S.guineense*, *Cordia africana* and gar trees.

“We want to improve our soils and conserve our land, but it is beyond our capacity and knowledge to do it, we need support and new technologies”
(Elderly male farmer Guta Michael, Zone II)

Farmers said they had tried the extension departments method of digging ridges, but it took a lot of work, erosion soon filled in the trench and they didn’t like it as it didn’t work. However, when farmers were questioned they said the “yaa” technique was the only practical soil and water conservation technique they knew off and it had been handed down to them by their fathers.

Although farmers recognised that soils have poor structure and fertility and were degraded, they still remained wary of new soil and water conservation campaigns. However, all farmers reported a strong interest in undertaking new soil and water conservation and practices and recognised the value. They said they would welcome new technology if it worked and there was no forced participation.
Figure 11. Stakeholders perspectives on soil erosion and conservation

Research and extension perspectives

- Major threat to productivity
- Lack resources and policy mandate
- Overgrazing, deforestation and unsustainable FS practices
- Farmers ignorant
- High human and livestock pressure
- Causes of soil degradation

Soil erosion & soil & water conservation

Farmers perspectives

- All farmers aware of soil erosion as a problem
- Needs community management and institutions
- Technology doesn’t fit
- Already use indigenous practices
- Insecurity of land tenure
- Shortage of land
- Fragmented and scattered land holding
- Poverty
- Termites
- Increase in human and livestock population
- Past and future historical events
- Collectivization and forced soil and water conservation

Causes of soil degradation
Extension workers perspectives

Currently soil and water conservation is implemented by regulatory section within the district agricultural development offices. The extension department is currently carrying out demonstration trials on soil and water conservation technology within the study area. It was not possible to get data on how many trials, number of participants, land area conserved or criteria for site selection. The current technology practices consist of digging trenches along the contour roughly a half a metre deep and wide, and sometimes planting vegetative strips parallel to the trenches. A specific farmers field is utilised and farmers are encouraged to join in, although given no financial or other incentive except the prospect of project success. Farmers are reportedly mobilised through local DAs and PAs however a typology of participating farmers or field types for intervention has not been developed. The selection of participating farmers seems to be relatively random and it does not depend on specific established criteria such as degree of soil erosion or farm typology.

There is nothing within the extension package programme to address the issue of soil and water conservation. Some technologies, specifically the cereal packages seem to exacerbate soil loss and land degradation, by increasing dependence on inorganic fertilisers and promoting cereal monocropping. When questioned about integrating soil and water conservation into the current package programme extension staff said this was outside of their mandate and was a policy issue to be addressed at a higher level, the importance was, however, recognised.

The team also visited a trial soil and water research site about 15 km outside of Nedjo on the Mendi road. The site had previously been severely degraded and affected by termites. The site had then been fenced and planted with trial grass and tree species. Unfortunately the fence had fallen into disrepair and livestock had again started grazing, however these conditions might be more realistic of farmers field conditions. Vetiver grass seemed to be surviving on the livestock and termite pressure and may hold future potential. One extension worker involved in the project in Nedjo reported that they would soon try exotic species such as the neem tree and may try gliricidia depending on the availability of trial plants. The research on the site seemed to lack a coherent management and structured approach. A comprehensive approach and further analysis and of plant species and regimes, could certainly yield valuable data.

In interviews with the extension department they expressed surprise as to why so few farmers were willing to cooperate in the soil and water conservation campaigns. They also stated they had limited knowledge of the variety of factors associated with the success or failure of the technologies adoption rate e.g. socio-economic or historical factors. The extension department also had no linkages with appropriate research that would address the soil and water research questions. They were, however, aware of the need for appropriate research to be undertaken but lacked resources and linkages with institutions capable of the work. In interviews extension respondents seemed to lack a systems perspective of the variety of factors contributing to soil erosion and primarily saw the major factor as only livestock pressure and deforestation. The extension department lacks the financial and human resources and technology to undertake large-scale soil and water campaigns and it is not a high priority for the department (Fig 11).
The mandate for soil and water conservation and soil fertility research falls under natural resource division of Bako research center (BRC). Currently the division has no research activities in West Wollega. Presently, there is no research on soil and water conservation technologies or practices and relevant research that addresses the issue of soil degradation and termites. The importance of soil and water conservation research is certainly recognised, however, the division lacks trained manpower and financial resources to undertake research in soil and water conservation.

Interview with researchers revealed that there is a recognition on the complexity of the termite problems in relation to soil and water conservation and approach to tackling the problems from systems perspectives. Through discussion it was also noted that there was no forum or working group either within Oromia region or nationally, that met to share information or technology on soil and water conservation. The Bako section has no relationship to research soil and water for the extension department and stated that they had never been contacted for advice, information or to undertake research for the extension department on soil and water conservation. There seems to be little likelihood for future research into soil and water conservation, without additional resources being made available or a significant shift in policy priorities.

Livelihood system and household economy

Sociocultural settings

Ethnicity and village setting

The farming community are predominantly Oromos and followers of Christianity (orthodox and protestant denominations). Oromiffa is a local language of the people and it is widely spoken, though some Amharic language is also spoken by the business community, educated professionals and other elite in the towns. Farming communities have widely scattered individual homesteads each formed by one household. However, sometimes two to three homesteads are found close to each other. In the strict sense, a real village (a social organization above household level) does not exist even though, concentration of homesteads (in physical sense) are found in some places due to villagization under the Derg regime. Traditionally, a notion of village (ganda) exists due to administration of scattered households (an administrative unit).

Household structure

Nuclear male headed household (with a married couple and their unmarried children) is common in the study villages. However, considerable percentage (30%) of the female-headed households were found in Zone I (Bafano Koreche). Death of the husbands is the major cause of female headed households. In some cases, in poorer households, the male migrate seasonally for off-farm activities to lowland (e.g. Dabus valley) and neighbouring areas, resulting in a temporary female headed household. Sons normally get separated from their parents after marriage. However, in some cases, they can continue to live with their parents for a while after marriage if they have not been able to build their own house and accumulate capital to set up their own households. If the parents are too old and incapable of doing their
farm work, one of the son (usually the youngest) stays with the parents to look after them.

Resource endowments

The resource endowments of the farm households are described in terms of availability of human resource (active labour force), farmland, grazing land/forests, livestock, oxen draught power and cash status. Endowment of land or field types by location and landscapes has significant influence on the productivity, income and social status of the households. Availability of active labour force and ownership of cattle, particularly oxen plays a significant role in the livelihood of smallholder.

Household size and labour force

Household size and age structure of a household are the important parameters impinging on labour supply and subsistence requirements. Household size in the study areas ranges from five to eight persons. However, active labor force with above 15-40 age in agriculture is very low ranging from two to three persons per household. Availability of adult active labor force is critical in sustaining the livelihood of small resource poor households. For young land and oxen less households, endowment of labour resource is the only factor that makes share cropping arrangement possible with land and oxen owner since human labor is easily exchanged for draft power (oxen).

Farm size

The majority of farmers are small-scale, with holdings varying from a quarter of a hectare to three hectare per household. Average farmland per household is less than one hectare and are highly fragmented. This holding includes privately owned crop, grazing and forest lands. Young households own very small pieces of lands inherited from their parents as presently there are no provisions for land reallocation. Land shortage and fragmentation have become chronic problems due to lack of land markets (e.g. buying and selling as there is no ownership rights), population increase and declining migration. Fragmented and diminutive farm size is also a constraint to agricultural production and adoption of new technology.

Since the hill-top and sloppy lands away from homesteads are often denuded, overgrazed and abandoned for cropping, size of farm lands at homestead and valley bottoms contributes greatly to social status, agricultural productivity and food security of the farming households. Poor and young households rarely own land at valley bottoms commonly used for the cultivation of spring maize (bone) and coffee at zone I. Sloppy lands near valley bottom are considered highly productive for coffee than homestead or land at hill tops.

Livestock holding

Livestock constitutes farmers important resources and are indispensable for sustaining livelihood of smallholders in rural Ethiopia. A farm household in the study areas owns about two to three livestock which includes cattle, sheep, goats and equines. Large animals (e.g. cattle) are considered as productive assets, whilst small ruminants (e.g. sheep, goats) and chicken are used as liquid assets whenever money is needed. However, the majority of smallholders do not own oxen or cattle. For example, in Zone III (Abono Dilla), out of 450 households, about 320 households (above 75%) do not own oxen. Poor farmers keep donkeys for draft purpose as they are cheaper than buying cattle. Donkeys are used as pack
animals for trading goods and transporting fertilizer and food from market. Non donkey owners also borrow cash and donkeys from the owners for trading food grains.

*Land tenure systems and share cropping*

**Land tenure**

Before 1974, most of the land was owned by large landowners and many farmers were landless. During the *Derg* regime, land was made state property and individuals were not allowed to own or sell. During this period, land insecurity remained high as there were periodic reallocations of lands among the farmers, eviction of farmers for the purpose of using the land for state farms, and rearrangement due to villagization process etc. Under the current land tenure system which was introduced by the previous socialist regime, land is still a public property and farmers have usufruct rights on land inherited from the family. Inheritance of land is patrilinial. If the land size is very small, parents often keep for themselves and do not pass to their sons. Though, women do not routinely inherit land, it was reported in Zone I (Bafano-Koreche) that daughters also do inherit some coffee plants as their share. By law, land can not be rented, sold or mortgaged, but in reality some renting and share cropping does occur in exchange for ox-power and human labor.

**Share cropping**

Endowment of resources such as land, oxen, and labour are important in making share cropping arrangement possible. Share cropping is common among small, land and oxen less and young and women headed households. Landowners with poor labour resource endowments are also involved in share cropping (*Kite Koto*) arrangements. Farmers who are better endowed with labour (adult) and oxen lease-in and/or share-in, while less endowed lease-out and/or share-out farm fields.

In most cases crop-sharing or leasing is renewed or terminated annually or every 1-3 years. Primary outputs are equally shared between two parties involved in share cropping irrespective of the type of arrangements (see below). However the crop residues are in most cases owned by the landowner. The following share cropping arrangements are prevalent in the study villages.

**Type A. Arrangement**

- Land owner: Land + labour
- Share cropper: Oxen + seed + manure + Food

Land owner provides land and labour while share cropper uses his seeds and oxen for ploughing and manuring the crop fields of landowner including food for working days. This type of share cropping arrangement occurs by the initiative of land owning households due to their possession of land and labour but lack of oxen and manure for ploughing and fertilizing crop fields.

**Type B. Arrangement**

- Land owner: Land + oxen + seed + meals during working days
- Share cropper: Labour from planting to harvesting and processing
Type B arrangement is initiated by the sharecroppers who have nothing except labour. Sharecropper receives land, oxen, seed and meals from land owner in turn he has to provide labour throughout the season from planting to harvesting, threshing and processing.

**Type C: Arrangements**

- Land owner: Land+seeds
- Share croppers: Oxen+labour

In the type C arrangement, land owner provides land and seeds while share croppers utilize his oxen and labour for planting to harvesting.

**Type D: Arrangements**

- Land owner: Land+labour+fertiliser+seeds
- Share cropper: Oxen+labour+fertiliser+seeds

In the type D arrangement, there is equal(1:1) sharing of seed, fertilizer and labour by both land and ox owner. Both parties divide the grain and straw harvest equally i.e ox power is weighted equally with land (e.g. Zone II-less infested).

**Farm household's survival strategies**

**Food status and availability**

In Zone III (Abono Dilla), out of 450 households, 350 (77%) are food deficit (thee to nine months) and about 100 households produce adequate food for a year. Similarly in Zone I (Bafano Koreche), Zone II (Oda Gunka and Gute Michael), the percentage of food deficit households is found very high. Discussion with farmers' group indicated that a family size of seven requires an average of six kilogramme cereals for daily consumption. The annual requirement comes to approximately 2160 kg for which a holding of 2.5 hectare of productive land is required at the present productivity level. This is because only one crop is possible to grow in a year. But interview revealed that the majority of the farmers (>80%) have less than 1 hectare of land indicating high level of food deficit in the study areas.

**Coping with food and cash shortages**

Farming systems in the study villages are purely subsistence oriented except in Zone II (Baffano Koreche) where farmers also do grow cash crop (coffee) for market. The livelihood of farmers in Zone II (Oda Ganka, Gute Michael) and Zone III (Abono Dilla) overwhelmingly depend on subsistence production of food crops particularly cereals (maize, sorghum, finger millet and tef). However, since recently an increasing number of farmers have adopted a strategy to produce root and fruit crops around homesteads and spring maize(bone) in valley bottoms to cope with hungry period (May-October). Since off-farm activities and other income generating options are limited in Zone II during lean season, resource poor farmers in Oda Gunka survive mainly on banana, mango and root crops. In Gute Michael, farmers reported that as much as 60% of the total food requirement particularly during food deficit period (July to November) is met by root crops like yam, anchote, Oromia potato, sweet potato, Irish potato, taro etc.
In Zone I (Bafano Koreche), since coffee production is a main economic activity for the majority of farmers, they used cash earned from coffee sale to buy much of the family’s food requirement.

Farmers in the study villages also opt for off-farm employment from February to May within or outside the villages to survive during hungry period. In Abono Dilla (Zone III), about 66% of food deficit households engage in some sort off-farm activities within the village whilst 11% of the households who do not own livestock, seasonally migrate (particularly the males) to neighbouring towns e.g. Jarso, Mendi, Nedjo etc. for non-farm employment.

Since formal and informal credit institutions hardly exist in the area, availability of credits to buy food and household needs is rare. To cope with cash shortage during May to December and be able to repay debts, farmers keep small livestock (sheep and goats) as liquid assets to sell when need arises. They also borrow money from relatives or friends without interest to buy food or household consumption needs.

Strategy to cope with food and cash shortages are more developed in Zone III (Abono Dilla) than the other two zones. Availability of off-farm activities, labor market (e.g. selling and hiring) and their better social linkages with outsiders have helped to reduce their vulnerability. This is probably due to better adaptations, strong coping mechanisms/skills and initiatives of the migrant population. For instance, resource poor farmers either seasonally migrate to other areas or involve in variety of off-farm activities within the village such as on-farm wage labour, logging, carpentry, collecting thatched grasses from forest and selling. Women also involve in trading food grains (January to June), firewood selling, fetching water and selling local beverage (Arake), in addition to normal agricultural wage labour (e.g. weeding). Migrants are also better aware of the importance and knowledge of maintaining soil fertility.

Coping with labour peak demand period: labour sharing and hiring systems

Labour is abundant in the study areas, except during peak cropping season. The family is the principle source of labour. The peak labour demand period is December-January (harvesting) and May to August (planting and weeding). The main operation for which additional labour is required are maize, sorghum, finger millet/tef planting, weeding and harvesting. Labour sharing is a common strategy to manage peak labour demand period. Hiring of labour is not common except during peak labour demand period at the rate of three to five birr per day depending on the task and season. Draught power is not generally hired; however, in Abono Dilla (Zone III) and Gute Michael (Zone II) oxen less households have a tendency to hire an ox for draught power and manuring crop fields for a season (April to September) at the rate of Birr 100.0-110.00.

The exchanged labour traditionally known as Kite kotu is very common in the study villages. This traditional cooperative labour sharing system play a very significant role as labour resource in the study sites. Ploughing and planting in some non ox owning households is only possible through such cooperation. Since ploughing is strictly a job of the men, young women headed households who do not own oxen manage to get their land ploughed by exchanging their labour time with the oxen owner. In this case two-three days of labor is exchanged with one day of oxen labor.
Labour availability together with social arrangements for labour sharing and hiring systems affect timeliness of cultural operations and farm management practices that in turn may minimize or increase the termite problem.

**Income sources**

**Farm income**

Major source of income from villages in Zone II and III comes from farm production (crops and livestock). Sales of food grains, live animals, honey and milk products provides some sources of income. Vegetables, fruits, root and tuber crops are also sold in small quantities by the women as a source of cash for household needs. In Zone I (Bafano Koreche), however, the bulk of income is derived from coffee. Coffee is more profitable than food grains both from individual and society’ perspectives.

**Off-farm income and employment**

Other sources of income are from off-farm employment such as agricultural wage labour, petty trading, thatch grass and fuel wood selling, logging, carpentry etc. Poor infrastructure, lack of labor market and non-farm enterprises have resulted poor availability of such off-farm and non-farm employment in the study villages. Lack of ownership of land also has hindered farmers to sell off land for investing on small cottage industries, and enterprises for generating assets, cash and employment opportunities. Rural to urban migration for the non-farm work is also rare due to remoteness of the areas and lack of information flow. However, off-farm income makes some contribution to sustaining the livelihood of marginal farmers (both men and women members).

Resource poor farmers try to keep donkeys for draft purpose as they lack resources to buy cattle. Donkeys are used as pack animals for trading goods, transporting fertilizer and food from market. Marginal farmers and landless people (non-donkey owners) borrow cash and donkey from the owners for trading food grains during off-season. Such off-farm employment opportunities have helped to reduce the vulnerability of poorer households.

**Inputs (fertilizer) and credit environment**

**Fertilizer**

Fertilizer is a major purchased input used in the study areas. After 1992, following withdrawal of the subsidy on fertilizer and subsequent devaluation of Birr against USD, the price of fertilizer has gone very high beyond poor farmers’ purchasing capacity for use in crop production. During the field survey, high price of fertilizer was identified as one of the major constraints to increased productivity in the study areas. Farmers indicated that fertilizer price has increased two to three folds whilst the price of output has remain the same over the years. Presently farmers need to sell five to six kilogrammes of grains (maize, sorghum, fingermillet etc.) to buy one kg of DAP or urea. It is uneconomic to use fertilizer for many of the cereal crops even though, some farmers are using it because it is available on credit through extension package programmes. Fig. 12 below presents the effects of fertilizer price increase on termite problems and farmers’ livelihood.
Figure 12. High fertilizer price: Its effects on termite situation and farmers’ livelihood

Because of high price of fertilizer and low productivity of the land, many farmers are reported to have sold their livestock to repay the fertilizer debts. Some farmers in Gute Michael (Zone II) reported that they have left land fallow/abandoned for cropping resulting in further degradation through overgrazing because of lack of resources to buy fertilizers and livestock for manuring crop fields. The basic reason for this is that after liberalization, the price of fertilizer is governed by international market forces and the macro-economic policies of the government whilst, the output price of food grain in a free market is dependent upon purchasing power of poor people.
Credit

Rural credit institutions for supplying credits to farmers are rare. Currently, farmers have an access to credit only through extension packages. Informal systems of credit i.e money lending is also not common within the villages. However, some coffee growers at Baffano Koreche have reported to have an access to money lenders (merchants) at Gori and Kiltu Kara towns to borrow cash for purchasing food grains during hungry periods. It is reported that the interest rate for such credit is very high (as much as 50%). A poor farmer has to pay coffee double in quantity in kind as the price of coffee during harvesting season is 50% lower than the price during credit borrowing season (food hungry period). In general the phenomenon of money lending and borrowing is not openly admitted due to various cultural and social relations.

Market and infrastructure

West Wollega is poorly supplied with roads and market infrastructures, thus access to many parts of the zones is still extremely difficult. This has detrimental consequences both on the ability to access markets for agricultural inputs, outputs and also provision of much needed agricultural support facilities such as agricultural extension, credit support schemes and regulatory services. Similarly poor infrastructure is found in terms of health, sanitation and other facilities. Periodic rural markets which are held weekly near the area of production are the only form of market exchange, buying and selling farm (foods and seeds) and non-farm produce (traditional handicrafts).

Coffee is the major output marketed in Zone I (Baffano Koreche) whereas Zone II (Oda Gunka, Gute Michael) and Zone III (Abono Dilla) have limited farm and non-farm products to export or sales. Transaction of food grains, seeds and non-farm products takes place mostly in rural weekly markets near areas of production or between neighbouring households. Marketing channels between producers and the major urban centers are poorly developed. Domestic markets for coffee are characterized by limited and variable trade volumes due to scattered and irregular supplies, large distances and high transportation costs. Prices vary during the year; they are lowest immediately after harvest, when supplies are abundant, and increase as the year progresses. Local markets for food are also unregulated and farmers relying on them for food are very much at the mercy of weather and termite effects.
Gender roles and decision making

The objective of gender analysis in this study is to identify gender-specific priorities and perspectives on farming systems and termite problems in order to identify leverage points for gender specific research and development interventions.

Gender Roles and Responsibilities

The roles and responsibilities of men and women differ in many households, farm and off-farm activities. Gender specific household, farm and off-farm production activities (gender division of labour) are presented below (Fig 13). Men have specific roles of ploughing, livestock tending, kraals construction, training oxen and off-farm activities like logging and house construction etc. Women's major responsibility lies in milking cows, household chores, vegetable cultivation, weeding and also in off-farm activities like fuel wood collection. However, planting crops, hoeing, harvesting, transport, buying food grains in low price during harvesting and selling during off-season, making pottery and mats are jointly done by men and women.

Figure 13. Gender division of labour

Women also work longer time with no leisure time: 15-17 hours as compared to their male counterparts who work only 10-12 hours a day.

Resource access, control and decision making

Patterns of resource access and control and decision making within the households differ according to gender. Socially men have more access and control and use of income, property and household resources including decision making power over important family issues. While women have access to some resources, inequality exists between men and women over control over resources (Table 3).

Women, as compared to their male counterparts have less access to and control over resource such as land (e.g., valley bottom), cash, and credit including control of investment and
education funds. They have also less control of market purchase inputs such as improved varieties and fertilizers. However, women can control the use of home produced seeds and manure.

Table 3. Gender resource analysis (access and control of household resources)

<table>
<thead>
<tr>
<th>Items</th>
<th>Access</th>
<th>Control</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homesteads</td>
<td>M/F</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Cereal fields</td>
<td>M/F</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Valley bottom</td>
<td>M</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own</td>
<td>M/F</td>
<td>M/F</td>
<td>M&gt;F</td>
</tr>
<tr>
<td>Family</td>
<td>M/F</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Exchanged</td>
<td>M/F</td>
<td>M/F</td>
<td>M&gt;F</td>
</tr>
<tr>
<td>Hired</td>
<td>M/F</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Input</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed (home produced)</td>
<td>M/F</td>
<td>M/F</td>
<td>F&gt;M</td>
</tr>
<tr>
<td>Seed (purchased)</td>
<td>M/F</td>
<td>M</td>
<td>M&gt;F</td>
</tr>
<tr>
<td>Chemical fertilizers</td>
<td>M/F</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Manure (home produced)</td>
<td>M/F</td>
<td>M/F</td>
<td>M&gt;F</td>
</tr>
<tr>
<td>Cash</td>
<td>M/F</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Credit</td>
<td>M</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Investment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td>M/F</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Large livestock</td>
<td>M/F</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Small livestock</td>
<td>M/F</td>
<td>M/F</td>
<td>M&gt;F</td>
</tr>
<tr>
<td>Market</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sale</td>
<td>M/F</td>
<td>M/F</td>
<td>M&gt;F</td>
</tr>
<tr>
<td>Purchase</td>
<td>M/F</td>
<td>M</td>
<td></td>
</tr>
</tbody>
</table>

Note: M>F: Male has greater control over resources

Table 4 presents the gender-specific decision making in various farm, household and sideline activities. Men are the major decision makers in cereal and cash crop (coffee) production and marketing, large animal purchase and sale, use of credit and new technology (extension package) and in the education and investment of the resources. Women get such authority only when she becomes the head of the household after the death or and in the absence of her husband when he is away from home for a season for off-farm employment. Except in root and vegetable crops and small animals sale, women’s role in decision making is less apparent. Pulses (haricot beans), vegetables and spices are grown in small areas at homesteads for cash purpose by the women. Women use these crops for their personal and household expenditure.

Women are not involved in selling large animals such as cattle, oxen and equines. This is because women have less access to decision making even though, they become head of
households. In addition, the sale of large animals requires written documents of agreement between the parties in which women can not play an important role because of lack of access and education. However, they are involved in selling small animals such as sheep, goats, and poultry as they are more accessible to them and do not require such documents.

Table 4. Household decision making by gender

<table>
<thead>
<tr>
<th>Items</th>
<th>Men</th>
<th>Women</th>
<th>Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal production &amp; sale</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root crop production &amp; sale</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Small-scale vegetable production &amp; sale</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Coffee plantation &amp; sale</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large animal sale</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Small animal sale</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Credit Use</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Cash Use</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment (long-term)</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New technology (extension package)</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>+</td>
<td>+</td>
<td>M&gt;F</td>
</tr>
</tbody>
</table>
CHAPTER SIX

STAKEHOLDERS AND AGRICULTURAL KNOWLEDGE, INFORMATION AND TECHNOLOGY SUPPORT SYSTEMS

Various stakeholders were identified throughout the study (Table 5). The stakeholder analysis identified who was involved in the termite situation; their various objectives and levels of influence. Although some stakeholders are listed as departments, there will be a number of lesser stakeholders e.g. individuals within organisations, who have their own objectives and influence on the termite situation. The stakeholder analysis is not exhaustive and should be considered dynamic, as new stakeholders arrive and established ones leave, their objectives and levels of influence change to suit new circumstances. Descriptions of key stakeholders, their background and further objectives can be found below within the AKIS section.

AKIS and technology support system

The objectives of the AKIS and technology support systems analysis was to identify the main stakeholders involved in information, knowledge and technology generation and dissemination in the termite situation. Then to analyse and describe the information and technology flows, and linkages and constraints between all stakeholders.

Agricultural extension and the package programme

Currently, an extension program for Green Revolution type (high external input) technology packages modelled after the Sasakawa-Global 2000 approach (in principal a modified T and V) is being promoted. Packages consist mainly of improved seeds for cereal to be paid after harvest. The typical package downpayment cost varies between 25-35 birr depending on the type of package. At present in all zones the main package is improved seeds of maize, teff and sorghum varieties with DAP and urea fertiliser. Farmers must buy the whole package and there is no provision for taking components of a package based on their needs resources. Extension services for soil and water conservation, micro-irrigation and horticultural and root crops is limited in all zones.
Table 5 Stakeholders and actors in the termite arena: Their objectives and influence in the context of current R and D interventions

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Current objectives</th>
<th>Current influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy makers and politicians</td>
<td>Maintain civil order- increase well being , food sufficiency</td>
<td>High</td>
</tr>
<tr>
<td>BRC</td>
<td>Develop new technologies</td>
<td>High</td>
</tr>
<tr>
<td>OADB.</td>
<td>Disseminate new technologies, meet regional objective policy</td>
<td>High</td>
</tr>
<tr>
<td>Local extension staff</td>
<td>Meet package targets</td>
<td>Medium</td>
</tr>
<tr>
<td>EARO</td>
<td>Develop new technologies</td>
<td>High</td>
</tr>
<tr>
<td>MOA</td>
<td>Meet national development objectives</td>
<td>High</td>
</tr>
<tr>
<td>MOA-plant protection and soil and water conservation Departments</td>
<td>Develop new soil and water technologies, guidelines</td>
<td>Medium</td>
</tr>
<tr>
<td>OADB plant protection and soil and water conservation Departments</td>
<td>Develop new soil and water technologies, guidelines</td>
<td>Medium</td>
</tr>
<tr>
<td>Farmers- (by typolgy)</td>
<td>Meet immediate needs food sufficiency and increase productivity. (differing objectives)</td>
<td>Low on policy issues, direction of research and extension efforts. Medium on village level issues High on field level</td>
</tr>
<tr>
<td>Peasant associations</td>
<td>Maintain civil order</td>
<td>Low</td>
</tr>
<tr>
<td>Farmers service co-operative</td>
<td>Distribute agricultural supplies, increase profit</td>
<td>Low</td>
</tr>
<tr>
<td>Informal community organisations</td>
<td>Maintain civil order, increase well being management of CPRs</td>
<td>Low policy issues Medium village level</td>
</tr>
<tr>
<td>Private input suppliers, AISCO, Dinsho, Ethiopian amalgamated, Ethiopia seeds enterprise.</td>
<td>Increase market share for agricultural supplies and increase profit</td>
<td>Medium</td>
</tr>
<tr>
<td>Bank and credit institutions</td>
<td>Lend to increase profit based on security</td>
<td>Medium</td>
</tr>
<tr>
<td>Mekana Yesus church</td>
<td>Raise rural livelihood status and convert</td>
<td>Low</td>
</tr>
<tr>
<td>ICRA team</td>
<td>Generate solutions to termite problem</td>
<td>High</td>
</tr>
</tbody>
</table>

The common formal media for transferring information and technology is through development agents (DAs) of agricultural extension office. In general, there is a shortage of DAs, as one DA often has to cover three PAs, roughly one DA per 1000 households. Furthermore, there is a heavy involvement of DAs on the extension package giving little or no time for general agricultural extension activities. The lack of transport, rugged topography and poor incentives hinder DAs’ efficient service provision to farmers.
The extension package has nothing for us, only for men
(Women headed household farmer in Zone I Baffano Koreche)

The ratio of DAs to farmers is not the only factor influencing the effective delivery of extension services. There is also limited service provisions facilities for resource poor farmers. The PA chairman and other farmers in Zone I stated that only three peasants out of 246 households were involved in the package, the rest could not afford it or it did not meet their needs. The majority of DAs are men and interventions are mainly for male farmers, as they are considered to be the decision-making unit of the household. There are no technologies or services offered for women farmers such as horticultural or homestead crops.

During the course of the field study, very few women headed household were involved in the package programme. There is a gender bias in the delivery of extension services offered. However, some respondents reported
Figure 14. Knowledge systems linkage map of stakeholders and AKIST in the termite arena
that they were happier now, as there are more women DAs and farmers now have a higher level of interaction with DAs

DAs have targets to achieve for the number of farmers participating in the package. Several DAs mentioned that it was difficult to achieve high attendance rates at meetings as farmers were reluctant to attend. Some farmers had reportedly taken the package programme and it had failed due to natural disasters, wild animals or poor seed quality and germination. However, farmers were still forced to pay the whole amount for the credit provision they had taken, and some had to sell oxen to raise cash or even migrated to avoid paying the credit loans.

During the study, farmers identified a variety of urgent problems, most of which were not addressed by the package programme. Important farmers’ problem found throughout the all zones was the lack of draught animals for which extension office has no provision to support. Farmers complained that the package has nothing for wild animals, termites or declining soil fertility etc.

Farmers in zone I stated that they needed a package programme on coffee their most important crop. There is also no homestead package for root and tuber crops, fruits or horticultural crops. These crops are an integral part of the farm system and farmers livelihood strategies, especially for income generation and food sufficiency during the hungry period.

The package works in situations where resource rich farmers have better access to credit, oxen and land. It is not able to access or provide services to the majority of resource poor farmers. This is because the program is designed without farmer participation or a comprehensive understanding of the diversity of environmental or socio-economic needs of the farmers. The extension and research systems lack an effective intervention typology based on farming systems, field types and households. So research and extension recommendations are difficult to target to specific groups of farmers based on their needs and priorities.

**Farmers perspectives**

"DAs have studied the knowledge of agriculture, but the limitation is that even if they know how to plough they don’t know our soils, our problems and our environment, they need to come and learn”

(Male farmer Zone II Odaganka)

The field study identified a diversity of different farmers (Table 1) with different socio-economic backgrounds and resource endowments and operating within a number of different environments. This lack of incorporation and awareness about the diversity of farming systems environments and clients has major implications for research and extension. Farmer participation in designing and delivering research and extension programmes is limited. Farmers complained that many could not use the package as the fertiliser rates, seed varieties and flexibility of credit that many were not suited to their needs. They also added that it was
difficult to accept the package programme without first evaluating it and said they would be interested to try smaller packages or be involved in on farm research and extension activities.

"""If we don’t see the result from the package how can we make a decision?, we want to be involved in extension but the cost is too high and past experiences have made us wary"""" (male farmer Zone II)

However, due to an immediate lack of other outside sources of information and technology support (e.g. private suppliers or NGOs), many farmers were forced to take the package programme to obtain seeds and fertiliser. Limited availability and high cost of fertiliser were reported to be major problems for many farmers, especially in areas with low soil fertility and limited options for organic manure.

Declining soil fertility and the lack of access to fertiliser and limited options for organic manure’s, means that farm yields have declined and increasing pressure is being put upon the already declining resource base.

Farmers own research and diffusion practices

Farmers regularly experiment with different technologies and practice and share technology with each other, and pool resources. In Zone III (Abono Dilla) which was a newly settled area with high soil fertility and pioneer migratory farmers from other areas, the diversity of farming practices and crops was found to be much higher. It was a mixing pot for all the different practices and varieties from other areas. Farmers exchange different management practices, seed varieties, fruits and coffee. New technologies are shared out by those who know, on the cultivation of new crops with knowledgeable farmers demonstrating how to clear and drain the land. Farmers select their own seeds keeping the best for next year and exchange new varieties amongst each other, even breeding and selecting specific seeds based on a variety of criteria including: storability, germination and yield. In an interview with women trader farmers at a local market in Zone II, they stated that they walked for two to three hours to buy and sell two birrs worth of small grains, to obtain seeds for homestead needs. This active trading was happening only 20 metres from the local DAs house yet the women had never met the DA and stated that although they had problems in obtaining quality seeds and improved varieties there was little that the extension service was offering them. Farmers are experimenting with different agricultural practises and varieties, knowledge and goods are shared between all actors through informal social relationships. Unfortunately, the extension service has not tapped into this indigenous technology and knowledge network. The extension and research services are not able to take advantage of this as they lack the necessary feedback flows and linkages and working relationships with individuals and informal local institutions.

Research, AKIS and technology support systems

Presently, the BRC uses general zonation based approach purely on high, mid and low altitudes, not based on specifically developed farm typology. In discussion, it was noted that there was a need for a more regional and client context specific zonation and typology to be developed to increase the effectiveness of research. Research priorities are identified by extension and passed onto them, but research priorities are predominantly set depending on
available resources, staff interests and capabilities. Farmers are not reportedly involved in setting priorities for research. The linkages with farmers and participatory research and information feedback between farmer’s research and extension is weak (Fig 15).

Figure 15. Current technology generation and diffusion process

There appeared to be weak interdisciplinary linkages, however different disciplines were very willing to co-operate but often lacked resources and formal networks. In some research projects of the BRC, farmers were involved on on-farm trials and there was a ready awareness of the need for farmer participation. There is a general lack of institutional information and knowledge networking within the national and regional agricultural research systems.

Strengthening research-extension linkage and farmer involvement in R and D

Linkages between the research systems and agricultural development activities are through the research extension liaison committee (RELC). In 1986, the RELC was formed with members representing both research (BRC) and extension (zonal agricultural administration). It is made up of researchers, represented by centre managers of the research centre plus one of two other scientists, zonal extension representatives, and subject matter specialists at the district level. Although the SMS are involved in the research planning process at a later time, together with the zonal officers, farmers themselves are not formally represented at any level. Each zone within Wollega region has its own RELC which links up with other counterparts and other stakeholders in agricultural research and development. The current linkages between the key players are however reported to be weak, and not all stakeholders are involved. There is also a problem of logistical constraints that tends to compromise the operations of RELC. Extensionists in general have not been involved in on-farm trials of the research institutes. There have been few attempts by extensionists and researchers to collect farmers feed back, concerning introduced technologies and packages.

Plans are underway to institutionalize the operations and of RELC for effective functioning. RELC branches will be opened at lower level up to district level. There are also proposals to changes in the working methodology in networking so as to reach different micro ecologies not currently reached by research owing to distance and logistical constraints. The exiting linkage mechanisms are being revised to include all stakeholders and their involvement. It is proposed that an oromia agricultural research organization (OARO) should be formed which will link up with other regional research organizations/ coordination’s bodies and the national Ethiopian agricultural research organization (EARO) currently being restructured to take charge of all agricultural research activities in the country.
The current mechanism of strengthening farmer participation in research and development is through RELC. However the linkages that RELC has with other stakeholders is still weak. The research-extension linkages are inadequate, farmer involvement in research planning technology generation, testing/evaluation and transfer still lacking. Feedback to research from farmers is so far wholly dependent on the DAs who themselves are rarely seen by farmers. The validity of and authenticity of the information they feed back in the research machinery is therefore questionable in some cases. No farmers are represented in RELC currently.

Steps being taken to strengthen farmer participation in R & D include:

1) Institutionalization of RELC  
2) Increased funding to RELC  
3) Establishment of RELC at all levels to the districts  
4) Involvement of all stakeholders  
5) Adoption of participatory research and extension approach and the use of farmer groups is hoped to achieve better two way exchange of information between researchers, extensionists an a farmers. Development agents are assigned every 15 days per district where participatory learning and exchange of information is facilitated.  
6) Use of farmers cooperatives  
7) Modification of the package programme to incorporate farmer’s views and needs.

Input suppliers

The agricultural input service corporation (AISCO), a government parastatal body is the main agency involved in the supply of essential inputs such as fertilisers, improved varieties, pesticides and veterinary drugs to the extension departments. Recently some private agencies such as Dinsho, Ethiopian amalgamate limited and Ethiopian seed enterprise are also involved in the supply of inputs to farmers. However, input use by small farmers is generally restricted for a number of reasons. Firstly, these agencies supply bulk of inputs (> 90%) through regional agricultural administrative bureau’s since inputs are tied with credits. Secondly, these agencies have not reached the rural areas in terms of supply, distribution and marketing. No private suppliers or traders were found in the study zones, and farmers access to technology inputs was severely limited.

Credit support

Farm household’s access to formal and informal credit sources is limited. Rural credit institutions hardly exist in all zones, due to the lack of well functioning credit and informal financial markets. Credit is scarce and is available only for variable inputs, mainly fertiliser, through the extension package. Commercial banks require collateral for credit, which is not available for the majority of farmers primarily due to the inability to offer land as security. Credits for medium and longer term inputs and investment such as purchasing oxen or ox-equipment’s for cultivation, soil conservation and farm investment are presently not available.
Informal saving (financial) groups

Farmers in all study villages within zones have some rudimentary form of informal social institutions/saving groups, which are formed to cope with emergency and adverse conditions such as loss of life, property and incurable sickness. In each village cluster, a group of 10-20 households are formed to organise revolving fund for social financial security and future emergency use. Members pay a fixed amount of money monthly into a common pool. Rules and regulations are well set and specified to organise and manage the fund during the time of the need. However such funds are not mobilised for agricultural and income generating activities and poorer farmers tended to be excluded.

Community social institutions and organisation

Management and mobilisation of community resources (natural and financial) depend for its success on community initiatives and decision making and organisational capacity at the village level. Informal and formal rural social institutions such as social/forest committee of PAs and informal community groups for the management of common property resources and mobilisation of financial resources and savings funds, were found in all sites. However, there are no such community groups found to minimise termite damage and control campaigns. Different institutions functioned in different zones with varying objectives and effectiveness.

The peasant association (PA)

Peasant associations (PAs) are local administrative bodies operating at the village level, linked to local government. Each PA is subdivided into “gandas”/or villages where, each household is a member of the association. Each PA has about 200-500 households and about 800 hectares of land. PAs are responsible for judiciary functions, settling land and other disputes, community organisation, management of CPR’s, distribution and administration of lands and carrying out local development activities.

Service co-operatives (SC)

During the Dergue regime Peasant Associations (PAs) were given the mandate to establish service co-operatives for the collectivisation of agricultural production. Service co-operatives were formed for every three to ten PAs with the objectives of delivering inputs, including credit, market outputs, establish merchandise shops, provide tractor and transport services and provide milling services. Members of PAs are automatically the members of the SCs. SCs in the past played an important role in supplying basic consumer goods and farm inputs at subsidised prices to the rural population, and in administering rural credit programmes.

Presently these service co-operatives are not functioning well. However, in Jarso district, a service co-operative was working, but in a passive way supplying fertilisers and seeds only to those farmers involved in the extension package. Farmers in Zone II reported that the SC were not supplying services to non-package participating farmers.

Women’s association (WA)

Government initiated women associations in each PA were common during previous government (Derg) regime. After the change of the new government, these associations at the village level were not regulated. Recently, however, women associations at each PA, have
been re-established by the local government. Unlike the PAs the membership to WA is not mandatory. In all study villages, the association are not found functional, though, executive bodies of the association have been formed. Many of the members of the association were ignorant of the purpose and mandate of the WA. Therefore associations are not well supported, or utilised for women’s welfare.

Informal livestock grazing groups

In Zone II (Oda Ganka), households with cattle, form a group of about 10-11 households for tending/grazing their pooled livestock and share a day of labour in each 10-11 days. Mostly children are used in tending cattle in a herd of 70-80 animals. Adults are only involved if they have no children or children failed to take care of animals. The group is based on lose social relationships and currently have no relationship to the veterinary department or extension services.

Disaster, rehabilitation and environmental protection committee

This is an arm of government whose activities are currently minimal. Previously very active in administration of aid to victims of natural disasters and wars, especially in the post war era, but currently emphasis is on environmental issues. Mandate includes promotion of development activities line with sound environmental protections principles as well as awareness creation to the rural population on the relieve of good farming practices to environmental protection/conservation. Member’s ship comprises representatives from the relevant line departments and administrators. Grass roots farmer representation is, however lacking and although the committee exists in principle, its impact farmers’ practices are questionable.

NGOs (Mekane Yesus, Western Synod)

An evangelical church (NGO) operating in West Ethiopia and other part of the country. Involvement in research has been feasibility study to develop an integrated and sustainable package for management of the termite problem. It also has plans to increased farmer participation in research and development through organization and funding of farmers training, workshops in collaboration with agricultural bureau staff of the districts in which they have development activities. It’s also plans to launch a community rehabilitation programme including environmental awareness and protection campaigns.

Stakeholders problem ranking and analysis

Different stakeholders have different perception of problems and priorities. In order to identify and understand the importance of different problems, major stakeholders related to termite situation were consulted by the team. agricultural problems of West Wollega were first listed through interview of each stakeholders (Appendix I) and then prioritized based on their importance. A total of 10 major problems (Appendix II and III) prioritized by the study team were used for separate ranking. The ranking of problem by different group of farmers was done during third phase of the field study in each zone and village while for other stakeholders viz: researchers and extensionists, it was carried out during mid-term workshop. The summary of overall ranking of the problems by the different stakeholders is presented in Table 6.
A. Farmers' problem ranking and analysis

Farmers' interviews (individual and group), direct observation and focussed group discussion revealed a number of agricultural problems. These problems are briefly described in each relevant section (see crop, livestock, AKIS and socioeconomic constraints sections). A total of 10 major problems identified and prioritized by farmers were used for separate ranking by different group of farmers (resource rich, resource poor (oxen less), women and women headed households). These problems were also presented among various farm groups during farmers workshops/meetings for further clarification and verification. Brief descriptions on the results of overall ranking of the problems by different groups of farmers is presented below and also in Appendix II.

High termite infested villages (Zone I and II)

- Termite is a number one problem ranked by all groups of farmers (rich, poor, men and women)
- Resource poor (without oxen) both men and women ranked lack of oxen as the second or third most priority problems
- Wild animal attacks and high fertiliser price are also ranked as important problems by all groups of farm households
- Resource rich (land and livestock/oxen owners) ranked feed scarcity and livestock disease also as the important problems

Less termite infested villages (Zone II and III)

- Wild animals attack as the number one problem ranked by all groups of farmers including women in Abono Dilla (Zone III: forested and newly settled village)
- High fertiliser price as the number one problem in Gute Michael (Zone II: relatively accessible) by all groups of farmers including women.
- Lack of draught power (oxen) was second most important problems in each of this villages for resource poor (non ox-owner and women headed) households.
- Termite as a problem was ranked third, fourth or fifth by all groups of farmers in each of this villages.

The analysis revealed that termite is a predominant problem perceived in termite infested zone I and II while it was wild animals attack in less termite infested Zone III. Lack of draught power (oxen) and high fertiliser price were the other major problems ranked by different group of farmers (Table 6).

B. Researchers and extensionist problems ranking

- The researchers and extensionists had similar perceptions of the problems. Both ranked termite as the number one problem followed by soil erosion and land degradation (Table 6 and Appendix III). However, high fertiliser prices, lack of draught power and wild animals attack were not in the priority problems in the ranking as to that of farmers.
Table 6. Summary of problem ranking by different stakeholders (researchers, extensionists and farmers)

<table>
<thead>
<tr>
<th>Agricultural problems</th>
<th>Researcher</th>
<th>Extensionists</th>
<th>Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Termite</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Soil erosion and Land degradation</td>
<td>II</td>
<td>II</td>
<td>VIII</td>
</tr>
<tr>
<td>Overgrazing/ Feed scarcity</td>
<td>III</td>
<td>IV</td>
<td>VII</td>
</tr>
<tr>
<td>Wild animals Damage</td>
<td>IV</td>
<td>VIII</td>
<td>II</td>
</tr>
<tr>
<td>Crop pests &amp; diseases</td>
<td>V</td>
<td>III</td>
<td>V</td>
</tr>
<tr>
<td>Livestock diseases</td>
<td>VI</td>
<td>V</td>
<td>VI</td>
</tr>
<tr>
<td>High fertilizer price</td>
<td>VIII</td>
<td>VI</td>
<td>IV</td>
</tr>
<tr>
<td>Lack of draught power</td>
<td>VII</td>
<td>IX</td>
<td>III</td>
</tr>
<tr>
<td>Lack of agricultural information &amp; technology</td>
<td>X</td>
<td>VII</td>
<td>IX</td>
</tr>
<tr>
<td>Insecurity of land ownership</td>
<td>IX</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
OVERVIEW OF THE TERMITE SITUATION

The termite situation

Termites have been implicated in damage to crops, forestry and infrastructure and economic losses have been quantified in many cases. Damage is generally greater in exotic plants than indigenous plants, rain fed crops than irrigated crops, dry periods than period regular rainfall, plants under stress than healthy and vigorous plants and low land areas than high land areas. In West Wollega only the negative aspects of termites have been emphasized, however, all termites are not damaging, soil feeding termites increases exchangeable and available phosphorous by up to 76 times. The positive roles of termites in nutrient cycling and as protein sources also need to be taken into consideration.

Causes of spread and intensification of the termite problem

Increased human and livestock population that followed by clearing of forest for cultivation (deforestation) and other uses, overgrazing, annual burning of grasses for regrowth and cultivation with out rest i.e. with out fallow have contributed to land degradation and intensification of the termite problem (EECMY, 1997). The damage caused by termite forced many farmers to abandon their land and migrate to lowlands where termites are less of a problem.

From the findings of the team that based on extensive literature review, key informant interviews and an in-depth analysis of the farming system of the study area, farmers' practices and the changes therein, the team prefers to refer to the condition under study as a situation rather than termite problem exclusively. This is because the factors that have resulted in the spread and intensification of the situation are largely a result of changes in the balances within the ecosystem following human interference and mismanagement of natural resource use. Termites have always co-existed with crops, livestock and vegetation where the balance has not been much disturbed as is currently still exhibited in valley bottoms and forested areas like zone III of the study area. The two words will, however be found used interchangeably in certain parts of the text.
Termites are abundant and widely distributed throughout the regions of Ethiopia but pose a threat to crops, forestry trees, rangeland, and domestic houses, especially in western Wollega zone. The termite fauna of Ethiopia as a whole is not well known. At present, 62 species belonging to 25 genera and four families have been recorded, and 10 of the species are endemic (Cowie et al. 1990). Distribution of termite species collected by Cowie et al. (1990) is shown in Figures 16, 17, 18, 19, and 20. About 25% of these species are pests of agricultural crops, forestry seedlings, and grazing lands. The four families that contain the pest species are Kalotermitidae, Hodotermitidae, Rhinotermitidae, and Termitidae (Abdurahman 1990). There are many species of termites, but Macrotermes subhyalinus (Rambur) is the most dominant pest of crops in the study area. Significant damage in field crops attacked by this species was recorded in West Wollega and Asosa (Abdurahman, 1990). The termite species, their nesting habits, and foraging sites in West Ethiopia were recorded by Abdurahman in 1990 (Appendix IV). Mound-building species may not build mounds at an early stage of colony establishment.

Besides the species composition study, Abdurahman also undertook studies on distribution and pest status of some of the species and termite ecology in 1993. Foraging activity of some of the predominant termites was studied in the area. The most abundant foraging species in the study areas was found to be Microtermes nr. adschagga, Microtermes aethiopicus, Macrotermes subhyalinus, and Pseudocanthotermes militaris. Microtermes species usually forage more significantly during the wet season than the dry season. In Manasibu, Macrotermes subhyalinus forage throughout the year and are more active during the dry season (Abdurahman, unpublished data).

Lower temperatures related to latitude and altitude limit the distribution of many termite species. The dominant species of termites in Western Ethiopia belong to the subfamily Macrotermitinae and include various species of Macrotermes, Odontotermes, Pseudacanthotermes, Ancistrotermes, and Microtermes. Most of these termites are found throughout the savannah and wooded steppe of tropical Africa, below altitudes of 1800-2000 m. Above 2000 m, there are fewer species, mainly soil feeders, and a few Odontotermes. Forest clearing and subsequent cultivation usually destroys above ground mound shallow, subterranean nests building species. However, cultivation has no effect on species with deep, subterranean nests (e.g., Microtermes, Ancistrotermes) and often increase in number and some become crop pests (Wood et al., 1997; and Johnson et al., 1981). Some of these surviving species have been implicated in damaging crops, newly planted exotic forestry trees, range land, rural dwellings, and food stores (Wood, 1991).

to clearing and burning those existing forest, different indigenous trees. In Zone I (Bafano Koreche) some individual tree spp. is still maintained to provide shade for coffee trees. Overall the major causes for land degradation are the combined effect of poor land management and termite infestation. As per information obtained a termite mound was for the first time observed inside a thatched house in zone I at Bafano Koreche in a place specifically called Tullu Gibole in 1904. As the farm belongs to a farmer name Aba Shebir the local people also call this place Tullu Aba Shebir. They reported that the place had some spiritual significance to the community in the area. Then termites were not a problem. According to information from different key informants and local farmers, termites are originated at Bafano Koreche in Manasibu districts around Kiltu Kara (Table 7). Historical events relating termite problem in West Wollega Most of the farmers interviewed in the surroundings believe termites are threatening their crops and houses have spread from Bafano Koreche in Manasibu districts to different localities. They said
Figure 16. Distribution of termites, Kalotermitidae, Rhinotermitidae and Termitinae in Ethiopia

Figure 17. Distribution of termites, Apicotermitinae and Nasutitermitinae in Ethiopia
Figure 18. Distribution of termites, Macrotermiteinae, in Ethiopia

Figure 19. Distribution of termites Microtermes spp. in Ethiopia
the termite problem spreading using different mechanisms, such as underground movements, infested plants and by flying termites. A farmer in Dandi Gudi said that in the past we did not know about termite problems. At the first time we heard from different individuals as this termite causing damages on different crops around Bafano Koreche and its surroundings. Farmers in Dandi Gudi (Zone I) said termites came to our area and this problem increased from timer to time. Then, there was one saying from elders “someone reportedly introduced termites within a hollow stick (Soyoma) from Bafano Koreche to Dandi Gudi.” The termite problem (damage) on crops noted in early 1953, this coincides with Abdurahman findings (1990). Typical signs of termite infestations include swarming of winged adults in the spring (March, April, May and June) and occasionally (September and October) in autumn. A swarm is a group of adult male and female termite reproductive that leave their nest to establish a new colony. Swarming occurs when a colony reaches a certain size. Emergence is stimulated when temperature and moisture conditions are favorable, usually on warm days following rainfall. Other signs of termite presence include pencil size mud tubes constructed over the surface of bare lands and residue of crop stables (Ohio University, 1991). All termites swarm during the rainy season, but never have two different termite species been observed swarming at the same time (Abdurahman, 1990). This swarming although slow and only within a short distance is believed to have strongly influenced the spread of the termite problem in western Ethiopia over the years. Termite distribution can be related to temperature and rainfall. Overall factors affecting distribution of termites can be land bridges, islands and natural barriers. Termites spread by various ways, including transportation in wood parts, infested ornamental plants or nursery stocks, furniture and underground movement can all provide a means of carrying live termites (Pearce, 1998).
The study sites, Zone I Bafano Koreche (Manasibu), Zone II Oda Ganka (Jarso), and Zone III Abono Dila (Jarso) and Gute Mecheal (Nedjo) almost have the same historical background about termite and vegetation situations. According to information obtained from the local communities before termite infestation intensified the area was covered with savannah woodland, human and livestock populations were less, crop and livestock productivity was high and land was quite abundant. Gradually, human and livestock population has increased. This has lead to demand for land and led to clearing and burning those existing forest, different indigenous trees. In Zone I (Bafano Koreche) some individual tree spp. is still maintained to provide shade for coffee trees. Overall the major causes for land degradation are the combined effect of poor land management and termite infestation. As per information obtained a termite mound was for the first time observed inside a thatched house in zone I at Bafano Koreche in a place specifically called Tullu Gibole in 1904. As the farm belongs to a farmer name Aba Shebir the local people also call this place Tullu Aba Shebir. They reported that the place had some spiritual significant to the communities in the area. Then termites were not a problem. According to information from different key informants and local farmers termites are originated at Bafano Koreche in Manasibu districts around Kiltu Kara (Table 7). Historical events relating termite problem in West Wollega Most of the farmers interviewed in the surroundings believe termites are threatening their crops and houses have spread from Bafano-koreche in Manasibu districts to different localities. They said the termite problem spreading using different mechanisms, such as underground movements, infested plants and by flying termites. A farmer in Dandi Gudi said that in the past we did not knew about termite problems. At the first time we heard from different individuals as this termite causing damages on different crops around Bafano Koreche and its surroundings. Farmers in Dandi Gudi (Zone I) said termites came to our area and this problem increased from timer to time. Then, there was one saying from elders “someone reportedly introduced termites within a hollow stick (Soyoma) from Bafano Koreche to Dandi Gudi.” The termite problem (damage) on crops noted in early 1953, this coincides with Abdurahman findings (1990).
<table>
<thead>
<tr>
<th>Year</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1904</td>
<td>A termite mound was first observed in a farm house at Tullu Gibole, (Bafano Koreche) in Manasibu district (Zone I)</td>
</tr>
<tr>
<td>1953</td>
<td>Termite damage was noted and reported for the first time on different crops from Zone I at Bafano Koreche</td>
</tr>
<tr>
<td>1953-58</td>
<td>People reportedly migrated from Zone I, Bafano Koreche to surrounding lowlands and uninfested areas (e.g. Dandi gudi, Dilla, Dabus, Melka Ebicha) due to termite damage</td>
</tr>
<tr>
<td>1958</td>
<td>Someone reportedly introduced termites within a hollow stick (Soyoma) to Dandi Gudi</td>
</tr>
<tr>
<td>1958</td>
<td>Termite damage on agricultural crops recognized by farmers around Dandi Gudi</td>
</tr>
<tr>
<td>1968</td>
<td>Reportedly effective chemical control initiated at Bafano Koreche area</td>
</tr>
<tr>
<td>1972</td>
<td>Farmers from Oda Ganka (Jarso) migrated due to termite damage on crops</td>
</tr>
<tr>
<td>1974-83</td>
<td>Large scale termite mound poisoning campaign using Aldrin (at Manasibu and Jarso)</td>
</tr>
<tr>
<td>1986</td>
<td>Termite damage monitoring study on maize by FAO at Manasibu</td>
</tr>
<tr>
<td>1987/88</td>
<td>Queen removal campaigns around Arya-Guliso &amp; other places in West Wollega</td>
</tr>
<tr>
<td>1988</td>
<td>Chemical mound poisoning campaigns at Manasibu, Jarso, Ghembi, Ayra-Guliso</td>
</tr>
<tr>
<td>1988</td>
<td>Study by Tom Wood on termite situation in West Wollega</td>
</tr>
<tr>
<td>1990</td>
<td>Species identification study by Abdurahman Abdulahi at West Wollega</td>
</tr>
<tr>
<td>1996</td>
<td>OADB protection department prepared documents on integrated termite control package</td>
</tr>
<tr>
<td>1997</td>
<td>Mekane Yesus West Synods development programme conducted feasibility study on termite control at Manasibu district</td>
</tr>
<tr>
<td>1998</td>
<td>Participatory systems oriented field study on the termite situation by ICRA team</td>
</tr>
</tbody>
</table>
Negative effects of termites

Termite damage to crops

Termites cause widespread damage to a great variety of crops in tropical Africa (Harris 1969). The damage can occur from seedling to harvest and usually occurs every year; as termites form almost stable population and foraging by various combinations of several species occur throughout the year (Wood, 1991). Termites lowered the yield of maize, sorghum, teff, millet and beans by 82%, 76%, 86%, 94% and 84% respectively (Table 8) (EECMY.WS, 1997). These percentage yield loss figures seem exaggerated for each crops. Therefore these figures may be considered as percentage of damage, but not yield loss. The yield losses due to termite needs further detail study.

Table 8. Effect of termite damage to major crops of the study area, Manasibu district.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Yield (qt/ha)</th>
<th>Percent reduction</th>
<th>yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before termite</td>
<td>After termite</td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>34</td>
<td>6</td>
<td>82</td>
</tr>
<tr>
<td>Sorghum</td>
<td>38</td>
<td>9</td>
<td>76</td>
</tr>
<tr>
<td>Teff</td>
<td>21</td>
<td>3</td>
<td>86</td>
</tr>
<tr>
<td>Finger millet</td>
<td>31</td>
<td>2</td>
<td>94</td>
</tr>
<tr>
<td>Bean</td>
<td>31</td>
<td>5</td>
<td>84</td>
</tr>
</tbody>
</table>

Source: EECMY-WS (1997)

The effects are both direct and indirect. Termites decompose organic material and transport it into deeper soil layers that are not accessible by crops, which leads to poor crop growth. Farmers related the high yield reduction of millet especially to this indirect effect that termite poses through soil fertility. The consequence of termite damage is not only yield reduction, but also the direct and indirect effects of termites interrupt planting of important crops like barley, wheat, field pea, faba bean, and chickpeas some of which have now been abandoned. These crops play vital roles in human diet and their absence in the diet of the study area may have contributed to malnutrition. Infestation to coffee, mango, fruits and root crops is not as severe as cereals and pulse crops. Low crop yields due to termites have negative consequence, such as, low income, shortage of food and migration of the community to the low land areas. The consequences of termite infestation as described above result in further reduction in overall agricultural productivity.

Termite damage to grazing land

Grass eating termites are often many in tropical and subtropical grass lands where livestock also graze. Occasionally, spectacular effects of termite activity resulting in almost complete denudation and leading to accelerated erosion have been reported. These incidents have been well documented in South Africa (Coaton, 1954), where the species responsible for damages are largely specialized grass-harvesting species. Massive termite damage was observed in grazing
land in Manasibu and Jarso districts that led to degradation of the pastureland. Degradation of pastureland is consequence by lack of fodder and erosion. Lack of fodder leads to weak animals that are susceptible to diseases, give low milk and beef yield and are weak in traction. Lack of fodder also leads to over grazing. Animals trampling on overgrazed land leads to soil compaction. Infiltration on compacted soil is low and results in high runoff, and subsequent erosion. Compacted soil is also difficult to work on. Termites primarily feed on dead grass (i.e., grass litter) during the dry season. In the overgrazed range lands they remove all grasses’ litter and much of the small amounts of dry grass biomass to such low level that grass consumption by termites results in the denudation of the area EECMY-WS (1997).

Termites damage to forestry trees and plantations

Termite damage to forestry trees/plantations is more on exotic tree species (Eucalyptus species and Cuprus species) than on indigenous species. The damage is more severe during the first 2-4 years after transplanting. Soon after transplanting seedlings suffer severely from moisture stress, because of soil compaction and low water holding capacity resulting from poor infiltration rates. The roots of such plants begin to dry out. This creates a favorable situation for termite infestation. Damage to forestry trees can be increased due to incorrect transplanting of tree seedlings and lack of treating soil during raising seedlings.

Damage to houses

The community of the study area maintained that the wood made houses can only last for about 2-3 years compared to over ten years in the past. This undesirable consequence of repeated rebuilding of wood/straw thatch houses leads to excessive clearing of native woodland and forest. The vicious circle of cause and effect of the termite problem negatively affects the socioeconomic situation of the population of the area. The net effects are deforestation and in combination with overgrazing, denudation and accelerated erosion. Additional human health and environmental hazards arise from the use of cyclodiene insecticides. Using proper stone foundations should protect buildings.

Interactive effect of termite damage

The interactions of the various facets of termite damage and human responses (negative) to damage are shown in Fig. 21. According to Wood (1991), the net effects are deforestation, and in combination with overgrazing, denudation and accelerated erosion; additional human health and environmental hazards arise from the use of insecticides (cycloideine).
Fig. 21. Termite damage, human responses to damage and their environmental impact
(Wood, 1991)
Positive aspects of termites

Although usually considered as pests, termites do provide many benefits to the people of the tropics and to tropical ecosystems (Wardell, 1987). The positive role of termites in nutrient recycling and as an alternative source of protein for humans and livestock needs to be taken into consideration (Mailu et al., 1995). The importance of termites should not be underestimated and it would not be desirable to eliminate termites from habitats in the tropics. Research indicates some of these positive aspects of termites as follows.

1. Food - termites provide a rich protein source for many organisms in tropical ecosystems, including Guinea Fowl, ants, many mammals such as the aardvark, and in some cultures, humans.
2. The burrowing activities of termites provide aeration and allow infiltration to tropical Savannah soils
3. Minerals enriched termite mounds can increase soil fertility when leveled, and are often licked by cattle to replace mineral deficiency.
4. Many termites eat soil that helps in the breakdown and release of organic matter
5. Puddle termite mound earth is often used for making pottery and for building.
6. Crop storage- crushed termite mound earth is often used in traditional grain bins for storing pulses
7. Laboratory tests by Breznak et al. (1973) showed that the castes of some species of termites were capable of nitrogen fixation through the activities of the bacteria in their hindguts. The activity of these termites could play an important role in soil fertility. Therefore, before control measures are undertaken, an assessment should be made of benefits weighed against loss of termites from the ecosystem.

Biology of termites

Termites (order Isoptera) are a large group of insects comprising approximately 2500 species. About 300 of these is recognized as pest species, widely distributed throughout the tropics (Logan et al. 1990). Termites probably cause most damage in tropical agriculture and forestry, including total loss of some young plantations. Termites have been implicated in damage to crops, exotic forestry, and wooden buildings in many areas in the tropics. Significant economic losses have been quantified.

Termites have three castes, soldiers, workers and reproductive. A new colony is formed when a pair of a winged reproductive fly away from the existing colony (Fig 24). They lose their wings on landing and after mating the female’s abdomen swells. She becomes a queen producing up to tens of thousands of eggs within her lifetime. The amount of egg production is species dependent but termite colonies do establish very quickly (Olkowski et al. 1991). The winged reproductives are dark brown to brownish black and have two pairs of equal size wings that extend well beyond the body. Swarms are common in spring and fall, especially after a rain. The queen may live up to 25 years and lay more than 60,000 eggs in her life time. The eggs are yellowish-white and hatch after an incubation of 50 to 60 days (Ohio University, 1991). The occurrence of swarming over a long period of time for the same termite indicates that swarming is not a single day phenomenon, but could last for several days. Following swarming the alates fall to the ground shed their wings and form tandem pairs. Tandem pairing continues for a few minutes until suitable nesting sites are located. Type of nests constructed could vary with the
species. Generalized termite mounds that adopted from Wood (1991) are presented in Fig 22. It is sometimes possible to observe sex in the afternoon. Some workers, soldiers and immature of termite spp. migrate above ground on barren lands. This is a rare method by which certain termite species establish new colonies and is known as sociotomie (Abdurahman, 1990). Alate is may exposed to different predators and approximately for about 99% of these alates are may destroyed by predators. But, natural enemies due to deforestation, burning the area etc destroyed and caused increased termite population and damage. Full-grown workers are soft bodied, wingless, blind and creamy white. In early stages, they are fed predigested food by the king and queen. Once workers are able to digest wood because they have symbiotic bacteria they provide food for the entire colony. The workers perform all the labor in the colony such as obtaining food, feeding other caste members and immature, excavating wood and constructing tunnels. Workers mature within a year and live from three to five years. Soldiers are creamy white, softly bodied, wingless and blind. The head of the soldiers is enormously elongated, brownish, hard and equipped with two jaws. Workers must feed soldiers because they cannot feed themselves. They are less numerous in the colony than workers and their only function is to defend the colony against invaders. Soldiers mature within a year and live up to 5 years (Shripat, 1991). Twelve species of termites belonging to two sub families and nine genera have been recorded in Wollega (Table 9). Four of the genera belong to the sub family Macrotermitinae and the rest to the sub family Apicotermitinae.

Table 9. Termite species recorded in West Ethiopia

<table>
<thead>
<tr>
<th>Subfamily</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrotermitinae</td>
<td><em>Macrotermes subhyalinus</em> (Rambur)</td>
</tr>
<tr>
<td></td>
<td><em>Microtermes nr. adschaggae</em> (Sjostedt)</td>
</tr>
<tr>
<td></td>
<td><em>Microtermes aethiopicus</em> Barnett et al</td>
</tr>
<tr>
<td></td>
<td><em>Odontotermes sp D</em></td>
</tr>
<tr>
<td></td>
<td><em>Odontotermes sp E</em></td>
</tr>
<tr>
<td></td>
<td><em>Odontotermes sp I</em></td>
</tr>
<tr>
<td></td>
<td><em>Pseudoacanthotermes militaris</em> (Hagen)</td>
</tr>
<tr>
<td>Apicotermitinae</td>
<td><em>Astratoteermes nr. Pacatus</em> (Silvestri)</td>
</tr>
<tr>
<td></td>
<td><em>Adaiphrotermes nr. Scaphheutes</em> (Sands)</td>
</tr>
<tr>
<td></td>
<td><em>Gyscotermes trestus</em> (Sands)</td>
</tr>
<tr>
<td></td>
<td><em>Ateuchotermes rastratus</em> (Sands)</td>
</tr>
<tr>
<td></td>
<td><em>Firmitermes abyssinicus</em> (Sjosted)</td>
</tr>
</tbody>
</table>

Macrotermiteinae
grass, wood, dung and plant debris feeders
some damage crops, trees and rangeland

Figure 22. Diagrammatic representation of termite nests in generalized Ethiopia
Savanna woodland
Figure 23. Total number of termite mounds counted and destroyed during last five years in the four districts of west Wollega, Ethiopia

<table>
<thead>
<tr>
<th>Name of the districts</th>
<th>Counted</th>
<th>Destroyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manasibu</td>
<td></td>
<td>120,000</td>
</tr>
<tr>
<td>Nedjo</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>Jarso</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>Boji</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Western Wolleg Zonal agricultural office, Crop Protection team. Yars Gudeta (Unpublished)

Figure 24. Different castes of termites (example, Kaltermitidae)
Research and development experiences on termites

Termites have been implicated in damage to crops, exotic forestry, and wooden buildings in many areas in the tropics. Significant economic losses have been quantified. The need to develop environmentally sustainable termite control technologies cannot be underestimated. Expensive control campaigns using highly toxic organochlorine termiticides have previously been misdirected against termite species of no significant economic importance.

Termites can be pests wherever there is woody vegetation as they have the ability to breakdown almost all types of plant cellulose. They can also cause severe damage to wooden housing. The generally accepted method of control over the years has been by organochlorine pesticides. However, owing to the detrimental impact pesticide have on the environment and health, and their high costs, there is a significant demand for alternative methods of control in different tropical countries.

The status of agricultural research on termites in Ethiopia

Termites pose a threat to agricultural production in Ethiopia and especially in West Wellega. They are reported to cause widespread damage to a variety of agricultural crops, forest trees, rangelands, houses and other wooden structures (OADB, 1996). Research on the termite problem has however been limited to scattered individual research projects, over time and in different institutes, and focussing on specific aspects such as the use of particular tolerant grass species to termite infestation or testing the effectiveness of different chemicals for control. Almost all the research so far done is entomological in orientation and no systems approaches have been adopted in analysing and understanding the problem. A survey was conducted in the affected areas to identify the species of the termites. Abdurhaman (1991) reviewed the survey conducted in western, southern and eastern Ethiopia and indicated that there are 15 new termite species, belonging to 5 genera. Cowrie et al (1990) recovered 61 species belonging to 52 genera and 4 families in Ethiopia as a whole. Abdurhaman (1991) also reviewed the foraging activity and differences in seasonality of the different termite species (Macrotermes, Pseudacanthotermes). Wood (1988) indicated that the Macrotermes and Ancistrotermes form small diffuse subterranean nests with numerous galleries extending toward the soil surface, and cause damage to plants by penetrating larger roots and excavating upward within the stem.

Wood (1986) quantified losses due to termite damage as 20 % in maize, sorghum, and groundnuts, and 25 % in pepper, and made several recommendations for short control, as well as development of long term pest management practices.

Sanna (1973) reported an increase in the termite problem in Manasibu district, which had resulted in the migration of farmers from the affected areas to the lowlands in search of new lands. Lack of fertilizer, over-cultivation, and the resultant soil denudation and erosion were said to have aggravated the situation.

Abdurhaman (1993) undertook studies on termite distribution, pest status, and ecology. Swarming of the macrotermes and microtermes was noted to occur at the beginning of the rainy season, while odontotermes swarmed from the middle of the rainy season. Microtermes were found to forage more significantly during the wet season than the dry season.
pseudocantothermes more during the dry season, while macrotermes subhyanus foraged throughout the year (Abdurhaman, unpublished data).

Further studies and morphometric analysis were conducted on the mound building behavior of termite species recovered from Manasibu and Meki-Ziway and showed different mechanisms are employed in mound building (Firdissa Eticha, unpublished report).

Abraham (1990) conducted studies on various chemical and non-chemical control methods, involving fertilizer application at different rates, different seeding rates on maize. Application of plants with insecticidal properties also did not control termites on *soyoma* (*vernonia thomsoniana*).

Trials at Bako, Didessa, Manasibu and Gimbi using different chemicals; Chloropyrifos (5%), Isophenfos (40%wp) and Aldrin failed to provide adequate protection against termites attacking maize. Furrow treatment, seed treatment as well as soil treatment all did not give satisfactory control of termite damage and effect on crop yields. Seed dressing trials with Aldrin however showed significant reduction in plant damage (Abraham and Adane, 1994).

Demonstrations of termite control methods were also organized between IAR, EPID and the plant protection section of the ministry of agriculture in 1980/81 (IAR, 1980). Termite control trials on grasses were conducted to establish permanent grazing with Aldrin seed dressing of forage seeds. However, results indicated poor germination and there was no adequate termite infestation in the Nedjo hill soil site at the time of the trial. The trial failed because of lack of cooperation from the local farmers. More research on resistant grass species was done. A hybrid of Napier grass and typhoides showed promising resistance to termite damage. Termite damage was not evident even though the planting material was not treated against the pest. The grasses were also thought to contribute to control of soil erosion.

Further trials by the IAR were conducted on yield loss due to termites on pepper, maize teff. Abdurhaman (1990) in concurrence with Sands (1976) and Wood (1986a and 1986b) observed that widespread denudation seen in the rangelands of West Ethiopia is a result of overgrazing by a heavy cattle population. He further observed that rangelands protected from cattle grazing had a luxurious grass growth while unprotected adjacent areas were barren and denuded though conditions were the same.

**Farmers termite management strategies**

Small holder farmers use various traditional methods of termite control to prevent crop damage caused by termites in the tropics and sub tropics. The traditional methods used by the farmers in western Ethiopia include flooding mounds, digging mounds and removal of the queen or excavating the top parts of the mounds and burning straw to suffocate and kill the colony. Placing the produce of different crops on wooden beds protects harvested crops raised few centimeters above the ground from termite damage. Malaka (1972) described 23 traditional methods of termite control used by farmers in Nigeria. These methods include burying dead animals such as goats and dogs in the middle of infested fields, or planting different species of grasses such as *Vetiveria nigratana* (Benth), *Digitaria* species and *cymbopagon shoenanthus* spreng at several spots in the farm to repel termites. Various recommendations based on general observations rather than on field trials and hence without quantifiable benefits, have been made for termite control. Some methods are believed to discourage the build up of large populations particularly that of microtermes.
In the tropics different pesticides have been used to control termites. Termite control has depended for the last 40 years on the use of cyclodiene organochlorine insecticides namely aldrin, dieldrin, chlordane and heptachlor. Different methods of insecticide application were used for termite control in crops. The most appropriate methods for farmers are seed and soil treatments. Alternative control options for termites have not yet been developed in Ethiopia.

Termites that cause crop damage in Ethiopia can be grouped into mound building and subterranean nesting termites. According to Sands (1976) most termite species that cause crop damage in Western Ethiopia are completely subterranean and the one species that builds mounds also exists as subterranean at its earlier stage of development. Mound poisoning is relatively simple to carry out and less likely to pollute the environment since small amounts of insecticide are used per nest, but it has several limitations. It can neither be carried out in areas where there is shortage of water since large amounts of water are needed for mixing the insecticides, nor can it be conducted during the dry season as the mounds get too hard to dig. However, the most important limitation is that it can be used only against the species that build mounds and on mature colonies, so that in areas with several termite species only partial control can be achieved and the subterranean species will continue to damage crops. Since the effect of mound poisoning on crop yield is not known, an assessment of the method is quite important.

The control of subterranean termites requires a different approach from that of mound building termites. Since they do not build mounds and location of their nest is not known, the colony cannot be attacked directly. Therefore, earlier scientists suggested that the most appropriate strategy is to protect crops from being attacked using such control measures requiring a persistent insecticide that would protect crops throughout their susceptible period such as the organochlorides mentioned in the previous page. In West Wollega mound poisoning and seed treatment using these chemicals were also common. In 1983 and 1988 extensive mound poisoning campaigns were organized and conducted by MoA in Manasibu, Jarso and parts of Nedjo districts (Table 10). In 1988 RRC also organized mound poisoning campaign in Assosa and Anger Gutin which was funded by UN resulted in 2145 mounds treated. Western synod based at Chalia (ayria) also organized queen removal campaign when 2300 queens were caught. Coffee and tea development also in 1988 organized a mound poisoning campaign when more mounds destroyed. Mound poisoning campaigns after 1990 by OADB are presented in 23.

Due to the intensification of the termite problem in the region, between September 1987 to September 1988 queen removal was adopted as an alternative and became a popular termite control method in the region. During this period more than 23,000 Macrotermes queens were handed in by farmers. Then government used a small monetary incentive to boost queen removal by farmers. As mentioned above mound poisoning is the most commonly used termite control in the region.

Aldrin 40% WP seed treatment is standard recommendation for termite control on staple food crops (Crowe and Shitye, 1977; Sands 1976, Wood 1986 a b). However several seed treatment studies conducted on maize showed no significant improvement in grain yield (IAR 1983; Abdurahman, 1990). No significant differences in grain yield and in crop infestation were observed in teff when Aldrin was applied as seed treatment (Abraham, 1987; IAR, 1985, 1986).
The failure of seed treatment is probably due to lack of effective barrier around the plant parts that lie below the soil surface. Due to lack of effective control, seed treatment is less frequently used. Continuous use of different chemicals have serious drawbacks, the effects of which have, however, to date not been assessed in Western Wollega region. These include persistence in the environment, development of resistance to pesticides by termites, and elimination of many beneficial organisms/insects from the ecosystem because of the non-selectivity of chemicals, among others. Lack of standard application rates and scarcity of foreign exchange further limit their use. Closure of soil aggregates by pesticides may reduce infiltration and contribute to soil erosion.

Table 10. Results of some mound poisoned campaigns.

<table>
<thead>
<tr>
<th>Year</th>
<th>Treatments</th>
<th>Applied (kg)</th>
<th>Mounds treated</th>
<th>Labour (man days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>Aldrin 40 % WP</td>
<td>12078</td>
<td>635098</td>
<td>208638</td>
</tr>
<tr>
<td>1988</td>
<td>Heptachlor 40 % WP</td>
<td>13077</td>
<td>557563</td>
<td>79197</td>
</tr>
</tbody>
</table>

Alternative termite control methods

Organic control methods

There are a number of alternatives to using organochlorine pesticides for termite control, which are in many ways more desirable to both the environment and the farmer. The organic ways in which to control termites can be categorized as biological control, plant resistance, natural methods and physical and cultural methods. Termite can be a major problem for farmers wanting to plant trees on their land. Chemical controls are expensive and also are damaging to the environment, but other methods may help to keep termites away. If poultry manure is mixed in with the compost being used for transplanting the young tree seedlings or wood ash or burnt cereal straw is spread on the soil around the base of the young trees, termites will be discouraged. Another proven method is to attract the large predator ants of termites. In order to do this, bones are ground down to form a powder which is then mixed in with the soil when the young trees are planted. Watering the trees with water that has been used for cooking cereal grains is also (Spore,1998). These methods of termite control work with natural systems and help to promote the natural pest control mechanism already operating in the field. The development of all these potential biological control can only be carried out and used effectively in well equipped laboratories of concerned organizations.

Biological control

Biological control is the use of natural enemies to control pest organisms that threaten forestry and agricultural production. Natural enemies of pests include predators, parasites and pathogens, many of them highly specific in their action. They can provide foresters and farmers with a free, self-renewing and ecologically sound means of pest control.

Predators

Termites have a large and wide range of predators, and provide a rich protein source to them. Arthropod predators include scorpions, spiders, solpugids, dragonflies, cockroaches, beetles,
flies, wasps, crickets and ants (Wood and Sands, 1987). Research into the use of these predators as a biological control has often had more success in the laboratory than in the field. A completely successful biological control method that can be adopted throughout the tropics has yet to be found. Most research has concentrated on the use of ants, nematodes and fungi, with many studies producing successful results.

**Ants**

Many ants are predators of termites, and a completely successful biological control species may be found amongst them. There is a potential for ants as biological control agents and species that show promise for this purpose are listed in Appendix

**Nematodes**

Nematodes enter their insect hosts both via natural openings (mouth, anus, and spiracles) and by active penetration of the cuticle and inter-segmental membranes (Bedding and Molyneux 1982). They have a pathogenic action, which is at least partly due to infection of the host by bacteria associated with the nematode (Georgis et al 1982). Studies on the use of Nematodes as a biological control are listed in Appendix

**Fungi**

Due to the behaviour of termite, biological control by fungi has provided limited success. Termites tend to isolate ill or dead individuals and consequently do not readily pass on diseases to one another. Lund (1971) discussed the microbial control of termites before 1971 and concluded that while laboratory work demonstrated the possibility of fungi as a biological control technique, field trials had given disappointing results. Research into the use of fungi for biological control is listed in Appendix

**Plants with termite resistance**

Many plants have evolved a natural resistance to termite attack and, where possible these should be used in preference to more susceptible plants. There has been little research in the laboratory into plants with termite resistance and most information has been reported from the field. In many cases reports do not mention which termite species the plant is resistant to or in which country, therefore the information has limited use. Wherever food crops can be grown in the tropics termites that are able to attack plants or trees will be found (Sands, 1973b). Owing to the lack of knowledge about crop resistance, the control of termites in a crop field may require other organic methods. However, like trees, indigenous crops are generally more resistant than exotic crops. For instance, in other parts of Africa, sorghum and millet are more resistant to termites than maize and cowpea and Bambara nuts are not attacked while groundnuts suffer serious damage (Logan et al 1990). The same situation pertains in the study area. However, some exotic plants such as mango, avocado and citrus have been shown to be resistant to termites in South Africa (Logan et al 1990). Crops are freely attacked when resistance is low. Annual crops are attacked towards harvest time while perennial crops are attacked most destructively either during any season or in the early stage of growth, such as newly transplanted seedlings or cuttings Sands, (1973b).
Tree resistance

The degree of resistance depends on trees species, tree provenance (the source of the seed), termite species and tree age and condition (Logan et al, 1990). Generally, indigenous plants are a great deal more resistant to termites than exotic species. The susceptibility of living trees to different termite species may also differ within region. In Australia, Eucalyptus marginata and Araucaria cunninghamii have different degrees of resistance to Coptotermes spp. and Nasutitermee exitiosus (Cowie et al 1989). A number of trees and shrubs that are reported to be termite resistant are shown in Appendix

Natural methods

Plant parts and plant extracts can be used effectively in termite control. Locally available plants can be a very useful source of termite control for foresters and farmers. These plants are either toxic or repellent to termites or have anti-feedant properties. Many of the termite controlling parts of the plants can be extracted and used as natural insecticides against termites by grinding up and placing the appropriate part of the plant in boiling water, stirring and leaving to soak. The mixture is then sprayed or painted onto the required area. Alternatively the plant part can be applied directly and this is often done with toxic fruit juices, pulps or shavings. Ideally, plant insecticides should come from readily available local plants or those that are easy to grow, preferably on poor quality land so that they do not compete with food or cash crops. The active ingredient should be available with little or no preparation and the plants should not develop into weeds or act as hosts for crop pests or diseases. In addition they should have low toxicity to non-target organisms, especially beneficial insects and humans (Logan et al,1990).

Most of the alternative control methods above are not yet available to farmers in West Wollega although they may provide opportunities for future management of the termite situation. Farmers have, however identified a few tolerant plants which they are currently trying to turn to in order to cope with termites. Organic control would be good avenues for further exploration by farmers.
CHAPTER EIGHT

A SYSTEMS ANALYSIS OF THE TERMITE SITUATION

Through out the study period, the team kept an open mind and viewed the termite problem from a broader systems perspective. Although the local staff, other counterparts as well as the farmers all incriminated the termite as the cause of all the environmental changes visible, at each stage of the study the team made an in-depth analysis of each problem and it stressed the relationship with others to see if it fitted in or influenced the complex termite situation.

The prominent feature observed at the time of the study were: high livestock numbers, grazing in the valley bottoms, hill slopes, around homesteads and in most of these place the scarcity of forage was clearly evident; heavily denuded/ degraded hill slopes, small thin and weak looking animals including oxen and steers; plenty of termite galleries and evidence of termite foraging the remnant grass litter (it was very dry at the time of the first phase of the study, highly water stressed soil and evidence of an intensive cropping pattern in the previous season, deep and sometimes massive gullies rainfall erosion, absence of any significantly visible soil and water conservation efforts (except shallow faros running almost down the slopes (along the gradient). Also absence of agro-forestry multi-purpose trees.

Even before the rains came, it became clear to the team from review of literature and informal discussions with woreda staff as well the reconnaissance survey, that there was a strong livestock -crop interaction and that livestock played a significant role in the farming system. This was later confirmed when the rains came and everywhere farmers were seen with one or two pairs of oxen preparing the land or planting the first crop. It further became clear to the team that termites alone were not the problem but rather there were many other factors inter-linked which if not tackled would result in failure of any current or future control/ management efforts as has hitherto been experienced.

The presence of termites in a region can depend on various factors, such as soil and vegetation type. Climatic features and water availability play an important part in termite survival. Daily and seasonal changes in these factors also affect termite distribution and situations. Not known exactly what would happen without the termite, but there would certainly be an accumulation of organic material. So that in different literature it mentioned that as the activity of these different termite species could play an important role in soil fertility and formations.

Problem causal analysis-research themes and leverage points

The termite situation is complicated due to its complex interaction and interrelationship with various farm systems, agroecological and socio-economic environment. To have a systematic understanding of the complexity and interaction of the termite situation affecting agricultural systems and livelihood of small farmers, the team brainstormed on cause and effect relationships of termite situation. The team analyzed and unraveled the complex linkages between factors (causes and effects) affecting the problem situation. Subsequently the team’s experiences and varying multidisciplinary background were used to integrate the different perspectives in order to build comprehensive problem-causal relationships (Fig 25 and 26).

Based on this exercise the following six key research themes (see also highlighted box in the causal diagram) related to this problem situations were identified and analyzed for
developing potential leverage points for interventions.

- Termite situation
- Crop management
- Natural Resource Management
- Livestock production
- Agricultural knowledge and information
- Socioeconomics

Among these six key research themes, the termite situation was the major theme for analyzing the cause-effect relationship. After developing problem causal tree or problem areas and leverage points related to each theme were identified. Then suggested potential solutions related to each theme (recommendations) were finally verified with stakeholders during the workshop to improve relevance of the study.

The causes of recent spread and intensification of the problem were systematically identified and linked to relevant boxes of the problem causal tree from below using information from various sources. Subsequently the effects of termite situations on biophysical environment and farmers livelihood are analyzed and linked through the relevant themes to termite situations from above.

*Analysis of the causes*

The causes for recent spread and intensification of the problems in West Wollega has been ecological change caused by unsustainable use of natural resources (Fig 25 and 26). The change in ecology has resulted disruption of prey-predator relationship, soil degradation and reduction of natural feed for termites. This has cumulatively affected increase reports of termite damage.

*Analysis of the effects*

The major effect of termite damage is land degradation, which results from cumulative effect of crop damage, reduced biomass and livestock feed sources from increased termite attack. It also has negative effect on farm productivity and income which finally results in increased poverty, migration and vulnerability (Fig 25 and 26).
**Figure 26. Summarised problem-causal diagram on termite situation**

<table>
<thead>
<tr>
<th>Poverty &amp; vulnerability</th>
<th>Low farm investment</th>
<th>Land degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease household income</td>
<td>Decrease farm productivity</td>
<td>Overgrazing</td>
</tr>
<tr>
<td>Decrease food availability</td>
<td>Damage to crops, coffee &amp; tree seedlings</td>
<td>Decreased feed availability</td>
</tr>
<tr>
<td></td>
<td>Pressure on livestock feed resources</td>
<td>Loss of top soils</td>
</tr>
<tr>
<td></td>
<td>Soil exposed to erosion</td>
<td>Reduced biomass</td>
</tr>
</tbody>
</table>

**Termite Situations**

<table>
<thead>
<tr>
<th>Increase visibility of abandonment of land</th>
<th>Increase termite population</th>
<th>Attack on crops, trees &amp; infrastructures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increased reports of termite damage</td>
<td>Shift in termite feeding behaviour</td>
</tr>
<tr>
<td></td>
<td>Disruption of prey-predator relationships</td>
<td>Reduction in natural termite feed sources</td>
</tr>
</tbody>
</table>

**Ecological change**

| Unsustainable use of natural resources | |
|---------------------------------------|
Farming system and termite inter-relationship

Increased human population that led to the clearing of forests and shortening of fallow period, combined with increased livestock population have largely contributed to the current land degradation widely seen in Zones I and II. Termites used to coexist with the environment, but has become a serious pest to range lands and crops following inappropriate crop, rangeland and soil management practices.

Many of the crops grown in Zones I and II are the outcomes of long time farmers’ deliberate selection. As soil fertility declined and termite attack on crops increased, the production of some crop species or varieties less suited to these situations was reduced or replaced by crops that are able to grow and give some yield. The shifts in farming system, over time is shown in Figure 8. The percentage figures represent cultivated land assigned to the crop species/varieties grown by a modal farmer in Zone II. Except slight decrease in area allotted to annual crops due to predominance of coffee, similar trends were observed in Zone I.

Among the strategies that farmers followed to cope with the termite situation, the gradual shift from cereal monocropping (maize/Sorghum) to root and tubers needs to be encouraged and should be backed by strong support from research and extension. By growing yam, taro, Irish potato, etc during off-seasons, farmers managed to minimize food shortage and increased food grain cost that otherwise many of them would confront and can not afford in lean periods (May-June). High yield per unit area and protection of the soil against the action of radiation and rainwater erosion are also the most important but less appreciated benefits of root and tuber crops production. In cereal crop fields that are noted for intensive cultivation, over grazing and high soil erosion, finger millet has almost replaced teff. Likewise maize in homestead fields has been moved to valley bottom fields and its place in the homestead fields is largely overtaken by sorghum and root/tuber crops.

The extent of termite attack on crops/ rangeland was observed to vary with differences in biophysical features (e.g. topography) and prevailing cropping system. Field type and termite relationship showing these differences are described below.

Homestead fields. In homesteads and valley bottom field types, crop damages that associated with termite are much lesser than cereal crop field types. The overriding cause for low termite damage of crops in the valley bottom fields is high soil moisture regime. Less crop damages by termites in homestead field types are mainly due to cropping systems, manuring and application of ashes from burning of household wastes and crop residues. Since homestead fields receive regular supply of ash, they have high in exchangeable cations (e.g. calcium, magnesium, sodium, etc) and hence soil pH. As a result, relatively crops are vigorous and less susceptible to termite attack. Biomass burning and ash distribution although important to temporarily raise the soil pH and the availability of some nutrients, the effect is short lived and results in the loss of important soil component, the organic matter, and needs to be replaced by some efficient organic waste/residue management techniques. Composting, for instance, is one of such techniques and farmers should be encouraged to practice it.

As opposed to cereal crop field types, in the homestead field types of all Zones, maize and sorghum are planted at the first shower of the main season rain and followed with interplanting of pulses, cabbage and pumpkins which provide vegetation cover to the soil and minimize loss of top soil and water. Part of the homestead fields that covered with the plantation crops (e.g. banana, coffee, etc) and dry season planted yam, taro and sweet potato.
not only have low incidence of soil erosion but also are less prone to crop damage by termite. But the size of these fields are influenced by resource endowment (e.g. availability of labour, oxen and manure) and in effect are small for medium resource and women headed household typology groups.

Better crop yields (See soil section) that associated to manured plots possibly could be due to all or some of the following factors.

- Shift in termite attack from the crop to the manure
- Nutrient release from part of the manure not removed by termites
- Improved soil physical properties which could be the outcome of the added animal manure and the action of the termites on the soil

Cereal crop fields. From direct observation and farmers interviews, cereal crop fields were found to be more affected by termites and inappropriate crop and livestock management practices. These fields being far from the homesteads receive no fertility restoring inputs like animal manure and household wastes. Their fertility status is further worsened by heavy erosion that come as a consequence of the steepness of the slopes and intensive cultivation practices required by crops (teff and finger millet) commonly grown on them. As crop growth and productivity on these field types are also constrained by low pH and soil nutrients (Table 2), the claim that put to termites as a sole cause of low crop yield is may be taken out of proportion.

In cereal crop fields, following crop harvest the stubbles/straw are removed both by humans and livestock and little if any is reinvested. This leaves the soil bare and expose it to erosion and soil impoverishment. In these fields, rotation sequences are based on nutrient demand of the crops, where crop demanding fertile soil e.g. teff is put immediately after the opening of the fallow and the less demanding finger millet grown up during the subsequent and end of the rotation cycle. This rotation sequence has little to do with the conventionally accepted merits of crop rotation, for example, fertility maintenance and control of insect pests and diseases and weeds. Alternating teff and finger millet, crops similar in many agronomic features, has led to the build up insect pest and disease (e.g. teff shootfly) and depletion of soil nutrient that results in less vigorous crops susceptible to termite damage. Farmers in Zones I and II say, at past times when the forests were opened for the first time they used to alternate field peas and faba beans with cereals. They do not grow them now. They attribute soil fertility decline and the susceptibility of these legumes to termite attack for dropping them out of the rotation sequence. Field pea and faba beans fetch good money on sale and are the preferred crops for sauce. Their absence, therefore, have serious economic and nutritional implications. Pulses that currently grown in small quantity on homestead fields serve similar purposes but farmers in Zones I and II complained that pulses neither are safe from attacks of termites nor suited to impoverished soils of cereal crop fields. To get these most hardy food legumes (field peas and faba beans) back into production and arrest further degradation of cereal crop fields, initiation of participatory genotype screening with special reference to termite tolerance and bio-physical situation of these fields is very important. Factors contributing to land degradation on cereal crop fields are summarized by Fig 27.
Figure 27. Interrelationships of crop/livestock management practices and land degradation
Natural resources and termite inter-relationships

Of the studied area the largest cattle’s population is found in Manasibu (Zone I), followed by Nedjo and Jarso (Zone II) districts. High livestock number, apart from being a cause to overgrazing, tramples and weakens whatever grass remains thus predisposing it to more attack by termite compacts the soil and rainwater infiltration grass the vegetation on weakens predisposes resulted in overgrazing. Overgrazing seems to have a direct relationship to the current high level of termite damage to the grass and natural vegetation. Termites causes damage to natural vegetation, and high livestock number means that they highly trample the vegetation on, leaving them stressed and more vulnerable to termite attack. The termites also attack more easily heavily grazed vegetation while the soils are more vulnerable to sheet erosion. This together with the rainfall erosion results in removal of organic matter from the topsoil therefore aggravating the termite problem. Where increased pressure on natural resources has resulted in deforestation, they make the problem worse. Farmers however believe that the apparent overgrazing is a result of termite damage of vegetation rather than the termite problem being aggravated because of overgrazing.

Forest resources and termite relationships

In both study zones, farmers use tree to fulfill their days to day needs. For example, wood made houses cannot last more than 2-3 years due to the damage by termites. Thus farmers cut trees for rebuilding their houses. Forests are cleared for such purposes like firewood, construction of kraals and expansion of agriculture. All these expose the soil to erosion, removal of organic matter and increase incidence on crops, range lands and wooden structures. The cause-effect relationships between multitude of factors and the termite situation are given in Fig 25 and 26.

Common property resources

Farmers and other rural actors are dependent upon access to a number of different CPRs for their livelihoods. Open access, pressures of poverty, insecurity of land tenure, lack of clear ownership and well functioning management structures and controls, have resulted in degradation of common property resources. This has resulted in ecological change and an intensification of the termite problem. The institutional capacity of CPR user groups and local government, to sustainably manage these resources is weak. At present the social and community context of management systems for natural resources management are inadequately addressed, with no emphasis given to the institutional delivery of projects or programmes. There is a need for clear ownership and access of resource rights to be outlined and effective community institutions and participatory management strategies developed to provide incentives for sustainable management of these common resources. A capable community based institution, with an integrated and participatory approach incorporating all levels of stakeholders is needed to assist in delivering interventions.

Forest resources

Farmers are highly dependent upon available forest resources for household needs including fuelwood, timber and tree fodder. The unsustainable use of these resources has led to severe deforestation over the last thirty years. The decline in forest area has lead to a shortage of available plant biomass. This has implications for resource poor households and the sustainability of future forest resources. Whilst also resulting in reduction of feed sources and suitable savannah woodland habitats for termites. The ecological change and competition by an expanding human population and termite population with reduced feed sources has
contributed to the increase in termite attack on crop and pastureland and lead to an intensification of the termite situation.

There is a need for forest management practices that foster wise use of diminishing multi-purpose tree and shrub resources. A participatory evaluation and dissemination of termite resistant tree species that meet farmers needs could ease the pressure on declining forest resources. To maintain valuable indigenous tree species and forest diversity, there is an urgent need to enhance farmer’s awareness of the consequences of deforestation. This will require a shift from current top-down approaches of forestry development programmes and the implementation of participatory forestry programmes that build upon the farmer’s priorities, management and indigenous knowledge.

Soil Management

The implementation of soil and water conservation is problematic due to; inappropriate technology with a high labour demand, a top down approach lacking farmer participation, fragmented land holdings, insecurity of land tenure and free grazing systems. Farmers have their own criteria for measuring the likely success or failure of soil and water interventions. There are a number of local plant species that might meet farmer’s criteria for soil and water conservation. The research and extension service have a limited knowledge of the systems complexity of the causes of soil erosion and of farmer focused participatory soil and water conservation technologies and delivery systems. There is a clear lack of resources and policies to mandate the departments to tackle the problem. A top down approach and the problems of land fragmentation, inappropriate technologies, fear of forced co-operation, free grazing, insecurity of land tenure and high labour costs as reported by farmers, are all likely to effect future project success.

Future research is needed to establish what farm management practices; crops, field types and typology of farmers contribute to soil erosion. Further research needs to establish an inventory of indigenous; technologies, plant species, soil fertility management practices and to then develop by typology and field types systems of delivery for appropriate soil and water conservation. This must all be considered within the context of a capable participatory community institution working in conjunction with the extension and research services.

Soils and termite relationships

In the field types most reportedly affected by termite damage (e.g., sloping and abandoned cereal) fields soil degradation was a significant problem. From direct field observation and through discussion with researchers it was noted that degraded sites had low infiltration rate and increased water runoff.

Termite damage was also reportedly higher in areas that had high grazing pressure. In theory if the land was heavily grazed grass cover would decline and available food biomass for termites is reduced. Vegetative cover to limit erosion and maintain soil structure would then decline and grass seeds be eaten and washed away and thus termite infestation and the subsequent removal of the remaining biomass would increase erosion. This would in turn lead to a decline in fertility and reduction in grass and more stress and so on. This cause a vicious cycle that contributes to the continuation of the problem (Fig 28). Studies should be conducted on enclosed trial plots cultivated and then sown with grass seed and other vegetative species to clarify the termite, soil fertility and grazing interrelationships.
There are difficulties in the methodology for quantifying if degraded areas have a higher population of termites per hectare. On degraded land termite activity and mounds were clearly visible, it is however very difficult to make the same comparison for grassland areas where termites are not so clearly visible. However in lands that have been allowed to recover such as the Nedjo extension departments soil and water test site, where grazing pressure has been reduced, signs of and vegetative regeneration were visible.

The positive aspects of termite and soil relationships were not mentioned once during the study, however the majority of secondary data indicate the importance of termites for soil formation and nutrient cycling. There is a need for further focused location and species specific research to evaluate the role of termites in the farm systems and land use of West Wollega.

The extent of land degradation or maintenance of the soil environment attributed to termites requires further extensive studies. The relationships between land degradation and soil erosion and termite infestation are hard to define. Many interrelated factors such as soil management practices, soil characteristics, ploughing and livestock pressure also impact on the soil erosion and degradation processes. There is an urgent need for more specific quantitative studies to analyse the relationships between termites and degraded land.

Historical factors have influenced the management of natural resources and termite situation. Insecurity of land tenure and lack of clear ownership rights have resulted in unsustainable natural resource utilisation. Clear rights of ownership and access would prove valuable incentives for sustainable resource management. Historical factors affecting the situation must be considered in any future research or interventions. In all zones there is increased pressure on natural resources This has been caused by an expanding human and livestock population, limited options for new land acquisition or migration, insecurity of land ownership and the unsustainable use of resources. This has resulted in ecological change, which has in turn has caused an intensification of the termite situation. The ecological environment cannot be easily separated from the farming systems, policy or socio-economic environment and this should be taken into consideration in any future research and development activities. There is a need for dynamic interventions that address the complexity of the entire system.
Figure 28. Soil erosion, termites and livestock interactions: The viscous cycle.
Analysis of the agricultural knowledge, information and technology support systems and factors relating to termites

A diversity of termite situation related stakeholders with differing objectives and levels of influence where identified throughout the study. The integration and information co-ordination between them is weak. There is a distinct lack of awareness of each other’s agendas and objectives. There is a diversity of skills and information available to tackle the termite problem, however it lacks co-ordination and the necessary information and knowledge networks to make it effective. Overall, there is lack of a co-ordinated and integrated approach to tackle the termite problem amongst all stakeholders. A closer and co-ordinated working relationship sharing information and networking together, would make solving the termite situation more feasible.

The current extension and research activities are top down orientated and focus little on farmers needs, and thus offers little to the diverse majority of resource poor farmers. There is limited participatory farmer involvement in the design and delivery of interventions. This means that potential interventions are less likely to be effective in meeting farmers needs or raising overall productivity and development levels. The extension and research system lacks effective interventions that address farmer’s priority problems such as termites, declining soil fertility and new technologies for coffee. The ineffectiveness of research and extension to meet farmers needs results partly from the lack of comprehensive systems understanding of their clients. Farmers are diverse and utilise different livelihood strategies within dynamic and diverse environments. There is no distinction made between the needs of male or female farmers, consequently technology design and dissemination has a limited involvement and utility for the 50 % of women farmers in study Zones. Many farmers fall outside of the current technology and information support system and are marginalised, especially the resource poor, functionally landless, women headed households and those who are not financially or politically well enough connected. A farm systems, zonation and household typology, developed with participatory techniques and utilised as a foundation to develop fitting research and extension activities, could go a long way to making agricultural research and extension more effective. Farmer participation in research and development is currently minimal there needs to be a bringing together of farmers researchers and extensionist to better understand each other needs and objectives. This could be achieved through on farm field training of staff in participatory techniques.

Many farmers reported dissatisfaction with the package programme and even said it made their situation worse. There is a need for the package programme and extension service as a whole to consider the impact of current programs both in the short and long term. A participatory evaluation of the package programme would yield quality information on its functioning and suggestions to increase effectiveness. This could be conducted in the broader context of a systems analysis of the current extension programmes services.

A variety of formal and informal social institutions exist. Farmers lack a variety of information services to get new information and technology, the deregulation of the private sector and institutional support to village level institutions for the supply of information and technology could increase farmers access.

Farmers undertake research and diffusion services themselves and have a wealth of indigenous knowledge that is not utilised. Research and extension should work with pioneer
farmers, such as those in Zone III and develop an inventory of best practices that might be suitable solutions for interventions in other areas.

Policy factors have a major impact on the overall termite situation, however there is no provision for feedback loops from farmers or fieldwork level actors. If a formal linkage was developed to promote knowledge and information flows from the bottom to the top, policy could be influenced to better meet the needs of all the actors, but primarily farmers to research and extension.

None of the above factors are independent of the termite problem, a poor farmer not being able to get fertiliser relates to the termite problem. A lack of fertiliser and organic manure means the overall farm productivity will decrease, putting an increasing strain on the declining resource base, promoting systems change and exacerbating the termite problem. The termite situation is complex, it needs a systems perspective and developed interventions from all stakeholders at all levels to bring about change.

Socioeconomic and policy considerations

Reduced farm productivity and household income

Poor farm productivity results partly from loss in crop output from termite damage and decline in productivity of the land (Fig 25 and 26). It also results from damage of economically important tree seedlings (e.g. coffee, eucalyptus) and poor productivity of animals by the intensification of termite incidence. Poor crop and livestock productivity also reduces household income from reduced market sales of farm products. Loss of farm output, and abandonment of cropping as a result of termite damage causes significant economic loss to the resource poor farm households. A significant proportion of farm lands (about 30%) in termite infested Zones (Oda Ganka and Bafano Koreche) are abandoned causing significant loss of output and income because of the land degradation, termite problem and poor soil fertility. Source of income from new coffee plantation has also decreased due to increase attack of coffee seedlings by termites. Buildings and wooden structures are damaged and do not last for more than 3-4 years. Farmers have to repeatedly build houses and construct kraals which results in high economic loss (cash and labor cost).

Capital constraint is an important factor responsible for low farm investment in the study area. Because of lack of remunerative off-farm income and employment opportunities in the areas, farmers are constrained to invest cash for better farm management and soil conservation structures. The farmlands are not replenished with both internal and external source of nutrients that are exhausted by continuous cropping and soil erosion. Cash deficit and subsequent use of low inputs and increased indebted ness from crop failures and poor income sources, have further intensified the land degradation and termite problems.

Food insecurity and vulnerability

Loss of farm productivity and income from termite incidence has significantly affected the food security of resource poor farmers particularly those of land less, women headed and marginal, non-ox owning households because they can neither produce sufficient food for their own consumption nor afford to buy part or all of their requirements. Similarly farmers with reasonable size of land but degraded and abandoned from cropping are also food-
insecure and vulnerable since they have to find supplemental income from non-farm sector for their survival.

**Increased workload and drudgery to women**

In terms of gender, women suffer more from termite problems because their workloads and drudgery is increased due to need for immediate transportation of food grains from fields to home after harvest in order to protect from termite damage. In addition, impact of termite damage appears to be high on them as they have more household responsibility of feeding and raising children including farming. They are also overburdened by extra workload of immediate storage of produce and additional construction of storage structure to protect from termite damage.

**Migration and increased disease Incidence (malaria and trypanosomiasis)**

Due to crop loss and resulting food scarcity and land degradation farmers in Baffano Koreche (Zone I) and Oda Ganka (Zone II) had to migrate to lowland with their livestock for their better livelihood. During this process, both animal and human beings have suffered from increased health related problems such as malaria (in human beings) and trypanosomiasis in livestock. Many people and animals were reported to have died during the process of seasonal and permanent migration.

**Increasing population pressure and political unrest**

The population of the farming community has increased significantly over the years. This has resulted in land shortage and temporal and spatial intensification of the farmlands. Fallow periods have been reduced without allowing sufficient time period for soil fertility regeneration. Similarly forested and marginal areas have been encroached onto cultivation and livestock grazing, resulting in land degradation and ecological imbalances (Fig 25 and 26). Historically (in the past), there was exploitation of peasants by feudal landlords before 1974. People were forced to migrate to lowlands by the exploitation of landlords and subsequently by villagization and collectivization during the Derg regime (after nationalization of land by the government). Frequent land reallocation and distribution during the Derg regime have also harmed peasants for the tenure security and effective management of lands (soil conservation). Farmers’ group interviewed indicated that villagization process in the past in addition to increased population pressure has resulted increase deforestation and vegetation loss. Combination of all these factors have disrupted ecological balance and cause poor management of lands which appeared to have aggravated the intensification of termite problem.

**Increased livestock pressure on the farm land**

The study area has high numbers of livestock despite the scarcity of feeds and grazing lands. It is observed that the areas have no alternatives for income generation for securing better livelihood. Due to insecurity of land tenure and remoteness there are also no lands, credit and labor markets (off-farm opportunities) operating in the study area which ensure them from the social and income insecurity. Since livestock are assets that can be easily sold and get cash, it is the only easily available and socially accepted livelihood systems that provides poor farmers with insurance against crop failures, famine and unexpected sickness and other risks. Therefore, farmers in the study area tend to keep a lot of livestock without proper
husbandry practices. This has resulted in overgrazing, intensification of termite problems and subsequently degradation and land abandonment.

**Poor markets and infrastructure**

Agricultural markets for both inputs and outputs are generally underdeveloped because of the subsistence nature of farm production, the previous exploitative marketing policies and institutions, lack of marketing and communication networks infrastructure. Therefore, only small volume of farm and non-farm products (e.g. traditional craft) enters the marketing chain.

There is lack of private sector participation in inputs (fertilizer, seeds and pesticides) supply which has constrained the use of relevant technology and inputs for minimizing termite problems. Unavailability of pesticides and improved seed varieties and high price of fertilizer are commonly reported problems by the farmers in the study areas. Similarly, lack of effective markets for the agricultural outputs has hindered farmers to produce more and invest more on the farms.

**Women's poor access and control over resources**

Women, as compared to their male counterparts have less access to and control over resource including decision-making (Table 3). Men have specific control over resources such as land, cash, and credit including control of investment and education funds. Women can control the sale of root crops, fruits (banana, mango, citrus etc.), vegetables (pulses, spices etc.) and that of sheep, goat, and poultry jointly with their husband or alone. Cattle, donkeys and coffee sales are undertaken and controlled by men. However, poor women headed households in Zone I (Baffano Koreche), normally do not have access to Bone maize, oxen and valley bottom coffee land. The activity wise detail of gender related access, and control over resources is presented in chapter 4.

It is observed from the focused group discussion and interviews with women that inequality in access, control over resources and decision making have put disincentives for women to actively involve in sustainable farm management and contribute to reducing vulnerability to termite damage.

**Policy constraints:**

**Land tenure policy**

Current land tenure policy of the government which gives no ownership rights to individual farmers has been observed as one of the prime factors responsible for poor management of lands, low use of technology, inputs and credits resulting in high incidence of termite and vulnerability (Fig 29).
Lack of land ownership has resulted in lack of collateral arrangements for accessing institutional credit. This has also reduced incentive for sustainable land management and land attached investments including poor use of variable inputs. Tenure insecurity also makes farmers develop a tendency to keep high numbers of livestock thereby resulting in overgrazing, degradation, and increase termite incidence. It has also a negative influence on technological change involving the cultivation of perennial crops and trees (Workneh, 1996).
Therefore, presently there is no incentive for farmers to invest more, produce more, and take better care of land.

Credit supply policy:

Cash shortage is a prominent constraint in small farm household production. However, interview with farmers revealed that presently, access to credits is very difficult for resource poor farmers. Commercial banks require collateral to access credits while merchants / moneylenders exploit or charge high interest rate for the credit. At present, governments policy of credit supply is also tied in with inputs (fertilizer) and package which does not give open options for farmers for the use of credit. Moreover this can only be obtained through the government agricultural office (OADB). There is also no policy for credit provisions for medium and longer-term inputs such as purchasing oxen, ox-drawn equipment’s and investment on lands. A specially targeted credit policy for people in termite affected areas is also absent. This has virtually resulted in poor investment on land, low use of variable inputs and increased vulnerability of resource poor farmers to termite damage and crop loss.

Policy on taxes (land/household) at local level

Agricultural taxes at the village level include land use tax and taxes on agricultural incomes. They are issued based on various criteria out of which land size, number of coffee trees, cattle heads, income level and ownership of property become important. Special committees formed by peasant associations are responsible for assessing, levying and collecting taxes. Taxes are also levied uniform by among the households irrespective of the locations, land types, and quality. No reward is given for those who manage land better and effectively. This has probably resulted in no incentives for soil water conservation with the consequence of land abandonment and further degradation of land.
VULNERABILITY AND STRATEGIES TO COPE WITH TERMITE SITUATION

Vulnerability by farm/household typology

Resource rich farm households have adequate farmlands, oxen and other animals, greater access to Bone maize. Therefore, effect of termite damage on this group is less. This is because unlike poor farmers, resource rich farmers with large and many pieces of lands can adjust and change their field whenever there are termite problems. Similarly they have more resilience from termite damage/vulnerability because of the availability of manure for the maintenance of better soil fertility and ability to sell off coffee and/or livestock during adverse situations. They can also afford to buy the current high cost of fertilizer for improving crop productivity.

Since resource poor households lack oxen they are involved in share cropping by exchanging their labor with oxen owning households. Lack of timely access to oxen seriously affects crop planting times of these households and subsequently reduces agricultural productivity and increases their vulnerability. These poor farm households are the last to have access to oxen after every household has finished ploughing or planting crops. In all the study villages, percentage of oxen owning households appear to be very less (<50%). High percentage of land and oxen-less people working as agriculture labour is common in termite infested area of Zone I (Bafano) and II (Oda Gunka). This group is the most vulnerable to productivity decline, crop failures and termite damage. They comprise households, which suffered in the past from productivity decline, land shortage, social unrest and termite damage and migrated to lowlands to get relief. However, because of severe malaria problems and livestock diseases they returned to their present place of abode and have to work as cheap agricultural wage labourers to earn a living.

With respect to gender, women appeared to be more vulnerable to productivity decline and termite effects as they have less access and control of household resources. Women groups in both Zone I and II, admitted that their workload and drudgery have increased after intensification of termite damage. The proportion of women headed households who are at the edge of survival are found high in zone I (Bafano). However, in the other zones, they did not appear to be significant. Villagers considered women headed and households that were dependent on single wage earner to be at high risks of food insecurity and vulnerability. Old age and lack of income support also make it difficult for elderly women headed households to cope.

Socioeconomic Factors Reducing Vulnerability

Household income and cash availability plays an important role in better farm management and increasing farm productivity. Ownership of coffee land in lower slopes near valley bottom (zone I: Baffano) directly influences household income and availability of cash. The production of off-season crops (e.g. Bone maize, root and fruit crops) and the availability of off-farm income during lean season, reduce vulnerability of resource poor farm households. Availability of active labour force also helps in better farm management and timely planting of crops, thus reducing the risks of crop failures, low productivity and subsequently...
minimizing vulnerability to termite problem situation. Social organizations and institutions (e.g. women association, farmers’ service cooperative, peasant association etc.) play vital roles in mobilizing people and community resources to minimize vulnerability from termite damage. In Bafano (Zone I), the community with the initiation of peasant association is supporting to the livelihood of vulnerable women headed households (who lack land and livestock resources) through their labour time.

Farmers indigenous knowledge and coping strategies.

Farmers use different strategies to minimize the effects of termite on crops/ pastures and seedlings. Some of these preventive-coping strategies are:

1. Introduction of new crops: The introduction of sweet potatoes and the gradual increase in the production of tolerant crops like banana, sweet potatoes, taro, tobacco, ginger and yam are some of such initiatives. The tolerance of those crops to termite is attributed to their high moisture content. succulent crops or those with milky secretion such as cactus and sisal are also tolerant to termite attack.

2. Changing field types for crop production: Growing crops in locations of low termite activity like valley bottoms using residual moisture is the other widely undertaken practice by farmers.

3. Use of high seed rate: To compensate for damage by termite farmers’ use higher seed rates at planting.

4. Replanting: In Zone I and II, when farmers are confronted with unexpected crop failures or damages on early-planted crops like maize, they make use of the land and the season by growing tobacco. At Abono Dilla where the soils are more fertile and the season by growing choice, barley, faba bean or pulses replace lost plots of maize or sorghum.

As curative coping strategy possible to mention such as farmers organize themselves into groups through peasant association to destroy termite mounds from their crop fields and in communal grazing areas. As far as cultural control concerned, the communities have attempted to control termites using various traditional and introduced methods. These cultural methods usually used by farmers are:

1. Burning areas of high termite infestation to deprive the termites’ food and to control of weed infestation. Clearing and burning of crop residues are useful to destroy food resources of termites. Unfortunately, this method also takes time and energy. In some areas farmers can remove crop residues and plough the land immediately after harvest to deprive termites their food (Sands, 1977a). This is not always possible in arid zones if the soil is too hard.

2. Hoe weeding or ridging soon after rain is also considered beneficial for destroying the foraging galleries that run near the soil surface and disturbing termites that are foraging (Johnson and Wood, 1980).

3. Varieties of crops may differ in their susceptibility to termite attack, but this variation has not been exploited to a great extent in termite control. Generally, termite damage is considered to be greater in crops grown on poor soils probably the crops tend to be more woody due to lack of moisture, by increasing the humus content of soil termite damage has
been reduced (Harris, 1954). Unfortunately few farmers have sufficient cattle's manure to maintain adequate humus levels (Abdurahman, 1990), but some farmers in all stud zone using these approaches especially around their homestead.

4. Mulching crops with various items including hay, manure, wood shavings, wood ash or threshed maize cobs was said to be dramatically reduce attack by small species of Macrtermitinae (*Microtermes* spp.) in south Africa, although it had much less effect on attack by danger species (*Macrotermes* spp.) (Logan *et al* 1990).

5. Smoking mounds using teff straw, pepper pods, a eucalyptus tree leaves to suffocate and killed termites within the mounds.

6. Dusting ashes around fences and in the fields to protect termite damage.

7. Excavating the top parts of the mounds locating the main underground channel then diesel fuel is poured down the path or underground channel of termites followed by firing using matches to killed termites.

8. Directing water run off or flooding of the mounds to reduce termite population.

9. Growing healthy and vigorous crops using chemical fertilizers that help increase the ability of crops to withstand or tolerate termite damage.

10. Application of a salt solution (brine) into the mounds is also believed to kill the termites.

11. The residue of a local gin (Areke) is usually applied to the bases of construction poles where termites have attacked and built nests in house.

12. Farmers' mechanical control includes digging and removal of queen and exposing the other castes to direct sunshine, birds and other predators to prevent termites from gaining access to their crops.

The other very important control option is biological control. Biological control is in the narrow sense involves the use of predators and parasites to control pest species. In the broader sense also includes disease organisms (pathogens). Use of the latter is some times referred to as microbial control. As far as concerning biological control options, according to key informants of the study areas (Nedjo, Manasibu, Jarso and Boji), *Woldigessa* (*Aardvark oryxteropus afer*), Big ants (*Gadulesa*), and small ants, birds (*Alati*), as well as apes and monkeys were said to be potential natural enemies of the termites. The *Woldigessa* is capable of digging Macrotermes mounds and remove entire castes of the termites. The team observed that the activity of the waldigessa seems to increase following the onset of rains. In Zone I (Bafano Koreche) and Zone II (Oda Ganka the team was able to count between 30-50 mounds showing evidence of Waldigessa activity the previous night. However, the population of the Waldigessa itself is said to have decreased in the study area. Two reasons were mentioned.

1. Farmers kill this predator since it destroys crops and crop fields while digging mounds and searching for termites.

2. The side effects of chemicals used for termite control or mound poisoning is reported to have killed many of them.
Other natural enemies (birds, apes, ants) feed on the swarming termites and contribute to the control of termite spread by preventing the establishing of new colonies, but also through eating foraging termites from their galleries on the surface of the soil. In a situation of increased termite infestation, however, the contribution of biological agents in termite control is insignificant. The use of other biological control agents has not been tried yet in Ethiopia. Abdurahman (1990) indicated that no biological control agents has so far been developed for control of termite in the field. He cited Nematodes (mix 1985) and some nuclear polyhidrosis viruses (Al Fazairy and Hassan, 1988) which were only effective under laboratory conditions. Nevertheless, failed to provide satisfactory control in the field: unfortunately, nematodes are susceptible to both high and low temperature and drying (Mix, 1986). According to Sands (1973) the major limitation to the use of these biological agents is the difficulty of applying sufficient bio-control agents on termites without losing their efficacy. In particular termites, in them so protect the nests and moving subterranean galleries, that applying bio-control agent is very difficult. Walling of dead bodies and cannibalism on dead individuals for nest sanitation (Lee and Wood. 1971) also limits the use of biocontrol agents on termites. Although biological control seems an option, its prospects for termite control are still remote. However, due to the environmental hazards associated with use of chemical, attention is being given to use of biological agents. In Ethiopia no detailed study has been done in this field to identify effective biological agents. Also possible to mention ecological changes of the region causes decline in the prey predator relationship disappearance of some predator species and other natural enemies.

Past and present research and extension interventions

Most attempts to control pests down the ages have been both primitive and largely ineffective. During the present century, and more particularly during the past 50 years, vast improvements have been made in research on pest including control techniques. Pest research and extension control procedures fall rather naturally under a number of headings such as chemical control, biological and cultural control which are descriptive of the techniques involved and which have until recently been well-defined categories. However, some new procedures cut across these established boundaries and furthermore there is now a strong tendency to use two or more approaches together in systems of integrated control or pest management.

In response to farmers' complaint, chemical control on termites started in late 1960s. Reportedly the pesticides came as powder and was diluted in big barrels at the central points and applied to termite mounds. This gave farmers a temporary relief. Subsequent chemical control campaigns on termites were undertaken in 1983 and 1988. In both campaigns farmers were charged a nominal fee of two birr/household. For those farmers interested to apply on their farm they sold Aldrin at a cost of one birr/kg. The cyclical flare up of termite, infestation following few years of these chemical campaigns, however, clearly shows the less likelihood of bringing down the termite problem by chemicals means alone. The chemical control mechanism used in the study area was based on the use of Organochlorine (cyclodiene) insecticides such as Aldrin, Dieldrin, Heptachlor and Chlorodane. However, these insecticides were banned in several other countries. Farmers in the study areas still appreciate the use of these chemicals against termites without considering the main side effects. Also no one has assessed the deleterious effects of the slowly degrading chlorinated pesticides on the environments in the region, deaths of natural predators like Waldigessa around Dandi gudi have been reported. To over come such problems various research programmes were conducted in developed countries to replace the highly toxic organochlorine with less toxic ones. Most insecticides were tested against termites in different
parts of the world where termite problems exist including Ethiopia. However, very few insecticides have so far been recommended as alternative to Organo chlorine insecticides. These were Chloropyrifos, Carbosulfan (Marshal), Cymbush and Gaucho. As the termite problem in the study area reached an alarming level, insecticides were recommended to be used for the control of termites on crops, domestic houses and nurseries. These insecticides were recommended to be applied for mound destruction, seed dressing, treatments for planting holes, furrow and as foliar treatments (Table 11).

Table 11. List of recommended chemicals on termite control

<table>
<thead>
<tr>
<th>Type of chemical</th>
<th>Usage</th>
<th>Rate</th>
<th>Availability in Ethiopia</th>
<th>Supplier in Ethiopia</th>
<th>Current price (Eth.Birr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorpyrifos 48% EC (Pymex)</td>
<td>Mound poisoning with water mixture</td>
<td>50-80 ml/mound</td>
<td>Available</td>
<td>General chemicals and trading PLC (GCT)</td>
<td>80-90 Birr/liter</td>
</tr>
<tr>
<td>Cymbush 25% EC VLV</td>
<td>Foliar treatment</td>
<td>300ml/ha</td>
<td>Available</td>
<td>Chemetex PLC</td>
<td>200 Birr/liter</td>
</tr>
<tr>
<td>*Corbsulfar dust</td>
<td>Seed dressing&lt;br&gt;-planting holes treatment&lt;br&gt;-furrow treatment&lt;br&gt;-domestic houses nurseries plantation</td>
<td>18ml/kg seed</td>
<td>Available</td>
<td>BASF</td>
<td>250 Birr/kg</td>
</tr>
<tr>
<td>**Gaucho</td>
<td>Seed dressing</td>
<td>ES</td>
<td>Bayer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Has sticky elements in it  
** = it is at experimental level but the two years data in Ethiopia and the results else where indicates that the insecticide is the best for termite control  
ES + experimental stage

Source: EECMY-WS (1997)

Pest management is fundamentally different from other approaches to pest control in that it aims
A) to utilize two or more control techniques together in an integrated fashion.
B) to make maximum use of natural mortality factors, and
C) to apply specific control measures only as and where necessary.

Most of the farmers interviewed mentioned that they are forced to use any possible control options to tackle the termite problem. The practical applications of this control options can be as combinations or individuals. Termite tolerant crops such as taro, yam, sweet potato, finger millets, banana, mango and grass spp. (*chomo*) have become farmers' favorite crops to overcome the termite problem. Besides, they used to dig out and destroy mounds, seed dressing and mound poisoning using available chemicals. As mentioned above they also include their own local knowledge to protected their crops, building and plantation. Farmers was not followed the same
procedures of scientific methods of IPM. However, all control options are there in their day to day activities.

The Oromia agricultural development bureau, crop protection departments recently formulate a project on “integrated termite management”. This is combined with cultural control methods of mound destruction, queen removal as well as chemical poisoning and seed dressing with the major objectives of controlling termites through poisoning, seed dressing, surface spraying and by employing other cultural practices together with soil and water conservation practices. The main activities under this project are:

- Destruction of termite mounds through mound poisoning
- Seed dressing with insecticides and surface spray
- Carrying out cultural control practices: such as Tie ridging to reduce termite movement, removal of a crop residue and weeds that harbor termites and preparing compost out of these material, use of well decomposed manure
- Carrying out demonstration on selected farmers’ field to demonstrate integrated termite control packages.

- Training farmers on the basic concept of termite control, soil conservation practices and managing cattle population to desirable carrying capacity of the range land.
- Complete protection of the severely denuded areas from human and animal interference and carrying out conservation practices on the highly degraded areas.

The project above is a good starting point in looking at the termite problem not only as an entomological problem but taking into consideration other contributing factors. There is a need to support and strengthen by establishing collaboration works with other institutes, organization and any actors that are involving in termite situation studies and their control using biological (predators, parasites, entomopathogens), botanicals and other agents.
CHAPTER TEN

PRIORITIZATION OF PROBLEMS, SCREENING OPTIONS AND POTENTIAL INTERVENTIONS

Prioritization of problems

Farmers (resource poor, resource rich, and women), researchers, extension workers and other stakeholders identified several problems related to agriculture and termite situation in the study area. The team listed all these problems as perceived by the different stakeholders (see Annex - list of problems) and prioritized using the following steps.

Steps

1. Preliminary identification and listing of the problems as perceived by the different stakeholders (farmers, researchers and extension workers) through participatory rural appraisals, direct observation and stakeholder analysis

2. Prioritization and ranking of these host of the problems identified by the stakeholders during the farmers meeting (workshops) and mid-term workshop including use of team members' different perspectives and disciplinary background

3. Verification and feedback on the prioritized problems by different stakeholders during third phase of the field study

Screening options and prioritization of interventions

The fieldwork identified the termite problem as being more complicated than originally thought of by local counterparts. The systems analysis demonstrated the diversity of complex interlinkages. From this analysis, it became apparent that a variety of integrated and systems orientated interventions were needed.

An overarching and priority objective of the screening and prioritising process was for recommendations that: “Are most likely to meet the study objectives and output and effectively target the termite situation”

First research and development options were identified after analysis of problems from problem causal diagrams. Then R and D options within the research themes developed were screened basing on the ability to meet study objectives and whether or not the addressed issues of social equity, environmental sustainability as well their economic competitiveness. All stakeholders’ perspectives and team members’ points of view are taken into account in screening a series of R and D options. The following criteria are used for screening process.

- Environmental sustainability- long term versus short-term impact.
- Economic competitiveness- viability, ease of adoption
- Social equity- gender, farm typology, stakeholder participation and benefit distribution
This ensured that all unsuitable recommendations were eliminated. Due to resource constraints, it would be impractical for IAR or Bako to adopt all of the recommendations, also some of the proposals although relevant are outside of Bako’s remit, but are recommended for other agencies adoption. It was thus necessary to prioritise the recommendations to increase the efficiency of research and potential impact on the termite situation. Recommendations / interventions were prioritised using the following criteria and then developed into outline proposals.

- Resource availability- financial and human
- Likelihood of success- ease of adoption, appropriateness and system compatibility
- Timeframe- technology development, interventions and expected output
- National, regional and organisational priorities-policy and objectives

Resources availability considers the availability of both financial and human resources to undertake the research or implement the recommendations as well the availability of the necessary infrastructure for the activity. Likelihood of adoption dwelt of the ease of adoption appropriateness of the technology/recommendations especially in terms of compatibility to the farming system, which would in turn influence, its acceptability. Timeframe referred to whether the recommendation/proposal was short term; medium or long term basing on the time required to develop the technology for implement the activity. The options were also scrutinized in order to propose those that are in line with national objectives and priorities. This was considered important, as it would determine whether or not it appeals to government and attracts funding. However the team also noted that where a recommendation did not fall within the national objectives but was considered vital, it could be included as the process of national objectives and priorities setting it is iterative.

Other consideration in determining the final options to be taken were the type of constraint an, its magnitude the farming system, the extent to which it would address the problem in relationship to farm and farmer’s typologies developed and the recommendation domain to which it would apply, considering the three zones identified for the study. For instance it was discovered that in the typology of farmers in zone II (less infected—Gute-Michael, a class of farmers comprising 17% of the peasant association belonged to have no oxen, and had to engage in share cropping order to access draught power. A recommendation was therefore included for research into alternative animal draught power sources e.g. using donkeys to target this typology of farmers.

Interventions not considered feasible in the farming system, or not likely to address the multifaceted termite problem, were dropped. Policy recommendations were made because even though they fell outside of BRCs mandate, some of the farmers typologies are more affected as a result of policy factors. It was also noted that these would serve s an eye-opener toward the termite problem viewed in its wider context to understand interrelationships and systems complexity of the situation. This was necessitated by the fact that although the government/policy makers are aware of the gravity on the termite problem in Western Wollega, it has always been handled as an entomological problem, thereby ignoring the compounding factors. This is believed to be the reason for repeated failure of the control strategies and escalation of the problem. For instance the current extension package was developed at national level with general recommendations for the country but no consideration was made of the peculiar problem of termites in Wollega zone.
CHAPTER ELEVEN

RESEARCH AND DEVELOPMENT RECOMMENDATIONS

A summary of research and development recommendations is given below. The study suggests recommendations for research and development on various research themes emphasizing on holistic interventions that incorporates stakeholders’ priorities and needs in the management of termite situation. These research and development recommendations were first identified after analysis of the problem situations from problem causal diagram and screened using various criteria especially whether or not they addressed the issues of social equity, environmental sustainability as well as their economic competitiveness. The recommendations are based on the stakeholders (farmers, researchers, extensionists and others) perceived constraints and priorities including their ability to meet the specific objectives of this study.

1. Promoting farmer participation in R and D

Currently farmer participation in the design and delivery of research and extension is low. Past measures to increase agricultural productivity have been constrained by a lack of farmer participation and a coherent methodological approach to incorporating farmers’ priorities into the R and D process. Fresh approaches to increasing effectiveness need to bring farmers, researchers and extensionists closer together to be understand each other’s priorities and objectives.

- Adoption, refinement and development of the sampling framework based on zonation and typology. Including: Zones, farm systems, field types and households To be used by Research, Extension and NGOs
- Identification and establishment of two representative outreach sites for farmer participatory research based on zonation and typology
- Increase the participation of farmers in technology dissemination through outreach activities e.g. farmers field days, on-farm trials, demonstration plots, etc.
- Development and dissemination of targeted technologies for resource poor farmers based on farmer priorities, typology and Zones
- Identify, strengthen or establish community based institutions (farmers, women, and user groups, etc. for implementation of research and extension activities (e.g. other recommendations)
- Practical field training and exposure of all stakeholders in research and development in participatory techniques

Agricultural knowledge and information systems

1. Establishment of an inter-institutional working group/platform to co-ordinate management of the termite situation

There are a variety of different stakeholders working on issues connected to the termite situation. However, these stakeholders often work individually and lack a platform for an integrated and co-ordinated approach to managing the situation. To effectively manage the
• Co-ordinate all different levels at national, regional district and village. R & D for Integrated Termite Management activities, and user groups e.g. researchers, extension, farmers, private agro-chemical suppliers and NGOs.
• Increase linkages and strengthen existing institutions e.g. OADB Integrated termite management project and Makene Yesus
• Resource mobilization e.g. funding, training, human resources and incentives for stakeholder participation
• Increase effective information dissemination and stakeholder involvement through networking, meetings and workshops
• Influence Policy formulation
• Incorporate all levels of involvement e.g. National, Regional and Village level

2 Strengthen existing institutions

Institutions already exist for service provision to farmers and for tackling issues relating to the termite situation. However, some of these institutions are currently not effectively targeting the termite situation and related factors. Strengthening of these institutions would help to effectively target the termite situation.

Strengthening participatory monitoring and evaluation of the effectiveness of the package programme by various criteria: sustainability, institutional capacity, and farmers’ priorities and programme objectives

1. Institutionalizing and strengthening of RELC

• Enhance the participation and interaction of all different stakeholders, farmers, extension researchers, input suppliers, NGOs, etc. To increase relevance and efficiency of technology generation and dissemination.
• Provide incentives for participation
• Workshops field days and training

R and D for sustainable solutions to land degradation and termite management

1. Inventory of past R and D experiences on soil and water conservation interventions.

Past activities on soil and water conservation interventions have been largely unsuccessful and have failed to be adopted by farmers. A review of past successes and failures would identify root causes for previous failures and provide recommendations for future interventions and technology development.

• Participatory analysis of past institutional delivery systems and technology interventions
• Review of in country and international literature.
• Report synthesizing information, with recommendations for future R and D
• Produce extension leaflet or pamphlet
2. Inventory and participatory research of indigenous farmers’ soil and water conservation practices and institutions

Farmers are currently undertaking their own soil and water conservation management practices. These practices are found throughout all zones and farm types, but thought to be unsustainable by research and extension, however farmers have their own logic and criteria for implementing existing practices and developing new technologies. Participatory research of indigenous practices would elaborate on farmers’ logic and enable this to be incorporated into new interventions.

- Analyse the variety of different practices and assess their sustainability.
- Elaborate and understand farmers logic, decision making and criteria for establishing soil and water conservation
- Look for best practices to be incorporated into future interventions
- Produce a report and incorporate recommendations into future programmes

3. Inventory and participatory research on indigenous and appropriate soil fertility management techniques e.g. composting, green manuring, crop residue incorporation etc.

Declining soil fertility and inadequate access to fertiliser is a major problem in all zones. Farmers have their own systems for maintaining homestead fertility. Research has been undertaken on soil fertility in many locations throughout Ethiopia and internationally. A synthesis of past research and participatory research on best practices for soil fertility enhancement could improve farm productivity and reduce the termite problem.

- Analyse current practices and assess their effectiveness.
- Elaborate and understand farmers practices, priorities and logic
- Look for farmers best practices to be incorporated into future interventions
- Research of new technologies Ethiopia and international
- Produce a report and extension leaflet or pamphlet.
- Incorporate recommendations into future programmes

4. Development of participatory research and extension practices for soil and water conservation and the regeneration of abandoned and degraded lands

Soil erosion and land degradation was common in all zones and exacerbates the termite problem. Abandoned and degraded land was identified in all zones. Farmers reported the impossibility of regenerating this land once it had become degraded. Participatory systems and practical technologies reducing soil erosion regenerating already degraded land are urgently needed.

- Develop methodologies for working with farmers to conserve soil and regenerate degraded areas.
- monitor and evaluate new technologies on representative field sites and based on farmers and researchers criteria.
- Develop technologies and methodologies based on zonation, typology & field type.
- Produce methodology and technology recommendations for other stakeholders
- Produce a report and extension leaflet or pamphlet.
5. Participatory identification of suitable grass, fodder, trees species for soil and water conservation. Using farmers and researchers criteria: e.g. utility, stabilizing bunds, agro-forestry, vegetation strips, multiple uses, grazing pressure, termite tolerance, etc.

Farmers and researchers have their own criteria for suitable plant species for soil and water conservation. At present there are several species which survive better on degraded areas and are more effective at soil retention. Past vegetative soil stabilizing species have shown to be ineffective. A review of species exotic and indigenous under farmers’ field conditions may identify appropriate species for farmer’s environments.

- Inventory and analysis of current vegetative species used for soil and water conservation
- Screening of different species based on farmer and researcher priorities
- Develop relationships with other stakeholders e.g. Soil and water and forestry departments to establish nursery sites

6. Participatory research on the establishment of coffee and tree seedlings in relation to termite damage.

Termite damage was reported on seedling coffee and tree species. Farmers have their own strategies for establishment, these are highly dependent upon chemical controls and are therefore costly and non-sustainable. New practices could help farmers to reduce tree seedling losses from termites.

- Involve all stakeholders
- investigate for best practices
- Evaluate value of cultural, biological and chemical control methods in order to develop an IPM control package.
- Establish nurseries and method for participatory extension
- Produce extension leaflet or pamphlet.

7. Integrated sustainable natural resources management. To develop and implement participatory and community based management plans. Provide resource users with capabilities and incentives to sustainably manage their shared environment.

Natural resources, especially soils are being rapidly degraded. Community institutions to manage common property resources are weak. Farmers report a lack of appropriate technologies and supportive institutions to sustainably manage their own and shared environments. The strengthening of existing, or establishment of new community management institutions to develop sustainable land use practices designed and implemented by all stakeholders will help to sustainably manage the natural resource base.

- All activities to be carried out in two representative participatory research villages, within target area, with target groups (typology) and community institutions and building upon participatory research (see No 4)
- Community approach -strengthen or establish community institutions
- Build on Indigenous Knowledge
- Training and awareness of relationships between land degradation, deforestation, farm management practices and termites
• The development of conservation land use management plans
• Increase co-ordination between Research, Extension and Farmers
• Involvement of all stakeholders
• Farmers trained in new technologies, soil and water control structures established.

**Integrated crop management**

1. *Collection, characterization and evaluation of indigenous food, fodder/pasture crop varieties/species*

   From the farmers interview and direct field observation, a number termite tolerant root/tuber, pasture/fodder and fruit crop species were identified.

   The potential and limitation as well as appropriate management practices of these crops have to be established through research taking into account the participatory approach.

2. *Participatory screening of food, fodder/pasture crops and trees for adaptability including termite tolerance*

   As there is no research sub station in the target area and distances to existing research centres are long, little location specific research recommendations are available. As development of a subcentre is not foreseen for the near future, future development of participatory research sites may assist the screening process for adaptive varieties and crop species, for instance on termite tolerance.

   • *Use of termite resistant crop varieties.*
     
     Participatory screening of genotypes that aims at identifying crops adapting to prevailing bio-physical and socio-economic environment including termite tolerance is important to increase farm productivity and avoid further land degradation.

3. Develop and promotion of appropriate management practices for roots and horticultural crops grown on homestead fields.

   Because of their tolerance to termite damage, high yield per unit area, etc. the area put to production of root/tuber and fruit crops (e.g. banana) is gradually increasing in Zones I and II. These crops are sources of household income and food, and are mainly managed by women.

   • Research and extension should respond to this shift in crop choices and be prepared to support farmers’ effort through the development of appropriate technologies and management practices using farmers research groups.

4. *Inventory and participatory research on the interaction between crop management practices and termite situation*

   There is a direct relationship between crop management practices and termite incidence. High termite activity in reported on less well managed cereal fields that are mono-cropped than on homestead fields that are planted to diverse crop species.
Joint farmer-extension-researcher appraisal is important to understand the interrelationship existing between crop management practices and termite incidence. This would give an insight into the real cause of the degradation problem and provides windows of opportunities available to manage the problem in a more sustainable and integrated manner.

5. Participatory research on appropriate crop and soil fertility management practices.

High termite incidence, declining soils fertility and subsequent drop of crop yields on cereal fields has increased the pressure on homestead fields. As these fields supply the multiple needs of the household, production is very diverse and intensive. Under the current management practices much more is removed than returned. To sustain production on this field type, in addition to integrated pest management (IPM), multiple cropping system, a careful balance should be maintained between nutrients extracted and reinvested.

- Composting, incorporation of multipurpose tree leaves, green manuring in conjunction with or without the current intensive animal manure management can lead to reach this goal.

- Cropping systems research.

In the homestead fields farmers' practice some form of multiple cropping system. The current multiple cropping system should be strengthened by the election of compatible crop genotypes and appropriate cultural practices that will contribute to the maintenance of soil fertility and protection of insect pests and diseases.

To address the multiple needs of the household and regenerative potential of the soil, research, extension and farmers should make an effort to promote intercropping and/or alley cropping systems suited to the agro-ecological and socio-economic environments within each zone (See methodology)

Cereal fields

Fertility management. Cereal mono-cropping, shortening fallow periods and severe overgrazing accompanied by grass foraging termites, is leading cereal fields into a downward spiral of nutrient depletion, loss of vegetation cover, soil erosion and land degradation. Loss of topsoil will expose the subsoil, which has a lower availability of nutrients, and pH results in low soil pH and low availability of nutrients. Nutrient availability should be improved by following more sustainable agronomic practices. In this regard, increasing soil organic matter can lead to improve soil physico-chemical properties.

- Incorporation of crop residues, crop rotation and also where community collaboration is well developed the introduction of a grass/legume fallow can be explored

- The current fallow system is not an efficient way of increasing soil fertility. Fallows are severely overgrazed and nutrients are transported by animal dung to homestead fields. It is recommended to explore possibilities for inclusion of leguminous crops in the crop rotation cycle through a participatory approach.
Valley bottom fields

- **Cultural control of maize stalk borer.** Currently *Bona* maize is widely grown in Zone I and used to bridge the food deficit period of May to June. Its production, however, is constrained by high stalk borer infestation. Cultural control of this pest is possible through adjustment of planting dates, crop residue management, crop rotation or and/or judicious use of chemicals. In order for these cultural practices to be effective requires community involvement and co-operation between farmers. Root/tuber crops can also be grown in these field types to break the life cycle of maize stalk borer; however, high soil moisture may encourage excessive vegetative growth and the development of leaf diseases that limit the potential of root/tuber and horticultural crops grown in the study areas.

Integrated livestock management

1. **Interdisciplinary research on livestock-termite-environment relationships**

   Overgrazing is a dominant factor aggravating the termite situation in addition to poor cropping and soil and water conservation practices. Livestock remove the vegetation cover, and trample and cause soil compaction, termites forage on the remaining litter and the effects of the two expose the soils to soil and wind erosion. Farmers’ practices aggravate the situation resulting in serious land degradation. However the blame is put solely on termites.

   - A participatory study needs to be undertaken to explicitly demonstrate the close inter-linkages between high livestock numbers, overgrazing and escalation of the termite problems and environmental degradation. This should be aimed at developing appropriate land use recommendations for farmers.

2. **Research and development to facilitate participatory community based sustainable rangeland management systems**

   High livestock populations characterize the study area. Grazing is communal and non-selective and in most cases livestock graze freely without any control. Overgrazing coupled with insufficient biomass yield on the little land results in degradation and compromised resilience of the land to regeneration. Overall productivity per unit animal is miserable.

   - A participatory, community based rangeland management system needs to be developed to ensure sustainable use of the resources.

   - Farmer training and awareness creation should be started in regard to limiting livestock numbers within the recommended stocking rates taking into consideration the carrying capacity of the available land.

   - Research should be conducted on appropriate alternative livestock husbandry techniques with emphasis on quality rather than quantity. The principle of maximal productivity per unit needs to be embraced by farmers.
3. Alternative livestock feed resource

Livestock is the source of livelihood of farmers in the study area and there exists a strong linkage between livestock availability and crop production. Dry season feed shortage is however, a major constraint in all zones of the study area and affects not only livestock performance, but also the timeliness of farm activities.

- There is need for research inventories of farmers’ current feed shortage coping strategies, explore into other conservable feed resources in the area and develop appropriate feed conservation technologies targeting the different typologies of farmers, while at the same time improving and promoting existing practices.

4. Animal traction

Animal draught power is the mainstay of agricultural production in the area. Oxen traction is almost the only source of farm power for land preparation, planting as well as weeding of certain crops. Donkeys and mules provide the only means of on- and off-farm transportation. Lack of oxen ranked high amongst farmers’ constraints while use of donkeys as pack only, limits carriage of crops like teff which are rapidly destroyed by termites after harvest.

- Research is needed to test and further explore the feasibility of harnessing donkey draught power for land preparation/ploughing. This has been used successfully in other countries. Moreover the soils in most of the study area are light and therefore would not pose a problem for donkey traction.
- There is also need for inventories to test and monitor with farmers’ groups and extensionists the performance of existing animal drawn farm implements in the study area, as well as others introduced from other areas. Harnessing equipment, currently the main bottleneck in utilising donkeys as non-pack should be developed.
- Donkeys are abundant in the study area and are widely used for transportation, but only as pack animals, which limits the quantity of produce they can transport. Farmers try to overcome this by using 2-4 donkeys for a single journey. Introduction or development of appropriate donkey carts suitable for the terrain is necessary to increase carrying capacity. This would also reduce the need for more than a couple of donkeys per household.

Animal health management

Livestock diseases are prevalent in the study area. Government veterinary services have declined, are ill supported logistically and not within easy reach. Treatment charges have become prohibitive forcing some farmers to resort to traditional herbal treatment of livestock diseases.

- Establishment of village-level animal health groups should be looked into as a means of improving the availability of animal health services to the farming community. Organization, selection of animal health assistants for training and monitoring will be through a participatory farmer approach.
- Livestock is a resource that cannot be ignored in the study area and its contribution to crop production in west Wollega cannot be underestimated. Government should improve logistical support to the district veterinary sections, and also increase the manpower resource. There are no animal production specialists in all the district studied, and special
training in this area is also vital if there is to be any change in the practices of livestock production in the area.

- Animal health researchers should consider making an inventory of current ethno veterinary medicine practices, and explore possible improvements therein to reinforce the modern veterinary practice.

**Socio-economics and policy considerations**

1. **Identification, strengthening and establishment of community based institutions**

   At present, the study area has inadequate and rudimentary form of community based institutions in natural resource management and saving and credits. Institutions on crop and livestock production and disease management, soil and water conservation, integrated termite management and agriculture marketing do not exist. Therefore, formation and strengthening farmers' led institutions will reduce termite effects and vulnerability.

   - Farmers groups on crop and livestock production and disease management
   - Community groups on saving and credits, group lending etc.
   - Community groups on integrated termite management
   - Farmers groups on agricultural marketing

2. **Favourable policy on strengthening linkage among research, extension, farmers and other stakeholders for solving the existing termite and broader farm problems.**

   - Institutionalisation and strengthening of research–extension liaison committee (RELC)
   - Adoption of zonation and, typology (recommendation domain) approach to improve the relevancy and efficiency in technology generation and research and development intervention.
   - Participatory involvement of farmers in all stages of technology generation, evaluation and transfer

3. **Appropriate policy and management approach for reducing the increased damage caused by wild animals**

   Wild animals (monkeys, wild pig etc.) attacks on valley bottom, cereal and homestead fields is one of the major problems reported by farmers in all zones. It comes second in nearly all zones after termites. This is especially a big problem in forested areas. The present law does not permit farmers to trap these animals even though severe damage often occurs to crops, livestock and human beings.

   - Revising and updating current rules and regulations on wild life protection
   - Strengthening community based institutions for tackling wild animal problems

4. **Development of opportunities for alternative income generating activities for resource poor farmers and women.**

   Many of the farm households in termite affected areas lack adequate size of productive land and livestock for meeting their food and income needs. Land shortage and abundant
underemployment among peasants is rampant. Opportunities exist for the identification, development and promotion of the following farm and off-farm micro-enterprises.

- Homestead root, tuber crops and vegetable farming for ensuring food security, minimizing termite effects and empowering the women for access and control over resources.
- Bee keeping, micro-livestock enterprises, traditional handicrafts (pottery, weavings etc.) for resource poor and land less agricultural labours (men and women)
- Strengthening existing farm saving/credit groups for income generating activities.

5. **Provision to improve access to improved technology and support services**

The productivity of the crops and livestock in the study area is very low due to low access to and adoption of improved technology. Support services in terms of technology development and dissemination and input supplies and credit sources are minimal. Access to improved seed varieties, fertilizers, credits and improved management practices are essential to improve returns to land and labour.

- Streamlining access and timely supply and delivery within agricultural input systems, both government and private sectors.
- Removing bureaucratic bottlenecks and constraints on credit supply and increase credit provisions to farmers e.g. private sectors, farmers’ service co-operatives, Church and NGOs.
- Improving farmers’ participation in agricultural technology generation and transfer

6. **Strengthen / develop market infrastructure for improved marketing of farm and off-farm produce**

Western Wollega is poorly supplied with roads and market infrastructure, thus hindering farmers’ ability to market farm and non-farm products. This includes access to the much needed agricultural inputs. Lack of market institutions and communications infrastructure have reduced farmers’ incentive to produce more and market more. There is need to:

- Develop and strengthen roads and communication infrastructures
- Develop rural market structures and institutions (farmers’ marketing groups)
- Make provision for increased participation of private sector in marketing of farm produce

7. **Favourable policy provision on land tenure, credits and input supply process**

Present land tenure policy does not provide adequate incentives for sustainable land management since land legally belongs to the state. The current policy on credits and input services are also mostly tied with package program giving no options for credit and inputs to resource poor farmers who are not involved in package programs or who do not meet eligibility criteria (e.g. land and oxen).

- Restoration of peasants’ confidence on land security for improving productivity and sustainable management of land.
- Suitable credit policy for resource poor farmers and women (who lack collateral) e.g. group and individual lending

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• Credit policy provisions for medium and long term investments such as purchasing oxen, ox-plough and land investments
• Suitable policy on input provisions (seeds, fertilisers and pesticides) and incentives to termite affected areas.

**Recommendations for integrated termite control**

1. Research on integrated termite management (ITM) to facilitate participatory community-based sustainable termite control.

Pest control procedures fall under a number of headings such as chemical, biological, cultural and etc., which are descriptive of the techniques involved and which have until recently been distinct well-defined categories. However, some new procedures cut across these boundaries. There is now a strong tendency to use two or more approaches together in a systems of integrated pest control management. The termite problem in western Wollega is very complex. Here natural and man made factors have played a big role in creating the existing termite situation. Thus, using different control options in an integrated approach is very essential.

1. Participatory screening of crops for termite tolerance

   • With respect to termite tolerant or resistant crops, it is reported that crops such as sweet potato, taro, yam, banana are tolerant / resistant. The identification and promotion of these and other crops are very important to be conducted at different participatory research involving farmers researchers and extensionists (see crop screening section).

2. Further studies on identification, promotion and use of biological control options.

   • Biological control is the use of natural enemies to control pest organisms. Natural enemies of pests include predators, parasites and pathogens, many of them highly specific in their action. They can provide foresters and farmers with a free, self-renewing and ecologically sound means of pest control. So far certain predators, parasite and pathogens have been identified elsewhere. However, location specific research is very important for collection, identification and determination of their effectiveness on termites.

3. Research on development of botanical control strategies on termites

   • Botanical control is one of the pest management techniques which currently received the attention of different researchers. Extracting anti termite properties from tree species is very important. As information obtained from the communities during survey and observation made by the team, termites do not damage some tree sp. Therefore such trees sp. have to be selected and testing their extracts on termite. Then, if effective they may be recommended to be planted widely for anti termite agent extraction’s.

4. Research on developing the organic termite control practices

   • These methods of termite control work with natural systems and help to promote the natural pest control mechanism already operating in the field. They do not pollute the environment and are not harmful to beneficial insects or to the farmers using them. They use locally available materials such as manure’s, composts and any decayed materials.
Organic control methods are cheap and easy to employ and preserve genetic diversity. They also regulate termite numbers rather than eliminate them, which means that the benefits termites provide to the ecosystem are not lost and important to improve soil fertility. Thus, these systems had to develop and practiced by the locality of the farmers through participatory research activities.

5. **Participatory research on improvement and promoting indigenous knowledge of the local farmers.**

Farmers from Zone I and Zone II practice different methods to protect their crops and buildings from termite damage. These practices do not give full control of termites. Some good practices may need further development. Therefore evaluating these indigenous knowledge and integrated them for their effective control should be conducted.

6. **Networking with institutions and actors working on biological and botanical termite control.**

A termite network with regional and district coordinating units should be established to coordinate/monitor/evaluate participatory trials in western Wollega. Potential topics to be investigated comprised:

- Participatory on-farm trials for screening of crops, grasses and trees for termite resistance or tolerance
- Development of crop loss assessment and cost benefit methodology, after study of secondary sources to develop a termite ecology and termite effect assessment and direct further research to fulfill identified gaps
Research proposal

The outlines of project proposal on integrated soil and water conservation for the regeneration of degraded lands is purposed here to minimize the termite situation using as a starter program. The proposals suggest a framework for minimizing the termite situation, firstly by strengthening farmer participation in research and development, secondly the establishment of a co-ordinated working group to collectively and systematically manage all research and development activities connected to the termite situation.

Methodologies to be followed

In order to address the complex and interrelated agro-ecological and socio-economical problems and bring about sustainable impact, it is deemed important to incorporate the following methodological steps in R and D programmes to be initiated in the future.

1. **Promote farmer participation.** Currently farmer participation in the process of technology generation and transfer is generally inadequate. This has resulted in low adoption of past R and D efforts and overlook farmers’ priority problems and opportunities. To enhance the efficiency of investment in R and D, every effort needs to be made to actively involve farmers in the research and development activities.

Strategy

- Identify, strengthen or establish community-based institutions (e.g. user groups, women association, farmers association, etc.)
- Establishment of representative farmers’ participatory site (outreach village sites)
- Establishment of farmers’ panel/research groups
- Increase the participation of farmers in technology generation and dissemination through outreach programmes e.g. farmers field days, on-farm trails, demonstration plots, etc.
- Adoption, refinement and development of the sampling framework which includes zones, farming system, field type and household typology
- Production of on-farm research and extension pamphlet, posters, etc. with the involvement of farmers

1. **Establishment of termite management coordinating body or platform.** There are a number of stakeholders working in isolation on an issue related to termite. The establishment of working group that bring together these stakeholders and layout the foundation for inter-institutional collaboration in terms of resource use (manpower and facilities) and coordinating R and D activities is key to maintain continuity of effort, avoid duplication, and manage the complex termite situation in a holistic manner.
Strategy

- Establish a formal coordinating body representing all relevant stakeholders with a structure at national/regional and district/village level.
- Practical field training of all stakeholders in PRA techniques
- Clearly state and formalize the contribution and responsibilities of each collaborating parties
- Adopt or develop a sampling framework (zonation, field and household typologies) that could allow to develop intervention addressing specific agro-ecology and socio-economic environments
- Devise a means to ensure effective information dissemination and participation of different stakeholders through networking, workshops, field tours, etc.
- Establish a participatory monitoring and evaluation system where R and D activities are regularly assessed against their conformity to commonly agreed criteria and for timely promotion of promising ones

Research proposal

**Title:** Integrated and participatory soil and water conservation to regenerate degraded land affected by termites

**Objectives:**
- To regenerate degraded lands through appropriate soil and water conservation measures
- To improve the productivity of land affected by termite
- To promote farmer participation in R and D

**Expected output**
- Degraded land rehabilitated
- Improved crop and livestock production
- Soil and water conserved
- Farmers indigenous technical knowledge tapped and the likelihood of technology adoption improved

**Background and justification**

In the study area, the problem of soil erosion and land degradation is quite serious and is further complicated by the termite situation. Past interventions on soil and water conservation have been largely unsuccessful and have failed to be adopted by farmers. The so far tested intervention are very much limited (e.g. physical terraces) and have little if any involvement from the farmers. They often have not taken into account the biophysical and socio-economic...
circumstances of the farmers. Given the current high rate of land degradation, there is an urgent need to identify an appropriate soil and water conservation measure that rehabilitate and regenerate degraded areas through a participatory research involving farmers and other relevant stakeholders.

8 Implementation strategy

- Explore the indigenous soil and water conservation measure(s) and the reasoning behind it
- Collaborate and strengthen existing projects on soil and water conservation and termite management
- Establish effective linkage and collaboration with relevant institutions
- Promote farmer participation (See above for detail)
- Participatory assessment of different soil and water conservation technologies on representative farmers' participatory outreach sites based on farmers' criteria

Collaborators/stakeholders

Farmers by typology, farmers institutions e.g. PA, FSC, and informal groups, BRC, OADB (e.g. soil and water conservation, plant protection), EARO, NGOs, input suppliers, MOA, etc
CHAPTER TWELVE

CONCLUSION

The information presented in this report is a result of an in-depth study of the problem situation in Western Wollega and the findings indicate that the termite issue is much more complex in regard to its causes and effects than appears outwardly. Attempts to control the termites using chemicals, as has hitherto been the case would not provide a permanent solution unless the key factors underplaying the complexity of the situation are clearly understood and tackled.

The team therefore preferred to refer to the subject of study as a termite situation rather than a problem. The complexity of the factors responsible for what is outwardly seen as the termite problem and their very strong and intricate interrelationships could only become clearly apparent when the situation is viewed from a broader systems perspective. The role of overgrazing due to high livestock numbers that clearly supercedes the carrying capacity of the available land characterizes the study area. Increased human population and the resultant increased pressure on land characterized by deforestation, high cropping intensity and poor agronomic practices such as shifting cultivation are all factors that have had their toll on the land. All these are a result of human activity and have had a significant role in the termite situation.

Poor soil and water conservation practices, such as the traditional furrowing that have been adopted from the elders and a non-dynamic system on a land characterized by highly rugged sloppy terrain have been found to further aggravate the effects of termite damage. Lack of deliberate efforts to improve the change status quo by the government or other stakeholders has left the problems of soil erosion and the subsequent degradation to go unchecked in many of the areas.

All the factors are interlinked as explained in various chapters of the text and contribute in one way or another to the viscous cycle of the termite situation. Farmers, some government officials and extension workers, however continue to view the situation as a termite problem and do not want to accept the active role of other factors. Consequently the problem has always been handled as an entomological problem. The control strategies have also been non-continuous and unsystematic in some cases such as targeting the crop fields and leaving out the fields in the immediate vicinity of the farmlands. This, apparently is one reason, among others why the problem has not been stamped out to date.

Little research has been done embracing all different facets of the situation in order to fully understand their roles and contribution, while little priority has been given to it in the national research system.

The flow and exchange of agricultural knowledge and information among key stakeholders is still weak and not all stakeholders are currently involved. Steps have, however been taken to address this issue through the formation of the research–extension liaison committee. Farmers' participation in technology generation and evaluation, which would help harness
their indigenous knowledge in tackling the termite problem and developing appropriate farmer-friendly strategies is conspicuously minimal or totally lacking in certain aspects.

Policy factors such as the land tenure system, credit and agricultural input supply mechanisms together with infrastructural development have all been found to play a role in increasing the vulnerability of farmers to the effects of termite damage.

For the termite situation to be adequately and summarily tackled there is needed to develop participatory community based approaches to matters of land use and management and environmental sustainability. The need for continuous farmers' education on these aspects need not be over emphasized. Linkages between key players in agricultural development as well as farmers participation the research, extension and environmental management and development programmes need to be further strengthened. The transfer of research results to farmers and the mechanisms of feed back from farmers need to be improved. The research system needs to adopt a specific farmer typology-orientation in targeting areas for transfer of technology. The concept of typologies and recommendation domain needs to be embraced in this regard in order to improve the effectiveness of research and development activities in addressing farmers' production constraints.

A summary of research and development recommendations is given in chapter 11. It is the team's strong conviction that if appropriate measures such as those proposed are put into place and correct and concerted efforts are made, looking at the problem from its wider context, and within an appropriate policy environment, the current termite problem can be managed and a peaceful coexistence between humans, termites and the environment as used to be years ago, reinstated, the increase in human population not withstanding.
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Appendix I. List of problems identified by different stakeholders

1. Termite damage
2. Wild animals attack
3. Livestock feed scarcity
4. Over grazing (not by farmers)
5. Soil fertility decline
6. Soil erosion
7. Land degradation
8. Rust/smudge on teff
9. Stalk borer on maize
10. Coffee berry disease
11. Insects damage on beans
12. Livestock disease
13. Land shortage
14. Land insecurity
15. Cash shortage
16. Credit unavailability
17. Unavailability of improved seeds
18. Unavailability of pesticides for termite control
19. High fertiliser price and unavailability
20. Poor infrastructure and market facilities
21. Lack of alternative income and employment opportunities
22. Inadequate information and technology support
23. Lack of draught power (oxen)
24. Lack of health facilities
25. Malaria problem (Zone III)
26. Weak linkage between research and extension
27. Lack of farmers involvement in technology generation evaluation and dissemination
28. Weak indigenous social institutions and organisations
29. Lack of private sector involvement in input and output marketing
Appendix II. Ranking of agricultural problems by different farm household groups

<table>
<thead>
<tr>
<th>Agricultural problems</th>
<th>Problem rankings by different group of farmers in four villages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Resource rich</td>
</tr>
<tr>
<td></td>
<td>V1 &amp; V2</td>
</tr>
<tr>
<td>Termites</td>
<td>I</td>
</tr>
<tr>
<td>Soil erosion / Land degradation</td>
<td>VII</td>
</tr>
<tr>
<td>Overgrazing / Feed scarcity</td>
<td>IV</td>
</tr>
<tr>
<td>Wild animals</td>
<td>II</td>
</tr>
<tr>
<td>Crop Pests &amp; Diseases</td>
<td>VI</td>
</tr>
<tr>
<td>Livestock diseases</td>
<td>V</td>
</tr>
<tr>
<td>High fertilizer price</td>
<td>III</td>
</tr>
<tr>
<td>Lack of draught power</td>
<td>VIII</td>
</tr>
<tr>
<td>Lack of agril. information &amp; technology</td>
<td>IX</td>
</tr>
<tr>
<td>Insecurity of land ownership</td>
<td>X</td>
</tr>
</tbody>
</table>

V1 = Village 1 (Bafano Koreche: high termite infested, zone 1)
V2 = Village 2 (Oda Gunka: high termite infested Zone II)
V3 = Village 3 (Gute Michael: less termite infested Zone II)
V4 = Village 4 (Abono Dilla: less termite infested, newly settled, Zone III)
Resource rich = Farmers with land, oxen and others
Resource poor = Farmers with no oxen but with or without land
<table>
<thead>
<tr>
<th>Agricultural problems</th>
<th>Researcher</th>
<th>Extensionists</th>
<th>Overall rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Termite</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Soil erosion and land degradation</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Overgrazing/ feed scarcity</td>
<td>III</td>
<td>IV</td>
<td>III</td>
</tr>
<tr>
<td>Wild animals damage</td>
<td>IV</td>
<td>VIII</td>
<td>V</td>
</tr>
<tr>
<td>Crop pests &amp; diseases</td>
<td>V</td>
<td>III</td>
<td>IV</td>
</tr>
<tr>
<td>Livestock diseases</td>
<td>VI</td>
<td>V</td>
<td>VI</td>
</tr>
<tr>
<td>High fertilizer price</td>
<td>VIII</td>
<td>VI</td>
<td>VII</td>
</tr>
<tr>
<td>Lack of draught power</td>
<td>VII</td>
<td>IX</td>
<td>VIII</td>
</tr>
<tr>
<td>Lack of agricultural information &amp; technology</td>
<td>X</td>
<td>VII</td>
<td>IX</td>
</tr>
<tr>
<td>Insecurity of land ownership</td>
<td>IX</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Species</td>
<td>Nesting type</td>
<td>Foraging sites</td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------</td>
<td>--------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Macrotermitinae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Macrotermes subhyalinus</em> (Rambur)</td>
<td>M</td>
<td>Plant roots and stem, maize cobs, barley stock, tree trunks, grasses stand of maize cribs, grain sacks, coffee husks, logs, polythene bags</td>
<td></td>
</tr>
<tr>
<td><em>Microtermes</em> nr <em>vadschagae</em> (Sjost)</td>
<td>S</td>
<td>Maize, sunflower and haricot bean roots and stems, maize stubble, Eucalyptus and Juniper stumps, wood baits, pegs, wall of macrotermes mounds</td>
<td></td>
</tr>
<tr>
<td><em>Microtermes aethiopicus</em> Barnett et al</td>
<td>S</td>
<td>Maize, pepper, sunflower, haricot bean and cassava roots and stems, maize stubble, eucalyptus and juniper roots, tree stumps, coffee mulch, wood pegs and bait, wall of macrotermes mounds</td>
<td></td>
</tr>
<tr>
<td><em>Odontotermes</em> sp. D</td>
<td>S/M</td>
<td>Maize roots, teff stacks, leaf litter, logs and mounds</td>
<td></td>
</tr>
<tr>
<td><em>Odontotermes</em> sp. E</td>
<td>S/M</td>
<td>Maize roots, pepper stem and roots, eucalyptus roots, eucalyptus and juniper trunk, grass roots, wooden houses, fences, baits</td>
<td></td>
</tr>
<tr>
<td><em>Odontotermes</em> sp. I</td>
<td>S</td>
<td>Runways and sheeting on eucalyptus and mango trunk and on stem of coffee seedlings, coffee mulch, wood pegs, wood baits, cow dung</td>
<td></td>
</tr>
<tr>
<td><em>Pseudocanthotermes militaris</em> (Hagen)</td>
<td>S</td>
<td>Grass and maize roots, stalks and stubbles, pepper, eucalyptus roots, tree trunks, structural wood, wood litter, wood pegs, wood bait, cow dung</td>
<td></td>
</tr>
<tr>
<td>Apicotermitinae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Astratotermes</em> nr. <em>Pacatus</em> (silvestri)</td>
<td>S</td>
<td>Soil</td>
<td></td>
</tr>
<tr>
<td><em>Adaiphrotermes</em> nr.<em>scapheules</em> (Sands)</td>
<td>S</td>
<td>Soil</td>
<td></td>
</tr>
<tr>
<td><em>Alyscotermes</em> <em>trestus</em> (Sands)</td>
<td>S</td>
<td>Soil</td>
<td></td>
</tr>
<tr>
<td><em>Ateuchotermes</em> <em>rastratus</em> (sands)</td>
<td>S</td>
<td>Soil</td>
<td></td>
</tr>
<tr>
<td><em>Firmictermes</em> <em>abyssinicus</em> (sjoestent)</td>
<td>S</td>
<td>Soil</td>
<td></td>
</tr>
</tbody>
</table>

Nest type: M = mound, S = subtermean. Source: Abdurhman (1990)
Appendix V. The potential for the control of termites by ants

<table>
<thead>
<tr>
<th>Ant species</th>
<th>Termites controlled</th>
<th>Author/year</th>
<th>results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lasisus alienus,</td>
<td>Reticulitermes flavipes</td>
<td>Beard (1973)</td>
<td>All invaded and destroyed colonies under experimental conditions</td>
</tr>
<tr>
<td>Lasisus umbratus,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetramorium caespnum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mymicaria eumenoides</td>
<td>Hodotermes, Trinervitermes, Macrotermiteinae</td>
<td>Logan et al</td>
<td>These species were found to be the main opportunist ant predators in Zambia</td>
</tr>
<tr>
<td>Pheidole megacephala</td>
<td>Hodotermes, Trinervitermes, Macrotermiteinae</td>
<td>Wilde (1977)</td>
<td></td>
</tr>
<tr>
<td>Termitopone commutata</td>
<td>Syntermes spp.</td>
<td>Logan et al (1990)</td>
<td>in south America over 100 ants carried off one or two termites each</td>
</tr>
<tr>
<td>Megaponera foetens</td>
<td>Macrotermitinae, macrotermes-michaelseni</td>
<td>Longhurst &amp; Howe</td>
<td>Longhurst et al (1978) reported that macrotermidae was the exclusive prey for M.foetens in Nigeria</td>
</tr>
<tr>
<td>Anoplolepis custodiens</td>
<td>Hodotermes spp. Microhodotermites spp.</td>
<td>Bouillon (1970)</td>
<td>These ants attacked termites in south Africa, and limited termite foraging to an hour or two in any one location</td>
</tr>
<tr>
<td>Iridomyrmex humilis</td>
<td>Reticulitermes spp.</td>
<td>Olkowski et al (1991)</td>
<td>readily prey on subterranean termites, and proved effective in protecting buildings. However, the ant may be a pest in itself</td>
</tr>
<tr>
<td>(Argentine ant)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iridomyrmex sanguineus</td>
<td>Amitermes-laurensis</td>
<td>Higashi and Ito (1989)</td>
<td>Has been observed frequently raiding termite colonies, and could provide a biological control.</td>
</tr>
<tr>
<td>Myrmicaria striata</td>
<td>Not specified</td>
<td>Levieux (1982)</td>
<td>shows potential for biological control as termites form 46% of its diet</td>
</tr>
</tbody>
</table>

Source: The Henry Doubleday research association international research department, organic termite control in the tropics, Paol Forshaw (1994).
Appendix VI. The potential for the control of termites by nematodes

<table>
<thead>
<tr>
<th>Nematodes</th>
<th>Termites controlled</th>
<th>Author/year</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Steinernama feltiae</em></td>
<td><em>reticulitermes tibialis</em></td>
<td>Epsky &amp; Capinera (1988)</td>
<td>They were applied to the soil beneath bated traps and provided protection for 2-4 weeks, as termites avoided the area.</td>
</tr>
<tr>
<td><em>Neoaplectana carpocausae</em></td>
<td><em>Subterranean termites</em></td>
<td>Mix &amp; Beal (1985), Georgis et al (1982)</td>
<td>Laboratory studies showed that the nematodes were termite predators. However, Mix &amp; Beal 1985 reported they were ineffective in the field, as termites passed through infected soils and attacked pinus spp. Georgis et al found 96-98% mortality of zootermes spp &amp; Reticulitermes spp in the laboratory with this nematodes and suggest it has potential.</td>
</tr>
<tr>
<td><em>Heterorhabditis bacteriophora</em></td>
<td><em>Reticulitermes hesperus</em></td>
<td>Poiner &amp; Georgis (1990)</td>
<td>was found to be able to penetrate the external cuticles of worker termites and could provide a useful control method.</td>
</tr>
<tr>
<td><em>Heterorhabditis spp</em></td>
<td><em>Glyptotermes dilatatus</em> (dry wood termite)</td>
<td>Danthanaraya &amp; Vitarana (1987)</td>
<td>The nematodes controlled termite in the laboratory &amp; field. High application rates were needed, but complete control occurred within 60-95 days.</td>
</tr>
<tr>
<td><em>Rhabditidae</em></td>
<td><em>Reticulitermes virginicus, r. Flavipes cortotermes formosanus</em></td>
<td>Coppel &amp; Liang (1987)</td>
<td>This nematode readily infected termites and shows promise as a potential biological control agent.</td>
</tr>
</tbody>
</table>

Source: Paul Forshaw (1994)
Appendix VII. The potential for the control of termites by fungi

<table>
<thead>
<tr>
<th>Fungus</th>
<th>Termites controlled</th>
<th>Author/year</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Metarhizium anisopliae</em></td>
<td>Nasutitermes exitiosus</td>
<td>Hanel &amp; Watson, (1983); Hanel, (1981/82/83)</td>
<td>Field tests in Australia where <em>M.anisopliae</em> was introduced to termite colonies proved successful. In some cases the disease persisted for 15 weeks, by which time few healthy termites could be found in half the treated colonies.</td>
</tr>
<tr>
<td>Bipolaris tetramera</td>
<td>Odontotermes obesus</td>
<td>Singh <em>et al</em> (1976)</td>
<td>In India healthy termites inoculated experimentally with <em>B.tetramera</em> died within 72 hours, and the fungus was successfully reisolated from diseased individuals.</td>
</tr>
<tr>
<td>Serratia marcescens</td>
<td>Workers of: Microcerotermes - championi Heterotermes-indicola, Nymphs of: Bifiditermes-beesoni</td>
<td>Khan <em>et al</em> (1977)</td>
<td>Laboratory studies were carried out where 3 groups of termite species were infected three times. 100% mortality was observed with all species. Workers of <em>M.championi</em> died in a shorter time.</td>
</tr>
<tr>
<td>Beauveria bassiana, Metarhizium anisopliae</td>
<td>Cornitermes-cumulans</td>
<td>Fernandes &amp; Alves (1991)</td>
<td>Cornitermes cumulans, a pest of pastures in Brazil, were treated in the field. After 10 days the fungi caused 100% of nest mortality.</td>
</tr>
</tbody>
</table>

Source: HDRA (1994)
<table>
<thead>
<tr>
<th>Species</th>
<th>Termite resistant part</th>
<th>Comments</th>
<th>Author/year</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acacia catechu</em></td>
<td></td>
<td>Tested in Zimbabwe</td>
<td>Wardell 1987</td>
</tr>
<tr>
<td><em>Acacia mearnsii</em></td>
<td>Wood/pulp</td>
<td>More resistant than most acacias due to high number of resins</td>
<td>Teel 1988</td>
</tr>
<tr>
<td><em>Acacia melanoxylon</em></td>
<td></td>
<td></td>
<td>Wardell 1987</td>
</tr>
<tr>
<td><em>Acacia polyacantha</em></td>
<td></td>
<td></td>
<td>Teel 1988</td>
</tr>
<tr>
<td><em>Afromosia laxiflora</em></td>
<td>Wood/pulp</td>
<td>termite-durable but not resistant</td>
<td>Grainge &amp; Ahmed 1988</td>
</tr>
<tr>
<td><em>Albizia odoratissima</em></td>
<td>Wood/pulp</td>
<td></td>
<td>Grainge &amp; Ahmed 1988</td>
</tr>
<tr>
<td><em>Albizia saman</em></td>
<td></td>
<td></td>
<td>Teel 1988</td>
</tr>
<tr>
<td><em>Albizia zygia</em></td>
<td></td>
<td></td>
<td>Teel 1988</td>
</tr>
<tr>
<td><em>Azadirachta indica</em></td>
<td></td>
<td></td>
<td>Teel 1988</td>
</tr>
<tr>
<td><em>Balanites aegyptica</em></td>
<td></td>
<td></td>
<td>Teel 1988</td>
</tr>
<tr>
<td><em>Borassus aethiopum</em></td>
<td></td>
<td></td>
<td>Teel 1988</td>
</tr>
<tr>
<td><em>Brachylaena hutchinsii</em></td>
<td>Wood/pulp</td>
<td>Termite resistant shrub</td>
<td>Teel 1988</td>
</tr>
<tr>
<td><em>Bridelia micrantha</em></td>
<td>Wood/pulp</td>
<td>Tested in Zimbabwe</td>
<td>Grainge &amp; Ahmed 1988</td>
</tr>
<tr>
<td><em>Capparis aphylla</em></td>
<td>Wood/pulp</td>
<td>Resistant to reticulitermes flavipes</td>
<td>Wardell 1987</td>
</tr>
<tr>
<td><em>Cassia brewssteiri</em></td>
<td></td>
<td></td>
<td>Mcdanial 1992</td>
</tr>
<tr>
<td><em>Casuarina- cunninghamman</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Catalpa bignoniodes</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cedrus deodora</em></td>
<td>Wood/pulp</td>
<td>oral poison</td>
<td></td>
</tr>
<tr>
<td><em>Daniellia oliveri</em></td>
<td>Gum/resin</td>
<td>termite resistant shrub</td>
<td></td>
</tr>
<tr>
<td><em>Detarium senegalense</em></td>
<td>Wood/pulp</td>
<td>oral poison</td>
<td></td>
</tr>
<tr>
<td><em>Dodonaea viscosa</em></td>
<td>Wood/pulp</td>
<td>more resistant than other eucalyptus</td>
<td></td>
</tr>
<tr>
<td><em>Erythrophleium suaveolens</em></td>
<td>Wood/pulp</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Eucalyptus camaldulensis</em></td>
<td>Wood/pulp</td>
<td>tested in zimbabwe</td>
<td></td>
</tr>
<tr>
<td><em>Eucalyptus microcorys</em></td>
<td></td>
<td>Termite tolerant in Tanzania</td>
<td></td>
</tr>
<tr>
<td><em>Giricidia sepium</em></td>
<td>Wood/pulp</td>
<td>Highly resistant</td>
<td></td>
</tr>
<tr>
<td><em>Grevillea glauca</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Grevillea robusta</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Juniperus procera</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Khaya nyasica</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Leucaena leucocephala</em></td>
<td>Wood/pulp</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Melia azedarach</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Olea welwitschii</em></td>
<td>Wood/pulp, Leaves,seeds,oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Piliostigma thonningii</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Sesbania sesban</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Strychnos nux-vomica</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Terminalia brownii</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Terminalia prunioides</em></td>
<td>Leaves</td>
<td>Almost termite proof but not totally resistant</td>
<td></td>
</tr>
<tr>
<td><em>Terminalia spinoa</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Zanthoxylum- xanthoxyloides</em></td>
<td>Wood/pulp</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Paul Forshaw (1994)
### Appendix IX. Soil analysis data Zone I (Bafano Koreche)

<table>
<thead>
<tr>
<th>Field type</th>
<th>Texture class</th>
<th>pH</th>
<th>Exchangeable cations (me/100g soil)</th>
<th>Organic carbon (%)</th>
<th>Total N (%)</th>
<th>Avail. P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Na</td>
<td>K</td>
<td>Ca</td>
<td>Mg</td>
</tr>
<tr>
<td>HS</td>
<td>Loam</td>
<td>5.69</td>
<td>0.31</td>
<td>0.67</td>
<td>9.98</td>
<td>4.66</td>
</tr>
<tr>
<td>VB</td>
<td>Loam</td>
<td>5.65</td>
<td>0.23</td>
<td>0.20</td>
<td>2.00</td>
<td>3.17</td>
</tr>
<tr>
<td>CCF</td>
<td>Clay</td>
<td>5.61</td>
<td>0.15</td>
<td>0.32</td>
<td>9.08</td>
<td>0.92</td>
</tr>
<tr>
<td>DL</td>
<td>Clay</td>
<td>5.39</td>
<td>0.15</td>
<td>0.15</td>
<td>4.94</td>
<td>0.42</td>
</tr>
<tr>
<td>CF</td>
<td>Clay loam</td>
<td>5.68</td>
<td>0.31</td>
<td>0.87</td>
<td>3.49</td>
<td>2.83</td>
</tr>
<tr>
<td>Termite mound</td>
<td>Clay Loam</td>
<td>5.16</td>
<td>0.23</td>
<td>0.50</td>
<td>8.33</td>
<td>1.25</td>
</tr>
</tbody>
</table>

### Appendix X. Soil analysis data Zone II (Odagunka)

<table>
<thead>
<tr>
<th>Field type</th>
<th>Texture class</th>
<th>pH</th>
<th>Exchangeable cations (me/100g soil)</th>
<th>Organic carbon (%)</th>
<th>Total N (%)</th>
<th>Avail. P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Na</td>
<td>K</td>
<td>Ca</td>
<td>Mg</td>
</tr>
<tr>
<td>HS</td>
<td>Sandy Clay loam</td>
<td>5.34</td>
<td>0.62</td>
<td>2.10</td>
<td>15.62</td>
<td>3.67</td>
</tr>
<tr>
<td>VB</td>
<td>Loam</td>
<td>4.89</td>
<td>0.15</td>
<td>0.23</td>
<td>3.74</td>
<td>1.17</td>
</tr>
<tr>
<td>CCF</td>
<td>Loam</td>
<td>5.15</td>
<td>0.23</td>
<td>0.47</td>
<td>3.44</td>
<td>0.83</td>
</tr>
<tr>
<td>DL</td>
<td>Loam</td>
<td>4.71</td>
<td>0.15</td>
<td>0.15</td>
<td>3.49</td>
<td>0.67</td>
</tr>
</tbody>
</table>

### Appendix XI. Soil analysis data Zone II (Gute Michael)

<table>
<thead>
<tr>
<th>Field type</th>
<th>Texture class</th>
<th>pH</th>
<th>Exchangeable cations (me/100g soil)</th>
<th>Organic carbon (%)</th>
<th>Total N (%)</th>
<th>Avail. P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Na</td>
<td>K</td>
<td>Ca</td>
<td>Mg</td>
</tr>
<tr>
<td>HS</td>
<td>Loam</td>
<td>6.22</td>
<td>0.70</td>
<td>2.69</td>
<td>15.57</td>
<td>4.66</td>
</tr>
<tr>
<td>VB</td>
<td>Clay loam</td>
<td>5.38</td>
<td>0.31</td>
<td>0.30</td>
<td>9.63</td>
<td>3.92</td>
</tr>
<tr>
<td>CCF</td>
<td>Silty loam</td>
<td>4.96</td>
<td>0.15</td>
<td>0.30</td>
<td>3.14</td>
<td>0.58</td>
</tr>
<tr>
<td>DL</td>
<td>Loam</td>
<td>4.65</td>
<td>0.15</td>
<td>0.15</td>
<td>3.90</td>
<td>0.25</td>
</tr>
</tbody>
</table>

### Appendix XII. Soil analysis data Zone III (Abono Dilla)

<table>
<thead>
<tr>
<th>Field type</th>
<th>Texture class</th>
<th>pH</th>
<th>Exchangeable cations (me/100g soil)</th>
<th>Organic carbon (%)</th>
<th>Total N (%)</th>
<th>Avail. P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Na</td>
<td>K</td>
<td>Ca</td>
<td>Mg</td>
</tr>
<tr>
<td>HS</td>
<td>Loam</td>
<td>7.02</td>
<td>0.23</td>
<td>0.32</td>
<td>15.19</td>
<td>3.08</td>
</tr>
<tr>
<td>VB</td>
<td>Silty clay</td>
<td>5.45</td>
<td>1.47</td>
<td>6.38</td>
<td>11.93</td>
<td>9.16</td>
</tr>
<tr>
<td>CCF</td>
<td>Clay loam</td>
<td>6.19</td>
<td>0.46</td>
<td>1.41</td>
<td>17.07</td>
<td>21.61</td>
</tr>
<tr>
<td>CF</td>
<td>Loam</td>
<td>5.55</td>
<td>0.54</td>
<td>1.87</td>
<td>7.29</td>
<td>4.08</td>
</tr>
</tbody>
</table>
# Appendix XIII

## Indigenous tree, food crop and grass species

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Local name (Oromiffa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>Comberetum shsalense</em></td>
<td>Dhandhamsa</td>
</tr>
<tr>
<td>2. <em>Acanthus arboreus</em></td>
<td>Sokorruu</td>
</tr>
<tr>
<td>3. <em>Faurea rochetiana</em></td>
<td>Dabbaqaa</td>
</tr>
<tr>
<td>4. <em>Ficus avata</em></td>
<td>Dambii</td>
</tr>
<tr>
<td>5. <em>Euphorbia canadelabrum</em></td>
<td>Adaamii</td>
</tr>
<tr>
<td>6. <em>Carissa edulis</em></td>
<td>Agamsa</td>
</tr>
<tr>
<td>7. <em>Acacia abyssinica</em></td>
<td>Amboo</td>
</tr>
<tr>
<td>8. <em>Syzygium guineense</em></td>
<td>Baddeessa</td>
</tr>
<tr>
<td>9. <em>Podocarpus falcatus</em></td>
<td>Birbirsa</td>
</tr>
<tr>
<td>10. <em>Sapium ellipticum</em></td>
<td>Bosoqa</td>
</tr>
<tr>
<td>11. <em>Stereospermum kunthianum</em></td>
<td>Botoroo</td>
</tr>
<tr>
<td>12. <em>Maytenus arbutifolia</em></td>
<td>Kombolcha</td>
</tr>
<tr>
<td>13. <em>Maytenus senegalensis</em></td>
<td>Kombolcha</td>
</tr>
<tr>
<td>14. <em>Combretum molle</em></td>
<td>Dhandhamsa</td>
</tr>
<tr>
<td>15. <em>Acacia lahai</em></td>
<td>Garbii</td>
</tr>
<tr>
<td>16. <em>Acacia albida</em></td>
<td>Garbii</td>
</tr>
<tr>
<td>17. <em>Acacia abyssinica</em></td>
<td>Garbii</td>
</tr>
<tr>
<td>18. <em>Anbergeria adolffriedericii</em></td>
<td>Gudubaa</td>
</tr>
<tr>
<td>19. <em>Grewia bicolor</em></td>
<td>Harooreesa</td>
</tr>
<tr>
<td>20. <em>Prunus africanus</em></td>
<td>Hoomi</td>
</tr>
<tr>
<td>21. <em>Berchemia discolor</em></td>
<td>Jejebaa</td>
</tr>
<tr>
<td>22. <em>Acacia sieberiana</em></td>
<td>Lafto</td>
</tr>
<tr>
<td>23. <em>Acacia lahai</em></td>
<td>Lafto</td>
</tr>
<tr>
<td>24. <em>Acacia sieberiana</em></td>
<td>Lafto-adi</td>
</tr>
<tr>
<td>25. <em>Croton macrostachyus</em></td>
<td>Makaniissa</td>
</tr>
<tr>
<td>26. <em>Albizia schimperiana</em></td>
<td>Mukarbaa</td>
</tr>
<tr>
<td>27. <em>Ficus sycomorus</em></td>
<td>Odaa</td>
</tr>
<tr>
<td>28. <em>Ekebergia capensis</em></td>
<td>Somboo</td>
</tr>
<tr>
<td>29. <em>Cordia africana</em></td>
<td>Waddeesa</td>
</tr>
<tr>
<td>30. <em>Vernonia amygdalina</em></td>
<td>Abbicha</td>
</tr>
</tbody>
</table>

## Horticultural crops

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Local name (Oromiffa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31. <em>Citrus sinensis</em></td>
<td>Burtukaana</td>
</tr>
<tr>
<td>32. <em>Rhamnus prinoides</em></td>
<td>Geeshoo</td>
</tr>
</tbody>
</table>
| 33. *Ensete ventricosum* | Kooba (Wese)
<p>| 34. <em>Catha edulis</em> | Chaatii |
| 35. <em>Colocasia esculenta</em> | Godorre |
| 36. <em>Dioscorea alata</em> | Qochoo |
| 37. <em>Solanum tuberosum</em> | Dinnicha |
| 38. <em>Ipomoea batatas</em> | Albaambee |
| 39. <em>Ricinus communis</em> | Guloo |
| 40. <em>Cucurbita pepo</em> | Buqqee |
| 41. <em>Cucumis melo</em> | Buqqee |
| 42. <em>Nicotiana tabacum</em> | Tamboo |
| 43. <em>Capsicum spp.</em> | Mimmixa |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Common Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.</td>
<td>Brassica sp.</td>
<td>Raafuu</td>
</tr>
<tr>
<td>45.</td>
<td>Musa sapientum</td>
<td>Muzii</td>
</tr>
<tr>
<td>46.</td>
<td>Coccinia abyssinica</td>
<td>Anchotee</td>
</tr>
<tr>
<td>47.</td>
<td>Coleus edulis</td>
<td>Dinnicha Oromo</td>
</tr>
<tr>
<td>48.</td>
<td>Manihot esculenta</td>
<td>Cassavaa</td>
</tr>
<tr>
<td></td>
<td><strong>Field crops/weeds/animals</strong></td>
<td></td>
</tr>
<tr>
<td>49.</td>
<td>Vicia faba</td>
<td>Baaqeelaa</td>
</tr>
<tr>
<td>50.</td>
<td>Pisum sativum</td>
<td>Atara</td>
</tr>
<tr>
<td>51.</td>
<td>Snowdenia polystachia</td>
<td>Mujjaa</td>
</tr>
<tr>
<td>52.</td>
<td>Guizotia scabra</td>
<td>Hadaa</td>
</tr>
<tr>
<td>53.</td>
<td>Zea maize</td>
<td>Boqqoloo</td>
</tr>
<tr>
<td>54.</td>
<td>———</td>
<td>Daaphoo</td>
</tr>
<tr>
<td>55.</td>
<td>Eleusine coracana</td>
<td>Daaguujaa</td>
</tr>
<tr>
<td>56.</td>
<td>Eragrostis tef</td>
<td>Xaaftii</td>
</tr>
<tr>
<td>57.</td>
<td>Hordeum vulgare</td>
<td>Garbuu</td>
</tr>
<tr>
<td></td>
<td><strong>Grasses species</strong></td>
<td></td>
</tr>
<tr>
<td>58.</td>
<td>Eleusine jaegeri</td>
<td>Choqorsa</td>
</tr>
<tr>
<td>59.</td>
<td>Berchemia discolor</td>
<td>Jejeba</td>
</tr>
<tr>
<td>60.</td>
<td>Cynodon dactylon</td>
<td>Serdoo</td>
</tr>
<tr>
<td>Date</td>
<td>Task accomplished</td>
<td>Place</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>11/4/98</td>
<td>Revised first week plan</td>
<td>Addis Ababa (AA)</td>
</tr>
<tr>
<td>14/4/98</td>
<td>Briefed IAR &amp; OADB officials</td>
<td>AA</td>
</tr>
<tr>
<td>16/4/98</td>
<td>Presented field plan</td>
<td>Bako Research Centre (BRC)</td>
</tr>
<tr>
<td>17/4/98</td>
<td>Introduction to Nejo farmers training centre</td>
<td>Nejo training centre (NTC)</td>
</tr>
<tr>
<td>18/4/98</td>
<td>Cleaning &amp; checking in at Nejo training centre</td>
<td>NTC</td>
</tr>
<tr>
<td>19/4/98</td>
<td>Decided payment rates to resource persons, drivers, interpreters, domestic helpers and criteria for site &amp; translator's selection; interviewed Dr. Abera</td>
<td>NTC</td>
</tr>
<tr>
<td>20/4/98</td>
<td>Reconnaissance survey to Mendi, Nejo &amp; Jarso districts</td>
<td>Wagara, Jiru, Gori, Dandi Gudi, Jarso</td>
</tr>
<tr>
<td>21/4/98</td>
<td>Reconnaissance survey to Nejo district</td>
<td>Wagabura, Muxuxo Georgis</td>
</tr>
<tr>
<td>22/4/98</td>
<td>Reviewed windscreen survey (21-22/4/98) &amp; summarized observation &amp; stakeholders perspectives and set temporary zonation criteria</td>
<td>NTC</td>
</tr>
<tr>
<td>23/4/98</td>
<td>Interviewed Nejo DA trainer (Tesfaye Eba) &amp; district extensionists (Imiru Wale &amp; Alias Terfase), oriented translators, divided write up of report sections, list of stake holders, prepared interview checklist for zonal &amp; district OADB and Admins heads and NGOs</td>
<td>NTC</td>
</tr>
<tr>
<td>24/4/98</td>
<td>Interviewed Markus Kitila (Mekanyesus), Takele Bekele (Boji district ODBA), Temesgen Fikadu (Boji A/adminstruter), prepared checklist for key informants</td>
<td>Bila (Boji) and NTC</td>
</tr>
<tr>
<td>25/4/98</td>
<td>Interviewed Horra Kando (Secretary of West Wollega Zonal Admins), Fekadu Geleta (Jarso district OADB head), Hundessa Kajella Nejo OADB head, Abdeta (West Wollega OADB head), Taye Asfaw (W.Wollega OADB Plant protection team leader) &amp; Igigi Kindesa (OADB team leader of seed quality)</td>
<td>Gembi</td>
</tr>
<tr>
<td>26/4/98</td>
<td>Analysis of interview note from Drs. Weilimaker, T. Wood, Zonal &amp; district (W.Wollega) OADB, Abera &amp; Tesfaye Nejo DA training centre</td>
<td>NTC</td>
</tr>
<tr>
<td>27/4/98</td>
<td>Interviewed farmers groups &amp; DAs Tabato Giro (for zonation) at Gutee Michael (Nejo), Abono Dilla (Jarso), Tuqu Kelli (Jarso) and Oda Gundi</td>
<td>Nejo &amp; Jarso districts</td>
</tr>
<tr>
<td>28/4/98</td>
<td>Interviewed farmers, DAs- Oli Goshu at Kara Kiltu, Guyo Lalisa, Bafano Koriche, Dandi Gudi</td>
<td>Manasibu District</td>
</tr>
<tr>
<td>29/4/98</td>
<td>Interviewed farmers, DAs-Tesfaye Waktola at Sombo Guta; Analysis of Boji (Mekane Yesus, local admins, OADB) info</td>
<td>North Nejo district &amp; NTC</td>
</tr>
<tr>
<td>30/4/98</td>
<td>Team analysis from previous day continued</td>
<td>NTC</td>
</tr>
<tr>
<td>Date</td>
<td>Activity</td>
<td>Interview Location(s)</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1/5/98</td>
<td>Interview with farmers groups</td>
<td>Bafano Koreche &amp; Dandi Gudi</td>
</tr>
<tr>
<td>2/5/98</td>
<td>Interview with farmer groups</td>
<td>Bafano Koreche, Wara Giru</td>
</tr>
<tr>
<td>3/5/98</td>
<td>Analysis of info gathered from farmers; decision about meals for translators; food expenses</td>
<td>NTC</td>
</tr>
<tr>
<td>4/5/98</td>
<td>Analysis continued; discussion on the date of midterm workshop</td>
<td>NTC</td>
</tr>
<tr>
<td>5/5/98</td>
<td>Farmers’ interview</td>
<td>Oda Ganka</td>
</tr>
<tr>
<td>6/5/98</td>
<td>Farmers’ interview</td>
<td>Oda Ganka</td>
</tr>
<tr>
<td>7/5/98</td>
<td>Farmers interview</td>
<td>Abono Dilla</td>
</tr>
<tr>
<td>8/5/98</td>
<td>Farmers interview</td>
<td>Gute Michael</td>
</tr>
<tr>
<td>9/5/98</td>
<td>Farmers interview Oda Ganka</td>
<td>ICRA team and translators</td>
</tr>
<tr>
<td>10/5/98</td>
<td>Arrival of Dr. Enserink and briefing him about the groups phase I</td>
<td>NTC</td>
</tr>
<tr>
<td>11/5/98</td>
<td>Planning for the workshop</td>
<td>NTC</td>
</tr>
<tr>
<td>12/5/98</td>
<td>Validation of zonation with Dr. Enserink and Melaku</td>
<td>Bafano Koreche, Oda Ganka Abono Dilla and Gute Michael</td>
</tr>
<tr>
<td>13/5/98</td>
<td>Preparation for the mid term workshop and summarizing finance with Dr. Enserink</td>
<td>NTC</td>
</tr>
<tr>
<td>14/5/98</td>
<td>Mid term workshop</td>
<td>NTC</td>
</tr>
<tr>
<td>15/5/98</td>
<td>Rest</td>
<td>NTC</td>
</tr>
<tr>
<td>16/5/98</td>
<td>Start writing the report from info gathered in phase I</td>
<td>NTC</td>
</tr>
<tr>
<td>17/5/98</td>
<td>Group meeting to identify gaps for phase two data gathering</td>
<td>NTC</td>
</tr>
<tr>
<td>18/5/98</td>
<td>Soil sampling (all five) and problem-causal diagramme</td>
<td>NTC &amp; study sites</td>
</tr>
<tr>
<td>19/5/98</td>
<td>Interview on missing gaps &amp; wealth ranking</td>
<td>Oda Ganka</td>
</tr>
<tr>
<td>20/5/98</td>
<td>Problem ranking, and interview with different farmers' typologies</td>
<td>Oda Ganka</td>
</tr>
<tr>
<td>21/5/98</td>
<td>Analysis of Oda Ganka’s second phase info gathering; planning for the week</td>
<td>NTC</td>
</tr>
<tr>
<td>22/5/98</td>
<td>Problem ranking, and interview with different farmers' typologies</td>
<td>Abono Dilla</td>
</tr>
<tr>
<td>23/5/98</td>
<td>Problem ranking, and interview with farmers' typologies</td>
<td>Gute Michael</td>
</tr>
<tr>
<td>24/5/98</td>
<td>Problem ranking, and interview with farmers' typologies</td>
<td>Bafano Koreche</td>
</tr>
<tr>
<td>25/5/98</td>
<td>Problem ranking, and interview with farmers' typologies</td>
<td>Mendi/Bafano Koreche</td>
</tr>
<tr>
<td>26/5/98</td>
<td>Problem ranking, and interview with farmers' typologies</td>
<td>Abono Dilla</td>
</tr>
<tr>
<td>27/5/98</td>
<td>Problem ranking, and interview with farmers' typologies</td>
<td>Gute Michael</td>
</tr>
<tr>
<td>28/5/98</td>
<td>Problem ranking, and interview with farmers' typologies</td>
<td>Bafano Koreche</td>
</tr>
<tr>
<td>29/5/98</td>
<td>Problem ranking, and interview with farmers' typologies</td>
<td>Mendi/Bafano Koreche</td>
</tr>
<tr>
<td>30/5/98</td>
<td>Analysis info gathered from Abono Dilla, Gute Michael &amp; Bafano Koreche</td>
<td>NTC</td>
</tr>
<tr>
<td>31/5/98</td>
<td>Analysis info gathered from Abono Dilla, Gute Michael &amp; Bafano Koreche, planning for Soil &amp; Water conservation interview (Gembi) and other interview</td>
<td>NTC</td>
</tr>
<tr>
<td>1/6/98</td>
<td>Interview Soil &amp; Water conservation head</td>
<td>Gembi</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
<td>Location</td>
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<tr>
<td>--------</td>
<td>----------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>2/6/98</td>
<td>Travel to Addis</td>
<td>AA</td>
</tr>
<tr>
<td>3/6/98-6/6/98</td>
<td>Vacation</td>
<td>AA</td>
</tr>
<tr>
<td>7/6/98</td>
<td>Team converge &amp; resumed work</td>
<td>AA</td>
</tr>
<tr>
<td>8/6/98</td>
<td>Take appointment for interview</td>
<td>AA</td>
</tr>
<tr>
<td>9/6/98</td>
<td>Interview OADB Extension and Plant Protection Depts. &amp; library</td>
<td>AA</td>
</tr>
<tr>
<td>10/6/98</td>
<td>Interview AISCO, OADB Research Coordinator, MOA soil &amp; Water Conservation Dev. Head &amp; MOA Plant Prot. Dept.</td>
<td>AA</td>
</tr>
<tr>
<td>11/6/98</td>
<td>Travel to Ambo</td>
<td>Ambo</td>
</tr>
<tr>
<td>12/6/98</td>
<td>Interviewed BRC researchers (Livestock, soils, crop improvement, horticulture, and RELC secretary)</td>
<td>BRC</td>
</tr>
<tr>
<td>13/6/98</td>
<td>Travel to Nejo</td>
<td>NTC</td>
</tr>
<tr>
<td>14/6/98</td>
<td>Resumed work and report writing</td>
<td>Nejo</td>
</tr>
<tr>
<td>15/6/98</td>
<td>Consulted hosts about diesel shortage and decided to move to Ambo</td>
<td>Ambo</td>
</tr>
<tr>
<td>16/6/98</td>
<td>Informed ICRA about movement of the team from Nejo to Ambo</td>
<td>Ambo</td>
</tr>
<tr>
<td>17/6/98-21/6/98</td>
<td>Report writing continues</td>
<td>Nejo/ARC</td>
</tr>
<tr>
<td>22/6/98</td>
<td>Exchange of draft report among team, revised report structure</td>
<td>ARC</td>
</tr>
<tr>
<td>25/6/98</td>
<td>Dr. Driek joined the team</td>
<td>ARC</td>
</tr>
<tr>
<td>26/6/98-3/7/98</td>
<td>Report writing continued</td>
<td>ARC</td>
</tr>
<tr>
<td>4/7/98</td>
<td>Final workshop given</td>
<td>BRC</td>
</tr>
<tr>
<td>5/7/98</td>
<td>Travel to Addis</td>
<td>AA</td>
</tr>
<tr>
<td>6/7/98-10/7/98</td>
<td>Incorporation of comment from workshop &amp; writing of unfinished sections and report editing</td>
<td>AA</td>
</tr>
<tr>
<td>11/7/98</td>
<td>Travel back to Wageningen</td>
<td>AA</td>
</tr>
<tr>
<td>12/7/98</td>
<td>Arrived Wageningen</td>
<td>Wageningen</td>
</tr>
<tr>
<td>13/7/98</td>
<td>1998 ICRA trainees &amp; ICRA staff converge at IAC and plan for the remaining two weeks at Wageningen</td>
<td>Wageningen</td>
</tr>
<tr>
<td>22/7/98</td>
<td>Award giving ceremony</td>
<td>Wageningen</td>
</tr>
<tr>
<td>24/7/98</td>
<td>Departure of the ICRA team to their home countries</td>
<td>Wageningen</td>
</tr>
</tbody>
</table>
Background & justification

➢ Termites are causing serious problems in the Western Wollega region and affecting the livelihood of farmers

➢ Termites cause damage to crops, trees, pasture grasses, soils and even buildings and are believed to contribute soil degradation.

➢ Over 600,000 ha of land is reported to be affected by termites in West Wollega. The problem has been reported for the last 20 years.

➢ An intensification and spread of the termite damage has been reported in Mendi, Nejo, Jarso & Boji districts

➢ Past control measures have not effectively reduced termite damage

➢ Farmers, development workers, and researchers consider the intensification and spread of the termite as a high priority problem

Knowledge and information gaps

However, the problem seems not to have been approached from systems perspective. The reasons and the causes of the recent spread and intensification of the termite problem are therefore still unclear.

Purpose

Promoting farmer-participatory problem-solving R&D (research and development) activities to reduce termite infestation and its effects on crops, soils and the livelihood of farmers in Nedjo Woreda and surroundings

General objective

To analyse the termite problem from a dynamic systems perspective so as to better understand the cause-effect relationship and to propose a systems-oriented, integrated and participatory way of managing the pest and the damage caused by it.
Specific objectives

1. To analyse the possible cause-effect relationship of the termite problem from a dynamic systems perspective.
2. To identify characteristics of farms (and their production systems) that affect their vulnerability to termite damage.
3. To identify and indicate areas for improvements / interventions on the basis of lessons learnt from previous R&D experience.
4. To prioritize potential R & D options and formulate relevant proposals.
5. To make recommendations for a systems-oriented, integrated and participatory way of managing the pest.

Immediately intended clients, beneficiaries and stakeholders

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Beneficiaries</th>
<th>Clients</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRC</td>
<td>Bako researchers</td>
<td>BRC</td>
</tr>
<tr>
<td>EARO</td>
<td>EARO researchers</td>
<td>EARO</td>
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<tr>
<td>OADB.</td>
<td>OADB.</td>
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<tr>
<td>ICRA team</td>
<td>ICRA team</td>
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<tr>
<td>ICRA institute</td>
<td>ICRA as institute</td>
<td>ICRA institute</td>
</tr>
<tr>
<td>Farmers</td>
<td>Farmers</td>
<td></td>
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<tr>
<td>NGOs</td>
<td></td>
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<tr>
<td>Consumers</td>
<td></td>
<td></td>
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<tr>
<td>Input suppliers (eg chemical companies, fertilizer/seed suppliers)</td>
<td></td>
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<tr>
<td>Credit institutions</td>
<td></td>
<td></td>
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<tr>
<td>Community organisations</td>
<td></td>
<td></td>
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<tr>
<td>MOA-Plant protection depts</td>
<td></td>
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<tr>
<td>Politicians</td>
<td></td>
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</tbody>
</table>

Overall outputs of the study

- Final report
- Proposals for R & D
- Prioritised potential research contributions for BRC and IAR
- Recommendations for strengthening farmer involvement in R and D
- Secondary information resulting from field study, e.g. reports, diagrams etc.
- Three workshops conducted
### Main Research Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Product</th>
</tr>
</thead>
</table>
| 1 What are causes (ecological, socioeconomic, farming systems etc.) & effects (+ve or –ve) of the recent spread and intensification of the termite problem on farmers livelihood? | - Historical calendar and listing of causes and effects and relationships  
- Generic problem-causal tree |
| 2 Is there a relationship between differential characteristics of farms and their production systems in relation to termite problems? | - One or more flow charts analysing this relationship  
- Typology of farms affected differently by the termite problems |
| 3 What are the leverage points for R&D interventions for different types of farms that contribute to reducing the termite problem and making farms less vulnerable? | - Highlighting of leverage points in the problem-causal trees  
- Diagram(s) indicating the leverage points for each farm type separately |
| 4 What are farmers practices to manage the termite problems?            | - Inventory of indigenous technologies and of the (type of) farms using each of them |
| 5 How do farmers get the information they need to develop these technologies? What is the current status of the AKIS? | - Analysis and assessment of farmers' experimental and diffusion practices  
- Flow diagram |
| 6 What are the present and past research & development efforts in reducing the termite problems? | - Lessons learnt from the experience of these research & development activities |
| 7 How can research contribution can be improved to manage the termite situation/problem | - Suggestions for new R&D activities aimed at integrated management of the termite problem |
| 8 What are the major policy and market factors affecting the termite situation? | - Problem trees |
| 9 Who are the key stakeholders (research, extension, chemical companies etc.) what influence and interest do they have on managing the pest? | - List of stakeholders and their influence matrix |
| 10 What are the key R & D priorities of the major stakeholders?         | - List of R & D priorities matrix |
| 11 Do other insects, diseases, microclimatic change and soil degradation compound termite damage? | - List of interactions, contribution and the role of other biotic and abiotic factors shall be identified. |

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<table>
<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Activities</th>
<th>Methodology</th>
<th>Output</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13-19 April</td>
<td>Sorting out personal things, internet service, bank a/c, interview resource person/organizations, review work plan, presentation of work plan, collection of secondary data, travel to Ambo/Bako, interview Bako researchers, travel to Nedjo.</td>
<td>Informal and formal meetings and interviews, group presentation/discussion, rich pictures</td>
<td>Secondary info collected, study plan presented (to officials &amp; researchers), comments, incorporated, study plan revised.</td>
<td>Addis, Bako</td>
</tr>
<tr>
<td>2</td>
<td>20-24 April</td>
<td>Settling in and arranging working place/Office, sorting out domestic affairs etc. Introduction to stakeholders and resource persons, key informants, reconnaissance discussion on site selection with host, agricultural development and termite situation in west Wollega, orientation and training of interpreters. Review &amp; planning of future activities.</td>
<td>Stakeholder analysis, systems diagram (RP/SD), reconnaissance surveys</td>
<td>Stakeholders perspectives identified, list of stakeholders compiled, transect maps, interpreters trained, updated study plan, Agro-ecological zones identified.</td>
<td>Nedjo surrounding</td>
</tr>
<tr>
<td>3</td>
<td>Week 4</td>
<td>Introduction on representative villages, &amp; selecting representing villages (based on topo-sequence; cropping system, population pressure, ecological stage in deforestation, etc.), typology, information gathering &amp; concurrent analysis, knowledge and information system, agro-ecosystem, farm system socioeconomic and stakeholder analysis, identifying constraints and opportunities, review and planning of future activity.</td>
<td>RAAKS Interest/influence/importance matrix transects, interviews, historical calendar, cropping calendar, flow diagram (resource information).</td>
<td>Interview notes, farming systems and agro-ecological/socio-economic problems identified, updated perspectives of key stakeholders, AEZ and FSZ classified, farm typology identified, villages (&lt;10) selected.</td>
<td>As above</td>
</tr>
<tr>
<td>4</td>
<td>27/April-8/May</td>
<td>Categorizing problems &amp; opportunities, problem causal trees, preparation of mid term workshop, analyze and summarize field data and relate with secondary data, prepare outline of field study report (coat hanger), external reviewer's visit (11-17 May), review and planning of activities.</td>
<td>Problem-causal diagram</td>
<td>List of problems and opportunities, report skeleton (outline) ready, mid-term workshop preparation completed</td>
<td>Nedjo</td>
</tr>
<tr>
<td>5</td>
<td>11-15 May</td>
<td>Reviewer's visit, (May 11-17) mid-term workshop, prioritizing problems and opportunities, priority setting and screening options, incorporating comments, prepare detailed report outline.</td>
<td>Problem ranking matrix.</td>
<td>Mid-term workshop held, Problems and opportunities prioritized, detailed report outline ready.</td>
<td>Nedjo</td>
</tr>
<tr>
<td>6</td>
<td>18-22 May</td>
<td>Collection &amp; analysis of complementary information, refine R and D options &amp; priorities, analyze previous R&amp;D experiences, data analysis writing of report, review and adjust plan of activities, take holiday (5-10 June).</td>
<td></td>
<td>Refined constraints and opportunities, gaps in R &amp; D identified</td>
<td>Nejo</td>
</tr>
<tr>
<td>7</td>
<td>25 May 5 June</td>
<td>Screening options and setting priorities, feed back to farmers, write report, clarify research questions, develop research proposals, external reviewer's visit (June 25), circulate draft, prepare final workshop.</td>
<td>Priority setting methods and tools.</td>
<td>First draft report circulated.</td>
<td>Nejo</td>
</tr>
<tr>
<td>8</td>
<td>9, 10 &amp; 11</td>
<td>Hold final workshop (July 4), incorporate feedback, finalize report</td>
<td></td>
<td>Final workshop held, final report ready</td>
<td>Bako, Addis</td>
</tr>
<tr>
<td>9</td>
<td>29 June 3-7 July</td>
<td>Leave draft copies of final report. Travel back to Wageningen.</td>
<td></td>
<td>Final report (draft) submitted</td>
<td>Addis</td>
</tr>
</tbody>
</table>
Number of livestock stocks in four districts western Wollega Ethiopia, 1998

Source: Western Wollega Zonal agricultural office, Animal team by Waktole Torfa (unpublished)
Appendix XVIII. General interview checklist for key informants

1. General introduction
2. Village name, peasant association, districts
3. Agro-ecological characteristics: altitude, landscape, soil type, vegetation and slope

Land use

4. Percent of agricultural land and forest land
5. How much land do you have and
6. What is farm land non farm land
7. Land tenure and share cropping
8. What land is divided up for what uses? Unused land
9. Percentage by area and topography, valley slopes?
10. Do you share any land or resources, inter household/village
11. Grass for thatching
12. What are the mgmt. systems for CPR/control/access/benefit?
13. What are the land mgmt. practices, manure, fallow, residual mgmt., and burning and ploughing, crop rotations?
14. Do you practice any soil and water conservation practices?
15. Environmental degradation what are your recommendations for control?

Farming systems

16. Introduction (gear towards client and study needs e.g. termites and ICRA)
17. What types of farming systems are there in the area? Do they differ by location? If so why?
18. What types of crops do they have? Do these differ by area?
19. Cereals, household, legumes (rotation) fruits?
20. What cropping systems, inter-mono, multiple?
21. What crops grow where?
22. What types of livestock do these differ by area? And average number per household?
23. Are these any changes in husbandry?
24. What are the feed sources? Seasonality, or availability, pastures?
25. What are your traditional husbandry practices
26. Do you get any new information, breeds, health mgmt. and where from?
27. Do you stall feed, when, how and why not more?
28. Do you have Oxen, no. Uses condition, relate to ploughing, hiring?
29. What are the main tree species?
30. What are the farm management practices?
31. What is farmers' main problem (agriculture/infrastructure)?
32. Are different FS found in different areas (agro-ecological zones)?

Extension

33. What are the extension and support activities and organizations in the area?
34. What roles and service do they provide?
35. How does extension work?
36. Are farmers involved? What does if offer poor farmers? What services do farmers want and need?
37. Who are the key people and institutions involved?
38. How are farmers involved in extension activities? Past, present future?
39. Should farmers be involved in R and D? If so why and how?
40. Where do farmers get their information (AKIS)
41. The interrelationship of different parties involved in R and D (linkages). If it is weak, what is the reason and how could it be improved
Termites

42. What is the history and spread of termite? (Any areas and FS not affected?)
43. What is the seriousness of the termite infestation (by area)?
44. What are the causes of termite infestation? /spread?
45. What factors contribute to intensification of termites?
46. Is there an interrelationship between FS (agr ecology / Population changes and termite infestation
47. What changes (crop yield, weather, socioeconomic, ecological) follow from term infestation?
48. What effects do termites have? (Damage crops, trees, pasture, buildings, livelihoods, soil and socio-economic?)
49. Degree and location of damage (seasonally, yield/crop/tree losses)?
50. What are the negative and positive aspects of termite?
51. Relationship of FS, farm type (resource endowment, infrastructure) and vulnerability (gender) to the termite problem? Which farm types and groups are more vulnerable to termite?
52. Does termite damage differ? (In terms of spread and intensity of damage)?
53. Is there any relationship between termite and livestock?
54. Are there any termite resistant fodder species/ introduced versus indigenous?
55. What are the past, present termite preventive and curative control methods? Which have succeeded, which have failed and why?
56. Is there any change in species of termites?
57. Pattern, ways and factors of spread?
58. Termites damage relationship with topography where bottom valley hill? Location and intensity of spread?
59. Is the termite population actually increasing? What factors help increase?
60. Is there a change in feeding behavior?
61. Is the spread a result of environmental changes?
62. What is the cause effect relationship of termite problem and environmental degradation/ soil erosion/Overgrazing?
63. Have termites changed their strategies due to past control measures?
64. Are there predators feeding on termites?
65. If so, have there been any changes in their number/ activities over the years? Why?
66. Is there any relationship between soil types, level of Organic matter content, depth of ploughing, cultural practices (burning/ fallow/ residue management/crop rotation/fertilizer use) and termite damage/species distribution?
67. Is there relationship of grazing density /manure availability and termite population/damage/species diversity?
68. What are the possible leverages points to tackle termite problem by farm type and production system?

General

69. What extension activities are there to approach the termite situation?
70. Past and present R&D experience of termite control?
71. What policy and market factors affect the situation?
72. What is the future scenario if the problem persists and what recommendations do you have to control the problem?

Socio-economic

73. Population of the area?
74. No. Of household? What is a household? Dynamics? What is a farm? What is village?
75. Male and female?
76. No. of household involved in farming activities
77. Literacy rate?
78. What are the social institutions in the area?
79. Access to infrastructure-market distance roads, schools clinics?
80. Do you have food for all the months of the year from your own production-food sufficiency? Famine?
81. What changes have there been in your SE conditions over the last 20 years population change, migration, also Derg regime-collectivization and vellagisation? Pattern of land holding?
82. What is the land market, traded, bought and sold?
83. Who are the rich farmers, their criteria for measurement? Wealth ranking?
84. What are the criteria for categorizing different farmers?
85. What are the economic costs of termite damage and control? CBA, threshold analysis?
86. Labour availability, hiring and sharing?
87. Cash and credit and flow availability, money lending?
88. Male and female migration?
89. Of farm activities and income sources?
90. Who is more vulnerable men or women, children, old and young? And which farm system?
91. Do you feel secure in the ownership of your land?
92. Is there an incentive to invest in your land?

Gender

93. Who does what activities and during the day, week and year?
94. Who has access and control to land and other resources, decision-making, cash, farm management practices?
95. Who benefits from what?
96. Does termite affect your activities?
97. What are the consequences of the termite problem upon the household by gender and age?

Historical

98. What ecological changes occurred over last 20 years, climatic, vegetation, drought, and soils
99. What are the human/ livestock populations changes over the last 30 years?
100. What is the cultural history, value of livestock?
101. Is there any change in human/livestock/crop diseases/pests?
102. Are there crop species/crop land/ grazing lands that have been abandoned due to termite problem?
103. Did the cropping pattern/ crop spp. change over the years?
104. What is the crop productivity change over the years (yield/ha 20 years ago and now)?
105. Any questions the interviewee wants to ask?