Floristic Composition of Woody vegitation with Emphasis to Ethnobotanical importance of Wild Legumes in Laelay and Tahtay Maichew districts, Central zone, Tigray, Ethiopia

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This is to certify the thesis prepared by Mohammed Shumbahri entitiled: *Floristic Composition of Woody Vegitation with Emphasis to Ethnobotanical importances of Wild Legumes in Laelay and Tahtay Districts, Central Zone, Tigray, Ethiopia* and submitted in fulfillment of the requirement for Masters of Science (Plant Biology and Bidiversity Managment: Ecology) compiles with the regulation of the University and meets the accepted standards with respect to originality and quality.

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ABSTRACT

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This study was focussed on the floristic composition of woody plants and ethnobotanical importance of legumes in Laelay and Tahtay Maichew, central zone, Tigray. To study woody plants study sites were selected via preferential sampling in protected, mountains and degraded watershades following survey. At the end of the day, sixty (60) plots were laid down. Interviews were conducted with informants and field observations were made to collect Ethnobotanical data. Statistical tools like hierarchial cluster analysis and Shannon-Wiener diversity index were used for vegetation data analysis. Preferential ranking was also applied for Ethnobotanical data analysis. As a result 57 woody species and 8 herbaceous legumes were identified. The most species rich family was Fabaceae with 13 species. The result of cluster analysis show that, five community types with distinct species number and the community types found in protected areas have more species than unprotected ones. The prefertial ranking for ethnobotanical study of legumes show that, widely used plants for food and farm implements are Ziziphus spina-christi and Acacia lahai respectivelly. The traditional medicinal knowledge is acquired more from parents in the area. The major threats of woody plants are cutting, continuous cultivation and overgrazing Woody. Meanwhile plantations are the main conservation practices applied in the areas to conserve and facilitate regeneration of woody plants.

KEY WORDS and PHARASES: Woody plants, cluster analysis, Ethnobotany, legumes, plantation

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ADOPT - Adaptation and Dissemination of the ‘Push-Pull’ Technology

CBD - Convention on Biological Diversity

CSA - Central Statistical Agency

EEPFE - Environmental Economics Policy Forum for Ethiopia

EFAP - Ethiopia Forestry Action Program

EFD - Environment for Development

ICRISAT - International Crops Research Institute for the Semi -Arid Tropics

FAO - Food and Agricultural Organization

ISD - Institute of Sustainable Development

IUCN - international Union for Conservation of Nature and Natural resources

M - Meter

MASL - Meter above Sea Level

MM - Mili Meter

NAPRECA - Natural Product Research Network for Eastern and Central Africa

NGO - Non Governmental Organization

SE R- Society for Ecological Restoration

UNESCO - United Nation Education, Science and Cultural Organization

USIDA - United States International Development Association

CHAPTER ONE

INRODUCTION

1.1. Background and Justification

Ethiopia is a country in east Africa with a total population over 80 million and 3 % annual growth rate estimated in 2007 (CSA, 2008). Among of these people (88%) live in the highlands which is above 1500 m and that constitute 43 % area of the country approximately. The country's ecology is quite diversified in terms of altitude, climatic, soil and other ecological features (Ensermu Kelbesa, *et al*., 1992; Paulos Dubale, 2001).

The topographical features of Ethiopia range in altitude between 125 metres below sea level to 4,533 metres above sea level (Friis *et al.*, 2011). The extensive highland plateaux, with an altitude of over 2,500 m above sea level, cover 40 percent of the country. The Great African Rift Valley runs from north to south bisecting the plateau, and, in conjunction with the surrounding lowlands, this feature isolates and separates the plateau from other parts of the continent. The varied topography, the Rift Valley and the surrounding lowlands have given the country a wide spectrum of habitats and a large number of endemic plant and animal diversity (Zerihun Woldu, 1999). Due to this reason Ethiopia is the fifth major country in tropical Africa in terms of the diversity of flora (Ensermu Kelbesa *et al*., 1992).

Different researchers had reported various reasons for the exploitation of forests in different part of the country. According to Alemnew Alelign *et al.,* (2007), the unsustainable exploitation of the forest by the local communities has critically affected species evenness of the woody plants and population structure of the forest in Zegie peninsuala. This is evidenced by the very low density of not only many woody species but also the forest as a whole as well as the dominance of individuals with lower diameter and reduced height classes. The main driving force for the selective destruction of these woody plant species is the desire to generate income from the sale of fuel wood by the local people in the area.

Now a day's forest area coverage in Ethiopia is 2.7 % (2.7 million hectares), of which only about half is natural forest, and there is fast rate of decline (Shibru Tedla and Kifle Lemma, 1998 cited in Gete Zeleke *et al.*, 2006). A growing population needs, among other things, more food, fire wood, construction wood and arable land (Zelalem Abebaw, 2006). To satisfy these needs, farmers in Ethiopia have been destroying the remnant forest all over the country. For example, the cases of Zegie peninsula, peoples are removing the shade trees required for the maintenance of the distinctive coffee plants, and hence contributing to decreased coffee production (Alemnew Alelign *et al.*, 2007).

There are about nine major vegetation types in Ethiopia among of these; Dry evergreen montane forest is a very complex vegetation type occurring roughly above 1500 m and below 3200 m in altitude. Treating this as one vegetation unit is an oversimplification, which the bulk of the plateau within the vegetation zone consists of volcanic rocks (Zerihun Woldu, 1999).

Human population pressure is considered as a major factor in the deterioration of forests, that many people now depend on what have become degraded ecosystems to sustain their livelihoods (SER and IUCN, 2004). In Ethiopia different form of agriculture and grazing systems had been greatly influenced the forests (Gessesse Dessie, 2007). Sedentary rain fed agriculture is the rule in this different vegetation zone, even though sedentary pastoralism may outweigh farming in a few parts, e.g. the flat plateau of northern Bale. The economy of the northern and eastern parts is based primarily on mixed cereal agriculture, with the farmers growing teff, finger millet, sorghum, maize, barley, wheat, as well as pulses and oil crops (Zerihun Woldu, 1999). This is also true in sub-Saharan African countries (Tewolde berhan Gebre Egziabher and Edwards, S., 2010). The northern and northeastern area, especially Wollo, is the most densely populated part of this agricultural zone (Zerihun Woldu, 1999; Selome Bekele and Assefa Hailemariam, 2010). Even forests and woodlands are thus valuable a resource supporting the broad rural agrarian as well as pastoral and agro-pastoral populations of the country, because of grazing in Ethiopia is free roaming with forests and woodlands providing 10 and 60 percent of livestock feed during dry and wet seasons respectively, agricultural production become low (Mulugeta Lemenih and Tadesse Woldemariam, 2008).

Heavy grazing and cultivation are mentioned as a factor for deteriorating forest in Ethiopia (Abiot Berhanu, 2010; Gessesse Dessie, 2007; Solomon Tefera *et al.*, 2007; Selome Bekelle and Assefa Hailemariam, 2010). For instance, the important contributing factors that can be suggested for woody plant decrement in the communal(shared or public) and government sites in Borona area is heavy grazing pressure (in both the communal and government sites), expansion of cultivation and reduced mobility of livestock due to settlement of the pastoralists in the communal (shared or public) lands (Solomon Tefera *et al.,* 2007) and high population density in large areas of Ethiopia had negative impacts on agricultural production and environmental security in the highlands of Ethiopia, contributes significantly to environmental deterioration (Selome Bekelle and Assefa

Hailemariam, 2010). In south central rift valley of Ethiopia grazing and cultivation are also considered as major factors of forest decline (Gessesse Dessie and Kleman, 2007).

The study employed by Alemnew Alelign *et al.*, (2007), at Zegie peninsuala of north-western Ethiopia, also indicates that, fuel wood selling has become almost the only option for earning an income for the entire population on the peninsula, and it is common to hear and see logging activities in all parts of the peninsula. Not only such activity is unsustainable, but also through the loss of shade trees, and contributing to decreased coffee production. The advent of tree cutting and the associated loss of forest resources that serve as shade and a means of soil and water conservation, the environment in the peninsula have been disturbed. It can be predicted that until realistic and acceptable alternatives can be found, deforestation will undoubtedly continue, and the forest resources will be exhausted in the very near future. This, in turn, may lead to land degradation in the form of soil erosion and loss of soil fertility, drying up of streams on the peninsula, decline and even loss of biological resources as well as degradation of Lake Tana. Ultimately, this may affect the welfare of plants, animals, micro-organisms and the community living in the peninsula as well as the town of Bahardar and the country at large (Alemnew Alelign *et al.*, 2007). The severity of the land degradation problem is quite serious in the northern parts of the country, where the damage has led to the displacement of people from their villages (Paulos Dubale, 2001).

The Tigray Region of northern Ethiopia is highly degraded, posing difficult challenges to farmers. As a result the degraded environment contributes to low agricultural production, in turn exacerbating rural poverty (Edwards, S. *et al.*, 2010; Paulos Dubale, 2001). This is why ADOPT had been engaged on this work through establishing project namely Tigray project/ISD in local communities (central, eastern and southern zones) of Tigray starting from 1996 up to now. This project is aimed at application of conservation agriculture approach in small holder cereal-livestock production in dry areas by introducing crop varieties which have potential to withstand harsh and dry climate; for instance, sorghum and millet are among the crops. In addition to this ADOPT project had work in promoting ecological agriculture through improving soil fertility with compost, and natural resource rehabilitation / management, particularly combined physical and biological soil and water conservation, to help farmers in degraded areas to maintain and improve the best of their own varieties of crop, and cropping systems (Edwards, S. *et al.*, 2010).

This study was also trying to relate with ADOPT particularly in identifying woody plants which have potential in agro-forestry in trapping stem-borers and maintaining soil fertility via intercropping system. Farmers' participation in community resource management was also identified during the study. The way that most peoples in the country how depend on the natural resource to enhance their income generation is as such unfair and does not take in to account that unwise use of these resources will result in hazardous condition, so that there should be means of protecting our natural resource specially the forests and woodlands which serve multiple economic, ecological and social purposes and the provision of productive (fertile) virgin land for crop cultivation through adequate studies and researches.

1.2. Research Questions

Before the study the following research questions were raised.

A. What is the nature of the environment and woody vegetation composition of the study area?

B. What are uses of legumes for the local people found in the areas?

C. What are human variables affecting the woody vegetation distribution?

D. What are opportunities of the local peoples in managing and using their vegetation resources in the study area?

1.3. Objectives of the study

The general and specific objectives of the study were the following.

1.3.1. General objective

A. To document the floristic composition of woody plants in the study areas and collect baseline information on socioeconomic importance of the family Fabaceae.

1.3.2. Specific objectives of the study

A. To identify woody plants and plant communities in the study area;

B. To provide baseline information on the Ethnobotanical importance of woody plants particularly, legumes for the livelihoods of the local people and for their domestic animals;

C. To describe major threats on woody plants and select measurements taken to reduce the effects of human interferance on woody plants distribution.

1.4. Statement of the problem

Tigray Region is highly degraded, posing difficult challenges to farmers. The degraded environment contributes to low agricultural production, in turn exacerbating rural poverty and displacement of people from their villages (Edwards, S. *et al.,* 2010; Paulos Dubale, 2001). As Leul Kidane Woldemariam *et al.,* (2010) indicates, it can be said that environmental degradation, drought and socio-economic instability are common in contemporary Tigray region. Most farmers, in Tigray particularly those in degraded and drought prone areas, are not able to afford external inputs and application of ecological or organic agriculture system with participation of women, farmers and individuals should be available in the country to build a healthy and food-secure future for Ethiopia, (Edwards, S. *et al.,* 2010). Broad leaved deciduous woodlands of Ethiopia, together with their associated grasslands, are not very heavily used economically in many parts particularly in Tigray, except in the Tekezze Valley in recent years (Zerihun Wodu, 1999). This is because of shortage of knowledge and skill of local people about forest and woody vegetations especially limited knowledge concerning their role in ecological agriculture and ecosystem stability, (Edwards, S. *et al.,* 2010).

Considering the growing need for, and importance of woody and other vegetations in ecological agriculture and ensuring food security, it is the only time that the research and development institutions of Tigray, Ethiopia, Africa and the rest of the world take it seriously and providing appropriate measures for conserving forest and woody vegetation in order to break inherent problems of farmers whom suffered from soil erosion, degradations and etc (Edwards, S. *et al.*, 2010).

This study was carried in order to come up with certain solutions that can help to protect the forest and woody vegetation from such effects.

1.5. Significance of the study

Diversity of Woody plants in the country now become burning issue because of fast rate of decline of trees in the forest and many areas become degraded due to extensive farming and overgrazing. As a result to conserve woody plants floristic study is vital. This study will provide an ecological study concerning woody species because there is no research done bu any body else. When this study is completed any interested bodies can access information about the floristic composition of the areas. The importance of legumes especially in house hold economy, food, medicinal value, farm implement, livestock fooder, shade and etc is important that helps to know the ststus of the plants which are used by the local people and domestic animals. Reduction in woody vegetation cover is may emanated from anthropoge so that, the actual factor existing in that area also important Because, it helps us to identify how the the government and people reacts towards these factors and measures taken in the areas that helps as experience for other areas.

1.6. Scope of the study

This study was carried out in Lalay and Tahtay Maichew weredas of Central Zone, Tigray Regional State, Ethiopia. The study aimed at describing floristic composition of woody vegitations and socio-economic importance of woody plants with emphasis on Fabaceae (Leguminoceae) family in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1. Highlands of Ethiopia: Geography and Geology

Ethiopia is a land-locked country in the central part of the horn of Africa and extends from 3^0 $24^{'}$ to 14^0 $53^{'}$ northern latitude and from 33^0 $00^{'}$ to 48^0 $00^{'}$ eastern longitude and it consists of extensive areas of Highland suronded by lowlands in all direction except to the north Ethiopia (Friis *et al.*, 2011). Ethiopian Highlands have great geographic diversity, with high and rugged mass of mountains, flat-topped plateaus which is sometimes referred to as the (Eritrean Highlands). The Ethiopian Highlands form the largest continuous area of its altitude in the whole continent, with little of its surface falling below 1500 m (5000 ft), while the summits reach heights of up to 4550 m (15,000 ft). It is sometimes called the Roof of Africa for its height and large area coverage (Zerihun Woldu, 1999; Abiot Berhanu, 2010; Paulos Dubale, 2001; http, www.wikipeda.com).

The Highlands are divided by the Ethiopian sector of East African Rift Valley, into north-western and south-eastern portions. The north-western portion, which covers the Tigray and Amhara Regions, includes the largest massif namely Semien Mountains, part of which has been designated as a national park. Its highest peak, Ras Dashan (4533 m), is the highest point in Ethiopia (Friis *et al.*, 2011; Zerihun Woldu, 1999). Lake Tana of Amhara region which is the source of the Blue Nile also lies in the north-western portion of the Ethiopian Highlands (Zerihun Woldu, 1999; http, www.wikipeda.com). The Ethiopian montane grasslands and woodlands is much of the largest of the highland eco-regions, occupying the area between 1500 and 3000 meters elevations (http, www.wikipeda.com; Zerihun Woldu, 1999). The south-eastern portion's highest peaks are located in the Bale Zone of Ethiopia's Oromia Region. The Bale Mountains, also designated as one of a national park, are nearly as high those of Semien Mountains, with peaks over 4000 m, such as Tullu Demtu (4337 m) and the second-highest peak in Ethiopia is Batu (4377m) is found in this region (Zerihun Woldu, 1999).

Around 30 million years ago, a flood basalt plateau began to form, piling layers upon layers of voluminous fissure-fed basaltic lava flows. Most of the flows were tholeiitic basalts, save for a thin layer of alkali basalts and minor amounts of felsic (high-silica) volcanic rocks, such as rhyolite. In the waning stages of the flood basalt episode, large explosive caldera-forming eruptions also occurred (http,www.wikipeda.com). A number of transgressions of the sea in the Mesozoic era deposited sandstones and limestones and they are most extensive ones being along the (Sidamo), west (Wellega), east (Harar) and north (Tigray) are major geologic features (Friis *et al.*, 2011; Zerihun Woldu, 1999). This condition makes the rocks to have their own distinctive vegetation pattern as a result certain plants like *Acacia etbaica (legume family)* and *Zizyphus spina-christi (Rhamnaceae)* tend to predominate on limestone, especially where the moisture conditions are good (Zerihun Woldu, 1999).

2.2. Population pressure on Ethiopian highland

The Ethiopian highlands cover about 40 % of Ethiopia’s land mass, but 95 percent of the land account for cultivated land. Almost 88 percent of its human population lives there, with 70 percent of the total livestock population of the country. The high concentration of the population in Ethiopia is concentrated on the highlands (Hailemariam Teklewold and Gunnar, 2010; Selome Bekele and Assefa Hailemariam, 2010). It is estimated that over 90 percent of the economic activities in Ethiopia are concentrated in the highlands. Sustainable use of land in these areas is loaded with various problems due to continuous cropping and repeated cultivation of sloping lands without proper consideration for vegetation protection, soil conservation and fertility amendments. Due to high economic dependence of population on these areas, they become degraded (Selome Bekele and Assefa Hailemariam, 2010). Soil resources are eroding at an alarming rate, but as yet there is insufficient awareness, both within and outside the farming community, of the sources of the problems. Now, even the more productive areas in Ethiopia are facing high rates of soil erosion (Hailemariam Teklewolde and Gunnar, 2010).

The mismanagement of natural resources coupled with their underutilization has so far reduced their contribution to Ethiopia's overall development. Various reports show that due to increasing human and livestock population pressure on arable land and forest resources, large areas of the country, particularly in the northern and central highlands, have highly degraded lands where the soil has lost its fertility and there is an overall ecological imbalance (Selome Kebede and Assefa Hailemariam, 2010).

2.3. Vegetation types of Ethiopia

Classifications of vegetation in Ethiopia were reported in various papers, but they have been unsatisfactory because, aside from terminological problems (e.g. the use of the terms savannah, steppe, that often give unrealistic connotations) (Zerihun Woldu, 1999). According to the study employed by Zerihun Woldu, (1999), basically many attempts have been made to classify the vegetation types of Ethiopia by integrating climatic features with vegetation type and species association.

According to Friis *et al.*, (2011), there are 12 major vegetation types and 12 subtypes recognized for Ethiopia. The major types are the following:

(1) Afroalpine belt (AA),

(2) Dry Evergreen afromontane Vegetation and grassland complex (DAF),

(3) Moist Evergreen afromontane Forest (MAF),

(4) Freshwater lakes, lake shores, marsh and floodplain vegetation (FLV),

(5) Transitional rain forest (TRF),

(6) *Combretum-Terminalia* woodland and wooded grassland (CTW),

(7) *Acacia-Commiphora* woodland and bushland (ACB),

(8) Riverine vegetation (RV),

(9) Desert and Semi-Desert scrubland (DSS),

(10) Wooded grassland of Western Gambella region (WGG),

(11) Ericaceous belt (EB) and

(12) Salt lakes, salt-lake shores, marsh and pan vegetation (SLV)

The detail description of each vegetation types of Ethiopia including their characteristic species and human dependence on the vegetation types had been well described and available in (Friis *et al.*, 2011).

2.4. Species diversity, species richness and evenness

Species diversity may be defined as a measure of species composition, in terms of both the number of species and their relative abundances. It is a synthetic biotic index which captures multidimensional information relative to the species composition of an assemblage or a community (Pierre and Louis, 1998). Species diversity is expressed in two components which should be interpreted separately. These two components are the number of species (species richness) and the evenness (equitability) of their frequency distribution Evenness measure attempts to quantify this unique representation against a hypothetical community in which all species are equally common such that all species have equal abundances in the community, and hence, evenness is maximal (Pierre and Louis, 1998). Species richness is a count of the number of species in a quadrate or community. The number of species may be a function of the stability of the environment. Indeed, a more stable environment entails a higher degree of organization and complexity of the food web, so that such an environment contains more niches and, thus, more species. The number of species is proportional to the number of niches since, by definition, the realized niche of a species is the set of environmental conditions that this species does not share with any other sympatric species. This approach has the advantage of linking species diversity to environmental diversity. The value of evenness index falls between 0 and 1. The evenness of species distribution may be inversely related to the overall biological activity in the studied environment; the lower the evenness, the higher the biological activity (e.g., productivity, energy flow, life cycle etc...) (Pierre and Louis, 1998).

In ecology, H' (diversity index) is widely used to measure the diversity of a species assemblage; it is generally computed for each sampling site separately. Diversity indices must be applicable to any type of species assemblage regardless of the shape of the abundance distribution. Diversity indices characterize species composition at a given site and a given time. These indices are used by ecologists for various purposes, which may be of theoretical or practical in nature (Pierre and Louis, 1998).

2.5. Woody plant species diversity

Plant diversity is heterogeneously distributed across the earth and this is because they are rarely at dynamic equilibrium in different part of the world (McKenzie *et al.,* 2007). Ultimately, understanding the variation in plant diversity patterns at different scales is an important topic of concern both for ecological explanations and for effective conservation design. Patterns of plant species diversity have often been noted for prioritizing conservation activities because they reflect the underlying ecological processes that are important for management. The woodland vegetation of Ethiopia mostly occurs in two vegetation types, these are *Combretum-Terminalia* (broad-leaved) Deciduous Woodland and *Acacia-Commiphora* (small-leaved) deciduous woodland. The two types of woodland vegetations are quite different in their nature of environment and their vegetation status and type. In addition to this all the broad vegetation types of Ethiopia are unique in their own right and need conservation efforts at least for the sake of ecosystem and species diversity (Zerihun Woldu, 1999).

2.6. Plant Community types

According to Michael, (1997), a plant community is defined as an abstraction of exactly the same kind as the population. Community simply consists of all the plants occupying an area which an ecologist has circumscribed for the purpose of study.

Plant community also defined as the collection of plant species growing together in a particular location that shows a definite association with each other (Kent and Cooker, 1992). Most plant communities consist of many different species which are not particular to discover all species within a community (Michael, 1997; Kent and Cooker, 1992). Hence, it is common to use the dominant species in naming plant communities (Kent and Cooker, 1992). The description of plant community involves the analysis of species diversity, richness and evenness.

2.7. Community classification and indicator species

Cluster analysis is the broader term applied to many ecological techniques in order to build classification. The concept of classification in ecological works it aims at grouping individual stands or species in to homogenous (similar) categories based on their similarity with one another. The stands those are similar with one another form one class, which is separated from other such classes that also consists of similar stands (Digdy and Kempton, 1996). The properties common to a group of similar stands are then abstracted to serve as a description of that class. Therefore, the abstracted class properties may be compared to the average or mean of a set of various values when combined with a measure of range. For practical and scientific validity, the abstracted class features should adequately describe the individual members of each class (Mueller and Ellenberg, 1974; Digdy and Kempton 1996). This technique is primarily qualitative. However, since this makes it too broad or too narrow for practical purpose, it is necessary to consider the quantity of more prominent species. This means that it provides a useful summary when complemented by an ordination (Digby and Kempton, 1996). Dufrene and Legendre, (1997) define indicator species as the most characteristic species of each group, found mostly in a single group of the typology, and present in the majority of the sites belonging to that group. The indicator value ranges from 0 (no indication) to 100 (Perfect indication) (Tadesse Woldemariam, 2003). The novelty of this approach is that the indicator value of species is based only on within species abundance and frequency comparisons, without any comparison among species. The analysis procedure provided in R-program software was used to perform the indicator species analysis. The statistical significance of the indicator values was tested using the summary table of the similarity ordination complemented by cluster analysis.

2.8. Role of forests and woodlands

2.8.1. Agricultural role

Forests and woodlands serve multiple economic, ecological and social purposes. The most prominent importance of forests and woodlands is the provision of productive (fertile) virgin land for crop cultivation. Ethiopia is an old agrarian nation, and agriculture remains the dominant economic and employment generating sector with around 65 to 70 million people employed in the sector. Despite its old history, agriculture in Ethiopia remains low in modern technological inputs and dependent on nature. In such a traditional agricultural system, horizontal expansion predominates as a strategy to sustain and increase productivity. Thus, forests and other naturally vegetated areas have been supplying fresh and fertile productive land to maintain agricultural productivity for millennia (Nyssen *et al.*, 2004, cited in Mulugeta Lemenih and Tadesse Woldemariam, 2008). Nyssen *et al.*, 2004, cited in Mulugeta Lemenih and Tadesse Woldemariam, (2008), attributed that overall rise in total food production in Ethiopia since 1995, to both the improved climatic conditions and the extension of cropped areas and increased grazing lands. When unconverted to cropland, areas of natural vegetation in Ethiopia serve as rangelands for the largest livestock population in Sub-Saharan Africa. Grazing in Ethiopia is free roaming with forests and woodlands providing 10 and 60 percent of livestock feed during dry and wet seasons, respectively. Forests and woodlands are thus valuable resources supporting the broad rural agrarian as well as pastoral and agro-pastoral populations of the country.

2.8.2. As Source of Timber

The loss of forest cover is no longer a problem of concern to foresters alone. Based on this long-term plan for forest management, such as which forests should be protected, which should be used as sources of timber and firewood, and which should be re-afforested, should be developed. Because, forests are used as a source of timber if they are properly managed (Sebsebe Demissew, 1988).

2.8.3. Regulation of Water

One of the most important aspects of the forest cover is its water regulation properties. Catchment areas which well covered by natural forest provide a maximum infiltration of water and a continuous stream flow. Once the forest cover is removed, the natural infiltration capacity of the soil will be impaired, and the rain-water will flow on the surface, leading to a higher rate of erosion and the consequent drying up of streams and rivers. Among the many projects initiated in Ethiopia associated with rivers are irrigation schemes and hydroelectric power plants, both of which depend on continuous flow of streams and rivers which ultimately depend on the forest cover of the mountains (Sebsebe Demissew, 1988).

2.8.4. Conservation of Soil Fertility

In natural forests the soil is intact and thus the effect of erosion is minimal. Although the forest soils support a luxuriant plant growth, they are of lower fertility. The main source of nutrients in tropical forests is in the litter which is decomposing and recycling rapidly. Thus the bulk of the nutrients are found in the standing biomass (Sebsebe Demissew, 1988).

2.8.5. Shelter for Animals

Forests are used as habitats for many wild animals which plays great role in seed dispersal in the forests. Destroying the forest means is just depriving animals of homes and shelter and this accelerates their extinction (Sebsebe Demissew, 1988; Feyera Senbeta & Demel Teketay, 2001).

2.8.6. Source of Economically important Plants

Now a day most modern medicines are of plant origin, and a large proportion of the Ethiopian population uses the services of traditional healers who depend entirely on herbal medicines. The forests provide most of the remedies used today by the population and may well be the source of the yet undiscovered medicines for the near future and able to eliminate the problems of medicines in the country (Sebsebe Demissew, 1988).

2.8.7. Education and Recreation

Even if animals and plants are denied the opportunity to exist, there is no way of denying a person's right to education. From each species something is to be discovered and learned. Allowing plant species to become extinct means depriving later generations of their rights to observe, under-stand and enjoy nature (Davidson, 1985 cited in Sebsebe Demissew, 1988).

2.9. Push Pull system

Push-Pull is a novel approach in pest management that uses a repellent intercrop and an attractive trap plant. It involves attracting stem borers with trap plants (pull) whilst driving them away from the main crop using a repellent intercrop (push). Insect pests are repelled from the food crop and are simultaneously attracted to a trap crop. Maize is intercropped with a legume, silverleaf Desmodium *(Desmodium uncinatum)*, and Napier grass *(Pennisetum purpureum)* are planted around the intercrop. Both plants provide quality fodder for livestock. Therefore, farmers using Push-Pull technology for pest control not only reap three harvests (Maize, Napier grass and Desmodium). Chemicals released by the intercrop roots induce abortive germination of *Striga hermonthica* seeds and dramatically reduce the devastating effects of this parasitic weed through the effects of desmodium (Khan *et al.*, 2008; Khan *et al.*, 2010).

2.10. Push-Pull: How it works

Kenya's International Centre of Insect Physiology and Ecology (ICIPE) and Britain's Rothamsted Research collaborated with partners in Eastern Africa to develop the Push-Pull technology. The technique involves intercropping silver leaf desmodium, a fodder legume, with maize, Napier and Sudan grass to provide both immediate and longterm benefits. Aromas produced by the desmodium repel (push) pests like the maize stem borer while scents produced by the grasses attract (pull) the stem borer moths and encourage them to lay eggs in the grass instead of in the maize. Napier grass produces a gummy substance that traps the stem borer larvae so, once they hatch; only a few survive to adulthood, thus reducing their numbers. Desmodium roots produce chemicals that stimulate germination of striga seeds, but then prevent them from attaching successfully to maize roots. The striga eventually dies and the number of seeds in the soil is also reduced. Besides being a good ground cover, desmodium is a nitrogen-fixing legume that improves soil fertility. Agnes Ambuvi used to graze three zebu cows on weeds growing along roadsides and footpaths. Now with her napier grass and desmodium providing quality fodder, she has two new cows that produce 15 litres of milk day, earning about 2,520 Kenyan shillings ($35) per week (Khan *et al.*, 2008).

2.11. Intercrops against Striga weed

The strategy of combining crop, trap crop and intercrop, whether to control stem borers alone or to reduce striga infestation, has been highly successful, from the initial experimental trials through to scientist managed farm trials and eventually to farmer managed trials (Khan *et al.*, 2000).

In 1997, it was noticed that maize intercropped with *Desmodium uncinatum* or *Desmodium intortum* suffered far less striga infestation than maize in monoculture. These trials were repeated, comparing Desmodium species with plants recommended widely as intercropping solutions to striga problems, for example sun hemp, Crotolaria spp, soybean, Glycine max (L) Merr and cowpea. With the conventional intercrops, either striga infestation was not significantly different from the maize monoculture, as with soybean, or the striga rating was only reduced by about 50%, as with sun hemp and cowpea. However, when maize was intercropped with a *Desmodium* species, the striga rating was reduced from 2±3 to 0.1 or less. At the same time, there was a statistically significant increase in maize yield ($P < 0.05$) (Khan *et al.*, 2000).

The *Desmodium* species are nitrogen fixing legumes and contribute to the nutrition of the crop. If allowed to grow uncontrolled, there can be competition with the crop, but this can easily be controlled by regular cutting. The mechanism by which these plants, as intercrops, reduce striga infestation so dramatically is now under investigation, there being clear evidence of allelopathic effects. There is already considerable knowledge of the nature of the stimuli, released from the roots of developing host plants that cause germination, haustorial development and colonization of crop plants and related wild species by striga. It is now imperative to identify the exact mechanisms by which *Desmodium* species interfere with striga development, to ensure that control measures based on these intercropping strategies are robust and reliable and with a view to exploitation in the longer term by means of plant molecular genetics. It can already be seen that *Desmodium uncinatum* is producing germination stimulation cues in the rhizosphere, and also that there are compounds interfering with haustorial development and colonisation of the maize hosts, the chemistry of which is under investigation (Khan *et al.*, 2000).

2.12. Intercrops against stem borer

The main goal of the ICIPE is to develop ecologically acceptable management strategies to control sorghum stem borers and improveing the yield of cereal crops. (Khan *et al.*, 2010). These strategies must also be economically and sociologically feasible for resource poor, small scale farmers in Africa and other developing countries. Components that are being developed for integrated management of stem borers belong to the following categories: plant resistance; intercropping of certain specific combinations of host and non host crops; other cultural practices such as sowing date, crop residues, disposal, biological control etc. (ICRISAT, 1989).

The strategy combining crop, trap crop and intercrop, whether to control stem borers alone or to reduce stem borer, has been highly successful, from the initial experimental trial to managed farm trials and eventually to farmer managed trials (Khan *et al.*, 2000).

The nonatriene 11 and ocimene 7 released by the Desmodium species are responsible for their repellency to stem borers as a result there was no detectable increase in parasitism in the intercropped plots. It may be that other components produced by *Desmodium*, including the large amounts of a-cedrene (12), are interfering with this effect. In the long term, this phenomenon may prove to be a useful discovery, as it is often necessary to repel parasitoids from situations where they could be harmed by other crop protection practices (*Khan et al.,* 2000; Khan *et al.,* 2010).

2.13. Intercrops and Trap plants use for forage

It has been a general principle that plants used to create Push-Pull pest management strategies must themselves have value for the communities involved. The trap crops and intercrops can all be used as forage for livestock. Indeed, the luxuriant stands of Napier grass and Sudan grass have allowed the farmers to improve their cattle husbandry and many have increased the size of their herds, although it must be stressed that these, at most, may represent only ten or so individual animals (Khan *et al.,* 2000). The companion plants provide high value animal fodder, facilitating milk production and diversifying farmers' income sources. Furthermore, soil fertility is improved and soil erosion prevented. The technology is appropriate as it is based on locally available perennial plants (Khan *et al.,* 2010).

Scientists in Trans Nzoia, now headed by Dr. C. Mwendia, have also been able to demonstrate, at the Farmers' Barazas, methods for producing cattle silage from the trap crops, which means that large amounts of forage produced during the growing season, can be preserved for later use. In these regions, where zero grazing is the usual method for cattle husbandry, such forage is extremely important. Using an adapted panga with a curved end, it is also simple to harvest the Mminutiora or *Desmodium* species intercrops for the same purpose (Khan *et al.,* 2000).

2.14. Conservation status of forest in Ethiopia

The forest and woodland resources in Ethiopia are severely threatened by degradation. This suggests that past and present management efforts of forests are far from being sufficient to achieve sustainable conservation and use of the country's biodiversity, although such sustainable management is crucial for the country's population that relies on this stock of natural resources for various economic activities. Vegetation resources in Ethiopia are mined rather than managed and their degradation has reached a critical stage (Mulugeta Lemenih and Tadesse Woldemariam, 2008). Past forest management efforts are characterized by unstable institutional arrangements with frequent restructuring and changes in emphasis stemming, in part, from the ideological and political history of the country (Mulugeta Lemenih and Tadesse Woldemariam, 2008; Gessesse Dessie, 2007).

According to Zerihun Woldu, (1999), all the broad vegetation types of Ethiopia are unique in their own right and need conservation efforts at least for the sake of ecosystem and species diversity. Ethiopia has designated 58 National Forest Priority Areas (NFPAs) (Zerihun Woldu, 1999; Abiot Berhanu, 2010). So far the proposed forests for protection are mainly in Dry Evergreen Montane Vegetation and Moist Evergreen Montane Forest.

The list appears to give attention to high forests with good timber trees. Some of the other vegetation types were partially protected in the official 'protected area' system. For example, *Acacia-Commiphora* woodland was protected as part of Abijata-Shalla Rift Valley Lakes National Park that focused on protecting mainly the avifauna, wetland and Palaearctic migrants. Since the avifauna do not directly interact with the terrestrial vegetation, the *Acacia* woodland has been highly interfered with and very little of it now remains because of little attention to protect the plant vegetation in that area (Zerihun Woldu, 1999). Except for limited areas, there has never been a well organized and persistent effort for planned national scale management of the country's forest and woodland resources.

However, in cases where remain state ownership of natural forests and commercial plantations there is a need to properly manage these resources as issues such as lack of enforcement and corruption. While some of the problems may be associated with policies and their implementation, others may have to do with availability of the necessary material and human resources. These problems should be identified and resolved, (EEPFE, 2008).

2.15. Tree plantation for forest regeneration

Tree plantation had become the main solution for forest regeneration and conservation. FRFRC had planned and implemented forest resources and tree improvement research program via Plantation (Alemu Gezahgne, 2007). Plantations can be useful to foster natural regeneration of native woody species, particularly on sites where soil seed banks of native forest species are lacking. They enhance the process of native forest succession over time by attracting seed dispersal agents and providing a nurse effect for the colonizing native species. As a result, tree plantations can enhance plant diversity of indigenous species. However, the need to have seed sources in the vicinity to facilitate the regeneration of native woody species under the canopies of tree plantations is a pre-requisite. It also appears that birds or mammals transport almost all woody species in the under-storey. Therefore, it is very important to keep enough natural forest not only to maintain seed sources in the vicinity but also habitats for seed dispersing animals (Feyera Senbeta & Demel Teketay, 2001).

2.16. Community participation in forestry activities

To improve the natural diversity and regeneration of forest, minimize the influence of the communities and utilize the forest resources sustainably for present and future generation, the basic needs and traditional rights of the communities over the uses of forest resources should be recognized. Positive attitudes towards forest protection and development can only be obtained from the rural communities through the development of benefit sharing mechanism (Sebsebe Demissew, 1988; Leul Kidane Woldemariam *et al.,* 2010).

Ethiopia's forestry problem has been one of ownership in the past. The larger proportion of the land was owned privately by a few individuals. Government legislation in 1974 that was elimnated private land ownership was a milestone for the development of forestry. The departments of the Ministry of Agriculture that are concerned with forests are now making a concerted effort to protect some of the forested areas. Although this is a most welcome idea, what is usually forgotten is the direct involvement of the farmers in the decision making process (Sebsebe Demissew, 1988). The future of Africa's forests is depended on farmers' hands. It is the farmers, who clear the forests to develop agriculture, use trees for constructing houses and as fuel, and who sell firewood and charcoal in the towns. Yet one cannot blame the farmers for what they are doing; they use the forests to provide the necessities of life (Brown and Wolf, 1985 cited in Sebsebe Demissew, 1988).

CHAPTER THREE

MATERIALS AND METHODS

3.1. Geographic location, population and climate of the Study area

3.1.1. Geographic location

There are nine regional states and two city administrations in Ethiopia, (CSA, 2008). Tigray forms the northernmost reaches of Ethiopia, and it is located 12.5 ^{0} and 15 ^{0} N; 36 ^{0} – 40 ^{0} E. It is bordered by Eritrea in the north, Sudan to the west, Amhara to the southwest and Afar in the east. Generally the region is regarded as the most degraded part of the country. Most of the region is highland, but the eastern part includes the escarpment facing the Great East African Rift Valley (Edwards, S. *et al.*, 2010).

Tigray regional state has an area of over 50 thousand square kilometres. Previously malaria prevented most of the population from living at the lower altitudes, but now all parts are being inhabited owing to effective malaria control measures.

This study was conducted in Tahtay and Laelay Maichew woredas (**Figure** 2.) which are located in the northern part of Ethiopia, Tigray region, and central zone. Laelay Maichew is with total area of 41,882 km^2; and with an altitudinal range of 1982-2301 metres above sea level. It also lies approximately between13^0 58' and 14^0 16' North latitude and 038^0 37' and 038^0 55' East longtude. Tahtay Maichew wereda covers a total area of 18,618 km^2 and with an altitudinal range of 1992-2333 metres above sea level and lies approximately between 13^0 52' and 14^0 19' North latitude and 38^0 29' and 38^0 42' East longitude. The landscape of the study areas is somewhat mountainous spotted with varying degrees of rocky areas. Thus the areas are covered with less vegetation distribution and cover.

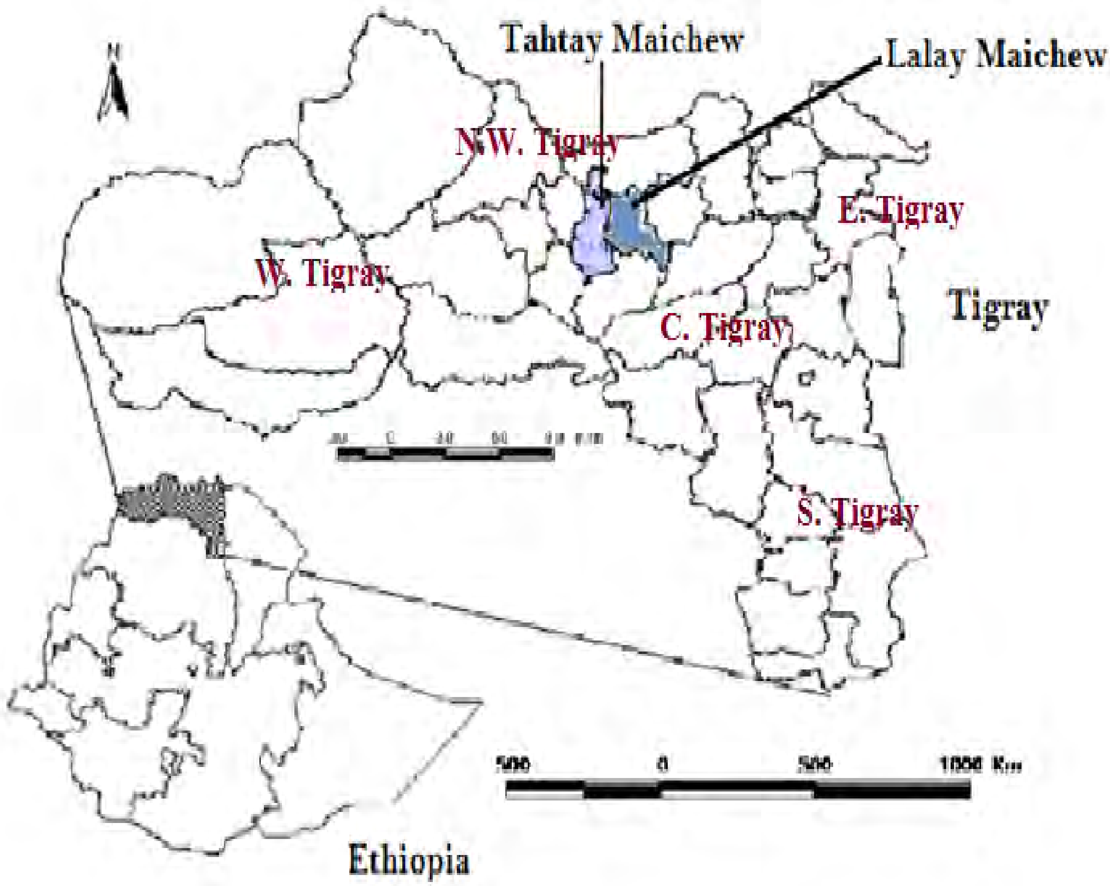

Figure 1. Map of Tigray region in general and study areas in particular

3.1.2. Population

In 2003, the population of Tigray was estimated to be over 4 million and in 2007 4.3 million, in 2008 it was estimated to be 4.5 million, with an annual growth rate of 2.5 %. The average population density of the region is 91.2 persons per km^2. The highest population concentrations are in the Eastern, Southern and Central Zones and it is 131, 122 and 115 persons per km^2

respectively. Most households are found above 1500 m altitude. Total population of Lalay Maichew woreda and Tahtay Maichew woreda is 82, 191 and 116,824 respectively. Average population density is 250 persons per square kilometer in Lalay Maichew woreda.

Table 1.Total population of Laelay Maichew

No.	Name the Tabia	No. Of house hold			Total population		
		M	**F**	**Total**	**M**	**F**	**Total**
1	A/Atsefa	706	241	947	2019	2059	4078
2	N/Belaq	364	216	580	1098	7859	8957
3	Lesaleso	927	288	1215	3047	2434	5481
4	M/Weyni	-	-	1529	-	-	6727
5	D/Berhan	386	199	585	1390	1468	2858
6	Dura	602	255	857	2861	2902	5763
7	Medago	948	252	1200	3610	3689	7299
8	Meha	393	156	549	1330	1418	2748
9	Q/Arbi	733	271	1004	2957	3023	5980
10	Hatsebo	1165	422	1587	2658	2822	5480
11	Welel	814	337	1151	2525	2544	5069
12	M/Selam	1112	522	1634	3486	3723	7209
13	Awleq	669	258	927	2591	2824	5315
14	Dereka	1138	412	1500	4559	4660	9219
15	Seglamen	297	145	442	1046	1074	2120
Total		**10,260**	**3,974**	**15,763**	**33,971**	**48,220**	**82,191**

Source: Rural and agricultural office of Laelay Maichew (2011)

3.1.3. Climate

Climate diagram was computed by using R program for windows version 2.11.1 statistical package, 2010. The climate of the study area is semi-arid climatic condition in both highland and lowlands of the region. The highest temperature of the study area is recorded in April and May since 2001-2010. The metrological data of Axum station reveals that maximum temperature of the area is 30.3 ^{0}C and the mean minimum temperature is also 9.9 ^{0}C recorded in December. The average annual temperature of the study areas reaches up to 19.9 ^{0}C recorded in April and May. Average annual rainfall in Tigray is 800–1000 mm in the west and the highlands of the south dropping to 400 mm in the extreme east. The precipitation occurs mostly during a short summer (end of June to mid-September) rainy season (Edwards, S. *et al*, 2010). In central zone of Tigray the rain fall is irregular and changeable (Edwards, S. *et al*, 2007). Laelay Maichew has 613 mm mean annual rain fall. The highest rainfall of the study area was 179.47 mm recorded in August followed by 118.42 mm in July whereas the lowest rainfall was 2.344 mm recorded in February. Tahtay Maichew has 728-800 mm average annual rain fall. The climate diagram of 2001-2010 is shown in (**figure** 2.)

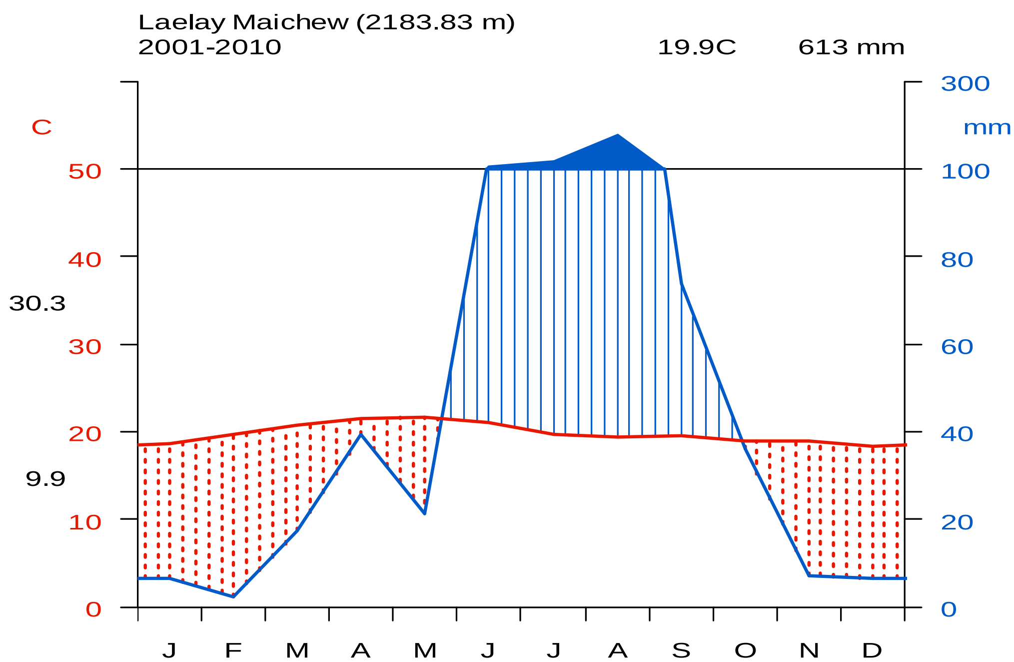

Figure 2. Klimadiagram showing rainfall and temprature from 2001-2010 of Axum station

Source: Data obtained from National Meteorological Service Agency (2010).

3.2. Materials

Materials used during the study were, Frame (pressing Materials and belt), Ventilators, Blotters, Flimsies (news paper), Secateur, Labelling format, Notebook, Digital photo camera, Geographic Positional System (GPS), Plastic rope, 70% Alcohols, Digger, Sharp knife, Gloves, Polythene bag, Lens(bug viewer) and Plastic sheet.

3.3. Methods

3.3.1. Reconnaissance survey and site selection

Reconnaissance survey was conducted in August 2011 to collect visual information about the vegetation and topography. Following the survey base line information, distribution of woody species and number of study plots were determined. Furthere more 8 study sites were selected following prefertial sampling. Study site selection was done with the help of Kebele's administration leaders, agricultural experts, forestry specialists, association of team leaders and others who are expected to have enough information about the study. Durra Mountain, May-Koho, Abune-pentelion and Sefeha were the study sites selected in Laelay-Maichew woreda. Lalay-Wukro, May-brazio, Ruba-kewanit and Enda-mickel are also the study sites selected in Tahtay-Maichew woreda.

3.3.2. Vegetation data collection

Vegetation data were collected in September and October 2011. During this study 60 study plots with 20 m x 20 m (400 m^2) were concidred and to cover all study sites each plots were 100 m far from each. The plots were laid down in protected, degraded areas, mountains and watershades. Within a plot, each plant's cover abundance estimated by percent, and vernacular names was recorded from reliable local persons. Voucher plants specimens collected from each study plots were pressed and dried prior to identification. Later, they were identified in the National Herbarium by referring to various published references of the flora of Ethiopia and Eritrea. Scientific Plant names were follow the published flora of Ethiopia (Edwards *et al*., 1995; Hedberg and Edwards, 1989; Edwards *et al*., 2000; Hedberg *et al*., 2003; Hedberg *et al*., 2004 and Hedberg *et al*., 2006). Specimens were deposited at the National Herbarium of (ETH), Department of Plant Biology and Biodiversity Management Program Unit, Addis Ababa University.

3.3.3. Informant selection

The numbers of the participants or Informant selection) was employed following Martin, (1995). According to Martin, (1995), indigenous knowledge held by knowledgeable traditional groups and systematic choice of informant is commonly crucial. Informants were selected systematically through certain criteria such as Traditional knowledge, time of residency (at least 25-30 years) in the area and training available through agricultural office of the government and non-governmental organizations was also studied. Later out of 60 informants, 40 (both men and women of local peoples) of them with the age ranged from 25-85 were selected randomly (filliping coin). Five key informants were selected based on the recommendations given by the association leader, the local authorities, elders and community leaders of the study areas.

3.3.4. Group discussion and semi-structured interviews

Concerning the semi-structured interviews following Martin, (1995) and group discussion, with in the informants, farmers and agricultural experts were done. Agricultural experts and local farmers were participated during group discussion and interview. Semi-structured questionaries were prepared for the interview (**Appendix** 2.) and the responses were discussed with the agricultural and forestry experts of the areas for reliability. Information like Ethnobotanical data of plants, environmental protection strategy by the people, their awareness concerning natural resource utilization and conservation, any action taken by the government in the area regarding forest protection in different years and participation of local people were collected. During the group discussion an attempt was made to encourage the local people particularly women and other informants in such a way that their cooperation has great benefit to the country for the health protection system as well as biodiversity conservation.

3.4. Vegetation data analysis

3.4.1. Hierarchial Cluster analysis

The vegetation data were analyzed using the multivariate numerical analysis tools such as cluster analysis and diversity index. Cluster analysis is the general term applied to many ecological techniques in order to build classification based on their attribute or vegetation similarities (for this study that is study plots). The concept of classification in ecological works aims at grouping individual species in to homogenous categories based on their similarity with one another (Digdy and Kempton, 1987). During vegetation data analysis, all types of plant species present in plots were recorded and percentage cover of each species was converted in to modified 1-9 Braun-Blanquet scale as follows: 1 = rare generally 1 - 4 %; 2 = few which are 5 – 10 % cover of the total area; 3 = abundant with 11 - 25 % cover of the total area; 4 = very abundant with 26 - 35% cover of the total area; 5 = 36 – 45 % cover of the total area; 6 = 46 - 65% cover of the total area; 7 = 66 - 75 % cover of the total area; 8 = 75 – 85 % cover of the total area; 9 = 86 - 100% cover of the total area. Finally, the data were analysed Hierarchial cluster analysis was performed using R: software program version, R.2.11.1 (2010).

3.4.2. Shannon-Wiener diversity index

Shannon-Wiener Diversity Index was applied because it helps in order to know plant species diversity which is expressed by species richness and evenness (equitability). The result of Shannon-Wiener diversity index is interpreted based on the values obtained through computation and the index ranging from (1.5-3.5) and 1.5 is referred as low species richness and evenness and 3.5 which is high species richness and evenness. The formula was the following.

$$H' = \sum_{i=1}^{s} (\mathbf{pi\ ln\ pi}),) \textbf{ where}$$

H' = Shannon Index

Ni - Number of individuals in species;

S - Number of species; also called species richness;

N - Total number of all individuals and

Pi - Relative abundance of each species calculated as the proportion of individuals of a given species of the total number of the individuals in the community.

It can be shown that for any given number of species, there is a maximum possible

H', H_{max} = lnS which occur when all species are present in equal numbers.

Species evenness is also calculated using the following formula. That is;

E=H'/LN(S) =H'/H_{max}, Where: E = Evenness; H' = Shannon-Wiener Diversity Index; = S = total number of species in the sample and LN; = Natural Logarisim. The value of evenness index falls between 0 and 1. The higher the value of evenness index, the more even the species is in their distribution within the given area. Species richness is a count of the number of species in a quadrant, area or community (Pierre and Louis, 1998).

3.5. Ethnobotanical data analysis

3.5.1. Preferential ranking

Preferential ranking was used to analyse the Ethnobotanical (food and farm implement values) of legumes plants. Ethnobotanical data, particularly legume plants which serve as source of food and farm implement; preference ranking was done following Martin, (1995), for five wild food and farm implement plants by using the report of informants. In this study, it was used to describe the most preferred sources of wild food obtained from the environment. For these purposes, five informants were identified to rank those sources of wild food and important plants according to their personal preference of efficacy. Each rank is stated by integer value (1= excellent, 2 = very good, 3= good, 4= less used, and 5= least used), i.e., the most effective plants for wild food were stated by highest value five, while the least important is stated by value of one.

CHAPTER FOUR

RESULTS

4.1. Woody vegetation cover and diversity

A total of 65 plant species were collected and taxonomically belonging to 29 families was identified. Among of these plant species, 57 of them are woody (25 tree and 32 shrubs) and eight of them are herbaceous legumes. The most woody plant species rich families of the study areas are Fabaceae (7 genera, 13 species), Lamiaceae (4 genus, 4 species), Euphorbiaceae (3 genus, 4 species), Anacardiaceae and solanaceae having 3 genera and 3 species and 2 genera, 3 species respectively. The most species rich family (Fabaceae) has encountered 22.8%. The two species rich families (Fabaceae and Lamiaceae) have also attained 29.8 % of the total woody plant species diversity in the study areas (**table** 2.).

Table 2. Number of families collected during the study

No.	Name of families	No. of species	Percentage (%)
1	Acanthaceae	1	1.75
2	Agavaceae	2	3.5
3	Anacardiaceae	3	5.26
4	Apocynaceae	2	3.5
5	Asteraceae	1	1.75
6	Balanitaceae	1	1.75
7	Boraginaceae	1	1.75
8	Bruseraceae	1	1.75
9	Cactaceae	1	1.75
10	Capparidaceae	1	1.75
11	Celasteraceae	1	1.75
12	Cupressaceae	1	1.75
13	Ebenaceae	1	1.75
14	Euphorbiaceae	4	7

15	Fabaceae	13	22.8
16	Lamiaceae	4	7
17	Loganiaceae	1	1.75
18	Malvaceae	3	5.26
19	Meliaceae	1	1.75
20	Moraceae	2	3.5
21	Myrtaceae	1	1.75
22	Oleaceae	1	1.75
23	Phytolacaceae	1	1.75
24	Polygonaceae	1	1.75
25	Rhamnaceae	1	1.75
26	Sapindiaceae	1	1.75
27	Solanaceae	3	5.26
28	Verbenaceae	1	1.75
29	Vitaceae	2	3.5
	Total	**57**	**100**

Shannon diversity index (H' value) of 57 woody species in 60 plots of the study areas was found to be approximately 3.5 while the species evenness value was 0.85. Out of the total number of plant species recorded in the study areas 63 of the plant species were recorded from the Lalay Maichew areas and 37 plant species were also recorded from Tahtay Maichew areas. Out of the total of 29 families recorded in both areas, 26 % of them are common to them while 47 % were exclusive to the Lalay Maichew and 27 % to the Tahtay Maichew area (**Table** 3.).

Table 3. Number of species recorded in Laelay and Tahtay Maichew

	Lalay Maichew	**Tahtay Maichew**	**In both**
No. of families	28	21	20
No. of genus	50	25	23
No. of species	63	37	35
Percent	47 %	27 %	26 %

4.2. Plant community classification

Plant communities are named after two or three indicator species. Indicators species are selected based on the species with greater value in the summary table of the cluster analysis are considered as indicator species of that specific community (Pierre and Louis, 1998). The results from the agglomerative cluster analysis (**Figure** 3.) reveals that, five plant community types and these are; **CT1:** *Acacia lahai-Euclea racemosa Subsp.schimperi community*; **CT2:** *Lantana camara community;* **CT3:** *Olea europeae subsp. Cuspidata, community;* **CT4:** *Calpurnia aurea-Cissus.quadrangularis-Senna singueana community; and* **CT5:** *Dodonaea angustifolia-Croton macrostachyus community.*

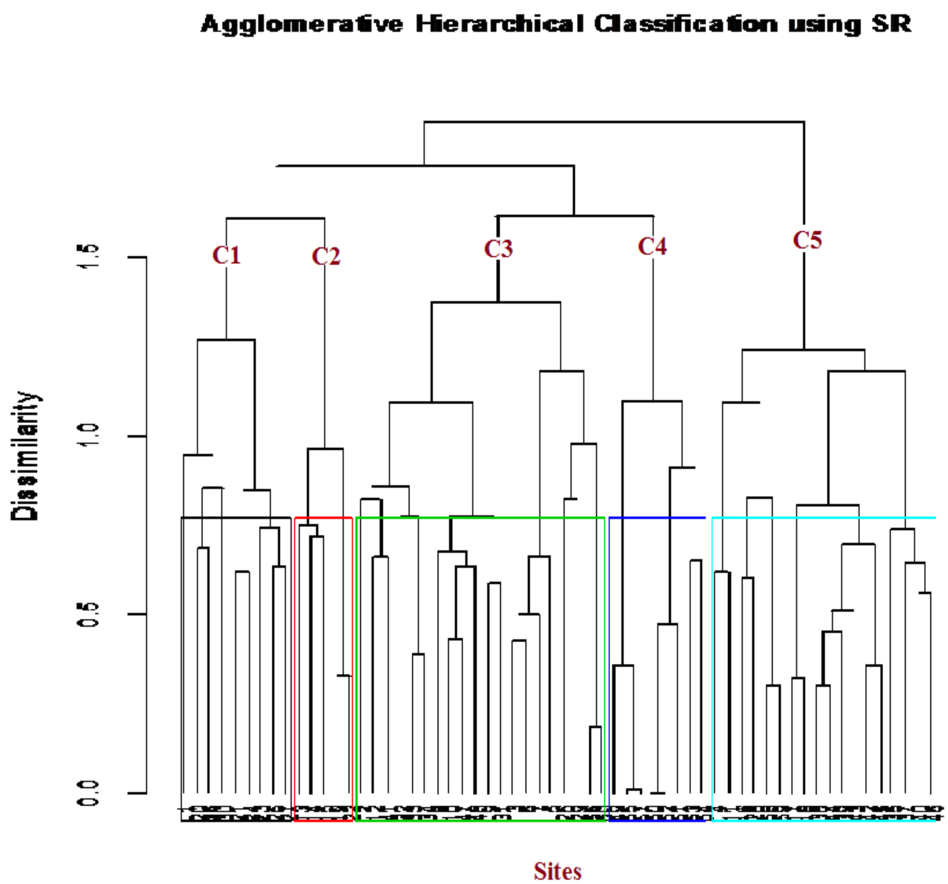

Figure 3. Dendrogram of cluster analysis of 60 study plots

Key: CT1 quadrant: p1,p20,p21,p23,p24,p25,p27,p30 and p36; **CT2**: p13,p14,p15,p19 and p22; **CT3**: p2,p3,p5,p6,p7,p8,p9,p10,p12,p26,p29,p31,p32,p33,p34,p41,p47,p48,p56 and p60; **CT4**: p49,p50,p51,p52,p53,p54,p55 and p57; **CT5**: p4,p11,p16,p17,p18, p28, p35,p37,p38, p39,p40, p42,p43,p44,p45, p46, ,p58 and p59

The following **Table** 4., shows the Synoptic values of species in each community. Each plant species are different in their value in this summary table. This is because of difference in abundance in the community. The indicator species for each community type were selected based on the values (highest mean abundance species). The species which are found only particular community type was considered as diagnostic species.

Table 4. Synoptic table of diagnostic species in five clusters

Species name	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Acacia abyssinica	0.00	0.25	**0.72**	0.00	0.00
Acacia saligna	0.00	0.00	0.56	0.00	**0.88**
Becium grandiflorum	0.00	0.60	0.61	1.00	**1.50**
Clerodendron myricoides	0.00	0.00	**1.28**	0.00	0.63
Gossypium bricchettii	0.00	**0.25**	0.00	0.00	0.00
Hibiscus ludwigii	0.00	**0.60**	0.00	0.00	0.00
Justicia schimperiana	0.00	0.70	0.33	**2.80**	0.00
Phytolacca dodecandra	0.00	**0.25**	0.00	0.00	0.00
Rhoicissus tridentata	0.00	0.25	0.00	**1.40**	0.00
Sesbania sesban	**0.78**	0.00	0.00	0.00	0.00
Sida collina	**0.56**	0.00	0.00	0.00	0.00
Turrae abyssinica	**0.67**	0.00	0.00	0.00	0.00

As you can see from **Table** 5., It shows that, the Shannon diversity index, evenness and species richness of each community type. All of the community types have more or less different number of species and eveness. Five community types were identified earlier and here below all of the community types were describe one by one.

Table 5. Shannon diversity, richness and evenness of five clusters

Clusters	H' value	Species Richness	Shannon Evenness
1	3.29733	30	0.9695
2	3.2105	40	0.9602
3	3.006163	31	0.8754
4	2.639969	17	0.9317
5	2.458769	13	0.9586

1. ***Sida collinia-Sesbania sesban- Turrae abyssinica Community***

This community type is formed by nine plots and 35 species which are dominated by *Sida collinia, Sesbania sesban and Solanum incanum*. The Shannon diversity for this community type is 3.29. Shannon evenness is also 0.92. It is located at an altitudinal range of 2214 m-2227 m. The commonly occurred plant species in this community type are *Solanum incanum* and *Ricinus communis.*

2. ***Phytolacca dodeccandra-Gossypium bricchettii-Hibiscus luduigii*** **Community**

This community is formed by five plots and 40 plant species which make it to be highest in species number. The commonly occurred plant species in this particular community are *Ocimum urticifolium and Acacia mearnsii*. The Shannon diversity for this community type is 3.21. Shannon evenness is also 0.87. It is located at altitudinal range of 2070 m-2224 m.

3. ***Acacia abyssinica-Clerodendrn myricoides Community***

This community is formed by 20 plots and 31 species. This community type is dominated *Acacia abyssinica and Clerodendrn myricoides*. The common woody plant species of this community are *Petrollobium stellatum and Senna obtustifolia.* The Shannon diversity index for this community type is 3.00. The Shannon evenness is also 0.85. This community type is located at an altitudinal range of 2070 m-2224 m.

4. ***Justicia schemperiana-Rhoicissus tridentata Community***

This community type is formed by eight plots and 17 species. The Shannon diversity index for this community type is 2.63 and Shannon evenness is also 0.93. This community type is located at an altitudinal range of 2166 m-2279 m. The commonly occurred woody plants species are *Acokanthera schimperi* and *Agave americana.*

5. ***Acacia saligna-Becium grandiflorum Community***

This community is formed by 18 plots and 13 species. All the quadrats were found in the salt house. This community is dominated by *Acacia saligna and Becium grandiflorum*. The commonly occurred woody plant species of this community is *Acacia Seyal and Carissa spinarum, Mytenus serrata and Ficus Vasta*. The Shannon diversity for this community type is 2.89 and Shannon evenness is also 0.85. It is located at an altitudinal range of 2062 m-2333 m.

4.2.1. Sorensen's similarity index of the five community types

Sorensen's similarity index of the five community types shows that, the identified community types are more or less similar. This is to mean those community types similarity cofficent is al most greater than or equal to 0.5. among of these similar community types, eapecially community two and three are more similar than others. In addtion to this community type three is also more or less similar with community type four and community type five. The least similar community types are community two and five, one and four and one and five respectivelly (**Table** 6.).

Table 6. Sorensen's similarity index of community types

	C1	**C2**	**C3**	**C4**	**C5**
C1		0.50	0.5	0.42	0.36
C2			0.73	0.56	0.48
C3				0.6	0.59
C4					0.64
C5					

4.3. Socio-economic importance of plants

4.3.1. Useful plants in the study area

As in most parts of Ethiopian rural areas, the community of the study areas at large depends on plant and plant products as a source of food, fodder, fire wood, medicines, wood for construction and farm implements and etc. The use categories of the useful wild and semi – wild plants in the study area were mentioned by the informants based on their experience of categorization. The collected information and categorization of plant uses was systematically arranged by the researcher.

The highest number of plants (22.45 %) is used for animal fodder; next to this about 18.3 % of the plants are also used for source of fuel wood. The plants are also used for medicine, fence, construction, farm implements and so on (**Table** 7.).

Table 7. Major use category of non-cultivated (wild/semi-wild) plant species

Use category	**No. of species**	**Percentage (%)**
Food	5	10.2 %
Fodder	11	22.45 %
Medicine	6	12.24 %
Construction and Farm implements	5	10.2 %
Fuel wood & charcoal	9	18.3 %
Fence (live or dry)	7	14.3 %
Miscellaneous (browse, shade, kitchen utensils,)	6	12.24 %
Total	**49**	**100 %**

4.3.2. Plants and their parts used in traditional medicines

Table 8. Parts of plants used in traditional medicines

No.	Plants name	Parts used
1	*Acacia albida*	Barks, fruits and leaves
2	*Acacia seyal*	Barks and gum
3	*Calpurina aurea*	Seeds
4	*Parkinsonia aculeta*	Pods
5	*Sesbania sesban*	Seeds
6	*Carissa spinarum*	Roots

During the field work six plants used for traditional medicine were recorded. Five of them are legumes and the remaining one is a member of family Apocynaceae. Parts like leaves, roots, seeds, pods and fruits are the commonly used in traditional medicines in the areas (**Table** 8.).

4.3.3. Traditional Medicinal Plant Use Knowledge Transfer

Most of the traditional knowledge of medicinal plants is passed along the family line from parents (40 %) followed by observation (25 %) to their trustworthy families and other intimate family members (**Figure** 4.).

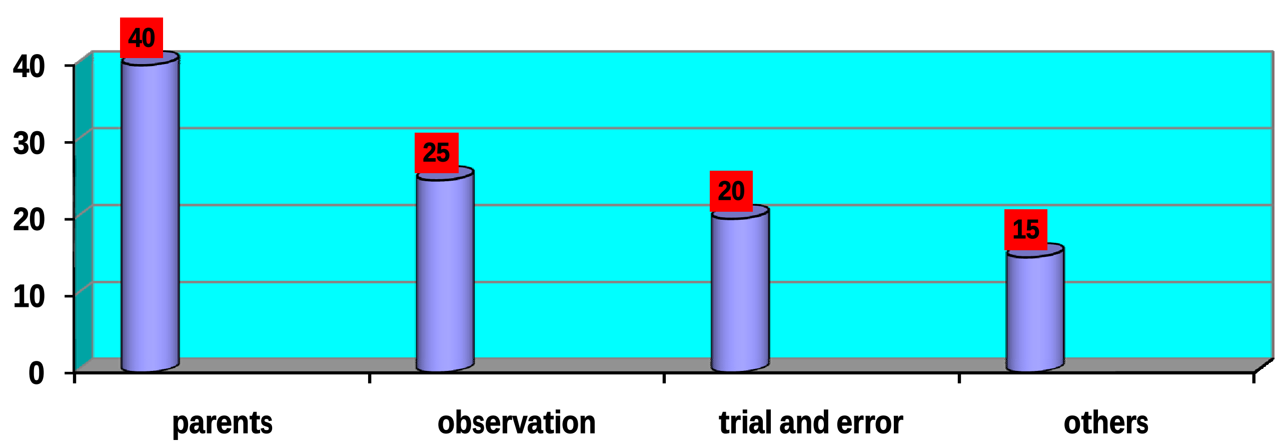

Figure 4. Traditional medicinal knowledge acquisition methods

4.3.4. Plants used for farm implements

About 10.2 % of the plant species (Legumes) are used for manufacturing farm equipments. In the study areas *Acacias* are the important plants used for the purposes of manufacturing traditional farm equipments. *Acacia lahai* is the most important plant species for manfuctering farm equipments. The least used plant species for the same purposes is *Acacia etbaica* (**Table** 9.).

Table 9. Preferential ranking of five Acacia species

Species name	R1	R2	R3	R4	R5	Total	Rank	Description
Acacia lahai	5	3	4	4	3	19	1	Mostly used
Acacia albida	4	3	3	2	4	16	2	Very good
Acacia abyssinica	3	4	3	3	2	15	3	good
Acacia seyal	2	1	3	4	2	12	4	Less used
Acacia etbaica	1	1	3	2	2	10	5	Least used

4.3.5. Plants used as food

Plants which used for food are about 10.2 %. Preferential ranking was employed by the key informants during the study. Based on the responses from the key informants, the edible fruits of *Ziziphus spina-christi* are the most important and widely used as source of food in the study areas. It also used as source of income by selling the edible fruits in the local markets. The second important food plant is also *opuntia ficus-indica.* The edible fruit of this plant is used as source of food. Legume species such as, *Parkinsonia aculeate* has also edible fruits and ranked in less used (**Table** 10.).

Table 10. Preferential ranking of five selected food plants

Species name	R1	R2	R3	R4	R5	Total	Rank	Description
Parkinsonia aculeata	3	1	4	3	2	13	4	Less used
Ziziphus spina-christi	4	5	4	5	4	22	1	Mostly used
Cordia africana	4	3	3	2	5	17	3	good
Opuntia ficus-indica	4	5	3	4	4	20	2	Very good
Carissa spinarum	2	1	1	4	3	11	5	Least used

4.3.6. Plants used as fodder (animal feed)

Parts of Legumes which are used as source of fodder consists mainly of the leaves of trees, shrubs, herbaceous plants and about 11 (22.45 %) percent of plant taxa were found to be used as source of fodder. The most common species used as fodder were various *Acacia* spp. and *Desmodium ospriostreblum* is from herbs. The leaves of these non-cultivated plants are used as a fodder and also the leaves of *Parkinsonia aculeata* are used as fodder in the study area.

4.3.7. Plant Uses in Push-Pull technology

During the study there was an opportunity to see the small plot of farm land where Push Pull technology was tested around Tabia Dura. There was an attempt to find the local *Desmodiums* species (intercrop) which are used in push-pull system. At the end of the day seven herbaceous legumes were collected from study sites including one species of *Desmodium*. It is can grow under *Eucalyptus* and this plant spcies may be used as intercrop in Push-Pull system (**Figure** 5.).

Figure 5. *Desmodium ospriostreblum* found in Laelay Wukro in Tahtay Maichew
[Photo by; Mohammed Shumbahri, 2011]

4.4. Major threats of plants in the areas

Apart from the natural effects human interferance is the highest cause of environmental degradation and vegetation reduction. Semi-structured interview was employed in the study. The result shown that, the main causes of vegetation reduction in the study areas are tree cutting, over grazing and cultivation.

Tree cutting is almost common in the areas for different purposes and it is one cause for forest reduction. It is accounted about 49 % when compared with others. Cutting tree for Fuel and charcoal in the study areas are the major means of income generation. *Acacia etbaica*, *Rhus retinorrhoea, Acacia lahai* and *Acacia abyssinica* are cut and used for fuel and fire wood. As result these plants are decrease their diversity from time to time, especially *Acacia albida* become least diversified among of the *Acacias*. Over grazing and continues cultivation are also deemed as common effects of the vegetation resource in the areas and accounted about 8 % and 38 % respectively (**Figure** 6.).

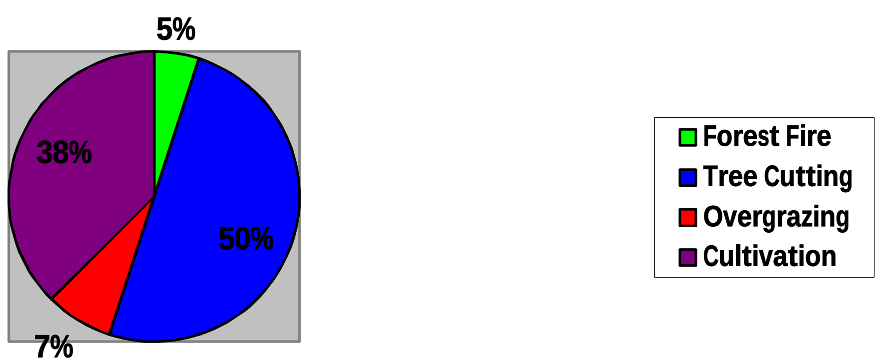

Figure 6. Major threats on vegitations

4.5. Opportunities for Forest Resource management practices

4.5.1. Natural and community forest distribution

Until the development of the system of enclosures by local communities, the best protected areas of natural vegetation were the small patches of sacred forests around churches and monasteries, in Muslim burial grounds and around holy springs. These areas have been protected by the strong beliefs of local people, not through official safeguard (Edwards, S. *et al*, 2010). Indigenous trees like *Olea europaae* subsp. *cuspidata, Juniperous procera, Cordia africana* and *Acacia lahai* are found in these places in the study area. Moreover same trees are also found in schools and governmental offices in the study areas.

Now a day there is forest protection work in the study area. A total of 5634 hectares are now protected for forest priority before and in 2011(**Table** 11.). According the response of the forest specialists of the areas there will be a better change after some years if this work is continued.

The other forest foundations are 'community forests', mostly of *Eucalyptus* planted during the military government of the 1970s or early 1980s. After the change of government in 1991, local communities throughout the region have designated hillside enclosures where indigenous tree and shrub species, particularly *Acacias* and some *olea europaea* subsp. *cuspidata* and *Juniperus procera* are in the way of regeneration.

Table 11. Natural forest priority areas

No.	Years	Area per hectares
1	Before 2011	4405.5
2	In 2011	1228.5
Total		**5634**

Source: Agriculteral and Rural development of Laelay Maichew, (2011) Concerning natural resource management in both woredas effective work is done in the previous years. Local farmers and peoples are weapon with how to use and manage their natural resources in the study areas. Particularly a lot of watersheds are now rehabilitated in the previous two and above years in the areas. For instance, in 2010 about 2340 hectares in Lalay Maichew was conserved (**Table** 12.).

Table 12. Protected areas for conservation

Year	**Area in hectares**
Before 2010	10209
In 2010	2340
In 2011	1428
Total	**13977**

Source: Agriculteral and Rural development of Laelay Maichew, (2011)

There was an opportunity to see peoples who were engaged in planting indigenous trees (e.g. *Acacia lahai* (**Figure** 7.) in Laelay Maichew woreda (**Table** 13.). In Axum there is *Acacia* spp. plantation in the mountain and watershed around the obelisks (May-Koho) by the time being.

Table 13. Tree plantation done in the area

No.	**Planted species**	**Status**
1	*Acacia spp.*	Good
2	*Eucalyptus sp.*	Excellent
3	*Juniperus procera*	Least
4	*Sesbanis sesban*	Very good

Source: Agricultere and Rural development of Laelay Maichew woreda, (2011)

Apart from the indigenous tree plantation local farmers in the areas have also planted *Sesbania sesban* plantation around farm lands which is also another good experience observed in the study areas. The impact on the health of their animals of having more forage available, particularly from *Sesbania sesban*, the small multi-purpose tree legume, and appreciated that the trench bunds and check dams stabilized the land.

Figure 7. ***Acacia*** **spp. plantation in May-Koho around Axum town**

[Photo by; Mohammed Shumbahri, 2011]

4.5.2. Farmers and women experience in resource management

The participation of local people in natural resources and environmental protection practices is paramount important that enables us to organize traditional experiences with scientific knowledge and come up with sustainable and effective results.

Local farmers are now participated in natural resource conservation works done in the area. The above (**Table** 14.) shows the number of local farmers of almost all age levels participating privately in conservation work through owning lands given by government.

The participation of youth farmers of both sexes is playing vital role in natural resource conservation and protection in the study areas. Farmers in the study area particularly around Dura Dam (**Figure** 8.) had been work effective ecological work that, there is more changes with the environment and in turn this boosts the income of the local farmers. According to the data obtained from Lalay Maichew rural and agricultural office, 310 farmers are able to get lands privately and about 118.5 hectares are given to private farmers in order to conserve and protect.

Table 14. Number of participants engaged in conservation work in the area

Items	**No. Of participants**	**Area in hectares**
Youth farmers of both sex	231	78.5
Adult farmers of both sex	79	40
Total	**310**	**118.5**

Source: Agriculteral and Rural development of Laelay Maichew, (2011)

Apart from fruit trees there is *Sesbania sesban* plantation around their farm lands of the study areas which farmers are now able to feed their animal easily (**Figure** 8).

Figure 8. *Sesbania sesban* plantation around Dura Dam in Laelay Maichew

[Photo by; Mohammed Shumbahri, 2011]

CHAPTER FIVE

DISCUSSIONS

5.1. Floristic composition

During this study 65 plant species (57 trees and shrubs) and 8 herbaceous plant species) belonging to 29 different families were documented both from Laelay and Tahtay Maichew areas. A total of 25 trees, 32 shrubs and 8 herbs were collected in this current study. The most species diverse family is Fabaceae (13 species). Shannon diversity of the woody species is 3.5 which reveals high species richness and evenness and evenness of the species is also 0.86 which indicates high species evenness (species equitability) (Pierre and Louis, 1998).

The cluster analysis of the woody plant species data revealed five community types, which are distinct in terms of species composition. The distributions of these plant community types were highly influenced by altitude, which in general influence availability of highest soil moisture content and other soil nutrients. Moreover, of the five communities identified, two communities (three and five) were found with less species abundance whereas, the other two communities (one and four) were found with more or less good species abundance than the former communities. The last community type which is two is the highest of the other four communities in species abundances. This reveals that the area is well protected than the others because species richness is dependant on the level of human interfereance on the plant biodiversity.

The mean Shannon diversity index of the five communities considering the 57 woody species was 2.904, which varies from an index value of 3.29 for community type 1 to 2.45 for community type 5. The mean evenness index of the communities was 0.9 with the highest value

(0.93) for community (3 and 4) and lowest (0.85) for community five. The species richness was high for community type 2 (40 species) and least for community type 5 (13 species). Analytical presentation of the degree of species diversity of the identified plant community types in the study area may give a clue to the degree of anthropogenic impacts (Pierre and Louis, 1998; Leul Kidane Woldemichael *et al*, 2010). In view of this, it was found out that plant community type four and five is limited in species number where owing to unchecked human exploitation.

The community types which are found around human settlements where both anthropogenic and livestock impact are seriously damaging the matured as well as under growths of woody plant species.

On the other hand, plant community two is relatively highest in number of species than the other four plant communities because the community is found in the protected area where tree cutting is relatively forbidden (Leul Kidane Woldemichael *et al.*, 2010). In addition to this community type one and three have also more or less good species diversity next to community type two. However, community type five which is found adjacent to settlements had less density because of unchecked human effects. In general it is to be noted that plant community around the protected areas had relatively highest woody plant species diversity than the unprotected ones (Leul Kidane Woldemichael *et al.*, 2010).

The comparison of species richness of the study area (Lalay Maichew) with the surrounding vegetation indicated that the Lalay Maichew vegetation had more species than the Tahtay Maichew. The most probable reason for species richness difference between the two areas is the micro climatic factors like temperature which have direct influence on soil physical and chemical properties. In addition altitude has also great influence in vegetation distribution of both areas. According to the result obtained from the computation of Sorensen's similarity coefficient between four different altitudinal variations of the pooled plots the species abundance of the area is more or less affected by altitudinal variation.

Churches and Masjides are main places of vegetation diversity particularly trees. Community forests are Eucalyptus and there is also *Schinus molle* plantations which were planted during the military government. After the eastablishment of government in 1991, local communities throughout the region have designated hillside enclosures in conservation where indigenous tree and shrub species, particularly Acacia species, *juniperus procera* and *olea europae subsp. cuspidate* have regenerated (Edwards, S., *et al.*, 2010).

5.2. Non cultivated Plants used by peoples

The socio-economic importance (source of food, fodder, construction, farm implement, fuel and charcoal, fence, shade and etc…) of the woody plant species particularly Legumes were described. *Acacia* species that are important in traditional medicine in the study areas are *Acacia albida* and Acacia *seyal* where used against headache, cold and stomach-aches. Different parts of the plants are used. Leaves, fruits, barks and gums of are used in different situation and similar results were obtained by Tesfaye Awas and Sebsebe Demissew, (2009).

The traditional Ethno-botanical knowledge of medicinal plants of the study areas are transferred more of from older people to younger generation and this knowledge are not existed in written form (Tesfaye Awas and Sebsebe Demissew, 2009).

According to the result from preferential ranking done by key informants the most important non cultivated food plants for the local peoples is *Ziziphus spina-christi*. *Opuntia ficus-indica* is the second non cultivated food plant in the study areas. *Opuntia ficus-indica* is available in most part of Ethiopia, this is may be due to the plants that are able to tolerate moisture stress, for example, *Opuntia ficus-indica* that occurs in most part of the Country and known as famine food plant. In Axum and Wukromaray they are used for food (Assegid Assefa and Tesfaye Abebe, 2011).

In addition to their use for house hold consumption identified trees and shrubs are marketable and provide an opportunity to supplement income for the households in the study areas. This was truly observed in the study areas where some of wild edible plants were sold to supplement incomes of poor households (Assegid Assefa and Tesfaye Abebe, 2011).

The most important *Acacia* for preparation of farm implement is also *Acacia lahai*. On the other hand *Acacia albida* is also ranked the second most important among the *Acacias* (Yohannes Tesfaye, 2009).

Many reports had suggested that the role of plants in agriculture is paramount important particularly the role of Legumes. *Acacias* have different benefits in agriculture particularly *Acacia albida* is recommended for effective agro-biodiversity in dry land areas. In addition to this, in soil fertility increment Legumes have effective roles since they have an ability to fix Nitrogen and change it to the available form (NO_2^- or NO_3^-). In insect pest and straiga weed management Legumes have also considered as the solution. For instance the herbaceous Legumes especially *Desmodiums* are effective for this matter and it was noticed that maize intercropped with *Desmodium uncinatum* or *Desmodium intortum* suffered far less *Striga hermonthica* infestation than Maize in monoculture (Khan *et al.*, 2010; Khan *et al.*, 2000).

The main cultural practices that are used against sorghum stem borers, including: tillage and mulching; time of planting; spacing; fertilizer and water management; crop sanitation; removal of dead hearts, volunteer plants, and alternative host plants; crop rotation; and inter - cropping. Inter-cropping has received most recent at tent ion from research workers. The effects of intercropping sorghum with various leguminous crops particularly *Desmodium* species to control *Cailo partellus* and reported that intercropping with cowpea or lablab reduced stem borer infestation and increased grain and straw yields. The results of intercropping experiments in Kenya which indicated that sorghum cowpea intercropping reduced the incidence of *Cailo partellus* and other borers. More research is needed but much information is already available and could be used by extension workers to advise farmers and to develop integrated pest management programs (Seshu Reddy 1985 cited in ICRISAT, 1989). Those *Desmodiums* were intercropped with Sorghum and Maize and able to protect the stem borers.

5.3. Main threats and conservation status of vegetation

Forest survey done showed that the vegetation in study areas are dominated by small sized herbs and shrub species in secondary stage of development, indicating that the big trees which were in the forest was heavily exploited and affected by the local peoples in the previous periods for different purposes. The same result was also reported from Hugumbirda forest done by (Leul Kidane Woldemichael *et al.*, 2010).

In some areas of the study sites, forests have virtually disappeared, most of the mountain sides are bare, valleys have been gullied, and springs and streams which used to have water the whole year round are now mainly dry in the dry season. To a slightly less extent, this is true of north-western Ethiopia as well. This is because the Ethiopian plateau is at its narrowest in the north and the problems of the northeast have easily engulfed the northwest. The eastern escarpment further south is similarly affected, but because of its higher altitude and consequent increased moisture, the degradation process has been felt more on vegetation and soil than through lack of water, be it in springs or streams. This is, in fact, not because these parts are less vulnerable than the central escarpment, but because the intensification of agriculture is more recent. Nonetheless, the forests have virtually disappeared. Especially in the Highlands, much of the topsoil has been removed resulting in a great reduction in agricultural productivity (Zerihun Woldu, (1999). The main causes of vegetation reduction of the areas are tree cutting, cultivation and so on. Deforestation and soil depletion are major environmental problems in the region (Gesesse Dessie, 2007).

According to Edwards, S. *et al.*, (2010), one of the major challenges for the regional government concerning forest and land management in the study areas is the increasing number of landless people who need alternative sources of income. There is also a strong push from the government to bring the farmers into the monetized economy through the development of markets. Local communities are being supported to build roads, and areas by these roads are being given to landless families to make small settlements, build houses and set up shops and markets. This condition was resulted in increasing the demand for wood to build houses. Often, arrangements are made for the new homeowners to buy and build their houses using *Eucalyptus,* but there are a lot of challenges to implement these laws.

Increasing economic benefits from the management of area enclosures and community woodlots also present a major management challenge. Capacity building and technical support is needed to manage the woodlots appropriately. Institutional arrangements are important in view of a fair distribution of the benefits. Regional efforts to plant trees have not been accompanied by incentives to encourage tree plantation at community level at large. Policies that assign the management responsibilities of woodlots at village level may increase plantation efforts.

According to Leul Kidane Woldemichael *et al.*, (2010) indicates the much-needed positive attitudes towards forest protection and development can only be obtained from the rural communities through the development of valid benefit sharing mechanism. Thus community participation is quite important; particularly participation of women and youth is very important one during conservation (Leul Kidane Woldemichael *et al.*, 2010). The participations of local peoples and women were play great role in the success of soil and water conservation. The other main work done in the study area is forest resources conservation. According to response of the respondents from Rural and agricultural office of the woreda in the same year, in Tabia Seglamen (found in Laelay Maichew) very huge watersheds are protected from erosion and forest resources are protected that forest regeneration is started right now and this could help as a model for other Tabias in the woreda and for other areas in country at large. In addition to this the Dura Mountain is now on the process of rehabilitation and some of plant species like Olives is now regenerated. In addition to this olives are also regenerated. Indigenous tree plantation is also started in some areas of the study areas. This way of resource management should be able to practiced/continue in other sites of the study areas and the whole Tigray.

Plantation is important measurement for forest regeneration forests (Alemu Gezahgne, 2007; Feyera Senbeta & Demel Teketay, 2001). Tree plantation is the main conservation measure taken in the study areas. In the study area there is Plantation of small multipurpose trees particularly *Sesbania sesban,* local grasses and other legumes like *Acacias* and *Desmodiums* on the bunds; land management with some selected additions from field-tested traditional and scientific knowledge gleaned from within Ethiopia and other countries is now practiced (Edwards, S. *et al.*, 2010). Many farmers (including women farmers) have started also planting fruit trees, both around their homesteads and in rehabilitated gullies. There is now a steady demand for fruit tree seedlings by the farmers and new nurseries have been developed to meet this demand (Edwards, S. *et al.*, 2010).

5.4. CONCLUSIONS AND RECOMMENDATIONS

5.4.1. Conclusions

The studies of woody plant species diversity and socio-economic importance of the vegetation were undertaken. The current study has shown that 58 woody (trees and shrubs) and 7 herbaceous plant species belonging to 29 different families were taxonomically identified both from the Laelay and Tahtay Maichew and areas. Mean while the area is less in woody plant species density, as a result vegetation resource conservation strategies should be able to apply in mountains, watersheds and other many areas.

The cluster analysis of the woody plant species data revealed five community types, which are distinct in terms of species composition. Plant community types that are found in relatively protected from such human explotations show higher species abundance as expected. The comparison of species richness of the study area (Laelay Maichew) with the surrounding vegetation indicated that the Laelay Maichew vegetation had more species than the Tahtay Maichew.

The socio-economic importance of the woody plant species reveals that, *Acacia lahai* is the most important plant for farm implement in the study areas.

The study areas are dominated by small sized tree and shrub species, indicating that the forest was heavily exploited and affected in the previous periods. But good regeneration is in process at the present time. Therefore, to improve the natural diversity and structure of the forest, to minimize the influence of the surrounding communities and utilize the forest resources sustainably for present and future generation, the basic needs and traditional rights of the communities over the uses of forest resources should be recognized. The much-needed positive attitudes towards forest protection and development can only be obtained from the rural communities through the development of a genuine benefit sharing mechanism. In the study areas local communities are currently uphold in planting more trees as part of watershade rehabilitation.

5.4.2. Recommendations

Despite the fact that vegetations in the study areas provide essential goods and service for thousands of peoples and these resources are not used sustainably. Thus, it is recommended to:

1. Make participatory management by the office of natural resources and the local people for sustainable utilization of the resources; the local communities should be trained about scientific tree propagation, silvicultural and forest management techniques which may enhance their level of knowledge on top of traditional conservation knowledge since they have limited knowledge in the silivicultural and tree propagation.

2. The area is dominated by small sized shrubs and big trees are exploited in the previous time as a result trees become low in density and conservation strategies should be able to apply in mountains, watersheds and other many areas.

3. This study was limitred only on the human factors on woody vegetation, as a result studying environmental variables on woody vegetation is important.

Future Research directions

- ✓ The biology of *Desmodium ospriostreblum* in relation to the biochemical mechanisms underlying its uses for organic agriculture particularly in Push-Pull Technology.
- ✓ Since the diversity of *Acacia albida* is becoming less and less through time in the study areas, the regeneration biology of *Acacia albida* which is recommended for agro-biodiversity should be studied
- ✓ For the future participatory sustainable uses, management and development of natural resources should be availiable.
- ✓ Environmental variables on woody vegetation pattern should be studied.

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APPENDICES

Appendix 1. Observation checklist for floristic and socioeconomic data collection of the area

Name of Plants			Socio-economic importance				
Scientific name	Local name	Family name	Source of food	Source of fuel wood	Constructi on	For agriculture (e.g., mulching, intercropping)	others

Appendix 2. Format for collecting floristic and related data using a checklist of questions to conduct semi-structured interview

Background information of the respondents

1. Date………………………residence area(village)……………..Kebele code…………….
2. Name of respondents ……………………..sex……age………..

2.1. Marital status…………….occupation…………………………..

2.2. For how long have you lived in the area? A. Since birth, B. for the last 20 years, C. for the last 10 years, D. for less than 10 years

2.3. Educational background (what is the last grade you attended?)……………

Floristic and socioeconomic data collection

3. What are the most common woody plants occurred in the area?

____

____

____

4. Is there any plant which found near to farm lands as intercropping?

____

5. What are the roles of the plants planted as intercropping? Explain

6. What are the most important woody/legume species for different purposes in the area?

7. Where do these plants grow? (From where you obtain it?)

8. What is the attitude of local people including women towards forest and woody plant resource conservation?

9. Are there any modern or traditional methods which applied for forest management in the area?

10. What is the role of women's experience in environment and resource conservation?

11. Is there any landscape/vegetation change in the area? If your answer is yes, explain it in words please?

____

12. What do you think the cause and consequence of landscape/vegetation change to the environment?

13. What do you think the solution for this problem?

Appendix 3. Plant species collected and identified both from Laelay and Tahtay Maichew areas

Scientific name	Local name		Habit	Altitude
	Tigrigna	Family name		
Acacia abyssinica Hochst. ex Benth.	Cha'a	Fabaceae Subfamily Mimosoideae	Tree	2155 m
Acacia albida Del.	Momona	Fabaceae Subfamily Mimosoideae	Tree	2207 m
Acacia etbaica Schweinf.	Seraw	Fabaceae Subfamily Mimosoideae	Tree	2163 m
Acacia lahai Steud & Hochst. ex Benth.	Lahai	Fabaceae Subfamily Mimosoideae	Tree	2062 m
Acacia mearnsii De.Wild.	Tsedeno	Fabaceae Subfamily Mimosoideae	Tree	2204 m
Acacia saligna (Labill.) Weadl.	Akkacha	Fabaceae Subfamily Mimosoideae	Shrub/ small Tree	2207 m
Acacia seyal Del.	Keyih cha'a	Fabaceae Subfamily Mimosoideae	Tree	2207 m
Acokanthera schimperi (A.DC.) Schweif.	Mebetti (Merez)	Apocynaceae	Tree	2114 m
Agave americana L.	Eqa tilian	Agavaceae	Shrub	2199 m
Agave sisalana Perr. ex Eng.	E'qa	Agavaceae	Shrub	2199 m

Becium grandiflorum (Lam.) Pic.Serm.	Tebeb	Lamiaceae	Shrub	2201 m
Buddleja polystachya Fresen.	Metere	Loganiaceae	Tree/Shrub	2178 m
Calpurnia aurea (Aif.) Benth.	Hisawisi	Fabaceae Subfamily Papilionoideae	Shrub	2070 m
Capparis tomentosa (Lam.)	Qandiel	Capparidaceae	Shrub	2223 m
Carduus nyassanus (S.Moore) R.E. Friis	Dandur	Asteracae	Shrub	2196 m
Carissa spinarum L.	Agam	Apocynaceae	Shrub	2294 m
Cissus quadrangularis L.	Qalke	Vitaceae	Shrub	2114 m
Clerodendron myricoides (Hochst.) Vatke	Surubatri	Lamiaceae	Shrub	2270 m
Commiphora tenuis Vollesen	Angule	Burseraceae	Tree	2223 m
Cordia africana Lam.	Awhi	Boraginaceae	Tree	2144 m
Crotalaria quartiniana A.Rich.		Fabaceae Subfamily Papilionoideae	Erect Herb	2178 m
Croton macrostachyus Hochst. ex Del.	Tambukh	Euphorbiaceae	Tree	2114 m
Desmodium ospriostreblum Steud. ex. Chiov.	Hareg	Fabaceae Subfamily Papilionoideae	Herb	2062 m
Dodonaea angustifolia L.f.	Tahses	Sapindiaceae	Shrub	2195 m
Dolichos sericeus E.Mey.	Adagura Gua'sot	Fabaceae Subfamily Papilionoideae	Herb	2070 m
Eucalyptus camaldulensis Dehnh.	Bahir zaf	Myrtaceae	Tree	2239 m
Euclea racemosa subsp.*schimperi*	keleauw	Ebenaceae	Shrub/ small tree	2163 m
Euphorbia abyssinica Gmel.	Qulonqal	Euphorbiaceae	Tree or shrub	2126 m
Euphorbia candelabrum	Qinchib	Euphorbiaceae	Tree or shrub	2126 m

Kotschy				
Ficus thonningii Blume	Shebaka	Moraceae	Tree	2163 m
Ficus vasta Forssk.	Da'ro	Moraceae	Tree	2207 m
Gossypium bricchettii (Ulbr.)Vollesen	Tsegot (saseg adgi)	Malvaceae	Shrub	2178 m
Hibiscus ludwigii Eckl. & Zeyh.	-	Malvaceae	Shrub	2178 m
Jacaranda mimosifolia D.Don.		Balanitaceae	Tree	2204 m
Juniperus procera Hochst. ex. Endl.	Tsihdi	Cupressaceae	Tree	2195 m
Justicia schimperiana Dell.	Shimiza	Acantiacaeae	Shrub	2178 m
Lannea fruticosa (A.Rich.) Engl.	Dgwdgwnna	Anacardiaceae	Tree	2195 m
Lantana camara L.		Verbanaceae	Shrub	2223 m
Medicago lupulina L.	Khakhuto	Fabaceae Subfamily Papilionoidae	Herb	2162 m
Mytenus seraata (A.Rich.) Wilczek.	Tsel'elo(At,at)	Celasteraceae	Shrub/small tree	2070 m
Nicotina glauca Graham.	Teklaytegegne	Solanaceae	Shrub	2146 m
Ocimum urticifolium Roth		Lamiaceae	Shrub	2178 m
Olea europeaea L., subsp. *cuspidata (Wall. ex. G. Don) Cif.*	Awlie	Oleaceae	Tree	2270 m
Opuntia ficus-indica L. (Miller)	Belas kulkalbahri	Cactaceae	Tree	2205 m
Otostegia fruticosa (Forssk.) Schweinf. ex Penzig	Sasa	Lamiaceae	Shrub	2070 m
Parkinsonia aculeata L.		Fabaceae subfamily Caesalpinioideae	Tree or large shrub	2157 m
Phytolacca dodecandra L.Her.	Shbti	Phytolaccaceae	Shrub	2178 m
Pterollobium stellatum (Forssk.) Bernan	Qwenteftefe	Fabaceae Subfamily Papilionoidae	Shrub	2163 m
Rhoicissus tridentata (L.f.)	Melhas korasi	Vitaceae	Shrub	2178 m

Wild & Drummond				
Rhus retinorrhoea Oliv.	Tetalo	Anacardiaceae	Shrub	2227 m
Ricinus comnunis L.	Guliea	Euphorbiaceae	Shrub	2062 m
Rumex nervosus Vahl.	Hahot,machico	Polygonaceae	Shrub	2062 m
Schinus molle L.	Tikur berbre	Anacardiaceae	Tree	2178 m
Scorpuirus muricatus L.	Menderto	Fabaceae Subfamily Papilionoideae	Herb	2062 m
Senna obtusifolia (L.) Irwin & Barneby	Serifrafi	Fabaceae Subfamily Caesalpinioideae	Shrub	2146 m
Senna singueana (Del.) Lock.	Hambohambo	Fabaceae Subfamily Papilionoidae	Shrub	2070 m
Sesbania sesban (L.) Merr.	Shahsahta	Fabaceae subfamily papilionoideae	Shrub	2062 m
Sida collina schlechtend.	-	Malvaceae	Shrub	2178
Solanum incanum L.	Ungulle	Solonaceae	Shrub	2062 m
Solanum sinaicum Bioss	-	Solanaceae	Shrub	2163 m
Turraea abyssinica Hochst. ex. A. Rich.	-	Meliaceae	Small Tree/Shrub	2223 m
Vigna membranacea A. Rich.	Hareg	Fabaceae Subfamily Papilionoidae	Herb	2062 m
Vigna oblongifolia A. Rich	Hareg	Fabaceae Subfamily Papilionoideae	Herb	2070 m
Vigna schimperi Bak.	Hareg	Fabaceae Subfamily Papilionoideae	Herb	2070 m
Ziziphus spina-christi (L.) Desf.	Gaba	Rhamnaceae	Tree	2195 m

Appendix 4. Shannon Diversity Index of woody species in each plots

Species name	Count	Pi	LNPi	H'=∑Pi LNPI
Acacia abyssinica	18	0.0081	-4.8153	0.039
Acacia albida	17	0.00765	-4.8725	0.0373
Acacia etbaica	118	0.05313	-2.935	0.1559
Acacia lahai	157	0.07069	-2.6495	0.1873
Acacia mearnsii	5	0.00225	-6.0963	0.0137
Acacia saligna	23	0.01036	-4.5702	0.0473
Acacia seyal	16	0.0072	-4.9331	0.0355
Acokanthera schimperi	11	0.00495	-5.3078	0.0263
Agave americana	28	0.01261	-4.3735	0.0551
Agave sisalana	21	0.00946	-4.6612	0.0441
Becium grandiflorum	40	0.01801	-4.0168	0.0723
Buddleja polystachya	25	0.01126	-4.4868	0.0505
Calpurnia aurea	184	0.08285	-2.4908	0.2063
Caparis tomentosa	10	0.0045	-5.4031	0.0243
Carduus nyassanus	25	0.01126	-4.4868	0.0505
Carissa spinarum	12	0.0054	-5.2208	0.0282
Chordia africana	15	0.00675	-4.9977	0.0338
Cissus quadrangularis	51	0.02296	-3.7739	0.0867
Clerodendron myricoides	28	0.01261	-4.3735	0.0551
Commiphora tenuis	15	0.00675	-4.9977	0.0338
Crotalaria quartiniana	5	0.00225	-6.0963	0.0137
Croton macrostachyus	102	0.04593	-3.0807	0.1415
Dodonaea angustifolia	126	0.05673	-2.8694	0.1628
Eucalyptus camaldulensis	61	0.02747	-3.5948	0.0987
Euclea racemosa subsp. *schimperi*	214	0.09635	-2.3397	0.2254
Euphorbia abyssinica	35	0.01576	-4.1504	0.0654
Euphorbia candelabrum	24	0.01081	-4.5277	0.0489
Ficus thonningii	37	0.01666	-4.0948	0.0682
Ficus vasta	18	0.0081	-4.8153	0.039
Gossypium bricchettii	5	0.00225	-6.0963	0.0137
Hibiscus ludwigii	12	0.0054	-5.2208	0.0282
Jacaranda mimosifolia	10	0.0045	-5.4031	0.0243
Juniperus procera	5	0.00225	-6.0963	0.0137
Justicia schimperiana	34	0.01531	-4.1794	0.0640
Lannea fruticosa	5	0.00225	-6.0963	0.0137
Lantana camara	91	0.04097	-3.1949	0.1309
Mytenus serrata	71	0.03197	-3.443	0.1101
Nicotina glauca	14	0.0063	-5.0667	0.0319
Ocimum urticifolium	5	0.00225	-6.0963	0.0137
Olea europaea subsp. *cuspidata*	61	0.02747	-3.5948	0.0987
Opuntia ficu-indica	51	0.02296	-3.7739	0.0867
Otostegia fruticosa	10	0.0045	-5.4031	0.0243

Parkinsonia aculeata	10	0.0045	-5.4031	0.0243
Phytolacca dodecandra	5	0.00225	-6.0963	0.0137
Pterollobium stellatum	11	0.00495	-5.3078	0.0263
Rhoicissus tridentata	12	0.0054	-5.2208	0.0282
Rhus retinorrhoea	30	0.01351	-4.3045	0.0581
Ricinus communis	5	0.00225	-6.0963	0.0137
Rumex nervosus	70	0.03152	-3.4572	0.109
Schinus molle	10	0.0045	-5.4031	0.0243
Senna singueana	91	0.04097	-3.1949	0.1309
Sesbania sesban	6	0.0027	-5.914	0.016
Sida collina	5	0.00225	-6.0963	0.0137
Solanum incanum	5	0.00225	-6.0963	0.0137
Solanum sinaicum	72	0.03242	-3.429	0.1112
Turraea abyssinica	5	0.00225	-6.0963	0.0137
Ziziphus spina-christi	20	0.009	-4.71	0.0424
TOTAL	**2179**	**0.98109**	**-271.93**	**3.4584**

Appendix 5. Relative Abundance of woody species

Species name	**Total abundance**	**Abundance of each spp.**	**Relative abundance**
Acacia abyssinica	18	0.008104457	0.810445745
Acacia albida	17	0.00765421	0.765420982
Acacia etbaica	118	0.053129221	5.312922107
Acacia lahai	157	0.070688879	7.068887888
Acacia mearnsii	5	0.002251238	0.225123818
Acacia saligna	23	0.010355696	1.035569563
Acacia seyal	16	0.007203962	0.720396218
Acokanthera schimperi	11	0.004952724	0.4952724
Agave americana	28	0.012606934	1.260693381
Agave sisalana	21	0.0094552	0.945520036
Becium grandiflorum	40	0.018009905	1.800990545
Buddleja polystachya	25	0.011256191	1.12561909
Calpurnia aurea	184	0.082845565	8.284556506
Caparis tomentosa	10	0.004502476	0.450247636
Carduus nyassanus	25	0.011256191	1.12561909

Carissa spinarum	12	0.005402972	0.540297163
Chordia africana	15	0.006753715	0.675371454
Cissus quadrangularis	51	0.022962629	2.296262945
Clerodendron myricoides	28	0.012606934	1.260693381
Commiphora tenuis	15	0.006753715	0.675371454
Crotalaria quartiniana	5	0.002251238	0.225123818
Croton macrostachyus	102	0.045925259	4.592525889
Dodonaea angustifolia	126	0.056731202	5.673120216
Eucalyptus camaldulensis	61	0.027465106	2.746510581
Euclea racemosa subsp. *schimperi*	214	0.096352994	9.635299415
Euphorbia abyssinica	35	0.015758667	1.575866727
Euphorbia candelabrum	24	0.010805943	1.080594327
Ficus thonningii	37	0.016659163	1.665916254
Ficus vasta	18	0.008104457	0.810445745
Gossypium bricchettii	5	0.002251238	0.225123818
Hibiscus ludwigii	12	0.005402972	0.540297163
Jacaranda mimosifolia	10	0.004502476	0.450247636
Juniperus procera	5	0.002251238	0.225123818
Justicia schimperiana	34	0.01530842	1.530841963
Lannea fruticosa	5	0.002251238	0.225123818
Lantana camara	91	0.040972535	4.097253489
Mytenus serrata	71	0.031967582	3.196758217
Nicotina glauca	14	0.006303467	0.630346691
Ocimum urticifolium	5	0.002251238	0.225123818
Olea europaea subsp. *cuspidata*	61	0.027465106	2.746510581
Opuntia ficu-indica	51	0.022962629	2.296262945
Otostegia fruticosa	10	0.004502476	0.450247636
Parkinsonia aculeata	10	0.004502476	0.450247636

Phytolacca dodecandra	5	0.002251238	0.225123818
Pterollobium stellatum	11	0.004952724	0.4952724
Rhoicissus tridentata	12	0.005402972	0.540297163
Rhus retinorrhoea	30	0.013507429	1.350742909
Ricinus communis	5	0.002251238	0.225123818
Rumex nervosus	70	0.031517335	3.151733453
Schinus molle	10	0.004502476	0.450247636
Senna obtusifolia	7	0.003151733	0.315173345
Senna singueana	91	0.040972535	4.097253489
Sesbania sesban	6	0.002701486	0.270148582
Sida collina	5	0.002251238	0.225123818
Solanum incanum	5	0.002251238	0.225123818
Solanum sinaicum	72	0.03241783	3.241782981
Turraea abyssinica	5	0.002251238	0.225123818
Ziziphus spina-christi	20	0.009004953	0.900495272
TOTAL	**2179**	**1**	**100**

Appendix 6. Absence and Presence of woody species in altitudes of pooled plots
Key: **+ = presence; - = absence**

Name of species	**2180 m**	**2236 m**	**2227 m**	**2211 m**
Acacia abyssinica	-	-	+	+
Acacia albida	-	+	+	+
Acacia etbaica	+	+	+	+
Acacia lahai	+	+	+	+
Acacia mearnsii	-	-	+	-
Acacia saligna	-	+	+	+
Acacia seyal	-	+	+	+
Acokanthera schimperi	+	-	-	+
Agave americana	-	+	+	+
Agave sisalana	-	+	-	+
Becium grandiflorum	-	+	+	+
Buddleja polystachya	-	+	+	+
Calpurnia aurea	+	+	+	-
Capparis tomentosa	+	-	-	-
Carduus nyassanus	-	-	+	-
Carissa spinarum	-	+	-	-
Chordia africana	+	-	+	-
Cissus quadrangularis	+	+	+	-
Clerodendron myricoides	-	+	+	+
Commiphora tenuis	+	-	-	-
Crotalaria quartiniana	-	-	+	-
Croton macrostachyus	+	+	+	+
Dodonaea angustifolia	+	+	+	+
Eucalyptus camaldulensis	+	+	+	+
Euclea racemosa subsp.*schimperi*	+	+	+	+
Euphorbia abyssinica	+	-	-	+
Euphorbia candelabrum	+	+	-	+
Ficus thonningii	+	-	+	+
Ficus vasta	-	+	-	+
Gosipium bricchettii	-	+	-	-
Hibiscus ludwigii	-	+	-	-
Jacaranda mimosifolia	+	-	+	-
Juniperus procera	-	-	+	-
Justicia schimperiana	-	+	+	+
Lannea fruticosa	-	-	+	-
Lantana camara	+	+	+	+
Mytenus serrata	+	+	+	+
Nicotina glauca	-	-	+	+
Ocimum urticifolium	-	+	-	-
Olea europaea subsp. *cuspidata*	+	-	+	+

Opuntia ficus-indica	+	+	+	+
Otostegia fruticosa	+	-	-	-
Parkinsonia aculeata	-	-	-	+
Phytolacca dodecandra	-	-	+	-
Pterollobium stellatum	+	-	-	-
Rhoicissus tridentata	+	-	-	-
Rhus retinorrhoea	+	-	-	+
Ricinus communis	+	-	-	-
Rumex nervosus	+	-	+	+
Schinus molle	-	-	+	-
Senna singueana	+	+	+	+
Sesbania sesban	+	-	-	-
Sida collina	+	-	-	-
Solanum incanum	+	-	-	-
Solanum sinaicum	+	+	+	+
Turraea abyssinica	+	-	-	-
Ziziphus spina-christi	+	-	+	+

Appendix 7. Ethnobotanical importances of plants

Species name	**Habit**	**Disease treated**	**Other uses**
Acacia abyssinica	Tree		Fuel wood and charcoal, timber is used for house construction, agricultural tools like (Arut, Newit, Mahresha), tool handless and shade
Acacia albida	Tree	Fruit and leaves used to cure Stomach-aches, headaches, and cold	Manufacturing farm tools like (Arut, Newit, Mahresha), kitchen utensils, doors construction, Animal forage and shade
Acacia etbaica	Tree		Fuelwood, charcoal, construction, agricultural tools like (Arut, Newit, Mahresha)
Acacia lahai	Tree		Fuelwood, charcoal, construction, agricultural tools like (Arut, Newit, Mahresha), fence
Acacia mearnsii	Tree		Fire wood, charcoal, ornamental
Acacia saligna	Shrub		Animal forage, firewood, ornamental purpose, live fence, shade
Acacia seyal	Tree		Fuel wood and charcoal, timber is used for house construction agricultural tools like (Arut, Newit, Mahresha) and for browse

Calpurnia aurea	Shrub	Seed is use to cure Dysentery	Live fence, fuel and charcoal
Carissa spinarum	Tree		Edible fruits, live fence
Chordia africana	Tree	Acute febrile illness	Food, fire wood, charcoal, construction
Desmodium ospriostreblum	Herb		Animal forage, soil, push-pull system
Dolichos sericeus	Herb		Animal forage named as "durka" in Tigrigna.
Medicago lupulina	Herb		Animal forage named as "durka" in Tigrigna.
Opuntia ficus-indica	Tree		Edible fruit (Food)
Parkinsonia aculeata	Tree	Pods are used to cure Fever	Animal forage, firewood, ornamental purpose, live fence, shade, edible fruits and shade
Phytolacca dodecandra	Shrub	Abortion	For washing purpose
Petrollobium stellatum	Shrub		Firewood and charcoal
Scorpuirus muricatus	Herb		Animal forage named as "durka" in Tigrigna.
Senna singueana	Shrub		The wood is used in hut frames.
Sesbania sesban	Shrub		Animal forage, browse and shade
Vigna membranacea	Herb		This herb is used for animal forage in the study area when it is dried and named as "durka" in Tigrigna.
Vigna oblongifolia	Herb		Used for animal forage in the study area when it is dried and named as "durka" in Tigrigna.
Vigna schimperi	Herb		Used for animal forage named as "durka" in Tigrigna.
Ziziphus Spina-chrsti	Tree	Dandruff	Food, fire wood, charcoal, construction, shade and live/dry fence