Floristic composition of herbaceous flowering plant species with emphasis to ethnobotanical importance of wild grasses in Laelay and Tahtay Michew Districts, Central Zone of Tigray, Ethiopia

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A Thesis Submitted to

The Department of Plant Biology and Biodiversity Management

Present in partial fulfillment of the requirements for the Degree of Masters of Science (Plant Biology and Biodiversity Management: Plant Biodiversity and Management)

Addis Ababa University

Addis Ababa, Ethiopia

June 2012

Addis Ababa University

School of Graduate Studies

This is to certify that the thesis prepared by Genet Atsbeha entitled: Floristic composition of herbaceous flowering plant species with emphasis to ethnobotanical importance of wild grasses in Laelay and Tahtay Michew Districts, Central Zone of Tigray, Ethiopia and summated in partial fulfillment of the requirements for the Degree of Masters of Science (Plant Biology and Biodiversity Management: Plant Biodiversity and Management) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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ABSTRACT

Floristic Composition of Herbaceous Flowering Plant Species with Emphasis to Ethnobotanical Importance of Wild Grasses in Laelay and Tahtay Michew Districts, Central Zone of Tigray, Ethiopia

Genet Atsbeha
Addis Ababa University, 2012

This study was carried out in Laelay and Tahtay Maichew districts. Objectives of the study were to: identify herbaceous flowering plant species found in the study area, to identify community types of the vegetation of the study area, to document the ethnobotanical importance of wild grasses and to sample wild grass hosts of stem borers that can be used as trap plants in the push-pull pest management approach. Within 65 sample quadrats, different herbaceous species were collected for taxonomic identification using preferential sampling method and coded for an analysis from 1m x 1m sub-quadrats placed within 20m x 20m quadrat. For ethnobotanical importance of wild grasses data was collected using semi-structured interview, guided field walk and direct observation, preference ranking, direct matrix ranking, group discussion and informant consensus. A total of 132 herbaceous flowering plant species of vascular plants belonging to 99 genera and 34 families were identified. With regards to species number, the most dominant plant family is Poaceae (34 species), followed by Asteraceae (16 species), Fabaceae (14 species). Four community types were also identified at 47.94% to 31.42% similarity levels. With regards to ethnobotanical importance of wild grasses, preference ranking indicated that, the most preferred grasses for animal feed are *Cynodon dactylon* followed by *Cynodon aethiopicus*, *Snowdenia polystathya*, *Pennisetum villosum* and *Pennisetum sphacelatum* 1^{st}, 2^{nd}, 3^{rd},$4^{th}$and 5^{th} respectively. Wild grass hosts of the stem borers was searched and among the large stemmed wild grasses known from the study area larvae and pupae of *Busseola fusca* and *Sesamia calamistis*-stem borers of maize and sorghum were found in Pennisetum purpureum.

Key Phrases: Laelay and Tahtay Maichew districts, floristic composition of herbaceous flowering plant species, ethnobotanical importance of wild grasses, wild grass hosts of stem borers

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my advisors Prof. Sebsebe Demissew, Prof. Zerihun Woldu and Ms. Sue Edwards for their inspiring guidance, advice, comments and follow up from problem identification to the completion of this work. My appreciation also goes to all members of the National Herbarium for their help in plant specimen identification. My special thanks go to Institute for Sustainable Development (ISD) for funding the project and for provision of useful materials that are important for this work. I would like also to thank the staff members of ISD specially, Dr. Hailu Araya and Ato Fentaw Ejigu for their experience sharing. I sincerely acknowledge the support obtained from the National Meteorology Service Agency for providing climate data of Laelay Michew and also the Agricultural Office of Laelay and Tahtay Maichew districts for their support and guidance during data collection. I also thank very much for the trustworthy co-operation received from the local community of Laelay and Tahtay Maichew districts for their positive response to avail their time to share their valuable knowledge as well as for their tremendous generosity and hospitality. Finally, I wish to thank my family and all my friends for their support and encouragement.

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List of Acronyms

ADOPT	Adaptation and Dissemination of the 'Push-Pull' Technology
EFAP	Ethiopia Forestry Action Program
EPA	Environmental Protection Authority
EWNHS	Ethiopian Wildlife and Natural History Society
FAO	Food and Agricultural Organization
IBC	Institute of Biodiversity Conservation
ISD	Institute for Sustainable Development
IUCN	International Union for the Conservation of Nature and Natural Resources
MoA	Ministry of Agriculture
PANESA	Pasture Network for Eastern and Southern Africa
SCBD	Secretariat of the Convention on Biological Diversity
USAID	United States of America International Development
WCWC	World Conservation Monitoring Center
WRI	World Resource Institute

CHAPTER ONE

INTRODUCTION

Ecosystems are geographic regions that contain biological communities related with the abiotic circumstances such as temperature, rainfall and seasons. The biodiversity of the different ecosystems of the globe is not evenly distributed and some regions of the world like those of tropics are relatively richer in biodiversity as compared to temperate areas. Ethiopia is one of the top 25 richest countries of the world in terms of biodiversity (WCMC, 1992).

The decrease of biodiversity in agricultural landscapes due to increasing demand for agricultural land is increasing concern. Consequently, conservation of plant species within patches of degraded areas has been considered to be a step towards reversing this trend (Mponela, *et al*., 2010). Botanical assessments such as floristic composition and structure studies are essential in understanding the plant biodiversity. Knowledge of the floristic composition of protected areas is also useful in identifying important elements of plant diversity like protecting threatened and etnobotanically important species through monitoring protected areas and others. Information on floral composition and diversity are absolutely essential in understanding forests ecosystem dynamics and conservation.

1.1 Justification of the Study

Nowadays, as the use of land for intensification of agriculture production increases, the demand for plants for different purposes is also increasing, affecting the vegetation in the area. Laelay and Tahtay Maichew districts are two districts where there is intensive use of land for agriculture with a high demand of plants for different purposes that are affecting the vegetation. Various plant species provide many uses such as habitat for wildlife, source of foods and drinks, raw materials for different skills and crafts, spiritual applications, herbal medicines, etc. Therefore, detailed biodiversity and ecological studies are desirable to draw the attention of stakeholders to understand the ecosystem services of this biodiversity assemblage and undertake appropriate

conservation measures. Due to absence of any previous biodiversity study in the area, this study is undertaken to provide information on floristic composition in the study area.

This study is also associated with Adaptation and Dissemination of the 'Push-Pull' Technology (ADOPT). ADOPT is concerned with the conservation of agricultural approaches for smallholder cereal-livestock production in drier areas to withstand climate change. In addition ADOPT focuses on crops grown in dry areas (e.g. sorghum). Push-pull is a novel cropping system developed by partners for integrated soil, pest and weed management in cereal-based farming systems. It involves attracting insect pests (stem borers) with trap plants (pull) whilst driving them away from the main crop using a repellent intercrop (push). This study contribute to the ADOPT project by identifying the herbaceous plants especially large stemmed wild grass species and selecting their host to serve as hosts of the stem borers that can be used as trap plants in the push-pull Technology (push-pull pest management approach). In addition to this it also provides ethnobotanical information on the ethnobotanical importance of wild grass species by taking sample "kebeles" where sample plots for floristic composition are taken and other areas where large stem wild grasses are available and sorghum and maize are grown recommended by the informants. The knowledge and use of plants is an integral part of many ethnic rural cultures in Ethiopia but has not yet been studied in depth. This study will contribute to better understand the ethnobotanical importance of wild grasses and utilization of these biological resources.

1.2 Research Questions

The objectives of the study were achieved by way of seeking answers to the following questions.

a) What is the species composition of herbaceous flowering plant communities in the study area?
b) What are the community types of the vegetation of the study area?
c) What is the ethnobotanical importance of wild grass species found in the study area?
d) What are the wild grass hosts of stem borers that can be used as trap plants in the push-pull pest management approach?

1.3 OBJECTIVES

1.3.1 General Objective

To study the floristic composition of herbaceous flowering plant species with emphasis on the ethnobotanical importance of wild grasses in Laelay and Tahtay Michew woredas.

1.3.2 Specific Objectives

a) To identify herbaceous flowering plant species found in the study area
b) To identify community types of the vegetation of the study area
c) To document the ethnobotanical importance of wild grasses and
d) To search and identify wild grass hosts of stem borers that can be used as trap plants in the push-pull pest management approach

CHAPTER TWO

LITERATURE REVIEW

2.1 Vegetation Types of Ethiopia

Vegetation formation is influenced by a combination of many factors, such as climate, geology, edaphic factors and biotic factors, including interference by humans in ecological succession. According to Friis, *et al.* (2010), the vegetation of Ethiopia is divided into twelve major types.

Out of these major vegetation types, the present study area is within the Dry evergreen Afromontane forest and grassland complex in the country. The vegetation type is characterized by the occurrence of *Olea europaea* subsp. *cuspidate and Juniperus procera* However, one of the characteristic species in the study area in the vegetation type *Juniperus procera* that is common in most dry forests of Ethiopia is almost none existent in Tahtay and Laelay Maichew except in few plantations, may be due to heavy forest degradation in the past.

2.1. 1. Dry evergreen Afromontane forest and grassland complex

Dry evergreen Afromontane forest and grassland complex vegetation type is occurring roughly between altitudes of 1,000 and 3,000 m (Friis *et al*., 2010). IBC (2001) also report that Dry evergreen Afromontane forest has average annual temperature and rainfall of 14-25^{0}C and 500-1500 mm respectively. Average annual rainfall in Tigray is 800–1,000 mm in the west and the highlands of the south dropping to 400 mm in the extreme east (Edwards, *et al.* 2010).

This vegetation type represents a complex system of successions involving extensive grassland rich in legumes on heavy black clay soil. According to Zerihun Woldu (1999) most part of the plateau on this vegetation type consists of volcanic rocks, which are not uniform either to vegetation or to soil; sedimentary rocks ranging from sandstone to lime stone; and Precambrian rocks which form heterogeneous substrata for plant growth. The economy of this area is based on mixed cereal agriculture common in northern and eastern parts and mixed root crop agriculture in western parts of south and central Ethiopia.

The Ethiopian highlands are the largest mountain complex in Africa and comprise over 50% of the African land area covered by Afromontane vegetation, of which dry afromontane forests form the largest part (Tamrat Bekele, 1993; Demel Teketay, 1996). This ecosystem covers much of highland areas and mountainous chains of Ethiopia in Oromia Region (Shewa, Arsi, northern Bale and western Hararge), Amhara Region (Gojam, Welo, Gonder), Tigray Region (Tigray) and SNNP Region (Shewa, Sidamo and Gamo Gofa) (IBC, 2005)

As Zerihun Woldu (1999), detailed, the Degradation in this zone is very high and even severe in the northeastern Ethiopia. Forests have virtually disappeared, as a result most of the mountains 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 (Zerihun Woldu, 1999). The forests have diminished due to human interference and replaced by grasslands in flatter areas with deep soil and by bushlands on steeper slopes with thin soil. Soils have become shallow as a result of soil erosion that has been taking place for centuries (Ensermu Kelbessa *et al*., 1992; Zerihun Woldu, 1999). According to Tewoldeberhan Gebreegziabher (1986), the vegetation is characterized by *Olea europaea* ssp. *cuspidata*, *Juniperous procera*, *Celtis kraussiana*, *Euphorbia ampliphylla*, *Dracaena* spp., *Carissa edulis*, *Rosa abyssinica*, *Mimusops kummel* and *Ekebergia capensis*. This vegetation type is associated with highland bamboo (*Arudinaria alpina*) and extensive areas of grassland rich in species. The most important genera are *Hyparrhenia, Eragrostis, Panicum, Sporobolus, Eleusine,* and *Pennisetum*. Many legumes are associated with this vegetation type, among these are the genera *Trifolium, Eriosema*, and *Crotalaria.*

2.1.2 Threats of biodiversity in Ethiopia

Ethiopia is one of the countries in the world that possesses a unique characteristic fauna and flora with high level of endemism and wide range of ecological variation (Tewoldeberhan Gebreegziabher, 1991). This wide range of ecological variation made the country to be one of the diversity rich areas in the world. Large species of trees, shrubs, herbs cultivated plants and their wild relatives are found in the different agro-ecological zones of the country (Tadesse Woldemariam, 2003).

Although biodiversity has valuable importance in terms of scientific, economic, ecological, aesthetic and other benefits, humans have a bad record of misuse of these resources (IBC, 2009). Ethiopia is severely threatened by deforestation, over grazing and degradation. This suggests that past and present management efforts are far from being adequate to attain sustainable conservation and use of the country's biodiversity. A loss in biodiversity due to degradation of environment and other threats to the components of ecological systems is the most serious challenge affecting biodiversity resources along with their habitats (Demel Teketay 1992). This loss in biological diversity ultimately results in economic losses of the country and the world as a whole (EFAP, 1994). If present trends in population growth continue, deterioration of natural resources will be even more rapid in the future. In Ethiopia rapid depletion of forest associated with other pressing environmental problems such as land degradation and soil erosion (EFAP, 1994). In addition to the increased demand for construction inputs, over grazing, fuel wood and clearing for agricultural expansions aggregates to the depletion of biodiversity (Million Bekele and Leykun Berhanu, 2001).

2.1.2.1 Forests and threats on forest resources of Ethiopia

Ethiopian forests are found in dry evergreen Afromontane forest and grassland complex, moist evergreen Afromontane forest and transitional rain forest vegetation types (Friis *et al.,* 2010). Forest resources are developed through the collective manipulation of physical environment and people, and play important economic, social and cultural roles in the lives of many local communities. All forests of Ethiopia are under extreme pressure from settlement, land use conversion to farming and grazing, excessive extraction, and neglect in terms of forest management and protection (Yonas Yemshaw, 2002). The growth of human and livestock population had caused the country to face problems such as: environmental degradation, soil erosion, drought and the loss of important plant species. Utilization regress changes in vegetation that finally results in the decline of quality of vegetation, reduction in the diversity and abundance of indigenous plant species and the majority of the fauna (Tamirat Andarge, 2001). The status of the forest resources should be considered at risk, however, the attention given to conservation and sustainable use of these biological resources is inadequate due to low level of awareness about the role of the forests (Tamirat Andarge, 2001).

Tigray Region is one of the environmentally degraded regions in Ethiopia, with very scanty vegetation and the original vegetation is found mostly around churches where remaining trees is forbidden to cut and in other isolated and protected areas (Leul Kidane, *et al*., 2010). Church forests and small forest fragments in northern Ethiopia play a meaningful role in conserving plant diversity (Ermias Aynekulu, 2011)**.** In Laelay and Tahtay Maichew districts, patchy remnants of old-aged forests that contain many grasses are found mainly around the Ethiopian Orthodox Tewahido Churches. Patches of forests are visible from a distance, usually built on small hills just above the surrounding villages. The local people call these churches with the surrounding trees as 'Debr' or 'Gedam' means church or monastery. Traditionally it is a taboo to cut a plant around churches. If anyone cuts a tree around churches, he or she is considered to be out of the cultural consideration breaking the rule of the church regarding the religion, and belongs on outcast. As a result, church compounds are the safe places for plants in general and particularly big grasses.

Forest resources in the country have under gone significant changes over the years due to competing land uses and unbalanced forest utilization. As a result it is often the natural forests, which were once covered more than 40% of the Ethiopian highland have now decreased to less than 3%. EFAP (1994) indicates that the forest cover was reduced to 2.7% in 1989 and less than 2.3% in 1990. One reason for the decline of the forests is attributed to energy requirement. About 94% of the energy requirement of the country relies on biomass alone (Haileleul Tebicke, 2002) of which, trees and shrubs contribute the largest percentage. To concentrate on these threats, it is serious to raise awareness of the importance of natural resources to the community facilitate dialogue with the government, civil society, and national and international organizations. Family planning can also help to reduce family size and slow population growth will give additional opportunities that other than farming or herding that are less dependent on limited natural resources. Other key actions include increasing enforcement of rules and regulations and environmental education. Taking the lost opportunities into account, foresters and conservationists have to develop new initiatives to respond to the convergence of local communities and forests (Regassa Feyissa, 2001).

2.2 Diversity

According to Krebs (1999) and Shackelton (2000), biodiversity is the number, variety and variability of living organisms The size of Ethiopian flora is estimated to be about 6,000 species of higher plants (flowering plants, conifers and ferns) 10% is considered endemic. Tewoldeberhan Gebreegziabher (1991) has reported that Ethiopia is a country of rich flora with about 7,000 species of higher plants and endowed with diversified agroecological zones with a long history of agriculture. Historical sources also indicate that, on the basis of potential climatic climax, high forests might once have covered some 35% of Ethiopia's land area. If the savanna woodland is included, two-thirds of the country was probably forest or woodland (Million Bekele and Leykun Berhanu, 2001).

2.2.1 Forest and field crop diversity plant diversity

The forest resources of Ethiopia are grouped in 5 categories, namely, natural closed forests, woodlands, bush lands, plantations and on-farm trees. The total number of woody species of Ethiopia are estimated to be 1017, out of which 29 tree species, 93 shrub species and 2 liana species are endemic (IBC, 2009).

Ethiopia is one of the major centers of diversity for many crops and their wild relatives. It is an important primary and secondary gene pool for many field crop species that are useful sources of germplasm for economic traits in general and sources of genes resistant to diseases and pests in particular (IBC, 2009). Ethiopia is a primary gene center for some crops including Noug (*Guizotia abyssinica*), Teff (*Eragrostis tef*), the Ethiopian mustard (*Brassica carinata*) and Enset (*Ensete ventricosum*). Field crops such as barley, sorghum, durum wheat, finger millet, faba bean, linseed, sesame, safflower, chickpea, lentil, cowpea, and fenugreek and grass pea have a large genetic diversity in Ethiopia (EPA, 2003).

2.2.3 Plant communities with regard to species diversity, richness and evenness

Plant community can be defined as the plant species growing together in a particular location. The two main factors taken into account when measuring diversity are species richness and evenness. Species richness refers to the total number of species in a community whereas evenness is the relative abundance of species within the sample or community making up the

richness of an area (Kent and Cooker, 1992). Species richness index is of great importance in assessing taxonomic and ecological values of habitats. Species diversity could be viewed from different approaches in terms of alpha, beta and gamma diversity (Rosenzweig, 1995).

- Alpha diversity (α) refers to the diversity of species within a particular habitat or community.
- Beta diversity (β) is a measure of the rate and extent of change in species along a gradient from one habitat to another. It is between habitat diversity that measures turnover rates. On the other hand;
- Gamma diversity (γ) is the diversity of species in comparable habitats along geographical gradients and is independent of the two (Kent and Cooker, 1992).

The species diversity from different those three approaches in this stydy were terms of alpha diversity. Similarity index also measures degree to which the species compositions of the quadrats/ samples are alike, whereas dissimilarity coefficient assesses which two samples/ quadrats differ in composition. It can be used to assess the similarity between different habitats with reference to the composition of species (Kent and Cooker, 1992).

2.2.4 Effects of agricultural practices and over grazing on floristic composition

According to FAO (1985), the major threats to the conservation of the Ethiopian vegetation are increasingly intensive use of forestlands for agriculture and livestock, need of fuel wood and construction materials, forest fires and human settlement. These major causes of forest destruction are very much interrelated and most are ultimately initiated by the rapid population growth in the country. In the northern parts of the country, the threats come from widespread land degradation through deforestation and erosion of the fertile soil (IBC, 2009).

Livestock in Sub-Saharan Africa are dependent primarily on native grasslands and crop residues and browse and grass species of communal grazing lands of sub-Saharan Africa are important sources of feed for smallholder ruminant production systems (Teklu Bela, et *al*., 2010). Natural pasture comprises the largest feed resource in Ethiopia, but estimates of its contribution vary. Alemayehu Mengistu (1998) estimated that 80- 85% of the livestock feed comes from natural pasture. Grazing is the predominant form of ruminant feeding in most part of the crop-livestock

farming areas in Ethiopia (Getachew Eshete, 2002). Nevertheless, Daniel Keftassa (1988) reported that crop residues contribute half (40 to 50%) of the livestock feed. Continuous grazing and stall-feeding with crop residues are common in the highlands of Ethiopia (Ahmed Hassen, 2006). Overgrazing reduces ground cover and changes are induced in the dominant growth forms of herbaceous plants as tall perennial bunch grasses which are replaced by annual grass (Alemayehu Mengistu, 2006) he also reported that overgrazing is the main factor for the decline in the composition and diversity of plant species over a long period of time. As a result of this highly desirable grass species were gradually replaced by less desirable and unpalatable species as a result of increased grazing pressure (Crawley, 1986). In some remote areas and around churches, by 1975 the natural dryland forest and woodland vegetation of Tigray Region had been destroyed and this was because of overgrazing, the progressive increase in demand for fuel wood and land for cultivation (Edwards, *et al*. 2010).

2.3 Literature Review on Ethnobotanical Importance of Wild Grasses

2.3.1 Definition of ethnobotany

In broad terms, ethnobotany is understood as the study of the relationship and interactions between plants and humans (Martin, 1995; Balick and Cox, 1996). It was further explained as the study of how the people of a particular culture and region make the use of indigenous plants, while ethno botanists explore how plants are used for such things as food, shelter, medicine, clothing, hunting and religious ceremonies. Many earlier ethnobotanical studies, whether of healing techniques or other plant uses, simply produced lists of plants deemed, “useful” by the people of an area. The early ethnobotanists often made little effort to understand how the indigenous people viewed the plants in their own culture (Balick and Cox, 1996). Martin (1995) noted that laboratory analysis of useful plants is a costly and time-consuming endeavor. Ethnobotany deals with the identification and documentation of important plants in many cultures. It has long been an active area of research and connected with various objectives.

2.3.1.1 Indigenous knowledge

Indigenous knowledge refers to the unique, traditional or local knowledge existing within and developed around the specific conditions of indigenous people to particular geographic area (Grenier, 1998). Local knowledge of indigenous peoples not only information about the

ecosystem in general, but also about specific plants used as medicine, food, building material and the like (Leonti *et al*., 2003). Establishing the historical depth of plant use is relevant from a variety of perspectives. Not only would it show definitely that indigenous cultures have an in depth knowledge of certain botanical taxa, which has been transmitted over centuries prior to it becoming important in the context of developing novel pharmaceuticals, but as importantly, such research would demonstrate the historical development of complicated relationship between a culture and its environment (Posey, 2002).

2.3.2 The Importance and values of plants

The use of plant resources by human kind has been going on for many centuries. In addition, plants provide food and shelter and source for raw materials. Since prehistoric times human beings have used plants for various purposes and this will continue as long as life continues on this planet. It is true that the living world depends on plant life because: plants purify the air we breathe, they are source of food for human and feed for animals, sources of energy for cooking, lighting, heating, and provide materials for building and construction. The entire dependence of human on plants and plant products, direct for their basic needs as food, clothing, and shelter and indirect for their beneficial influence on the climate and maintenance of their immediate and remote environment makes plants vital to their survival and the basis of their continued existence. Besides, plants are the most important organisms on earth, because they are the form of life on which all other living things depend and the earth's basic food stuff (Laetsch, 1979). Cotton (1996) also noted that plants are fundamental to almost all life on earth by providing protection and provisions for organisms ranging from bacteria to large animals.

2.3.2.1 Grasses as food

Food plants include those plants consumed by humans as major constituents of food preparations and plant products that are used as food can come from any part of the plant such as seed, fruit, leaf, stem, root and flowers. Ethiopians major staple crops include a variety of cereals, legumes, pulses, oil seeds, tubers, vegetable fruits, etc. Grains are the most important field crops and the chief elements of the diet of most Ethiopians. According to FAO (1999), a large proportion of the population in the tropical countries lives in rural areas. Most of rural communities are expected to obtain the bulk of their basic foods through their own efforts. Many different food crops are

cultivated and a great variety of additional foods can be obtained from semi-domesticated or wild herbs shrubs and trees found in localities.

2.3.2.2 Grasses used as fodder

Fodder or animal feed includes those plant materials harvested and fed to domestic animals and grazed and browsed in the wild. Nowadays, due to different reasons grazing pasture is scarce in highly cultivated areas and is becoming less available during the prolonged dry seasons. Noteworthy that grasses and other herbs may die when upper soil layers lose their moisture and the deep-rooted trees exploit moisture from deeper and continue to grow.

2.3.3 Conservation and management of plants

Conservation is defined within the World Conservation Strategy as: "the management of the human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations" (IUCN, 1980). At the heart of conservation is sustainable use of resources (including biodiversity). It is using resources in ways that enable the resources to meet the needs and aspirations of the current user without jeopardizing the resources ability to meet the needs and aspirations of future users (Quansah & Quansah, 1995). The objective of conservation is to conserve maximum diversity to ensure that its genetic potential will be available in the future. Ideally, all plants should be conserved as evolving populations in their natural ecosystem. However, this is not practically feasible for all species. Plant genetic resources can be conserved in-situ or ex-situ; the two systems are complementary and are being adapted as a strategy in Ethiopia (Abebe Demisse, 2001).

2.4 Push Pull Pest Management Approach

A 'push–pull' pest management approach is a cropping system in which specfically chosen companion plants are grown in between and around the main crop. These companion plants release semiochemicals that repel insect pests from the main crop using an intercrop which is the 'push' component; and attract insect pests away from the main crop using a trap crop which is the 'pull' component (Cook *et al*., 2007). The pest management approach targeted against pests tries

to reduce their abundance on the protected resource. The pests are repelled or deterred away from the resource (push) by using stimuli that mask repellent. The pests are simultaneously attracted (pull), using highly apparent and attractive stimuli, to other areas such as traps or trap crops where they are concentrated, facilitating their elimination (Shelton and Badenes-Perez, 2006).The principles of the push-pull pest management approach are to maximize control efficiency, sustainability, and output, while minimizing negative environmental effects. Each individual component of the pest management approach is usually not as effective as insecticide at reducing pest numbers. However, efficacies are increased through operation of push and pull components. By concentrating the pests in a predetermined site, the efficiency of population reducing methods can also be maximized (Shelton and Badenes-Perez, 2006). The development of reliable, robust and sustainable push-pull pest management approach requires a clear scientific understanding of the pest's biology and the chemical ecology of the interactions with its hosts and natural enemies (Cook *et al*., 2007). Such a system requires a good understanding of the plant–insect interactions on the different crops (Kahn *et al*., 2010).

2.4.1 Benefits of 'push-pull' pest management approach

The contribution of 'push-pull' pest management approach to food security cannot be over-emphasized. Intercropping or mixed cropping of maize, grasses and fodder legumes has enabled farmers to increase crop yields and thus increase food security. Farmers adopting the push–pull pest management approach have reported significant control of both *Striga* weed and stem borers, resulting in significant increases in grain yields (Khan *et al*., 2003). Research has shown that chemicals produced by the roots of desmodium are responsible for suppressing the *Striga* weed. Therefore, *Striga* does not grow where desmodium is growing. Moreover, farmers often cited additional benefits including improvement in soil fertility, fodder and milk productivity resulting higher income than the conventional cropping system (Kahn *et al*., 2010).

CHAPTER THREE

MATERIAL AND METHODS

3.1 Description of the Study Area

3.1.1 Geographical location

Laelay and Tahtay Maichew districts are located in central Zone of Tigray National Regional State; Lalay Maichew district includes the known historical town, Axum and Tahtay Maichew district includes a town called Wukro-Maray. Laelay Maichew district has a total area of 41,882 km^2; and an altitudinal range of 1982-2301 m a.s.l. It also lies approximately between13^0 58' and $14^0$16’ North and $038^0$37' and $038^0$55'East. Tahtay Maichew district covers a total area of 18,618 km^2 and with an altitudinal range of 1992-2333 m a.s.l. and lies approximately between 13^0 52' and14^0 19' North and 38^0 29' and 38^0 42' East.

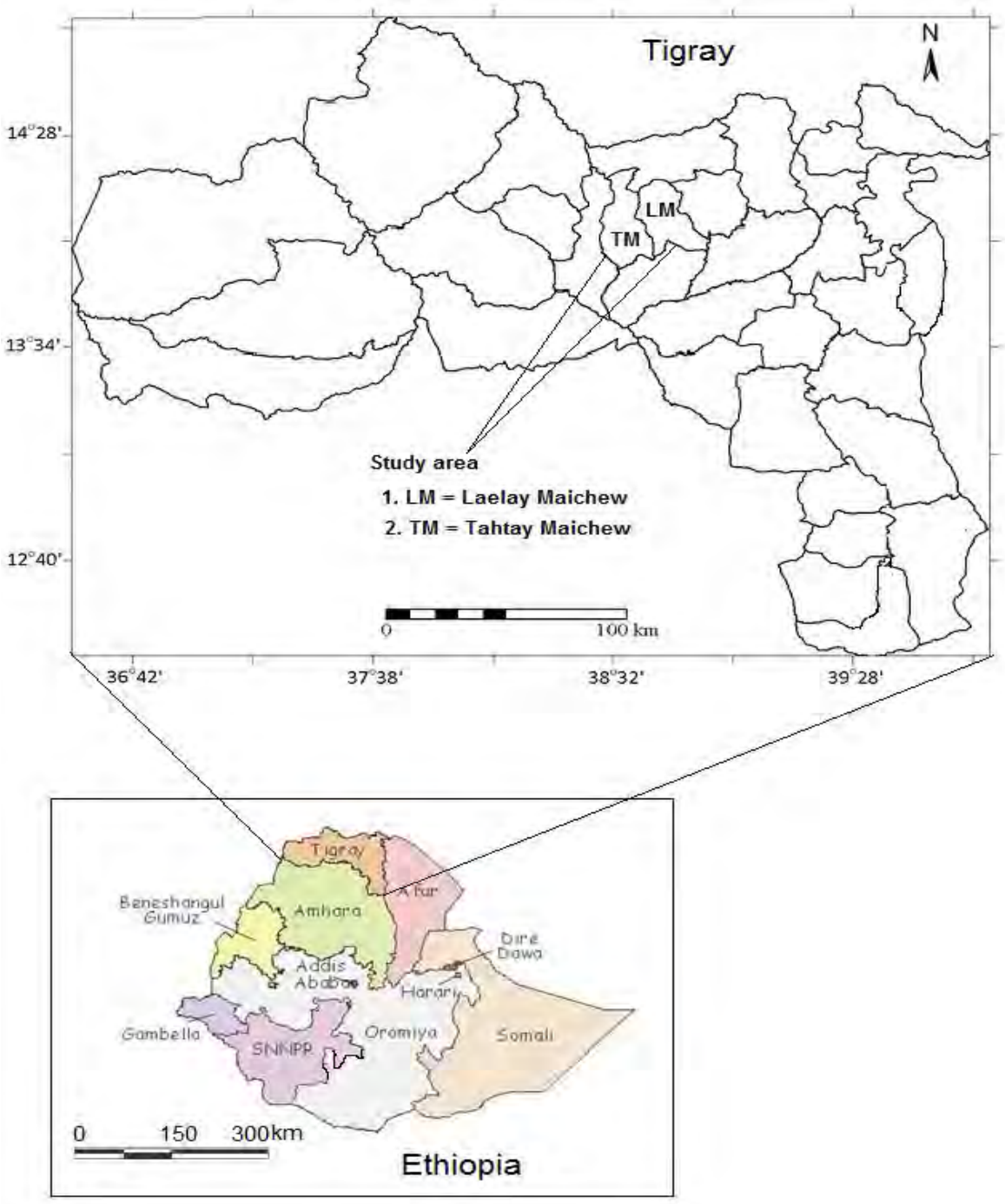

Figure 1: Map of Ethiopia and the study area

3.1.2 Climate

Climate diagram was computed by using R for windows version 2.11.1 statistical package. Meteorological data obtained from National Meteorology Service Agency (ten years (2001-2010) data) indicates that the mean annual rainfall in Laelay Maichew is about 613 mm and it obtains high rainfall between June to end of August and low rainfall towards September (Figure 2). The highest mean annual rainfall of the study area was 179.47 mm recorded in August followed by 118.42 in July whereas the lowest mean annual rainfall was 2.344 mm recorded in February. The mean annual temperature is about 19.9^{0}C and the mean minimum temperature was 9.9ºC recorded in December, whereas the highest was 30.3ºC recorded in April and May.

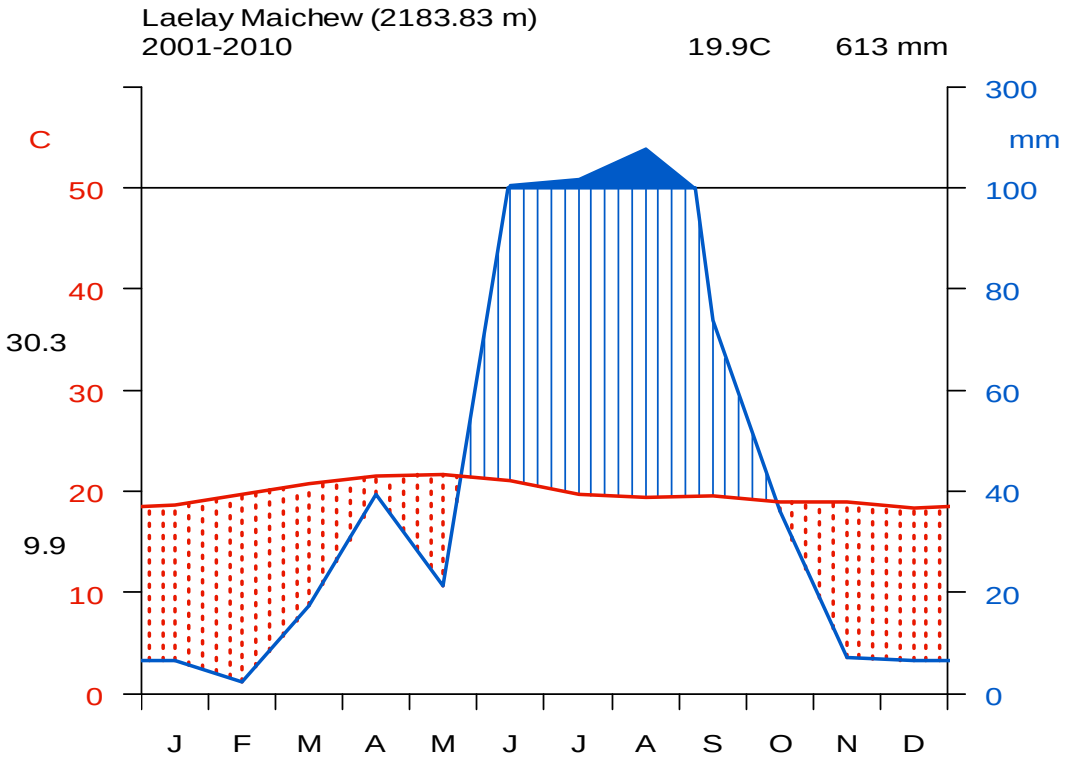

Figure 2: Climadiagram showing rainfall distribution and temperature variation from 2001-2010 of Laelay Maichew at Axum Station

Source: Data obtained from National Meteorological Service Agency (2011).

3.1.3 Human and Livestock population

The total population of the two districts (Laelay and Tahtay Maichew) is estimated to be 84,529 and 116,842 respectively. Crop production and livestock rearing are the main activities of the people of the districts. Due to rainfall during the rainy season, there is soil erosion on the degraded land, which leads to loss of soil fertility. Livestock population of Laelay Maichew is about 191,952 consisting of 40,142 cattle; 50,303 goats; 31 mules; 73 horses; 7,667 donkeys; 35,532 sheep and 58, 204 poultry. The livestock population in Tahtay Maichew is about 247,907 consisting of 75,707 cattle; 55,517 goats; 110 mules; 6,716 donkeys; 25,195 sheep and 84,102 poultry. Problems associated with shortage of browsing lands and inadequate health services and facilities are common.

3.2 Materials

The materials used during the plant data collection in the field were:

1. Herbarium presses – woody frame, straps, blotters, ventilators and flimsies
2. Field materials – GPS ,sampling frame of 1 m^2, digger, scissors, plastic bags, digital camera, lens for looking at details fine parts of the herbaceous plants, note book, pencil and tag labels

3.3 Methods

3.3.1 Data collection for the floristic composition of herbaceous flowering plant species

3.3.1.1 Reconnaissance survey

Reconnaissance survey of the vegetation of the two districts was conducted from August 22 to September 2 to get an overview of the study areas. The survey identifies the sites for detailed floristic sampling and collection of the herbaceous species. During the survey, 10 representative sites in 10 “kebeles” distributed at different altitudes were selected from the 32 “kebeles” for floristic composition of herbaceous flowering plants and for the ethnobotanical importance of wild grasses.

3.3.1.2 Sampling Design and data gathering techniques

Vegetation data were collected from sample quadrants using preferential sampling method. By sampling the quadrants from churches, borders and bunds, rehabilitated gullies, areas protected from grazing and areas where free range grazing takes place. Within 65 sample quadrants of the different herbaceous species was collected for taxonomic identification and coded for analysis of relative abundance in 1m x 1m quadrants placed within 20m x 20m quadrant (Figure 3) in the sites being studied. A total of five 1 x 1 sub-quadrants were taken from each quadrant of the major herbaceous vegetation types as shown in Figure 3. A complete list of herbaceous plants was done for each quadrant and percent cover value was estimated for each species and later converted to the Braun-Blanquet 1-9 scale as modified by van der Maarel (1979). During data gathering the physiographic variables such as altitude, latitude, and elevation using GPS were recorded. Plant specimens encountered in each of the quadrants were collected and brought to the National Herbarium (ETH) of Addis Ababa University for identification, using published volumes of the Flora of Ethiopia and Eritrea and comparing specimens with authenticated once deposited at the National Herbarium (ETH).

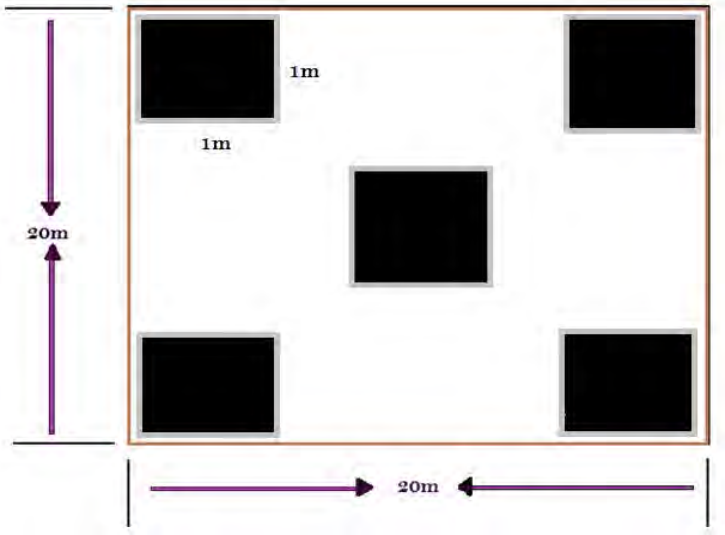

Figure 3: Sampling design of herbaceous flowering plant species in study area

3.3.2 Data collection and informant selection for ethnobotanical importance of wild grass species

Data was collected using semi-structured interview, guided field walk and direct observation, preference ranking, direct matrix ranking, group discussion and informant consensus. Informant selection was done following Martin (1995). When recording indigenous knowledge held by certain knowledgeable social groups – the systematic choice of key informant is crucial. Accordingly a total of 60 informants including 10 key informants were selected for 10 representative sites in 10 "kebeles" on the ethnobotanical importance of plants. As pointed by Martin (1995) the selection of key informants is systematic. This was based on comments and recommendations from religious leaders, elders and kebele administrators. Those, key informants were identified, later interviewed, and followed for further details.

3.3.2.1.1 Summary of information about the informants in the study area

A. Age group and gender of informants

Informants in the study area can be represented under three age groups young (20-35), middle age (36-49) and elders (≥50). The highest number in the age group is 50 and above. Information was gathered from 60 (30 females and 30 males) people using semi-structured questionnaire.

B. Educational and marital status of informants

Majority of the informants 33 (55%) were did not attuned either formal or church education, but traditionally knowledgeable farmers, whereas 19 (31.67%) and 8 (13.33%) have formal and church education respectively. The informants were free to tell the information on ethnobotanical importance of wild grasses. Out of the total informants 40 were married, but 14 and 6 were single and divorced respectively.

3.3.2.2 Semi-structured interview

During this study semi- structured interview was conducted with the informants, based on a checklist consisting of pre-determined questions (Appendix 7). The predetermined questions were administered in Tigrigna language. Based on the interviewees knowledge of wild grasses in the

study area parts used, traditional and ethnobotanical practices, conservation strategies, and so on were collected. All the resulting data were recorded and filled in the data collection format for analysis.

3.3.2.3 Field observational guided field walk

As pointed out by Martin (1995), direct field observation or guided field walk is helpful in gathering information on useful plants. Field observation was performed with the help of local guides, who were interviewed while walking through the study localities about characteristics of the grasses. This practice significantly helped to avoid confusion in identifying grass species in the study. During the exercise, etnobotanically important wild grasses were collected and identified. At the end of the interview, specimens of plants cited for their importance were collected and recorded in their local names (Tigrigna language). Voucher specimens of wild grasses were collected and dried in the field.

3.3.2.4 Preference ranking

Ranking on the importance of each species was conducted on a 1-5 scale mark given by key informant's preferences. The most preferred species was given a score of 5 (the highest score) while the least preferred species got 1 (the least score).

3.3.2.5 Direct matrix ranking

Direct matrix ranking technique was conducted for five chosen multipurpose plants commonly reported by key informants following Cotton (1996). Based on the relative benefits obtained from each plant, five informants were asked to assign values 5 - 1 to each attribute of the species compared and the resulting scores were summed and used to compare the use values of the plants. This was done for the most important multipurpose wild grass species that come up with two or more use values from the use report of the informants.

3.3.2.6 Group discussion

Short, brief and precise group discussions were held with informants regarding the useful wild grass species in the study sites. Information on local names of the grasses, their uses, methods of preparation of the wild grasses, and related data were recorded.

3.3.2.7 Informant consensus on grasses use reports

The informant consensus is helpful to see the similarity of information given by the informants that would help to verify the validity of information by comparing information given by different informants on the same issue. During the study, each informant was visited twice in order to confirm the reliability of the information. Consequently, the response of an informant that is not in agreement with each other was rejected since they are considered as unreliable information. While a certain wild grass species, that were independently cited by many of the informants for different uses were taken as relevant and statistically analyzed.

3.4 Data Analysis

3.4.1 Data analysis of the floristic composition of the herbaceous flowering plants

3.4.1.1 Plant community type identification

The plant community classification was made using cover abundance values as class labels. In addition, a floristic approach of Braun-Blanquet (1983) scale used to determine the relative cover proportion of individual species. All herbaceous plant species present in sampling unit were recorded and percentage canopy cover of each species was estimated visually converted in to 1-9 Braun-Blanquet scale later modified by Van der Maarel (1979)

1 = rare generally only one individual;

2 = sporadic (few) which are less than 5% cover of the total area;

3 = abundant with less than 5% cover of the total area;

4 = very abundant and less than 5% cover of the total area;

5 = 5-12% cover of the total area;

6 = 12.5-25% cover of the total area;

7 = 25- 50% cover of the total area;

8 = 50-75% cover of the total area;

9 = 75-100% cover of the total area

Finally, the data were entered into the spreadsheet of R.2.11.1 Program.

3.4.1.2 Diversity and similarity indices

Shannon and Wiener (1949) index of species diversity was applied to quantify species diversity and richness. This method is one of the most widely used approaches in measuring the diversity of species. The two main techniques of measuring diversity are richness and evenness. Richness is a measure of the number of different species in a given site and can be expressed in a mathematical index to compare diversity between sites. Species richness index has a great importance in assessing taxonomic, structural and ecological value of a given habitat. Evenness is a measure of abundance of the different species that make up the richness of the area. Species diversity shows the product of species richness and evenness.

Shannon-Wiener diversity index is calculated as follows

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Where, H' = Shannon diversity index

S = the number of species

Pi = the abundance i^{th} species expressed as proportion of total cover

ln = log $base_n$

3.4.1.2.1 Evenness (Equitability)

Evenness (J) measures degree of association between communities. Equitability (Evenness) index is calculated using the formula:

Equitability:

$$\mathbf{J} = \frac{\mathrm{H'}}{\mathrm{H'Max}}$$

H'= Shannon diversity index, H' max=lnS.

$$J = \frac{-\sum_{i=1}^{S} p_i \text{ in } p_i}{\ln S}$$

Where,

J = Equitability

H’ = Shannon diversity index

S = the number of species

Pi = the abundance i^{th} species expressed as proportion of total cover

ln = log $base_n$

The value of evenness index falls between 0 and 1. The higher the value of evenness index, the more even the species is distributed within the given area.

3.4.2 Data analysis of the ethnobotanical importance of wild grasses

Data collected for the ethnobotanical importance of the grasses were carried out using as recommended by Martin (1995) and Cotton (1996). Accordingly, various ethnobotanical ranking and scoring methods such as direct matrix and preference ranking techniques were employed to test consistency of responses and to obtain scientifically robust results.

3.4.2.1 Preference ranking

It was conducted following Martin (1995) for five ethnobotanically important wild grasses. The key informants were selected to identify the best preferred ethnobotanically important grass based on their personal preference or perceived degree of importance in the community. They were informed to assign the highest value (5) for the most preferred plant species and the lowest value (1) for the least preferred ones. Finally, the values were summed up and the ranks given to each wild grass species.

3.4.2.2 Direct matrix ranking

This was done for five multipurpose grass species ranked by key informants following Cotton (1996). Based on the relative benefit obtained from each, six informants were asked to give use values (5= excellent, 4= very good, 3 = good, 2 = less used, 1 = least used, 0 = not used).

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Floristic Composition

A total of 132 species of herbaceous flowering plants belonging to 99 genera and 34 families were identified from 65 quadrats examined from the study area. With regards to species number in a family, the most dominant family is Poaceae (34 species), followed by Asteraceae (16 species), Fabaceae (14 species), Lamiaceae (nine species), Cyperaceae (eight species) and Polygonaceae (seven species). On the other hand, the remaining families in the study areas are comprise 3, 2 or 1 species each (Table 5). Twenty eight of the families (82.35%) belong to dicot and six families (17.65%) to monocot groups.

Table 1: Plant families with their genera and species distribution in the study area

Family name	No. of genera	Genera in %	No. of species	Species in %
Acanthaceae	2	2.02	2	1.52
Amaranthaceae	2	2.02	2	1.52
Amaryllidaceae	1	1.01	1	0.76
Anthericaceae	1	1.01	1	0.76
Apiaceae	3	3.03	3	2.27
Asteraceae	15	15.15	16	12.12
Boraginaceae	1	1.01	1	0.76
Brassicaceae	1	1.01	1	0.76
Caryophyllaceae	1	1.01	1	0.76
Chenopodiaceae	1	1.01	1	0.76
Commelinaceae	2	2.02	2	1.52

Convolvulaceae	1	1.01	1	0.76
Cucurbitaceae	2	2.02	2	1.52
Cyperaceae	1	1.01	8	6.06
Euphorbiaceae	1	1.01	1	0.76
Fabaceae	8	8.08	14	10.60
Gentianaceae	1	1.01	1	0.76
Geraniaceae	3	3.03	3	2.27
Iridaceae	1	1.01	1	0.76
Lamiaceae	6	6.06	9	6.82
Malvaceae	3	3.03	3	2.27
Nyctaginaceae	1	1.01	1	0.76
Oxalidaceae	1	1.01	1	0.76
Papaveraceae	1	1.01	1	0.76
Plantaginaceae	1	1.01	1	0.76
Poaceae	21	21.21	34	25.7%
Polygonaceae	5	5.05	7	5.30
Primulaceae	1	1.01	1	0.76
Resedaceae	1	1.01	1	0.76
Rubiaceae	3	3.03	3	2.27
Scrophulariaceae	2	2.02	2	1.52
Solanaceae	3	3.03	3	2.27
Verbenaceae	1	1.01	1	0.76
Vitaceae	1	1.01	1	0.76
Total	99	100	132	100

Tahtay and Lalay Maichew districts contain 6 endemic species of herbaceous plants (Table 2). Two of them are strict endemic to Ethiopia while four are endemic to Ethiopia and Eritrea, and called near endemic.

Table 2: Endemic species found in Laelay and Tahtay Maichew districts, their families and distribution in Ethiopia

Endemic species	Family	Distribution in Ethiopia*
Aeollanthus abyssinicus Hochst. ex Benth.	Lamiaceae	TU, GD and WG
Bidens macroptera (Sch.-Bip. ex Chiov.) Mesfin	Asteraceae	TU, GD, GJ, WU, SU, AR, IL, KF, GG, BA and HA
Erucastrum abyssinicum (A. Rich.) Schulz.	Brassicaceae	TU, SU, AR, KF, BA and HA
Indigofera rothii Bak.	Fabaceae	SU and HA
Lapeirousia abyssinica (R.Br. ex A. Rich Baker	Iridaceae	TU, GJ, WU and SU
Trifolium schimperi A. Rich.	Fabaceae	TU, GD, GJ, WG, WU, SU, AR and KF

* TU=Tigray, HA=Harerge, SU= Shewa, GD=Gondar, WG=Welega, KF= Kefa, AR= Arsi, BA= Bale, WU=Welo, GJ=Gojam, IL= I1ubabor and GG=Gamo Gofa (Adopted from Flora of Ethiopia and Eritrea)

4.1.1. Identification of Plant Communities

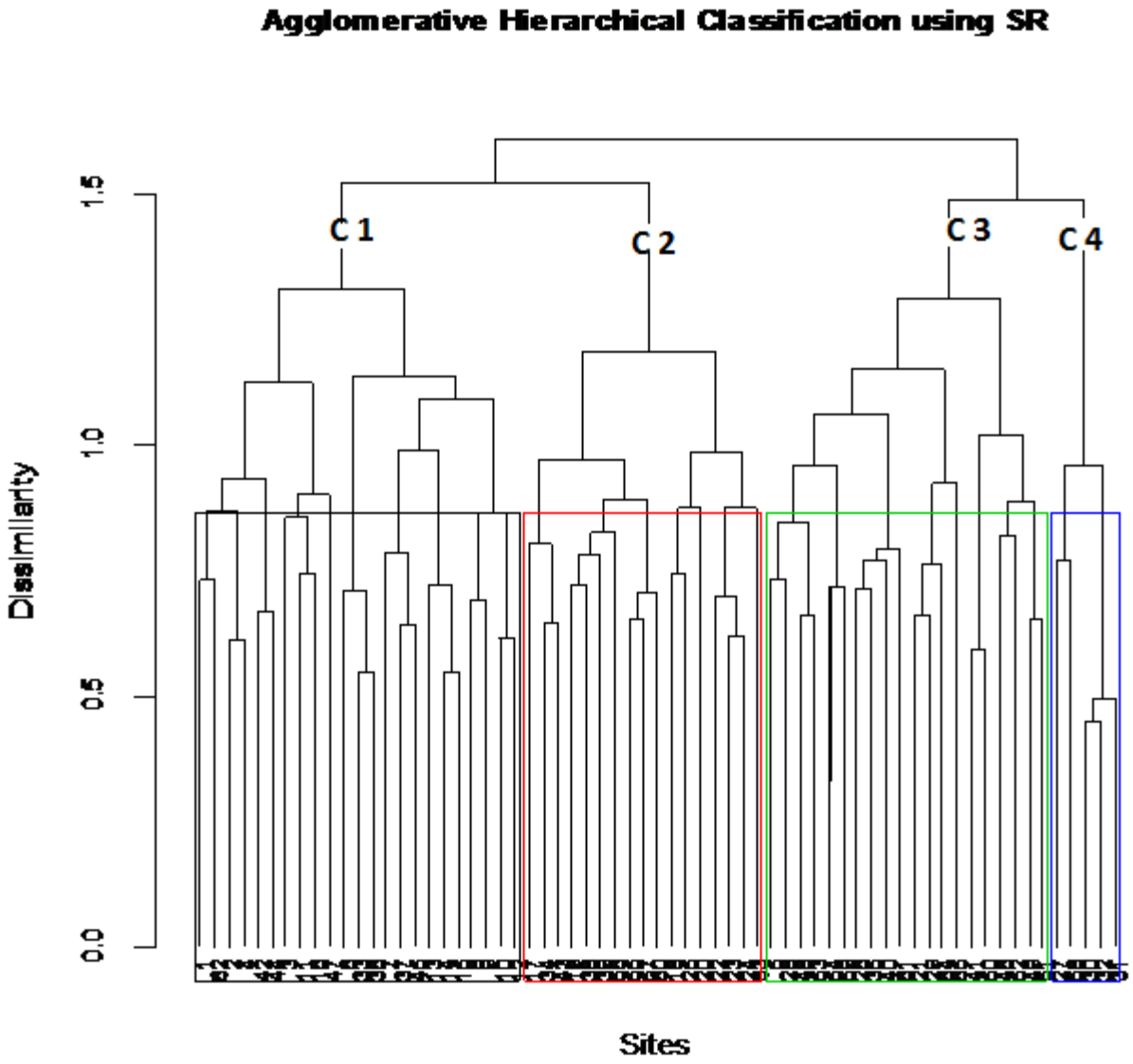

Figure 4: Dendrogram of the abundance of the 132 plant species and 65 quadrats from the study area (C 1 = Community 1; C 2 = Community 2; C 3 = Community 3 and C 4 = Community 4). The plot code and arrangement of plot along the dendrogram from left to right are as follows:

C1: (Plots 1, 62, 2, 4, 42, 44, 3, 11, 16, 47, 6, 33, 36, 7, 37, 45, 13, 14, 15, 8, 9, 10 and 12)

C2: (Plots 17, 34, 43, 19, 38, 39, 56, 55, 57, 60, 18, 25, 20, 22, 23, 24 and 63)

C3: (Plots 5, 28, 48, 53, 54, 59, 26, 35, 40, 61, 21, 29, 64, 65, 41, 50, 46, 52, 49 and 51)

C4: (Plots 27, 58, 30, 32 and 31)

Four clusters were recognized using hierarchical cluster analysis of R.2.11.1 computer program (Figure 4). Clusters represent plant communities in Laelay and Tahtay Maichew districts. The following plant communities have been named by two dominant species based on higher synoptic values. Based on the analysis, four plant communities identified from the study area were *Tagetes patula-Solanum nigrum* community typ (community 1), *Hygrophila schulli - Rhynchosia resinosa* community type (community 2), *Dactyloctenium aegyptium-Sonchus oleraceus* community type (community 3) and *Cyperus elegantulus-Gnaphalium rubriflorum* community type (community 4). Description of plant community types with their altitudinal distribution are given below.

Table 3: Synoptic cover-abundance values of species having a value of > 0.25 in at least one community type and values in bold refer to occurrences with higher synoptic values or species with high degree of fidelity (the degree to which species are confined to particular group of quadrats)

Species	Community1	Community 2	Community 3	Community 4
Acanthospermum hispidum	0.74	0.35	0.00	0.00
Achyranthes aspera	0.57	0.29	0.00	0.00
Aeollanthus abyssinicus	0.17	0.00	0.10	0.00
Amaranthus spinosus	0.87	0.24	0.95	0.00
Anagallis arvensis	1.26	0.00	0.55	0.00
Andropogon abyssinicus	0.00	0.53	0.35	0.00
Andropogon chrysostachyus	0.70	3.12	2.25	1.40
Anthephora pubescens	0.00	0.00	0.05	0.80
Argemone mexicana	0.22	0.06	0.05	0.00
Argyrolobium ramosissimum	0.43	0.12	0.55	2.20
Aristida adoensis	0.00	0.00	0.15	0.20
Aristida kenyensis	0.48	0.76	1.45	0.00
Astragalus fatmensis	0.22	0.35	0.20	0.00
Bidens macroptera	1.43	1.53	3.55	1.40
Bidens pilosa.	1.04	0.53	1.10	0.20
Bromus pectinatus.	0.04	0.71	0.05	0.00
Caylusea abyssinica	0.09	0.24	0.00	0.40
Celsia scrophulariifolia	0.17	0.00	0.40	0.00
Cenchrus Ciliaris	0.17	0.06	0.10	0.20
Cerastium octandrum	0.09	0.24	0.55	0.00
Chenopodium procerum	0.17	0.35	0.00	0.00
Chloris virgata	0.09	0.18	0.25	0.00
Chlorophytum tetraphyllum	0.13	0.82	0.20	0.40
Cicer cuneatum.	0.09	0.94	0.00	0.00

Commelina africana	0.13	0.24	0.10	0.00
Commicarpus pedunculosus	0.13	0.29	0.15	0.00
Conyza pyrrhopappa	0.43	0.29	0.30	0.00
Cotula abyssinica	0.22	0.06	0.20	0.00
Crepis rueppellii	0.04	0.18	0.00	0.00
Crinum Abyssinicum	0.17	0.00	0.00	0.00
Cucumis pustulatus.	0.17	0.00	0.40	0.00
Cyanotis barbata	0.26	2.94	0.60	1.00
Cynodon aethiopicus	0.87	0.35	1.35	1.80
Cynodon dactylon	0.43	1.35	2.25	0.60
Cynoglossum amplilofium	0.04	0.29	0.55	0.40
Cyperus a1atus	0.04	0.82	0.15	0.00
Cyperus assimilis	0.17	0.18	0.00	0.00
Cyperus costatus	0.09	0.12	0.05	0.20
Cyperus dichroostachyus	0.22	0.18	0.00	0.00
Cyperus elegantulus	0.00	0.00	0.15	**3.20**
Cyperus grandibulobsus	0.09	0.00	0.20	0.00
Cyperus renschii	0.17	0.24	0.05	3.40
Cyperus rotundus	0.39	0.35	0.30	6.60
Cyphostemma adenocaule	0.00	0.00	0.05	0.00
Dactyloctenium aegyptium	0.00	0.00	**0.60**	0.00
Datura stramonium	0.26	0.06	0.00	0.00
Daucus carota	0.04	0.35	0.65	0.00
Digitaria velutina	0.30	0.00	0.15	0.00
Echinochloa colona	0.43	0.71	0.35	2.40
Eleusine floccifolia	0.17	0.24	0.20	0.00
Eleusine indica	0.52	0.12	0.25	0.00
Emex spinosa	0.22	0.24	0.10	0.00
Eragrostis aspera	0.57	0.59	0.00	0.00
Eragrostis papposa	0.26	0.00	0.40	0.00
Erucastrum abyssinicum.	0.70	0.00	0.45	1.40
Euphorbia polycnemoides	1.74	0.29	0.15	0.00
Ferula communis	0.22	0.00	0.05	0.00
Flaveria trinervia	0.00	0.00	0.20	0.00
Galinsoga quadriradiata	2.17	0.47	1.30	0.00
Galium simense	0.48	0.00	0.25	0.00
Geranium arabicum	0.74	0.94	0.00	0.00
Gnaphalium rubriflorum	0.17	0.00	0.00	**1.20**
Guizotia scabra	0.91	0.76	0.45	0.60
Harpachne schimperi	0.09	1.06	0.20	0.00
Hibiscus trionum	0.17	0.00	0.35	0.00
Hygrophila schulli	0.00	**0.59**	0.00	0.00
Hyparrhenia sp.	0.00	0.00	0.10	0.00
Hyparrhenia anthistirioides	0.35	0.35	0.00	0.00
Hyparrhenia hirta	0.22	0.18	0.10	0.00

Hyparrhenia rudis	0.09	0.00	0.20	0.00
Hyparrhenia rufa	0.17	0.00	0.25	0.00
Hypoestes forskaolii	2.52	4.29	0.30	0.00
Indigofera congolensis	0.00	0.24	0.10	0.00
Indigofera rothii	0.09	0.00	0.05	0.00
Indigofera spicata	0.00	0.00	0.20	0.00
Ipomoea sp.	0.00	0.29	0.20	0.00
Justicia ladanoides	0.52	1.18	1.30	0.00
Kohautia coccinea	0.00	0.06	0.05	1.00
Lagenaria siceraria	0.00	0.00	0.10	0.00
Lapeirousia abyssinica	0.09	0.94	1.20	0.00
Leucas martinicensis	1.22	0.24	0.85	0.60
Malva verticillata	0.52	0.00	0.10	0.00
Medicago polymorpha	2.39	1.18	2.70	2.00
Melinis repens	0.30	0.06	0.65	0.60
Micractis bojer	0.04	0.00	0.15	0.00
Monsonia angustifolia	0.17	0.06	0.20	0.00
Nicandra physaloides	0.17	0.12	0.00	0.00
Ocimum americanum	1.35	0.41	1.10	0.40
Oxalis corniculata.	0.17	0.29	0.00	0.00
Oxygonum sinuatum	0.91	0.00	0.10	0.00
Panicum maximum	0.00	0.18	0.10	0.00
Paspalum scrobiceulatum	0.13	0.06	0.00	0.00
Pelargonium glechomoides	0.57	0.12	0.30	0.00
Pennisetum purpureum	0.00	0.35	0.75	0.00
Pennisetum sphacelatum	2.87	1.47	1.35	3.00
Pennisetum unisetum	0.09	0.76	0.10	0.00
Pennisetum villosum	0.13	0.47	0.65	0.80
Persicaria nepalensis	0.17	0.00	0.35	0.00
Persicaria setosula	0.09	0.00	0.15	0.00
Plantago lanceolata	3.09	2.06	0.65	0.00
Plectranthus lanunginosus	0.26	1.12	0.40	0.40
Plectranthus ornatus	0.00	0.00	0.20	0.00
Plectranthus punctatus	0.13	0.29	0.05	0.00
Polygala persicariifolia	0.26	0.59	0.25	0.00
Rhynchosia rerruginea.	0.61	0.82	0.00	0.00
Rhynchosia resinosa	0.00	**0.41**	0.00	0.00
Rumex abyssinicus	0.13	0.24	0.75	0.00
Rumex nepalensis	0.43	0.24	0.90	0.60
Salvia schimperi	0.30	0.12	0.10	0.00
Salvia tiliifolia	0.09	0.00	0.05	0.00
Satureja punctata.	0.26	0.59	0.05	0.00
Scorpiurus muricatus	0.48	0.06	0.00	2.40
Senecio hochstetteri	0.09	0.47	0.50	0.40
Setaria atrata	0.00	0.00	0.05	0.00

Sida schimperiana	0.57	0.94	0.35	0.60
Snowdenia polystathya	0.22	0.35	0.30	0.00
Solanum nigrum	**1.17**	0.00	0.30	0.00
Sonchus oleraceus	0.00	0.00	**0.25**	0.00
Spermacoce sphaerostigma	1.39	1.47	1.05	0.80
Sphaeranthus suaveolens	0.00	0.00	0.25	0.00
Sporobolus pyramidalis	0.30	0.00	0.30	0.00
Swertia abyssinica	0.04	0.41	0.20	0.00
Tagetes patula	**1.39**	0.47	0.00	0.00
Themeda triandra	0.00	0.24	0.00	0.00
Trachyspermum ammi	0.57	0.47	0.30	0.00
Trifolium burchellianum	1.79	0.88	0.90	0.60
Trifolium schimperi	1.09	0.88	0.75	1.80
Trifolium steudneri	0.00	0.41	0.10	0.00
Verbascum sinaticum	0.43	0.06	0.40	0.00
Verbena officinalis	0.09	0.00	0.45	0.40
Xanthium spinosum	1.30	0.24	0.20	0.00

1. *Tagetes patula*-Solanum nigrum community type

Tagetes patula-Solanum nigrum are main indicator species of the community type. Dominant species in this community type are *Plantago lanceolata, Galinsoga quadriradiata, Euphorbia polycnemoides, Trifolium burchellianum, Ocimum americanum, Anagallis arvensis, Leucas martinicensis, Solanum nigrum* and *Xanthium spinosum.* This community type consists 23 quadrats (1, 2,3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 33, 36, 37, 42, 44, 45, 47 and 62) and 108 species and it is distributed between 2054 and 2303m a.s.l. The three large sized wild grasses; *Hyparrhenia rudis, H. hirta* and *H. rufa* are mostly found in this community type.

2. *Hygrophila schulli - Rhynchosia resinosa community type*

Hygrophila schulli and Rhynchosia resinosa are main indicator species of this community type. *Cyanotis barbata, Spermacoce sphaerostigma, Plectranthus lanunginosus* (Figure 5), *Hypoestes forskaolii, Andropogon chrysotachyus, Harpachne schimperi* and *Cicer cuneatum* are the dominant species. This community type contains 17 quadrats (17, 18, 19, 20, 22, 23, 24, 25, 34, 38, 39, 43, 56, 55, 57, 60 and 63) and 92 species. This community type is distributed between 2158 and 2333 m a.s.l.

Figure 5: Gobo Dura, Lalay Maichew dominated by *Hypoestes forskaolii* and *Plectranthus lanunginosus* (Photo by Genet Atsbeha)

3. *Dactyloctenium aegyptium-Sonchus oleraceus* community type

Dactyloctenium aegyptium and Sonchus oleraceus are the main indicator species of the community type. Dominant species in this community include *Cynodon dactylon* (Figure 6), *Bidens macroptera*, *Aristida kenyensis*, *Lapeirousia abyssinic*, *Justicia ladanoides*, *Medicago polymorpha* and *Rumex nepalensis*. This community consists of 20 quadrats (5, 21, 26, 28, 29, 35, 40, 41, 43, 46, 49, 50, 51, 52, 53, 54, 59, 61, 64 and 65) and 108 species and it is distributed between 1992 and 2313 m a.s.l.

Figure 6: May Brazio, Tahtay Maichew dominated by *Cynodon dactylon*, *Bidens macroptera* and *Medicago polymorpha* (Photo by Genet Atsbeha)

4. *Cyperus elegantulus-Gnaphalium rubriflorum* community type

Cyperus elegantulus and Gnaphalium rubriflorum are main indicator species of the community type. *Cyperus rotundus, Cyperus renschii, Echinochloa colona* (Figure 7), *Scorpiurus muricatus, Argyrolobium ramosissimum, Cynodon aethiopicus, Erucastrum abyssinicum, Gnaphalium rubriflorum* and *Trifolium schimperi* are also dominant species of this community type. It contains five quadrats (27, 30, 31, 32 and 58) and 36 species. This community is distributed in altitudinal range between 1982 and 2270 m a.s.l.

Figure 7: Around Dura dam, Lalay Maichew dominated by *Cyperus elegantulus* and *Echinochloa colona* (Photo by Genet Atsbeha)

4.1.2 Species richness and equitability

The richness and evenness of species in the four different communities from the study area was calculated using Shannon-Wiener (1949) diversity index (Table 4). Communities I and III had the highest species richness while community IV exhibited the least species richness. The reason why community I and III have the highest species richness is that they are located in a relatively better protected area. Community II with the lower species richness is due to overgrazing because of the local people highly threatened the area for domestic animals rearing and agricultural expansion. Particularly community IV's lowest richness is due to that community IV is located in the moist areas. Those moist areas are dominted by *Cyperus rotundus*. Dominance of this single species

may results lowest richness and diversity. Magurran (1988) stated that the term diversityactually consists of species richness and relative abundance (evenness). From the four communities distribution (equitability or evenness) community II has the highest species evenness and community I has the least species evenness, while the other communities (communities III and IV) have intermediate evenness. The communities showed some dynamics in species richness and eveness. The main causative agents for the dynamism of the communities are anthropological activities such as overgrazing by domestic animals. In general, the probable reasons for the variability of richness between the four community types arise from altitude, degree of disturbance involved in the area, cover abundance value and other environmental factors (slope, soil and aspect) which were not included in this study.

Table 4: Richness, Diversity and Evenness

	Richness	H' (Shannon diversity index)	Shannon Evenness
I	108	4.165238	0.887855
II	92	4.055754	0.896936
III	108	4.168028	0.890199
IV	36	3.230179	0.894559

Where: I =*Tagetes patula-Solanum nigrum community type*

II= *Hygrophila schulli - Rhynchosia resinosa* community type

III = *Dactyloctenium aegyptium-Sonchus oleraceus* community type and

IV= *Cyperus elegantulus-Gnaphalium rubriflorum* community type

4.1.3 Similarity among plant communities

Similarity between communities is calculated using the formula:

$$\mathbf{J} = \frac{H'}{H'Max}$$

Where: J = Evenness

H'= Shannon diversity index H' max=lnS

S = the number of species and ln = log base$_n$

Accordingly, Communities I and III have the highest similarity ratio (Table 9) followed by Communities I and II and Communities II and III respectively. The least similarity was exhibited between communities I and IV (Table 5).

Table 5: Similarity among plant communities

Communities	Similarity	Altitudinal ranges (m a.s.l)
I, II	0.4565217	2054-2303/2158-2333
I, III	0.4791667	2054-2303/1992-2313
I, IV	0.3142857	2054-2303/1982-2270
II, III	0.4285714	2158-2333/1992-2313
II, IV	0.3191489	2158-2333/1982-2270
III, IV	0.3271028	1992-2313/1982-2270

4.2 Ethnobotanical Importance of Wild Grass Species

4.2.1 Knowledge transfer on ethnobotanical importance of wild grasses

Traditional knowledge transfer on ethnobotanical importance of wild grasses is passed along trustworthy families and other intimate family members' observation - 63.3 % followed by orally - 20 %, trial and error - 10% and other sources - 6.7% (Figure 8). Analysis of the data showed that observation is the most practiced way of ethnobotanical knowledge transfer of the wild geass species followd by verbal descrption and trial and errer in the study area.

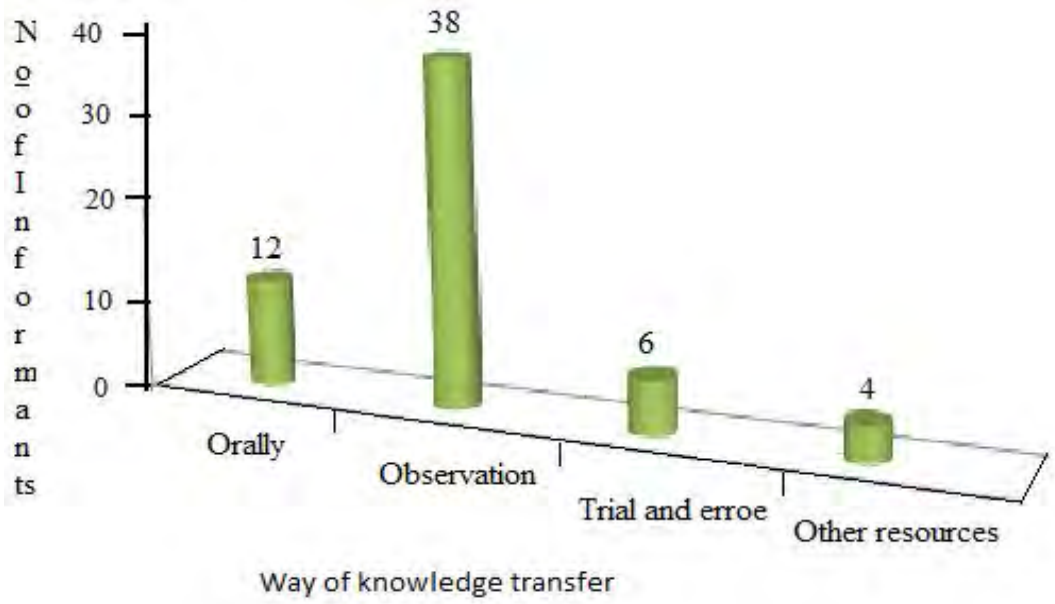

Figure 8: Ethnobotanical knowledge transfer of wild grass species

4.2.2 Conditions of preparations of wild grasses in the study area

In this study, different parts of the wild grasses were reported to be used for forage, mulching, broom making and, soil erosion control, basketwork to make kitchen utensils and decorative, to make hand bush to sweep the floor and hose building cover. A large number of plant species-23 (67.65%) were cited to be used in fresh form, relatively few wild grasses 8 (23.53%) in dried form and the rest 3 (8.82%) in dried and fresh forms (Figure 9).

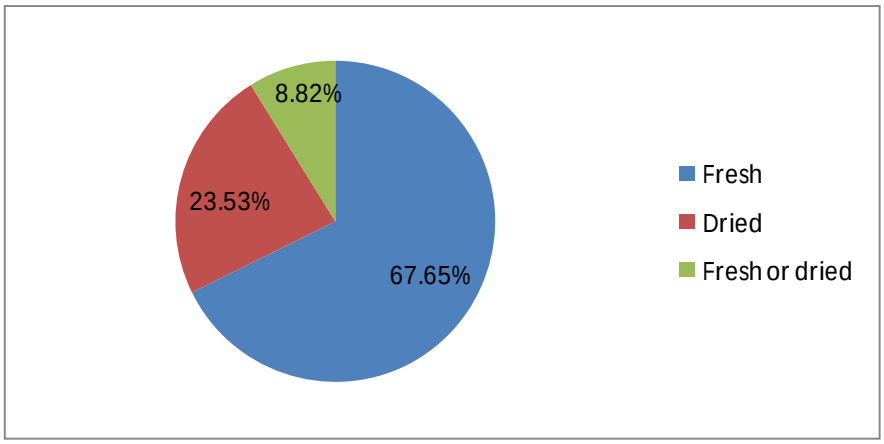

Figure 9: Conditions of preparations of wild grass species in the study area

4.2.3 Grass parts used of the wild grasses

The most widely used grass part of the wild grasses were whole parts except root (by cutting with a sickle) which account for 23 cases (67.65%) followed by whole parts of the grass (by uprooting) 7 cases (20.59%), leaf only 3 cases (8.82%) and stem only 1 case (2.94%) (Table 6). During group discussion sessions most informants reported that, they preserve plant materials that they could not find in the dry season like stem of *Eleusine floccifolia* to make kitchen utensils and decorative.

Table 6: Grass parts used in the study area

Plant parts used	**Total of grass parts**	**Total grass parts in %**
Leaf only	3	8.82%
Stem only	1	2.94%
Whole plant	7	20.59%
Whole plant except root	23	67.65%)
Total	34	100 (%)

4.2.4 Informant consensus

Wild grasses which are popular in their ethnobotanical importance that they use in the study area have local name and well known by the local people of the area generally. Based on the informants consensus conducted in the study area, five wild grass species which were cited by 47-56 informants out of 60 informants for their ethnobotanical importance are listed in Table 7.

Table 7: Grass species with high informant consensus

Scientific Name	**No. of citation (frequency)**	**Informant Consensus %**
Cynodon dactylon	56	93.3%
Eleusine floccifolia	52	86.7%
Snowdenia polystathya	50	83.3%
Hyparrhenia hirta	48	80.0%
Pennisetum purpureum	47	78.3%

The above five top wild grass species selected by 47 or more informants showed that, some wild grasses are more well-liked than others; *Cynodon dactylon* which stood 1st was cited by 56 informants, where as *Eleusine floccifolia*, *Snowdenia polystathya*, *Hyparrhenia hirta* and *Pennisetum purpureum* were cited by 52, 50, 48 and 47 informants stood 2nd 3rd 4th and 5th respectively (Table 7).

4.2.5 Preference ranking on forage

The preference ranking of grass species for animal feed (Use values given from 0 to 5: 5 = Excellent, 4 = Very good, 3 = Good, 2 = Less, 1 = least)revealed that *Cynodon dactylon* (37) was the most preferred one followed by *Cynodon aethiopicus* (32), *Snowdenia polystathya* (30), *Pennisetum villosum* (20) and *Pennisetum sphacelatum* (18).(Table 8)

Table 8: Preference ranking of wild grasses used for forage

Name of wild grasses	List of Respondents (R_1-R_8)								Total	Rank
	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8		
Pennisetum villosum	3	3	1	3	1	3	2	4	20	4
Pennisetum sphacelatum	3	2	2	1	2	3	3	2	18	5
Cynodon dactylon	5	5	4	5	5	4	4	5	37	1
Cynodon aethiopicus	4	5	4	3	4	3	5	4	32	2
Snowdenia polystathya	5	4	3	5	4	4	4	5	30	3

Preference ranking of five grasses use for animal feed indicated that, the 1st preferred grasses was *Cynodon dactylon* followed by *Cynodon aethiopicus*, *Snowdenia polystathya*, *Pennisetum villosum* and *Pennisetum sphacelatum as 2nd ,3rd, 4th and 5th* respectivelly (Table 12). From the discussion with key informants the reason why *Cynodon dactylon* is the most prefered is due to the fact that it is considered that animals feeding on the grass they give a relatively high quality meat and milk. Muyekhe *et al.* (2004) also reported that *Cynodon dactylon* is an excellent grazing grass with potential to improve livestock health, increase milk production and soil erosion control and is an indicator of fertile soils. In addition to this also details that *Cynodon dactylon* used for lawns in homesteads and sport fields thatching in the semi-arid regions and wilted solons for

mulching; soup form pounded and boiled roots used for treatment of abdominal pains and boiled roots used for abdominal pains and throat infections (colds and coughs) (Muyekhe et, al., 2004).

4.2.6 Direct matrix ranking for multiple use of wild grasses

Average score for direct matrix ranking of selected wild grasses with use diversity **(**Use values given from 0 to 5: 5 = Excellent, 4 = Very good, 3 = Good, 2 = Less, 1 = least and 0 = No use). The results of direct matrix ranking (Table 13), show that the highest value with the sum of 17 stood 1st was *Eleusine floccifolia* followed by *Hyparhenia rudis, Andropogon abyssinicus, Eragrostis papposa* and *Cynodon dactylon* with the sum of 16, 15, 14 and 10 stood 2nd, 3rd, 4th and 5th ranks respectively (Table 9).

Table 9: Direct matrix ranking of wild grasses with different uses

Main uses	*Eleusine floccifolia*	*Eragrostis papposa*	*Hyparhenia rudis*	*Cynodon dactylon*	*Andropogon abyssinicus*
Forage	3	4	3	5	3
Basket work	5	0	2	0	1
Soil erosion prevention	4	4	4	5	4
House building cover	1	0	5	0	4
To sweep the floor	4	5	2	0	3
Total	17	14	16	10	15
Rank	1	4	2	5	3

Similar results were also reported by Muyekhe *et al.* (2004) in Kenya where other grass species such as *Cenchrus ciliaris* and *Panicum maximum* were preferred to other grasses. These grasses were preferred because they are announced to be drought tolerant and excellent livestock feed with potential to improve animal health, milk production and soil erosion control. They are also show to be indicator of moderate to fertile soil suitable for growing crops. *Panicum maximum* is also known as a valuable grass for grazing and for making hay in dry areas, for thatching, mulching and broom making.

In the semi-structured interview 60 informants were interviewed, out of which 30 were females and the rest 30 were males. During the interview females listed about 24 species of the total 32 grass species in the study area while males listed about 27 species. Based on the results of the semi-structured interview knowledge on fodder were gender differentiated where nearly 20 to 30% of the species that men mentioned were not mentioned by women. On the other hand knowledge on basketwork to make kitchen utensils and decorative baskets for the homes were mentioned by women was not mentioned by men. Gender difference may be attributed to the roles played by each gender on their knowledge

Figure 10: Picture shows data collection on ethnobotanical importance of wild grass species in the field

4.3 Wild Grass Hosts of the Stem Borers

Wild grass hosts of the stem borers that can be used as trap plants in the push-pull pest management approach were searched. Nine large stemmed wild grass species were found, these are *Pennisetum purpureum*, *Hyparrhenia anthistirioides*, *Setaria atrata*, *H. hirta*, *H. rufa*, *Snowdenia polystathya*, *H. rudis*, *P. unisetum and Hyparrhenia* sp. However larvae and pupae of *Busseola fusca* and *Sesamia calamistis*-stem borers of maize and sorghum were found in *Pennisetum purpureum* in Tahtay Maichew in a “kebeles” called Akabi-Seat, May-Siye and May-Berazio.

Figure 11: Pupa of *Busseola fusca* (Fuller)-stem borer of maize and sorghum in *Pennisetum purpureum*

(a) *Hyparrhenia rudis* (b) *Hyparrhenia hirta*

Figure 12: Some of the big stemmed grasses (a) *Hyparrhenia rudis* and (b) *Hyparrhenia hirta*

Ingram (1958) describes that the plant families Poaceae, Cyperaceae and Typhacae serve as host plants for stem borers. however this study is restricted to the family Poaceae this is due to the fact that most species of the family Cyperaceae are found in moist area and the intention of the ADOPT project is to search and identify drought tolerant wild grass hosts for stem borers, which can with stand climate change.

Muyekhe *et al*. (2004) reported that *Amphistyllus pauli, Buseola fusca, Chilo partellus, chilo* spp., *Lixus* spp., *Nupserha* nr. bidentat and *Sesamia calamistis* are associated stem borers that are found in *Hyparrhenia rufa* and *Panicum maximum.* However *Hyparrhenia rufa* and *Panicum maximum* are not practiced in push-pull pest management approach. Napier grass is practiced to control maize stem borer by trapping the ovipositing moths if planted around the maize crop (Muyekhe *et al*. 2004). Khan *et al*. (2010) also reported that plants highly attractive for oviposition by stem borer pests were selected and employed as trap crops (pull), to draw pests away from the main crop. *Pennisetum purpureum* despite its attractiveness supported minimal survival of the pests' immature stages

4.4 Phytogeographical Comparison

Direct comparison of species diversity of a given area with others is not feasible due to differences in size, survey method and objectives of the study (Tadesse Woldemariam, 2003). Nevertheless the overall species richness of the districts can give general impression of their diversity with other dry evergreen montane forests of the country. Laelay and Tahtay Maichew districts can be compared with dry evergreen Afromontane forests such as Bale Mountain National Park, Donkoro forest, Gedo Forest and Menagesha Suba State Forest (Table 9). Laelay and Tahtay Maichew districts were compared with the forests based on their similarities in species diversity. Sorensen's similarity index is used for comparison of the forests using a formula (Kent and Coker, 1992; Krebs, 1999).

$$Ss = \frac{2a}{2a+b+c}$$

Where: Ss = Sorenson`s similarity coefficient

a = Number of species common to the current study area and the forest in comparison

b = number of species found only in the current study area

c = number of species found only in the forest in comparison

Table 10: Comparison of similarities of herbaceous flowering plant species composition between Laelay and Tahtay Maichew districts and other four dry evergreen montane forests in Ethiopia

Laelay and Tahtay Maichew districts and forest used for comparison with their respective author and year		Altitudinal range	Species richness	a	b	c	Ss
1	Bale Mountain National Park (Haile Yineger, 2008)	2441-3600	130	13	119	117	0.0992
2	Donkoro (Abate Ayalew, 2003)	1500-3500	104	14	118	90	0.1186
3	Gedo (Brihanu Kebede, 2010)	2300-3000	86	17	115	69	0.1560
4	Menagesha Suba state (Lema Etefa, 2011)	2350-3300	128	11	121	117	0.0850

*Note; the species richness of the forests in comparison with Laelay and Tahtay Maichew districts is only with respect to their herbaceous flowering plant species.

The above Table (Table 10) shows that Laelay and Tahtay Maichew districts have relatively highest species similarity with Gedo Forest and Donkoro forests having similarity of 15.60% and 11.86% respectively. Bale Mountain National Park with 9.92% similarity and Menagesha Suba state with 8.50% similarity are relatively lower seminaries.

4.5 Conclusions and Recommendations

4.5.1 Conclusion

This study contributes the basic data on floristic composition of herbaceous flowering plant species and ethnobotanical importance of wild grasses that provide base line information for ecological and ethnobotanical studies. Results confirmed that 132 species of herbaceous flowering plants were collected and identified belonging to 99 genera and 34 families: which were identified from 65 quadrats examined from the study area. With regards to species number, the most dominant family is Poaceae (34 species). This is followed by Asteraceae (16 species), Fabaceae (14 species), Lamiaceae (nine species), Cyperaceae (eight species) and Polygonaceae (seven species). The study revealed that among 132 species six of the herbaceous flowering plant

species are endemic to Ethiopia and Eritrean flora area, two of the six herbaceous flowering endemic plants are belong to the family Fabaceae and Asteraceae, Lamiaceae, Brassicaceae and Iridaceae contains one spies each. Two of the six endemic species are strictly endemic to Ethiopia where four are endemic to Ethiopia and Eritrea.

The vegetation was clustered in to four herbaceous flowering plants community types which had different degree of species richness, diversity and evenness. Based on the out puts of the R.2.11.1 computer program the community types that were identified under the current study are *Tagetes patula-Solanum nigrum* community typ, *Hygrophila schulli - Rhynchosia resinosa*, *Dactyloctenium aegyptium-Sonchus oleraceus* and *Cyperus elegantulus-Gnaphalium rubriflorum* community types. The distributions of these plant communities in the study area were influenced by various environmental factors and biotic stresses which are operated in a combined way; this is why variations in species richness, composition and species diversity among communities could exist. Among the large stemmed grasses *Pennisetum purpureum* bears hosts of stem borers this may be carried out in the future to check the big stemmed wild grasses such as *Hyparrhenia rufa* and *Panicum maximum*

The result attained demonstrates that Laelay and Tahtay Maichew districts verify that a minimum of 132 herbaceous flowering plant species when compared with Gedo forest, Donkoro Forest, Bale Mountain National Park and Menagesha Suba State Forest Laelay and Tahtay Maichew districts contain the highest herbaceous flowering plant species richness. This is due to that Laelay and Tahtay Maichew districts covers total area of 60,500 km^2. However Bale Mountain National Park, Donkoro Forest, Gedo Forest and Menagesha Suba State Forest each cover approximately 2,200 km^2, 355.75 km^2, 674.725 km^2 and 92.48 km^2 respectively. The similarity with , Bale Mountain National Park, Donkoro forest, Gedo Forest and Menagesha Suba State Forest is 9.92%, 11.86%, 15.60% and 8.50% respectively. Another reason for the richness of the districts in herbaceous species may be due to the distraction of woody plants allowing more space when compaired with the forests.This similarity show that the similarity between Tahtay Maichew districts and the above four Forests is low. This similarity and differences could attribute to their degree of protection from grazing and human interference, geographic proximity, climatic zone, altitudinal range etc.

4.5.2 Recommendations

Plant species are the potential stock for future genetic resources, and would have great implications for the environment and biological diversity. Based on the results of the study, the following recommendations were drawn.

- It is better to plan areas to serve as endower sustainable bases to conserve these herbaceous flowering plants species specially the wild grasses such as using by cutting with a sickle rather than uprooting.
- Potential traditional knowledge of the people on the diverse uses such as medicinal uses of herbaceous species should be studied to document endogenous knowledge of the local people and for the enrichment of ethnobotanical studies of the study area.
- It is recommended that the big stemmed wild grasses such as *Hyparrhenia rufa* and *Panicum maximum* need further check.
- The present study is limited to herbaceous species composition then further studies on, environmental parameters, protected areas management and conservation system and soil seed bank are recommended

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APPENDICES

Appendix 1: List of plants species identified from study area

Scientific name	Family	Common Name (Tigrigna)	COll. No
Acanthospermum hispidum DC.	Asteraceae	-	100
Achyranthes aspera L.	Amaranthaceae	Atiush	103
Aeollanthus abyssinicus Hochst. ex Benth.	Lamiaceae	-	126
Amaranthus spinosus L.	Amaranthaceae	Hamli adghi	067
Anagallis arvensis L.	Primulaceae	Chigaqwa'hit	142
Andropogon abyssinicus Fresen.	Poaceae	-	129
Andropogon chrysostachyus Steud.	Poaceae	-	059
Anthephora pubescens Nees	Poaceae	-	189
Argemone mexicana L.	Papaveraceae	Medafe-T'ilian	082
Argyrolobium ramosissimum Bak.	Fabaceae	-	141
Aristida adoensis Hochst.	Poaceae	-	169
Aristida kenyensis Henr.	Poaceae	-	112
Astragalus fatmensis Hochst. ex Chiov.	Fabaceae	T'et'em-Agazen	056
Bidens macroptera (Sch.-Bip. ex Chiov.) Mesfin	Asteraceae	Gelgelle-Meskel	068
Bidens pilosa L.	Asteraceae	Teneg	051
Bromus pectinatus Thunb.	Poaceae	Goncho	094
Caylusea abyssinica (Fresen.) Fisch. & Mey.	Resedaceae	-	167
Celsia scrophulariifolia Hochst. ex A. Rich.	Scrophulariaceae	-	181
Cenchrus Ciliaris L.	Poaceae	-	178
Cerastium octandrum A. Rich.	Caryophyllaceae	-	118
Chenopodium procerum Moq.	Chenopodiaceae	-	108
Chloris virgata Sw.	Poaceae	-	187
Chlorophytum tetraphyllum (Lf.) Baker.	Anthericaceae	-	117
Cicer cuneatum Hochst. ex A. Rich.	Fabaceae	Shmbra Guaset	116
Commelina africana L.	Commelinaceae	-	128
Commicarpus pedunculosus (A. Rich.) Cufod.	Nyctaginaceae	-	183
Conyza pyrrhopappa Sch. Bip. ex A. Rich.	Asteraceae	-	174
Cotula abyssinica Sch. Bip. ex A. Rich.	Asteraceae	-	149
Crepis rueppellii Sch.-Bip.	Asteraceae	-	115
Crinum Abyssinicum Hochst ex. A. Rich.	Amaryllidaceae	-	136
Cucumis pustulatus Naud. ex Hook. f.	Cucurbitaceae	-	085

Cyanotis barbata (L.) D.Don.	Commelinaceae	Maschill	127
Cynodon aethiopicus Clayton & Harlan	Poaceae		054
Cynodon dactylon (L.) Pers.	Poaceae	Tehag	086
Cynoglossum amplilofium Hochst. ex A.DC in DC	Boraginacea	-	110
Cyperus a1atus (Nees) F. Mueu.	Cyperaceae	Seti	120
Cyperus assimilis Steud.	Cyperaceae	Seti	188
Cyperus costatus Mattf. & KUk.	Cyperaceae	Seti	155
Cyperus dichroostachyus A. Rich.	Cyperaceae	Seti	154
Cyperus elegantulus steud.	Cyperaceae	Seti	146
Cyperus grandibulobsus C.B. lake.	Cyperaceae	Seti	179
Cyperus renschii Boeck. (C. ricbardii) Steud.	Cyperaceae	Seti	145
Cyperus rotundus L.	Cyperaceae	Seti	070
Cyphostemma adenocaule (Steud.ex A.Rich) Desc . ex Wild &Dr.	Vitaceae	H'areg-Temen	172
Dactyloctenium aegyptium (L.) Willd.	Poaceae	-	123
Datura stramonium L.	Solanaceae	Mstenagr	074
Daucus carota L.	Apiaceae	Zagda	161
Digitaria velutina (Forssk.) P. Beauv.	Poaceae	-	092
Echinochloa colona (L.) Link.	Poaceae	-	143
Eleusine floccifolia (Forssk.) Spreng.	Poaceae	Rghe	156
Eleusine indica (L.) Gaertn	Poaceae	-	076
Emex spinosa (L.) Campd.	Polygonaceae	-	119
Eragrostis aspera (Jacq.) Nees.	Poaceae	-	097
Eragrostis papposa (Roem. & Schulet.) steud.	Poaceae	-	052
Erucastrum abyssinicum (A. Rich.) Schulz .	Brassicaceae	-	064
Euphorbia polycnemoides Boiss.	Euphorbiaceae	-	098
Ferula communis L.	Apiaceae	Dog	102
Flaveria trinervia (Spreng.) C. Mohr.	Asteraceae	Neqel	165
Galinsoga quadriradiata Ruiz. & Pavon.	Asteraceae	-	060
Galium simense Fresen.	Rubiaceae	-	088
Geranium arabicum Forssk.	Geraniaceae	-	087
Gnaphalium rubriflorum Hilliard	Asteraceae	-	062
Guizotia scabra (Vis.) Chiov.	Asteraceae	-	057
Harpachne schimperi Hochst. ex. A. Rich	Poaceae	-	114
Hibiscus trionum L.	Malvaceae	-	083
Hygrophila schulli (Hamilt.) M.R. & S.M Almeida	Acanthaceae	-	182
Hyparrhenia sp.	Poaceae	-	133

Hyparrhenia anthistirioides (Hochst. ex A. Rich) Stapf.	Poaceae	-	192
Hyparrhenia hirta (L.) Stapf.	Poaceae	-	177
Hyparrhenia rudis Stapf.	Poaceae	-	193
Hyparrhenia rufa (Nees) Stapf.	Poaceae	-	191
Hypoestes forskaolii (Vahl.) R.Sch.	Acanthaceae	-	090
Indigofera congolensis de Wold. & Th.Dur.	Fabaceae	-	175
Indigofera rothii Bak.	Fabaceae	-	151
Indigofera spicata Forssk.	Fabaceae	-	176
Ipomoea sp.	Convolvulaceae	Meanta telli	111
Justicia ladanoides Lam.	Acanthaceae	-	077
Kohautia coccinea Royle	Rubiaceae	-	173
Lagenaria siceraria (Molina) standl st Standl.	Cucurbitaceae	-	164
Lapeirousia abyssinica (R.Br.ex A. Rich) Baker.	Iridaceae	-	121
Leucas martinicensis (Jacq.) R.Br.	Lamiaceae	-	084
Malva verticillata L.	Malvaceae	-	073
Medicago polymorpha L.	Fabaceae	Kwa'kito	053
Melinis repens (Willd.) Zizka.	Poaceae	-	104
Micractis bojer DC.	Asteraceae	-	166
Monsonia angustifolia E.Mey. ex A. Rich.	Geraniaceae	-	106
Nicandra physaloides (L.) Gaertn.	Solanaceae	-	075
Ocimum americanum L.	Lamiaceae	-	096
Oxalis corniculata L.	Oxalidaceae	-	147
Oxygonum sinuatum (Meisn.) Dammer	Polygonaceae	-	089
Panicum maximum Jacq.	Poaceae	-	186
Paspalum scrobiceulatum L.	Poaceae	-	079
*Pelargonium glechomoide*s Hochst. ex A. Rich.	Geraniaceae	-	124
Pennisetum purpureum Schumach.	Poaceae	Saeri harmaz	066
Pennisetum sphacelatum (Nees) Th. Dur. & Schinz	Poaceae	Waz Wazo	063
Pennisetum unisetum (Nees) Benth.	Poaceae	-	113
Pennisetum villosum Fresen.	Poaceae	-	125
Persicaria nepalensis (Meisn.) Miyabe	Polygonaceae	-	091
Persicaria setosula (A.Rich) K.L.Wilson	Polygonaceae	Leyekwa Riba	159
Plantago lanceolata L.	Plantaginaceae	Mandeldo	055
Plectranthus lanunginosus (Benth.) Agnews	Lamiaceae	-	093
Plectranthus ornatus Codd.	Lamiaceae	Antateh-Wollakha	135
Plectranthus punctatus (L.f.) L 'Her.	Lamiaceae	-	162
Polygala persicariifolia DC.	Polygalaceae	-	168
Rhynchosia rerruginea A. Rich.	Fabaceae	-	148

Rhynchosia resinosa (Hochst. ex A. Rich.)	Fabaceae	-	185
Rumex abyssinicus Jacq.	Polygonaceae	-	158
Rumex nepalensis Spreng.	Polygonaceae	-	140
Salvia schimperi Benth.	Lamiaceae	Abbadera	105
Salvia tiliifolia Vahl.	Lamiaceae	-	107
Satureja punctata (Benth) Briq.	Lamiaceae	-	130
Scorpiurus muricatus L.	Fabaceae	-	058
Senecio hochstetteri Sch. Bip. ex A. Rich.	Asteraceae	-	139
Setaria atrata Hook.	Poaceae	-	153
Sida schimperiana Hochst. ex Rich.	Malvaceae	Tef'reria	099
Snowdenia polystathya (Fresen.) Pilg.	Poaceae	-	072
Solanum nigrum L.	Solanaceae	Alamo	101
Sonchus oleraceus L.	Asteraceae	-	152
Spermacoce sphaerostigma (A.Rich.) Vatke.	Rubiaceae	-	080
Sphaeranthus suaveolens (Farssk.) DC.	Asteraceae	-	163
Sporobolus pyramidalis P. Beauv	Poaceae	-	190
Swertia abyssinica Hochst.	Gentianaceae	-	132
Tagetes patula L.	Asteraceae	-	061
Themeda triandra Forssk.	Poaceae	-	171
Trachyspermum ammi (L.) Sprague. ex Turrill.	Apiaceae	-	071
Trifolium burchellianum ser.	Fabaceae	Mesi	069
Trifolium schimperi A. Rich.	Fabaceae	-	065
Trifolium steudneri Schweinf.	Fabaceae	Mesi	157
Verbascum sinaticum Benth.	Scrophulariaceae	-	184
Verbena officinalis L.	Verbenaceae	Serrufit	160
Xanthium spinosum L.	Asteraceae	Melhas anshti	081

Appendix 2: Shannon diversity indices, altitudes and geographic co-ordinates

plot	Richness	Shannon Index(H')	Latitude	Longitude	Altitude (m)
1	15	0.11342	$14^0$06.555'N	$038^0$39.368'E	2062
2	16	0.11203	$14^0$06.610'N	$038^0$39.440'E	2059
3	17	0.10782	14^0 06.752'N	$038^0$39.990 'E	2054
4	19	0.11616	$14^0$06.707'N	$038^0$39.339 'E	2054
5	13	0.12262	$14^0$06.703'N	$038^0$40.246 'E	2114
6	16	0.12153	$14^0$06.950'N	$038^0$40.441'E	2163
7	12	0.08835	$14^0$06.992'N	$038^0$40.447'E	2205

8	18	0.10639	$14^0$07.005’N	$038^0$40.434’E	2223
9	18	0.11616	$14^0$07.084’N	$038^0$40.463’E	2303
10	14	0.10639	$14^0$06.774’N	$038^0$40.563’E	2125
11	17	0.12416	$14^0$07.289’N	$038^0$41.291’E	2144
12	17	0.09909	$14^0$07.375’N	$038^0$41.221’E	2171
13	14	0.10639	$14^0$0421’N	$038^0$41.208’E	2195
14	19	0.12675	$14^0$07.552’N	$038^0$41.288’E	2172
15	14	0.10923	$14^0$07.445’N	$038^0$41.552’E	2127
16	21	0.13058	$14^0$07.984’N	$038^0$43.011’E	2178
17	19	0.12425	$14^0$07.991’N	$038^0$42.973’E	2201
18	11	0.09456	$14^0$08.046’N	$038^0$42.967’E	2235
19	17	0.12907	$14^0$08.126’N	$038^0$43.002’E	2233
20	16	0.13838	$14^0$08.122’N	$038^0$43.111’E	2196
21	13	0.09759	$14^0$07.873’N	$038^0$43.309’E	2178
22	16	0.13532	$14^0$07.797’N	$038^0$43.312’E	2195
23	16	0.11931	$14^0$07.796’N	$038^0$43.367’E	2207
24	13	0.09438	$14^0$07.692’N	$038^0$43.453’E	2227
25	16	0.1035	$14^0$07.564’N	$038^0$43.551’E	2199
26	14	0.08677	$14^0$06.736’N	$038^0$42.863’E	2141
27	16	0.32816	$14^0$07.581’N	$038^0$44.566’E	2199
28	16	0.12097	$14^0$07.034’N	$038^0$39.702’E	2082
29	11	0.09759	$14^0$06.577’N	$038^0$42.962’E	2155
30	12	0.32297	$14^0$07.463’N	$038^0$44.980’E	1982
31	13	0.33524	$14^0$06.888’N	$038^0$41.405’E	2073
32	11	0.31138	$14^0$06.963’N	$038^0$41.538’E	2084
33	12	0.09909	$14^0$07.060’N	$038^0$35.923’E	2296

34	11	0.09456	$14^0$07.017’N	$038^0$35.995’E	2274
35	12	0.10366	$14^0$07.527’N	$038^0$35.854’E	2313
36	15	0.09303	$14^0$06.971’N	$038^0$37.703’E	2123
37	16	0.11064	$14^0$07.355’N	$038^0$35.687’E	2303
38	16	0.09627	$14^0$07.694’N	$038^0$35.668’E	2333
39	16	0.13378	$14^0$07.736’N	$038^0$35.635’E	2328
40	17	0.09303	$14^0$07.092’N	$038^0$33.502’E	2145
41	17	0.13222	$14^0$07.527’N	$038^0$35.854’E	2313
42	14	0.10204	$14^0$07.302’N	$038^0$33.673’E	2156
43	9	0.08659	$14^0$07.293’N	$038^0$33.814’E	2159
44	17	0.09456	$14^0$07.125’N	$038^0$33.497’E	2208
45	16	0.10495	$14^0$07.055’N	$038^0$31.511’E	2176
46	14	0.10184	$14^0$06.960’N	$038^0$31.564’E	2173
47	14	0.08677	$14^0$06.909’N	$038^0$31.348’E	2163
48	18	0.13686	$14^0$06.790’N	$038^0$31.796’E	2161
49	14	0.11594	$14^0$06.896’N	$038^0$31.865’E	2167
50	16	0.12097	$14^0$06.885’N	$038^0$32.004’E	2180
51	14	0.10547	$14^0$07.249’N	$038^0$32.022’E	1992
52	11	0.30821	$14^0$07.317’N	$038^0$32.124’E	2180
53	16	0.10184	$14^0$06.671’N	$038^0$36.950’E	2211
54	17	0.13065	$14^0$06.535’N	$038^0$36.854’E	2218
55	20	0.12907	$14^0$06.594’N	$038^0$36.878’E	2222
56	15	0.14139	$14^0$06.794’N	$038^0$37.012’E	2215
57	19	0.11594	$14^0$06.713’N	$038^0$36.913’E	2257
58	18	0.13686	$14^0$06.785’N	$038^0$36.923’E	2270
59	22	0.14435	$14^0$06.783’N	$038^0$36.862’E	2277

60	23	0.15014	$14^0$06.840'N	$038^0$34.804'E	2256
61	16	0.10204	$14^0$06.800'N	$038^0$36.676'E	2203
62	20	0.11342	$14^0$07.271'N	$038^0$34.243'E	2181
63	16	0.10902	$14^0$07.435'N	$038^0$37.435'E	2177
64	19	0.13924	$14^0$06.952'N	$038^0$35.936'E	2228
65	13	0.08355	$14^0$07.771'N	$038^0$44.423'E	2155

Appendix 3: List of Informants in the Study Area (Key to abbreviations: *-key informant, No-no education/illiterate, 1, 2, 3… education level (grade), and church-church/traditional education).

No.	Sex	Age	Marital status	Education Status	Residence kebele	Wereda	Occupation
1	M	53	Married	4^{th}	Dura	Lalay Maichew	Farmer
2	M	80	Married	No	Dura	Lalay Maichew	Famer
3*	F	42	Divorced	No	Dura	Lalay Maichew	Housewife
4	F	20	Single	10^{th}	Dura	Lalay Maichew	Student
5	M	61	Married	No	Dura	Lalay Maichew	Farmer
6	F	64	Married	No	May-Weyni	Lalay Maichew	housewife
7	M	35	Single	5^{th}	May-Weyni	Lalay Maichew	Farmer
8	F	51	Married	3^{rd}	May-Weyni	Lalay Maichew	Housewife
9*	M	65	Married	Church	May-Weyni	Lalay Maichew	priest
10	F	46	Married	3th	May-Weyni	Lalay Maichew	Housewife
11	M	32	Single	6^{th}	Miha	Lalay Maichew	Farmer
12	M	48	Married	Church	Miha	Lalay Maichew	priest
13	F	42	Married	No	Miha	Lalay Maichew	Housewife
14	F	35	Married	No	Miha	Lalay Maichew	Farmer
15	M	20	Single	10+2	Miha	Lalay Maichew	Student
16	F	33	Married	No	Hatsebo	Lalay Maichew	Housewife

17	F	68	Married	No	Hatsebo	Lalay Maichew	Housewife
18	F	52	Divorced	No	Hatsebo	Lalay Maichew	Farmer
19	F	20	single	10^{th}	Hatsebo	Lalay Maichew	Student
20	M	51	Married	Church	Hatsebo	Lalay Maichew	Deptera
21*	M	64	Married	No	May-Selam	Lalay Maichew	Farmer
22	M	36	single	5^{th}	May-Selam	Lalay Maichew	Farmer
23	F	37	Divorced	4^{th}	May-Selam	Lalay Maichew	Farmer
24	M	79	Married	No	May-Selam	Lalay Maichew	Farmer
25	F	25	Divorced	10+3	May-Selam	Lalay Maichew	Student
26	M	44	Married	4^{th}	Dereka	Lalay Maichew	Farmer
27	M	21	single	No	Dereka	Lalay Maichew	Student
28*	M	79	Married	No	Dereka	Lalay Maichew	Farmer
29	F	38	Married	No	Dereka	Lalay Maichew	Housewife
30	F	61	Married	No	Dereka	Lalay Maichew	Housewife
31	M	46	Married	No	May-Brazio	Tahtay Maichew	Farmer
32	M	73	Single	church	May-Brazio	Tahtay Maichew	Priest
33*	F	75	Married	No	May-Brazio	Tahtay Maichew	Housewife
34	F	51	Married	No	May-Brazio	Tahtay Maichew	Farmer
35	F	65	Married	No	May-Brazio	Tahtay Maichew	Housewife
36	M	70	Married	No	May-Siye	Tahtay Maichew	Farmer
37	M	34	Married	8^{th}	May-Siye	Tahtay Maichew	Farmer
38*	M	70	Married	No	May-Siye	Tahtay Maichew	Farmer
39	F	39	Married	No	May-Siye	Tahtay Maichew	Housewife
40	F	25	single	3^{rd}	May-Siye	Tahtay Maichew	Merchant
41	M	65	Married	No	Akabi-Seat	Tahtay Maichew	Farmer
42*	F	62	Married	No	Akabi-Seat	Tahtay Maichew	Housewife

43	F	20	Single	9th	Akabi-Seat	Tahtay Maichew	Student
44	M	32	Married	No	Akabi-Seat	Tahtay Maichew	Farmer
45	M	51	Married	No	Akabi-Seat	Tahtay Maichew	Housewife
46	F	25	Married	No	Mryena	Tahtay Maichew	Housewife
47	M	41	Divorced	No	Mryena	Tahtay Maichew	Farmer
48	M	22	Single	6th	Mryena	Tahtay Maichew	Farmer
49*	M	49	Married	Church	Mryena	Tahtay Maichew	Farmer
50	F	21	Single	No	Mryena	Tahtay Maichew	Housewife
51	F	23	Married	No	Hawesuta	Tahtay Maichew	Housewife
52	M	21	Single	church	Hawesuta	Tahtay Maichew	Farmer
53*	F	73	Married	No	Hawesuta	Tahtay Maichew	Housewife
54	M	22	single	10+1	Hawesuta	Tahtay Maichew	Student
55	F	58	Married	No	Hawesuta	Tahtay Maichew	Housewife
56	F	36	Divorced	No	Kewanit	Tahtay Maichew	Housewife
57	M	63	Single	church	Kewanit	Tahtay Maichew	Priest
58	F	48	Married	7th	Kewanit	Tahtay Maichew	Housewife
59*	F	56	Married	No	Kewanit	Tahtay Maichew	Housewife
60	M	50	Married	Church	Kewanit	Tahtay Maichew	Priest

Appendix 4: List of wild grass species in the Study Area including botanical names, family, local names and Coll. No-collection number

Scientific name	Local name (Tigrigna)	Distribution in Ethiopia	Coll No
Andropogon abyssinicus	Kerana-sa'ai	TU, GD, GJ, SU, AR, KF, GG and HA	129
Andropogon chrysostachyus	-	GD, SU,AR, SD, BA and HA	059
Anthephora pubescens	-	TU and SU	189

Scientific name	Local name (Tigrigna)	Distribution in Ethiopia	Coll No
Aristida adoensis	-	TU, GJ, WU, SU, WG, KF,GG, SG and HA	094
Aristida kenyensis	-	TU, GD, SU, AR and SD	112
Bromus pectinatus	-	TU, GD, GJ, WU, SU, KF, AR, GG and BA	159
Cenchrus ciliaris	-	AF, TU, WU, SU, WG, KF, GG, SD and HA	178
Chloris virgata	Sa'ri waza	TU, GD, SU, AR, HA	187
Cynodon aethiopicus	Thag	GD, SU, IL, KF, SD, BA and HA	054
Cynodon dactylon	Thag	AF, TV, GD GJ, WU, SU, AR, WG, IL, KF, GG, SD and BA	086
Dactyloctenium aegyptium	Adeghla	AF, TU, SU, AR, IL, GG, SO and HA	123
Digitaria velutina		TU, GD, GJ, SU, AR, IL, KF, GG, SD, BA	092
Echinochloa colona	-	AP, EW, TU,GD, GJ, WU, SU, AR, IL, KF, GG, SU and HA	143
Eleusine floccifolia	Rgehe	TU, GD, GJ, SU,AR, KF and HA	156
Eleusine indica	Dagusha-adgi	IL and GG	076
Eragrostis aspera	Taf zagroy	TU, GJ, SU, AR, GG, SD and HA	097
Eragrostis papposa	Taf tafo	AF, TU, WU, SU, GG, SD and HA	052
Harpachne schimperi	Chegwar-sai'r	TU and GD	114
Hyparhenia anthistirioides	Chechewa	TU, GU, GJ, SU, AR, KF and HA	192
Hyparhenia rudis	Sari bet	GD and HA	193
Hyparrhenia sp.	Sari bet		188
Hyparrhenia hirta	Sa'ri-awald	TU, GD, WU, WG, SU, AR, KF, GG, SD, BA	177
Hyparrhenia rufa	Qwar sa'ri	TU, GD, GJ, SU,IL , KF and SD	191
Melinis repens	-	TU, GD WU, GJ, WG, SU, KF GG, SU and HA	104
Panicum maximum	Qacha. sa'ri	TU, GD, WG, WU, SU, AR, IL, KF, GG, SD, BA and HA	186
Paspalum scrobiculatum		GD, WG, SU, IL, KF, GG, SD, BA, HA	079

Scientific name	Local name (Tigrigna)	Distribution in Ethiopia	Coll No
Pennisetum villosum	Selah-kurkur	TU, GD, WU, SU and 'HA	125
Pennisetum purpureum	Sari harmaz	SU and IL	066
Pennisetum sphacelatum	Selah kurkur	AR, GD, WU, SU, AR, KF, GG, SU, BA and HA	063
Pennisetum unisetum	-	EW, TU, GD, WG, SU, IL, KF, GG, SU and HA	113
Setaria atrata	-	GD, GJ, WG, SU, KF and SD	153
Snowdenia polystathya	Mg'way	TU, GD, WU, GJ, WG, SU, AR, IL, KF, SD and HA	072
Sporobolus pyramidalis		TU, GD, GJ, SU, KF,GG, SD and BA	190
Themeda triandra	Chmara-gwasot	TU, GO, WU, SU, AR, KF, GG, SD, BA and HA	171

* TU=Tigray, HA=Harege, SU= Shewa, GD=Gondar, WG=Welega, KF= Kefa, AR= Arsi, BA= Bale, AF= Afar, WU=Welo, GJ=Gojam, IL= I1ubabor, GG=Gamo Gofa and SD=Sidamo (Adopted from Flora of Ethiopia and Eritrea)

Appendix 5: Geographical location, altitude and abundance (common, rare, very rare) of each wild grass Species in the Study Area. Abundance of each species is based on perception of local people & personal observation.

Local name	Geographical location	Altitude	Abundance of species	Coll No
Andropogon abyssinicus	$14^0$07.797'N, $038^0$43.312'E	2195	Common	129
Andropogon chrysostachyus	$14^0$06.555'N, $038^0$39.368'E	2062	Rare	059
Anthephora pubescens	$14^0$07.771'N, $038^0$44.423'E	2155	Rare	189
Aristida adoensis	$14^0$08.122'N, $038^0$43.111'E	2196	Common	094
Aristida kenyensis	$14^0$07.991'N, $038^0$42.973'E	2201	Rare	112

Bromus pectinatus	14^{0}06.909'N, 038^{0}31.348'E	2163	Rare	169
Cenchrus ciliaris	14^{0}07.249'N, 038^{0}32.022'E	1192	Rare	178
Chloris virgata	14^{0}06.952'N, 038^{0}35.936'E	2228	Common	187
Cynodon aethiopicus	14^{0}06.703'N, 038^{0}40.246 'E	2114	Common	054
Cynodon dactylon	14^{0}06.703'N, 038^{0}40.246 'E	2114	Common	086
Dactyloctenium aegyptium	14^{0}07.873'N, 038^{0}43.309'E	2178	Rare	123
Digitaria velutina	14^{0}07.984'N, 038^{0}43.011'E	2178	Rare	092
Echnochloa colona	14^{0}07.581'N, 038^{0}44.566'E	2199	Common	143
Eleusine floccifolia	14^{0}07.736'N, 038^{0}35.635'E	2328	Very rare	156
Eleusine indica	14^{0} 06.752'N, 038^{0}39.990'E	2054	Common	076
Eragrostis aspera	14^{0}07.005'N, 038^{0}40.434'E	2223	Common	097
Eragrostis papposa	14^{0}06.555'N, 038^{0}39.368'E	2062	Common	052
Harpachne schimperi	14^{0}08.046'N, 038^{0}42.967'E	2235	Rare	114
Hyparhenia anthistirioides	14^{0}07.771'N, 038^{0}44.423'E	2155	Rare	192
Hyparrhenia rudis	14^{0}07.771'N, 038^{0}44.423'E	2155	Common	193
Hyparrhenia sp.	14^{0}07.771'N, 038^{0}44.423'E	2155	Very rare	133
Hyparrhenia hirta	14^{0}07.249'N, 038^{0}32.022'E	1192	Rare	177
Hyparrhenia rufa	14^{0}07.771'N, 038^{0}44.423'E	2155	Common	191
Melinis repens	14^{0}07.796'N, 038^{0}43.367'E	2207	Very rare	104
Panicum maximum	14^{0}06.952'N, 038^{0}35.936'E	2228	Common	186
Paspalum scrobiculatum	14^{0}07.552'N, 038^{0}41.288'E	2172	Rare	079
Pennisetum villosum	14^{0}07.873'N, 038^{0}43.309'E	2178	Common	125
Pennisetum purpureum	14^{0}06.610'N, 038^{0}39.440'E	2059	Rare	066

Pennisetum sphacelatum	$14^0$06.555'N, $038^0$39.368'E	2062	Common	063
Pennisetum unisetum	$14^0$07.991'N, $038^0$42.973'E	2201	Rare	113
Setaria atrata	$14^0$07.355'N, $038^0$35.687'E	2303	Rare	153
Snowdenia polystathya	14^0 06.752'N, $038^0$39.990'E	2054	Common	072
Sporobolus pyramidalis	$14^0$07.771'N, $038^0$44.423'E	2155	Rare	190
Themeda triandra	$14^0$06.909'N, $038^0$31.348'E	2163	Rare	171

Appendix 6: List of wild grass species, local name, use, plant part used for and methods of preparation

Scientific name	Local name (Tigrigna)	Use	Plant parts	Methods of preparation	Coll No
Andropogon abyssinicus	Kerana-sa'ai	- Forage (fodder)	Whole plant except roots	Fresh	129
Andropogon chrysostachyus		- Forage	,,	Dried	059
Anthephora pubescens		- Forage	,,	Fresh	189
Aristida adoensis	Tsmbya	- Forage	Whole plant	Dried and Fresh	094
Aristida kenyensis		- Forage	,,	Fresh	112
Bromus pectinatus		- Forage	,,	Fresh	169
Cenchrus ciliaris		-Forage, Mulching,Broom making and soil erosion control	,,	Fresh	178
Chloris virgata	Sa'ri waza	- Forage	Whole plant	Fresh	187
Cynodon aethiopicus Clayton & Harlan		- Forage	,,	Fresh	054
Cynodon dactylon	Tehag	- Forage - Runoff and soil erosion prevention	,,	Fresh	086

Dactyloctenium aegyptium	Adeghla	- Forage	- Whole plant except roots	Fresh	123
Digitaria velutina		- Forage	,,	Fresh	092
Echnochloa colona		- Forage	- Whole plant except roots	Fresh	143
Eleusine floccifolia	Rgehe	- Basketwork to make kitchen utensils and decorative baskets	- Stem	Dried	156
Eleusine indica	Dagusha-adgi	- Forage	- Whole plant except roots	Dried	076
Eragrostis aspera	Taf zagroy	- To make hand bush to sweep the floor	Whole plant except roots	Dried	097
Eragrostis papposa	Taf tafo	- To make hand bush to sweep the floor - Forage	Whole plant except roots	Dried	052
Harpachne schimperi	Chegwar-sai'r	- Forage	,,	Fresh	114
Hyparhenia anthistirioides	Chechewa	- Hose building cover	,,	Dried	192
Hyparhenia rudis.	Sari bet	- Hose building cover	Whole plant except roots	Dried	193
Hyparrhenia sp.	Sari bet	- Forage	Leaf	Dried and Fresh	133
Hyparrhenia hirta	Sari bet	- Forage	Whole plant except roots	Fresh	177
Hyparrhenia rufa	Qwar sa'ri	- Hose building cover,	,,	Dried	191

Melinis repens		- Forage	,,	Fresh	104
Panicum maximum	Qacha. sa'ri	- Forage -Soil erosion control	,,	Fresh	186
Paspalum scrobiculatum		- Forage	,,	Fresh	097
Pennisetum villosum	Selah-kurkur	- Forage	Leaf	Fresh	125
Pennisetum purpureum	Sari harmaz	- Forage	Leaf	Fresh	066
		- Runoff and soil erosion prevention	Whole plant except roots		
Pennisetum sphacelatum	Selah kurkur, Wazwazo	- Forage	Whole plant except roots	Fresh	063
Pennisetum unisetum		- Forage	,,	Fresh	113
Setaria atrata		- Forage	,,	Fresh	153
Snowdenia polystathya	Mg'way	- Forage	,,	Dried and Fresh	072
Sporobolus pyramidalis		- Forage	,,	Fresh	190
Themeda triandra	Chmara-gwasot	- Forage	,,	Fresh	171

Appendix 7: Questions for Semi-structured interviews on the ethnobotanical importance of wild grass species

General information

1. Date……..……..Kebele code…….
2. Sex……..…..age…….……
   2.1 Marital status…….…occupation (main Job)…….……

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

3. What part/s of the plant(s) is/are used? Leaf (lf), Roots (Rt), Stem (St), Flower (Fr), Fruit (Fr), Seed (Sd)), Inflorescence (In) or Whole plant (Wp).

Appendix 7 a : Information on local name, grass part used and parts used for

S. No	Local name	Grass part used	parts used for
1			
2			
3…			

4. Are the grasses easily accessible? If not, why?

_____

5. How is the knowledge of the plants transferred from elders to the young generation?

_____

6. Which wild grass species are the most preferred in their uses for ethnobotanical importance and why?

_____

7. Are there methods for wild grasses conservation in the area? If so please describe the management practices used by the local people.

_____

_____