



Floristic Composition of Wetland Plants and Ethnomedicinal Plants of Wonchi District, South
Western Shewa, Oromia Regional State, Ethiopia

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South Western Shewa, Oromia Regional State, Ethiopia

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This is to certify that the Thesis prepared by Getu Dida Abdo, entitled: Floristic Composition of Wetland Plants and Ethnomedicinal Plants of Wonchi District, South Western Shewa, Oromia Regional State, Ethiopia and Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Plant Biology and Biodiversity 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 Wetland Plants and Ethnomedicinal Plants of Wonchi District, South Western Shewa, Oromia Regional State, Ethiopia

Getu Dida Abdo, MSc Thesis

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Wetland ecosystems are one of the most productive ecosystems in the world and also are areas of high biodiversity. The study was undertaken to investigate the floristic composition of Wonchi Wetlands and traditional medicinal uses of plants in Wonchi District. For floristic data collection from plots of size 2 mx2 m (4 m²) were laid for estimation of cover abundance. Various techniques including semi-structured interview, group discussion and guided field walk were applied. These values were analyzed by using R software version 3.2.2. 50 plant species representing 45 genera and 23 families were recorded and all of them were herbaceous species. The family Asteraceae with 13 species was the dominant plant family followed by poaceae 9 species. Four community types were identified and these included Schoenoplectus corymbosus - Hygrophila auriculata community type, Persicaria setosula-Typha latifolia, Oenanthe palustris-Mentha aquatica and Alchemilla pedata-Sphaeranthus suaveolens. Sixty-eight (68) plant species distributed in 62 genera and 34 families were reported for their medicinal values. The most commonly used plant families were Lamiaceae represented by the highest number of species (9, 13.23%) followed by Asteraceae (8, 11.76%). Of the 68 medicinal plant species identified (48, 70.6%) were reported for used against human ailments, (14, 20.62%) were reported to treat livestock ailments and (6, 8.8%) to treat both human and livestock ailments. Herbs were most frequently reported (37, 53.7%) species followed by shrubs (17, 25.4%) and trees were (12, 17.9%) species. The most utilized plant parts were leaves (45, 66%) followed by roots (12, 17.64%). Oral route was the dominant route of administering herbal preparations (38, 55.9%) followed by dermal (20, 29.4%), nasal (8, 11.8%) and optical (2, 3%). The most important factors influencing the plant species composition of wetland plants are anthropogenic impacts followed by high population density of the district. Therefore, special attention should be given in the future management and conservation for sustainable use of wetland resources as well as medicinal plants of the study area.

Key Words: *Ethnobotany, Wonchi, Wetland, Medicinal plants*

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Acronyms

AAU	Addis Ababa University
a.s.l	Above Sea Level
ETH.	The National Herbarium, Ethiopia
ENMA	Ethiopian National Meteorology Agency
EWNRA	Ethiopian Wetland Natural Resource Association
GPS	Global Positioning System
ICF	Informant Consensus Factor
IK	Indigenous Knowledge
Km	Kilo metre
WWAO	Wonchi Woreda Agricultural Office
WWEO	Wonchi Woreda Education Office
WWHO	Wonchi Woreda Health Office
WWLO	Wonchi Woreda Livestock Office
TVET	Technical and Vocational Education and Training

CHAPTER ONE

1. Introduction

1.1 Background of the study

Wetlands refer to ecosystems whose formation, processes and characteristics are controlled by water (Maltby, 1986). Water being the driving factor, the presence of wetland ecosystems in all climatic and topographic locations makes them among the most diverse ecosystem types. Their diversity of form and fragments thus lead to lack of a widely accepted definition for wetland ecosystems. This has led many institutions and scholars to define wetlands based on their context. For instance, Philipose and Thomas (2003) defined wetlands as areas where water is the primary factor controlling the environment and associated plant and animal life. While Bardeckil *et al.* (1991) described wetlands as being ecotones, i.e., transitional ecosystem between terrestrial areas such as forests and farmlands and aquatic ecosystems such as rivers, lakes, etc. combining the structural and functional attributes. Based on their occurrences, Niering (1997) stated that wetlands occur where the water table is at or near the surface of the land, or where the land is covered by shallow water. However, the definition given in Ramsar Convention (1971) is a widely accepted definition for wetland ecosystems and it states that: wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters.

The major types of wetlands in Ethiopia include swamps, marshes wetlands, flood plains, natural and human-made lakes, peaty wetlands and swamp forest wetlands (Solomon Tilahun *et al.*, 1996; Leykun Abunie, 2003). In general, wetlands are complex systems that can be described and classified by a large number of characteristics. At the macro level, wetlands may be classified according to biomes. At the local and more specific level, wetlands may be grouped according to their habitat types, physical and biological characteristics (Dugan, 1990). Ethiopian wetlands can be grouped in to four major categories based on ecological zones, hydrological functions, geomorphologic formations and climatic conditions (Leykun Abunie, 2003). Ethiopian Wetland categories into four based in biomes these wetland biomes are the Afro-tropical highlands, the Somali-masai, the Sudan-Guinea and the Sahelian transition zone groups (Leykun Abunie, 2003). The Afro-Tropical Highlands are composed of Central, Western and Eastern Highlands of Ethiopia that serve as the prime water catchment and source of its major rivers. This area includes most of Ethiopian's alpine and fresh water Wetland ecosystems. The Wonchi Crater Lake is found in this Wetland biomes category.

Ethiopia, with its different geological formations and climatic conditions, is endowed with considerable water resources and wetland ecosystems, including twelve river basins, eight major lakes, many swamps, floodplains and man-made reservoirs. Major river and lake systems, together with their associated wetlands, are fundamental parts of life interlinked into the structure and welfare of societies and natural ecosystems. Wetlands are productive ecosystems that play an important role in socio-economic development if they are effectively utilized on a sustainable basis. The extent to which water and wetland resources can potentially contribute to Ethiopia's development has barely been assessed

(Solomon Tilahun *et al.*, 1996; Leykun Abunie, 2003). Ethiopian Wetlands are currently being lost or altered by, including water diversion for agricultural intensification, urbanization and dam construction.

There is increasing pressure on wetlands in Ethiopia as the human population continues to grow, and more land for agriculture is needed. Moreover, unregulated over-utilization, pollution, dam construction and other anthropogenic interventions all pose serious threat to the sustainability of Ethiopian wetlands (Leykun Abunie, 2003). These threats posed on wetlands are increasingly becoming acute and are increasing the rate of wetland loss (Schuyt, 2000) as reported for Africa.

Physical change of the hydrology of the drainage basin of a wetland will affect the input of water to a wetland and/or its outflow. The construction of dams, artificial maintenance of water and drainage will impair a wetland's ability to control flooding, since the soil has a reduced capacity to reabsorb water (Berhanu Tekaligne, 2003).

Wetlands are threatened by both anthropogenic (damming, irrigation and drainage systems) and natural processes (flood and drought). The building of biomass in the wetland can sometimes be so great that the water balance is altered, and the wetland dries out as open swamp vegetation is replaced by shrubs, and eventually, woodland. This natural process is greatly speeded up by wetland drainage and by the increase of sediment and nutrient input from upstream (Dixon & Wood, 2003).

Wetland ecosystems being one of the most productive ecosystems in the world are also areas of high biodiversity. Wetlands form convergence of hydrology, biodiversity and ecosystems productivity. High biodiversity of wetland ecosystems are given in terms of plant biodiversity, faunal and microbial biodiversity. High plant diversity in wetland

ecosystems has very important implication for use by humans. In Ethiopia, wetlands serve as grazing areas during acute dry periods serving an insurance against drought. But also, even though wetland ethnobotany received fewer attentions thus far, wetlands serve as sources of plants that have important use value for local population.

Harshberger (1896) cited in Cotton (1996) noted that ethnobotany has been a rather difficult term to define since its conception in 1895. But, the whole concept of ethnobotany is agreed around all studies concerning the relationship between people, plants and the environment involving broad range of disciplines. It tries to find out how people have traditionally used plants, for whatever purposes, and how they are still doing. Thus, ethnobotany tries to preserve valuable traditional knowledge for both future generations and other communities (Martin, 1995; Cotton, 1996).

The history of plant use by humans for the treatment of various diseases is as old as the history of the human species. Hence, humans had been looking to nature to provide them with remedies for their health problems most of which are derived from plant products. It is due to the fact that the plants have been used as a source of medicine in both developed and developing countries in general and in Ethiopia in particular since time immemorial (Mirutse Giday *et al.*, 2003; 2005). Nearly 80% of the Ethiopian population is still dependent on traditional medicine, which largely involves the use of plants (Dawit Abebe and Ahadu Ayehu, 1993).

Ethiopian's have attempted to come up with remedies or practices that restore good health in response to various health problems. But knowledge of remedies and practices was either based on oral transfer in the early medico-religious manuscripts (Getahun

Abate, 1989 and Dawit Abebe *et al.*, 2003); thus it needs proper documentation since it remains in the memory of elderly practitioners (Mirutse Giday *et al.*, 2003).

1.2. Research questions and objectives

1.2.1. Research Questions

The following research questions were formulated in order to achieve the objectives

- ❖ What are the floristic compositions of the Wonchi Wetlands?
- ❖ Where are wetland areas found in the Wonchi District?
- ❖ What are the medicinal plants used by the local communities to treat various ailments of humans and livestock and which parts of these species are used? And how many of them are derived from wetlands?
- ❖ What are the major threats to medicinal plants in the study area?

1.2.2. Objectives of the study

1.2.2.1 General objective

The main objective of this study was to investigate the floristic composition of the Wonchi Wetlands and traditional medicinal uses of plants both in wetlands and in other ecosystems in Wonchi District in South Western Shewa Zone, Oromia Regional State, Ethiopia.

1.2.2.2 Specific objectives

- To study floristic composition of the Wonchi Wetland plants and to map the wetland areas in the Wonchi District
- To identify and document traditional medicinal plants used to treat human and livestock health problems in the study area.
- To identify the plant parts used to treat health problems and describe the methods of preparation and route of administration as practiced by the local people
- To assess the major threats to medicinal plants in the study area

CHAPTER TWO

2. REVIEW LITERATURES

2.1. Ethiopian vegetation

Many scholars and professionals have attempted to classify and describe the Ethiopian vegetation. Among these Tamrat Bekele (1994), Friis and Sebsebe Demissew (2001), Sebsebe Demissew and Friis (2009) and others have made a considerable contribution in classification and description of the natural vegetation types mostly based on physiognomic basis as well as in proposing their appropriate conservation measures.

Ethiopia has documented more than 6000 plant species and is considered one of the countries in the world with rich biodiversity. One of these resources is natural vegetation where flora and faunal life forms occur its dynamic ecosystems (Girma Balcha, 2002). As defined by Goldsmith *et al.* (1986), vegetation is an assemblage of plants growing together in a particular location and characterized either by its component species or by the combination of structural and functional characters that determine the appearance, or physiognomy of vegetation. The various topography, the rift valley and the surrounding lowlands have given Ethiopia a wide spectrum of habitats and a large number of endemic plants and animals (Demel Teketay, 1999).

2.2 Wetland vegetation

The stresses and problems that plants encounter in the wetland environment are so peculiar and in some cases so extreme that only highly specialized species or hydrophytes and species that are sufficiently equipped to deal with those stresses and problems can be found there, forming their own typical vegetation composition (Keddy, 2000). Wetland vegetation condition is an important tool for monitoring wetland health. Kershaw (1973) pointed out that vegetation study may aid in the selection and implementation of appropriate conservation and management plans for sustainable use of ecosystems.

Mitsch and Gosselink (2002) wetland physical features are grouped into three basic elements: hydrology, soil and vegetation. Wetlands are distinguished from adjacent uplands by the presence of water (hydrology), either at the surface or within the root zone. Wetlands have unique soil type (hydric soil) that differs from adjacent uplands. Wetland vegetation is the most important component for characterizing and defining wetlands (Mitsch and Gosselink, 2002). The bottom of wetlands, at least periodically, supports predominately hydrophytes i.e. it supports vegetation adapted to the wet conditions. It favors particular type of trees, shrubby species and associated herbs, sedges and grasses.

2.3 Types of Wetlands

Wetlands differ due to various factors such as hydrology (water regime), water chemistry, existing plant and animal life. Wetlands include a wide variety of ecosystem types including tidal salt marshes, freshwater marshes, forested swamps, mangrove swamps, fens, bogs, tropical reed swamps and seasonally flooded riparian forests. In general, according to Cowardin *et al.* (1979), there are five recognized major wetland system

types as marine, estuarine, lacustrine, riverine, and palustrine. Of the global total wetland area estimated, the greatest part is occupied by wetlands in freshwater environments.

Marine and estuarine systems describe coastal, salt water wetlands whereas the other categories represent freshwater systems. Lacustrine wetlands are associated with lakes; riverine wetlands are found along rivers and streams; and palustrine wetlands represent those wetlands that are referred to as marshes, swamps and bogs. Swamps are permanently flood areas dominated by herbaceous vegetation (trees and shrubs). Marshes are periodically or continually flooded wetlands characterized by non woody emergent herbaceous (non-woody) plants that are adapted to living in shallow water or in moisture saturated soils. They are usually less than one meter in height. Bogs are characterized by spongy peat deposits, a growth of evergreen trees and shrubs. The major types of wetlands in Ethiopia include swamps, marshy wetlands, flood plains, natural and human-made lakes, peaty wetlands and swamp forest wetlands (Leykun Abunie, 2003).

Ethiopian wetlands can be grouped into four major groups based on ecological zones, hydrological functions, geomorphologic formations and climatic conditions. These categories interlink to form four major biomes, which also describe climatic conditions in Ethiopia. These biomes are the Afro-tropical Highlands, the Somali Masai, the Sudan-Guinea and the Sahelian Transition Zone groups (Solomon Tilahun *et al.*, 1996; Leykun Abunie, 2003). The Afro-Tropical Highlands are composed of Central, Western and Eastern Highland of Ethiopia that serve as the prime water catchment and source of its major rivers. This area includes most of Ethiopian's alpine and fresh water Wetland ecosystems. Wonchi crater Lake is found in this Wetland biomes category.

2.4 Importance of Wetland

Wetlands are considered to have unique ecological features which provide numerous products and services to humanity (Prasad *et al.*, 2002). Ecosystem goods provided by the wetlands mainly include: water for irrigation; fisheries; non-timber forest products; water supply; and recreation. Major services include: carbon sequestration, flood control, groundwater recharge, nutrient removal, toxics retention and biodiversity maintenance (Turner *et al.*, 2000). Wetlands such as ponds, lakes, and reservoirs have long been providing multiple-use water services which include water for irrigation, domestic needs, fisheries and recreational uses; groundwater recharge; flood control and silt capture.

2.4.1. Hydrological functions

Wetlands provide a number of important functions in regulating water flow through a hydrological system. They slow the speed of water moving through the system and act as natural reservoirs, storing large amounts of water. This regulates the downstream flow, maintaining it during the dry season and controlling flooding during the wet season. Wetlands recharge groundwater and are important for maintaining the water table. All of these factors are extremely important for communities living and farming around or downstream of a wetland. Large wetlands can also have an effect on rainfall, humidity and balance of the local microclimate through the high potential evapotranspiration rates of dense wetland vegetation. (Messele Fisseha, 2003).

2.4.2. Wetland resources

Wetlands deliver a number of resources for people and animals, the most important of these being water. They deliver a reliable and relatively clean source of drinking water for the local population and their livestock, and for local wildlife. They also provide dry

season grazing for livestock. Other resources provided by a wetland, often of greater importance to the poorer members of the community, include reeds for roof thatching and basket making, clay and sand for brick making, and a source of plants used in traditional medicine and food (Wood, 2003).

2.5. Challenges to Ethiopian wetlands

Ethiopia is often referred to as the water tower of Africa mainly because of its wide variety of landforms and climatic conditions, creating an extensive wetland system throughout the country (Leykun Abunie, 2003). Generally, wetland ecosystem values range from tangible subsistence uses and direct benefits to intangible goods and services and the fulfillment of human needs. The indirect uses of wetlands are their hydrological and ecological functions, which support various economic activities, life support systems and human welfare. This includes ground water recharge, flood control, nutrient cycling, erosion control and sediment traps, climate regulation, habitats for migratory wildlife and pest control (Dugan, 1990). The direct use also includes fishing, fiber production, water supply, recreational opportunities and increase tourism.

While wetlands are the most productive ecosystems on earth; they are also the most threatened. Wetland destruction and alteration has been and is still seen as an advanced mode of development, even at the government level. This indicates that wetlands and their value remain little understood. Another important reason for their vulnerability is the fact that they are dynamic systems undergoing continual change. As a result, many wetlands are temporary features that disappear, reappear and recreate themselves over time (Barbier *et al.*, 1997). (Matthew *et al.*, 2006) summarized stating it ‘most acute trade-off between environmental protection and development resulted from dynamics and

complexity of wetlands'. Though wetlands face number of threats from natural factors globally, most of the threats are resulted from the directly or indirectly human interaction with the wetlands. Dugan (1990) claims that 65% of wetland disturbances are of human origin, while the remainder have natural origins. Out of these human origin disturbances 73% are thought to result from direct human actions, while the remaining 27% are believed to come from indirect sources. Like in the other African countries, most of the threats in Ethiopian wetlands are result of the direct and/ or indirect un-healthy human interactions. Natural factors area also coming importantly influencing factors.

2.6 Consequences of wetland losses in Ethiopia

To consider the impact of wetland loss on local community, there are good examples of wetlands which are already lost (Haramaya Lake) and in loss such as Abijata and Cheffa (EWNRA, 2008). Moreover, considering the rapid conversion of the Ilubbabor wetlands is also very important. Bringing these wetlands in to mind, the local communities dependent on these wetlands for fisheries, dry season food crops, raw materials for construction, water, feed for animals, medicinal plants, income from sale of the products including handicraft, have lost or is in loss of the stated uses. For example, the conversion of wetlands in Ilubbabor (south western Ethiopia) is a means to loss the natural sedge (which is collected for roofing), drying of about 150 springs causing extra loads to women and poor, loss the use that medicinal healers gained from medicinal plants collection (Fricker, 1999; Wood, 2003). Considerable health problems like malnutrition of children also reported for this area due to the complete conversion of the wetlands (Yilma D. Abebe and Geheb, 2003). Thus, at community level since the significance of

wetlands in poverty reduction and ensuring food security is immense, their losses cause famine.

Since wetlands are sources of water and forage for livestock at dry season, it is major advantage next to land in agricultural areas and may benefit number one in pastoral communities (Wood, 2003) which will be absent due to the degradation and complete loss of wetlands. The consequence of wetland loss extends to aggravating climatic disturbances by increasing carbon build up in the atmosphere and biodiversity loss (Yilma D. Abebe and Geheb, 2003; EWNRA, 2008). As Ethiopia is prone to desertification and recurrent drought, the effects of wetland loss could be more visible in complicating the situation locally. It can also affect hydrological cycle or rainfall patterns. Rivers and streams may lose their strength. This will create shortage of water and narrow opportunities for irrigation based agriculture. Wetlands are prominent shelter of aquatic and terrestrial biodiversity. Endemic fishes, birds and other life forms depend on wetlands. Hence, the loss of these wetlands is devastating to several endemic species and particularly to wetland dependent species.

2.7 Ethnobotany

Cotton (1996) noted that much of the controversy surrounding the definition of ethnobotany has rooted from differences in the interests of workers involved in its study. It is from multidisciplinary approach involving the several fields of botany, chemistry, pharmacology and anthropology that ethno-scientists can derive information for different applications. Ethnobotanists have traditionally directed their efforts towards one of the two goals. While economic botanists sought to discover new natural products of commercial value, often for the benefit of the developed world, ethno-scientists focus on

achieving a theoretical understanding of how people perceive and manage the environment (Zemedu Asfaw and Mesfin Tadesse, 2001).

Cotton (1996) noted that the changing attitudes towards traditional peoples are among the key reasons for the growing interest in ethnobotany. Hence, ethnobotany attained potential applications since the early ethnobotanical studies in aboriginal plant use. The scope of ethnobotany currently has expanded enormously, encompassing the botanical aspects of a number of ethno-scientific studies including ethno medicine, ethno taxonomy, ethno ecology, anthropological and botanical studies of material culture (Cotton, 1996). The practical applications of ethnobotanical data in areas such as biodiversity prospecting and conservation biology are seen within the current scope of the subject. Cotton (1996) summarized that ethnobotany now constitutes a diverse field of study which examines all aspects of reciprocal relationships between plants and traditional people through its multidisciplinary approach drawn from broad range of subjects.

2.8. The Contribution of Ethnobotany to Research

It was noted by Sofowora (1984) that ethnobotany has contributed to the discovery of many important plant derived drugs. Ethnobotanical methods play vital roles in medicinal plant investigations through its multidisciplinary approaches. Moreover, these ethnobotanical methods are based on social, cultural and religious backgrounds as well as on the knowledge, attitudes and beliefs that are prevailing in the community regarding physical, mental and social wellbeing, the causes of disease and disability as well as environmental conservation and resource management. Hence, factors associated with social norms, values and attitudes are among the key concepts that the best

ethnobotanist/ethno scientist has to take in to account while conducting his scientific investigations.

2.9. The Contribution of Indigenous Knowledge (IK) to Ethno medicine

Ethnobotanical studies can contribute to modern drug development through recommendations based on the knowledge base tapped from the indigenous community (Martin; Sebsebe Demissew and Ermias Dagne, 2001; Zemedede Asfaw, 2005). According to Sojarto *et al.* (2005), bioprospecting or more simply biodiversity prospecting is field explorations to seek and document indigenous/traditional medicinal knowledge, and or the biodiversity with which the is attached, and its conversion into a number of commercialized products. However, it is obvious that these field explorations entirely involve ethno botanical methods. The implication is that there is strong relationship between ethno medicine, a field that studies the medicinal plant lore of indigenous local plant communities (Abera Geyid, 2003) and ethnobotany where medicinal plants play vital role in primary healthcare system as well as IK and practices. It becomes worth adding here the strong connotations by Zemedede Asfaw (2005) about the role of indigenous knowledge in natural resource management in general and medicinal plant conservation in particular.

2.10. Origin and Development of Traditional Medicine

Ethno medicine covers studies that are concerned with the mutual relationships between plants and traditional people (Cotton, 1996). It deals with the documentation, analysis and dissemination of knowledge on the interaction between biodiversity and human society, and how biodiversity is valued in different societies as well as how it is influenced by human activities.

Traditional people around the world possess unique knowledge of plant resources of their locality in terms of their use for food medicine and other uses (Martin, 1995). Since ancient times, plants have been essential sources of both protective and healing traditional medicine for human beings and livestock. Historical accounts of traditionally used medicinal plants illustrate that different medicinal plants were in use as early as 5000 to 4000 BC in China and 1600 BC by Syrians, Babylonians, Hebrews and Egyptians (Dery *et al.*, 1999). Since then, the major system of traditional medicine, which originated from ancient China, has continued to develop not only in China but also in neighboring countries such as Japan, the Republic of Korea and Vietnam (WHO, 2007).

2.11. Indigenous knowledge

Indigenous knowledge refers to the accumulation of knowledge, rule, standards, skills, and mental sets, which are possessed by local people in a particular area (Quanash, 1998). The immediate and intimate dependency of local people on natural resources resulted in the accumulation of indigenous knowledge that helped people to adapt to and survive in the environments in which they live. It is local knowledge that is unique to a given culture or society and the base for agriculture, health care, food preparation, education, environmental conservation and a host of other activities (Thomas, 1995). The complex knowledge, beliefs and practices generally known as indigenous knowledge develops and changes with time and space. Hence, such knowledge includes time-tested practices that develop in the process of interaction of humans with their environment (Alcorn, 1984).

Indigenous knowledge is a body of knowledge built up by a group of people through generations of living in close contact with nature and it is cumulative and dynamic. It builds upon the historic experiences of people and adapts to social, economic,

environmental, spiritual and political change. One of the widely used indigenous knowledge system in many countries is the knowledge and application of traditional medicine. Such knowledge, known as ethno medicinal knowledge involves traditional diagnosis, collection of raw materials, preparation of remedies and its prescription to patients (Farnsworth, 1994). Such secretive and crude transfer makes indigenous knowledge or ethno medicinal knowledge vulnerable to distortion and in most cases, some of the lore is lost at each point of transfer (Amare Getahun, 1976), hence there is a need for systematic documentation of such useful knowledge through ethnobotanical research.

2.12. Medicinal plants and Ethnomedicine in Ethiopia

In Ethiopia, the exercise of traditional medicine is diverse and varies greatly between different ethnic groups. Traditional medical practitioners mostly use herbs, spiritual healing, bone-setting and minor surgical procedures in treating diseases. Most traditional medical practices in Ethiopia rely on an explanation of disease that draws on both the “mystical” and “natural” causes of an illness and employ a universal approach to treatment (Bishaw Mengiste, 1991).

Under the rule of Menelik (1865-1913), Western medicine became more incorporated into the Ethiopian medical system. Numerous medical messengers from abroad, starting with the Italians and Russians were influential in building hospitals, providing medical training and participating in vaccination campaigns. However, most medical establishments primarily served the urban elites and foreign missionaries, and were concentrated in the major cities (Pankhurst, 1990).

Even though Western medicine was becoming more wide spread in Ethiopia, Ethiopians tend to rely more on traditional medicine. Conventional medical services remain concentrated in urban areas and have failed to keep pace with the growing population, keeping health care access out of reach for most Ethiopians living in countryside. Because traditional medicine is culturally entrenched, accessible, and affordable, up to 80% of the Ethiopian population rely on traditional remedies as a primary source of health care (Pankhurst, 1990; Kebede Deribe *et al.*, 2006).

2.13. Threats of Traditional Medicinal Plants in Ethiopia

Even if plants play a basic role in treating various human and livestock health care, they are currently under pressure because of accelerated devastation of plant resources with the loss of indigenous knowledge (Ensermu Kelbessa *et al.*, 1992). The current loss of medicinal plants and the associated indigenous knowledge in Ethiopia is due to natural and anthropogenic factors (Giday Yirga, 2010b; Ermias Lulekal *et al.*, 2008).

Some medicinal plant species of Ethiopia are reported to have been threatened because of over harvesting for marketing as medicine. Among many medicinal plants in Ethiopia, about 26 species are endemic and they are becoming increasingly rare and at the verge of extinction (Tesfaye Awas and Sebsebe Demissew, 2009). Equally threatened is the knowledge base on which the traditional medical system is based, as the ethno medicinal information is not documented and remains in the memory of elderly practitioner.

CHAPTER THREE

3 Materials and Methods

3.1 Description of the study area

The study was conducted in Wonchi District located in South West Shewa Zone of Oromia Regional State, Ethiopia (Figure 1 and 2). Wonchi District is located about 37 km West of Woliso, the capital town of South West Shewa Zone and 27 km South East of Ambo. Wonchi District is found 150 km from West of Addis Ababa, Ethiopia. The geographic location of the district lies between 8°41'N and 37°53'E. The altitudinal variation of the district extends from 1700 m.a.s.l upto 3387 m a.s.l from the Crater rim in the North on Mt. Wonchi to the lowest altitude along the south slope of Mt Wonchi toward the undulating foot slopes to the Woliso plain. The total area of the Woreda is 475.6 km² according to Taye Beyene and Verschuur (2014) and the total human population of the district is about 119,736. Seven Woredas bordering the Wonchi District are Toke Kutaye (North West), Ambo and Dendi (North), Dawo (North East), Woliso (East), Amaya (south West) and Goro (south) (WWAO, 2017)

The study areas of Wetlands are found in four kebeles. These kebeles include Meti Welga (Welga Wetland, Obe meda, Goda wobe and Boriftu Wetland), Belbela Bulbulo (Gagure wetland), Dimtu Godeti (Hora Galeyi) and Haro Wonchi (Wonchi Crate Lake and Hora Wetland) (Figure 1).

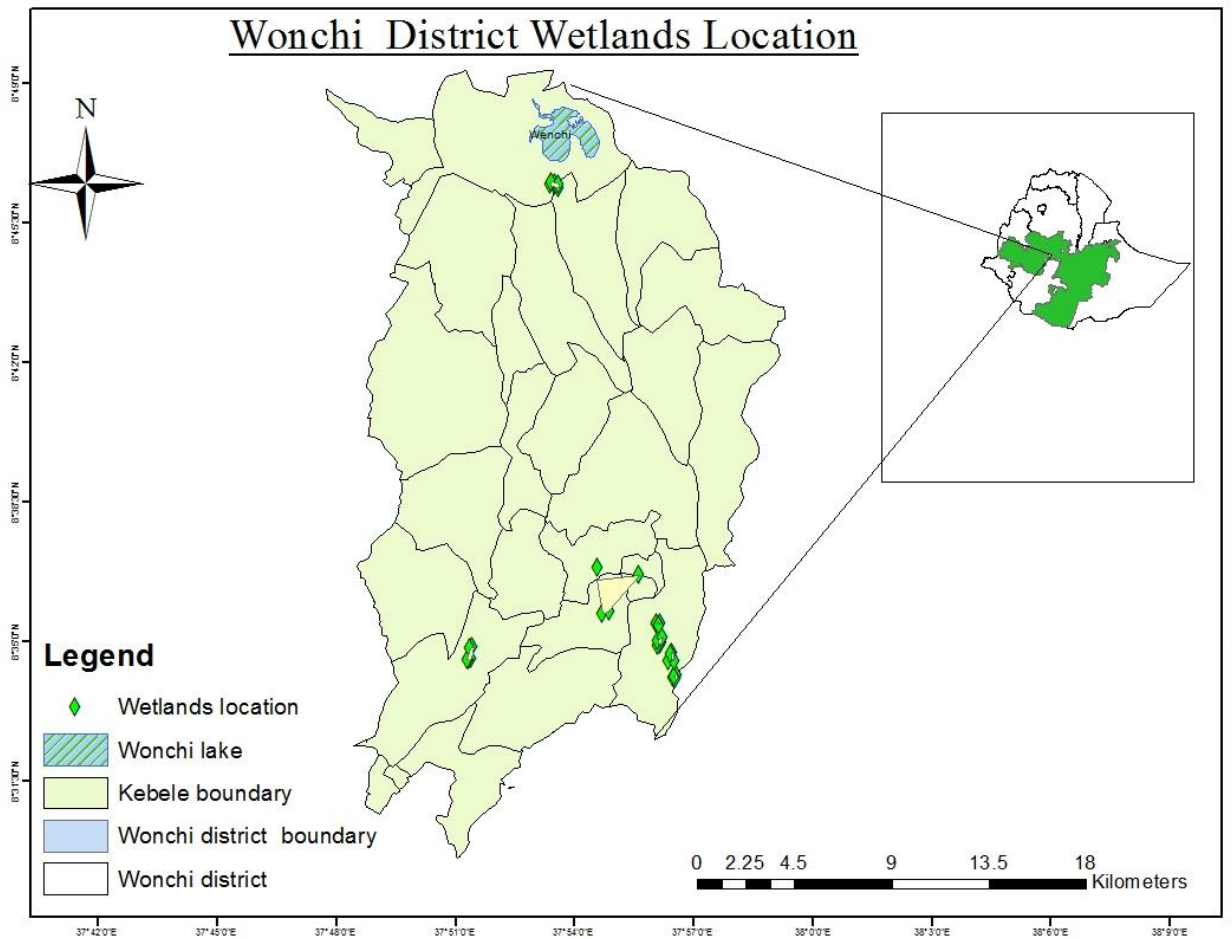


Figure 1 Map of Wonchi District showing Wetland area found within the District

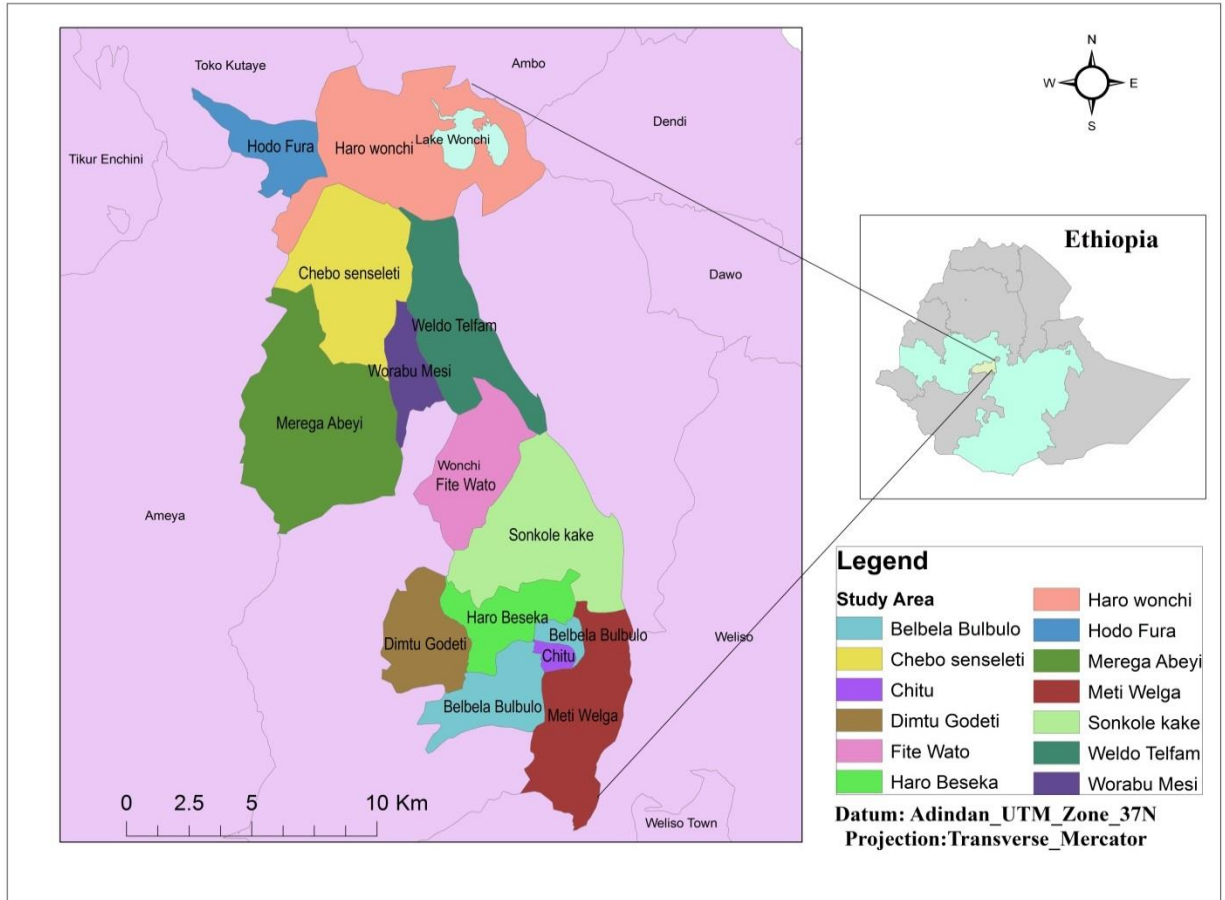


Figure 2 Map of Ethiopia showing the study area of ethnomedicinal plant in Wonchi District.

3.1.1. Climate of study area

The rainfall and temperature data collected from Woliso Giyon meteorological station indicated that the study area receives annual rainfall reaching up to 1142 mm in some peak years. The monthly mean maximum and mean minimum temperature of the area are 22.7 °C and 11.9 °C respectively. The mean annual temperature is 16.9 °C and with slight variation from year to year (Figure 3). The rainfall pattern shows low rainfall in December and February, gradually increasing to the peak period in July and then decreasing in November and December.

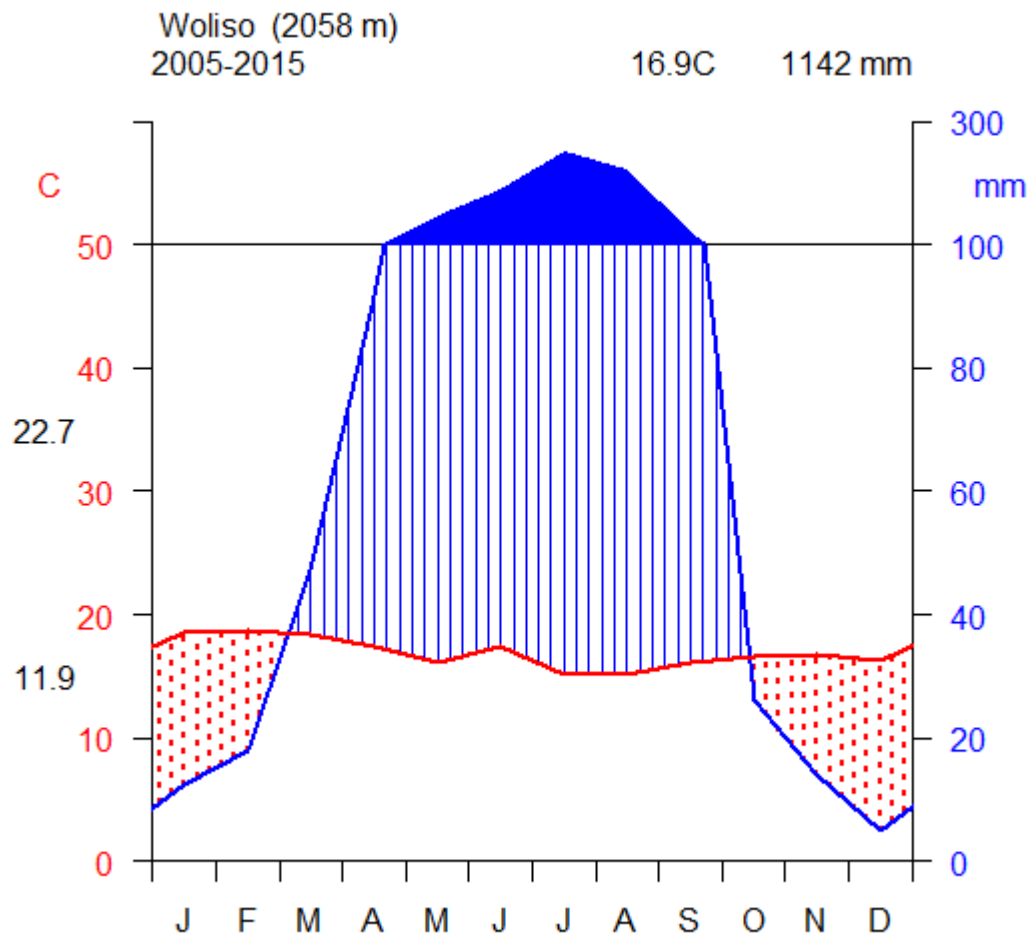


Figure 3 Clima Diagram showing the distribution of rain fall and temperature of the study area Data source: (ENMA, 2016).

3.1.2 Population, Education and Health care status

The Woreda has a population size of 119,736; from these, Males are 49% (56,059) and Females accounts for 51 % (63,677). The majority of the people live in the rural area while some live in town. The ethnicity of the Wonchi Woreda population is mainly Oromo and Afan Oromo is the first language for communication and office work.

Wonchi District has 38 first cycle primary schools and second cycle primary schools, 3 secondary schools and 2 preparatory schools, 1 TVET and 1 college. There are a total of 46 government schools with enrollment capacity of 29,000 students (WWEO, 2016).

The top ten human diseases in the study area are: Acute febrile illness, acute upper respiratory Pneumonia, Diarrhea (non-blood), Trauma (injury, fracture), Disease of the musculo skeletal system and connective tissue, Dyspepsia, Urinary tract infection, Diarrhea with blood (Dysentery) and other or unspecified infectious and parasitic diseases infection respectively. Wonchi District has six primary health care units' services for the surrounding population and one primary health care unit with 5 health stations for each primary health care (WWHO report, 2016).

3.1.3 Livestock and their common diseases

Wonchi District has 298,016 livestock population consisting of 114,312 cattle; 28,210 goats; 1,384 mule; 998 horses; 11,280 donkey; 57,612 sheep and 84,220 hens. There are problems like shortage of grazing and browsing land, adequate health services and facilities. The woreda has two central veterinary clinics and 5 health posts. As the woreda size and veterinary facilities do not match and unable to support this vast population of livestock, people try to treat their livestock with ethnoveterinary medicine.

The top ten livestock diseases in Wonchi Woreda include: Anthrax (Abbaa Sangaa), Black leg (Abbaa gorbaa), Pasteurellosis (Gororsaa), Rabies (Dhukkuba saree marattee) , Trypanosoma (Gandii), Newcastle disease (Dhibee Lukkuu) , Sheep and goat pox (Dhibee Hoolaa fi Re'ee), ectoparasite (ticks, mites and insect flies) and endoparasites (fascioliasis, Tape worm) according to Wonchi Woreda Livestock Office report (2016).

3.1.4 Geomorphology and Vegetation Type

The topography of the Woreda is characterized by two major agro climatic zones. The altitudinal range extends from 1700 upto 3387 m above sea level. Highlands (Baddaa) cover about 40% and the Midlands (Badda Daree) cover about 60%.

Table 1 Types of soils in Wonchi District

No	Soil types in Wonchi District	Local name	Percent
1	Red soil	Biyyee Diimaa	46
2	Verti soil	Biyyee Kooticha	11
3	Mixed soil	Biyyee Borbori	47

Source: (WWAO Report, 2016).

The district has diverse flora; the vegetation is dry ever green Afro-montane vegetation type (Tewoldeberhan G/Egziabher, 1998). Natural vegetation is mainly *Erica arborea* along the slopes and the indigenous forests are home to *Hagenia abyssinica*, *Juniperus procera*, *Schefflera abyssinica*, *Podocarpus falcatus* and *Erythrina brucei*.

3.1.5 Land use pattern

Land use pattern is usually the function of the type of the existing socio economic features and farming systems of the people dwelling in the study area. The land use that is dominantly utilized for crop production is the major means of livelihood of the people dwelling in the district. The amount used for cultivation is 27,817 hectares, 60,495 hectares for grazing, 4,634 hectares covered by forest and shrubs and 490 hectares covered by Water body (WWAO report, 2015).

3.1.6 Socio economy

3.1.6.1 Tourism

Ethiopia is well known with various sorts of historical, cultural as well as natural tourist attractions. However, much of these abundant resources are not utilized effectively for promotion of the tourist industry due to economic reasons, lack of experience and trained personnel in the sector. Oromia is one of the richest regions in the country with natural and man-made (Cultural and historical) tourist attractions. The region is endowed with a great deal of attractions which can be used and exploited for socioeconomic development of the people by development of tourism sector. Wonchi Crater Lake is one of the most visited due to the presence of Churkos Orthodox church monastery in the middle of the Crater Lake surrounded by water. The local societies benefited from the foreign visitors as well as from native people by providing boat, horse and other materials in exchange for cash.

3.1.6.2 Agriculture

Agriculture is the main stay for the majority of population in the project area and it provides the largest share for livelihood of the population. Mixed farming is a common practice in the area involving dominantly crop production and livestock rearing. The agro climatic condition of the area is very suitable for the production of cereals, pulses, and oil seeds. Thus, Teff, wheat, barley, maize and sorghum for cereals and field pea, house bean, Chick pea and lentil from pulse are the major types of crops produced. Enset is also widely cultivated in Wonchi District. The livestock husbandry is one of the dominant means of livelihood of the people in the study area. Wonchi District has the diversified

livestock population these include cattle, sheep, goat, horse, donkey and Bee rearing for honey production.

3.2 Materials used

The materials that were used for the data collection include Plant press, newspaper, Digital camera, and Global Positioning System (GPS)

3.3. Methods

3.3.1. Wetland Vegetation data collection

The reconnaissance survey of the study was conducted in September 23-24/2016. Floristic composition of the Wonchi Wetland was conducted from October to November 2016. The representative vegetation units of sampling site were selected in Wetland area found in Wonchi District. Plot sizes of 2 m x 2 m (4 m²) following Kent and Coker (1992) making a total of 80 plots were used for the study of floristic composition of wetlands. Plant species were recorded from the purposively (preferentially) established plot based on patch of Wetland vegetation.

The cover abundance data, defined here as the proportion of area in a plot covered by every species, gathered from each plot were later converted to cover abundance values using the modified 1-9 Braun-Blanquet scale (Van der Maarel, 1979).

Voucher specimens were collected, pressed, and dried for identification. Identification of all specimens was done by comparison with authentic specimens, illustrations and taxonomic keys from Flora of Ethiopia Addis Ababa University, in the National Herbarium (ETH).

Modified Braun -Blanquet scales

Value

Scales

1. Rare, generally one individual with less than 5% covered of the total plot area
2. Sporadic, with less than 5% of the cover total plot area
3. Abundant, with less than 5% of the cover plot total area
4. Very abundant, with less than 5% of the cover plot total area
5. 5-12% cover of the total plot area
6. 12-25% cover of the total plot area
7. 25-50% cover of the total plot area
8. 50-75% cover of the total plot area
9. 75-100% cover of the total plot area

3.3.2. Data analysis

The plant community analysis was performed using R software for windows version 3.2.2 for Agglomerative Hierarchical Cluster Analysis using SR (Version 3.2.2). The resulting groups were recognized as community types and the species occurrences were summarized by synoptic cover abundance values. Programs for ecological and environmental data analysis by Zerihun Woldu (2012) were employed. The community types were named based on the herbaceous plants that had high synoptic value. Community cluster analysis, Plant diversity index and evenness performed based on data of cover abundance.

Plant diversity analysis (H')

Shannon and Wiener (1949) index of species diversity was applied to quantify species diversity and richness. It is one of the most widely used methods in measuring the diversity of species and richness. The diversity and evenness were calculated Using Shannon diversity index (Kent and Coker, 1992).

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

Where: “H” is the Shannon and Wiener diversity index, Pi=the proportion of individuals or the abundance of species i the proportion of total cover in the sample and ln=natural logarithm

Evenness

Evenness or equitability is used to quantify the unique representation of a given species against a hypothetical community in which all species are equally common. The value of evenness index falls between 0 and 1. The higher the value of evenness index, the more even the species within the given area of distribution (Kent and Coker, 1992).

Evenness index was calculated using the formula:

$$J = \frac{H}{\ln(S)} \quad \text{Where } J = \text{evenness}$$

H' = Shannon-Wiener Diversity Index

S= total number of species in the sample

ln= natural logarithm

3.4 Ethnobotanical Data Collection

3.4.1 Site selection

For ethnobotanical data collection, the following thirteen Kebeles were selected. Haro Wonchi, Hodo Fura, Weldo Telfam, Sonkole Kake, Belbela Bulbulo, Meti Welga, Chitu, Dimtu Godeti, Fite Wato, Haro Beseka, Chebo Senselati, Meraga Abayi and Werabu Masi were purposively selected from among the 25 kebeles. By discussion with Woreda District kebeles were selected based on vegetation cover the presence of traditional healers and accessibility of road for transportation.

3.4.2 Informants selection

Respondents were contacted through kebele Administration and local elders in Afaan Oromo (Jaarsa Biyyaa). A total of 260 (104 Male and 156 Female) informants were selected from 13 kebeles (20 respondents =8 Male and 12 Female respondents per kebele) respondents (25 up to 90 years old). Out of these, 39 key informants were purposively selected based on recommendation from elders and local authorities (Development Agent and kebele administration leader). While other 221 Respondents were randomly selected. Key informants were first interviewed individually Afaan Oromo language to mention about the local names of the plants they use to treat diseases, diseases treated, part (s) of plants used, methods of gathering, methods of preparation, route of application, dosage, uses of the plants other than medicine and major threats to medicinal plants (Appendix 1). Group discussions were made with general respondents and some selected respondents asked for field walk for onsite observation of the medicinal plants.

3.4.3 Obtaining Informed Consent and Consideration of Ethical Issue

Good ethical consideration was very important in undertaking research ethical issue should be considered respecting elders, custom as well as participate what they are doing. When I am joining with them greeting, introduce my self Where and for what purposes I need them to ask their permission and if they are volenteers to answers my question. Studying of medicinal plants for the purpose of research further information generates from this study will give the information on medicinal plants of the Wonchi Districts. I promised for the respondents to keep the secrete and there is no risk resulting from their participation in this reaserch and I appreciated them for their interest to participate in the study.

3.5 Data collection techniques

Ethnobotanical plants of the Wonchi area were conducted from November to January 2017. The techniques employed for data collection were semi-structured interviews, group discussion, field observations or guided field walks with respondents was employed to obtain indigenous knowledge of the local people about plants, uses of plants, threats of medicinal plants and collected medicinal plant specimen (Martin (1995).

3.5.1 Semi-structured Interviews

Semi-structured interviews were prepared and used as guide (Appendix-1) following Martin (1995); Cotton (1996) and Cunningham (2001). Some questions were determined later and others arose during the course of the conversation. Both general information in the study area and ethnobotanical data focusing of medicinal plants were collected using the interview.

3.5.2 Observation and Market survey

Market surveys were made in two major markets in the Districts. These were Chitu and Haro. It was noted by Martin (1995) that an important part of building cooperation is respecting local peoples' need for confidentiality. Therefore, information was drawn carefully from the indigenous community of the study area with greater care and confidentiality. Multipurpose medicinal plants were observed during market surveys



Figure 4 Market Survey (Left and middle Chitu, Right in Haro)

[Photo courtesy by Getu Dida, 20/1/ 2017]

3.5.3 Group Discussions

According to Martin (1995), intuition and experience are the best guides to informal ways of gathering information. At the beginning in group discussion may not cover some issues not visibly linked to ethnobotany; important subjects were naturally arising as people begin to understand what interests the researcher. Group discussions with general informants were made during study time. There were five group discussion made with general Respondents and number of participants in group discussion in Belbela Bulbulo kebeles with 8 participants, Meti Welga kebeles 7 participants, Merega Abeyi 11 participants, Hodo Fura 5 participants and Haro Wonchi Kebeles 12 participates on this group discussion.



Figure 5 Group Discussion with general informants at Belbela Bulbulo kebele Station

[Photo courtesy by Getu Dida, 29/11/ 2017]

3.5.4 Guided Field Walk

Walking in the field with guides has played a vital role in order to take samples records, habits and other uses of medicinal plants mentioned. Traditional healers who walked with us during the guided field walk played a great role in plant identification and recalling parts used for medicinal purpose and the (vernacular) names and traditional uses of plants. Sample specimens were collected and recordings explaining about the medicinal plant were done. Voucher specimen collection was conducted in both the wild and home gardens of the study area.



Figure 6 Guided field walk (Left) Weldo Telfam kebele, (right) Haro Wonchi kebele Kemshashe area [Photo courtesy by Getu Dida, 2/12/ 2017]

3.5 Specimen Collection and Identification

At the end of the interview, sample specimens of the plants cited for their medicinal use were collected, numbered, pressed and dried for identification. Preliminary identification was done in the field by recording families to which, the plant specimens belonged. In addition, identification of unidentified specimens was done in February and March 2017, using Flora of Ethiopia and Eritrea and also by comparison with authentic specimens, illustrations and taxonomic keys in Addis Ababa University, National Herbarium. Voucher specimens with scientific names, vernacular names, families and collection numbers for all medicinal plants and other plants recorded from the study area, were deposited at the National Herbarium.

3.6. Data Analysis

3.6.1 Descriptive statistics

A descriptive statistical method such as percentage was employed using Microsoft Excel spreadsheet (MS EXCEL, 2010) to analyze and summarize the data on medicinal plants, use and associated knowledge. The most useful information gathered on medicinal plants reported by local people: medicinal value, application, methods of preparation, route of application, disease treated, and parts used and habit or form of medicinal plant was analyzed through descriptive statistics.

3.6.2 Informant Consensus

To evaluate the reliability of information during the interview, respondents were interviewed at least two times for the same ideas and the validity of the information was proved and recorded. Consequently, if the idea of the respondents differs from the original information, it was rejected since it is considered unreliable. Only the relevant ones were statistically analyzed. This method was adopted from Alexiades (1996).

The Informant Consensus Factor (ICF) was calculated for each category to identify the agreements of the informants on the reported cures for the group of ailments. The ICF was calculated as follows: number of use citations in each category (n_{ur}) minus the number of species used (n_t), divided by the number of use citations in each category minus one (Heinerich *et al.*, 1998). The factor provides a range of 0 to 1, where a high value acts as a good indicator for a high rate of informant consensus.

$$ICF = \frac{n_{ur} - n_t}{n_{ur} - 1}$$

Where: ICF is Informant Consensus Factor

n_{ur} is number of use citations

n_t is the number of species used

3.6.3 Preference Ranking

Preference ranking was conducted by using ten randomly selected key informants to rank five medicinal plants against febrile illness / **Mich**/ being given the highest (5=most effective) and the least (1=less effective) values to each medicinal plants species.

3.6.4 Paired comparison

Paired comparison can be used for evaluating the degree of preferences or levels of importance of certain selected plants/ parts of plants (Nemarundwe and Richards, 2002). A list of the pairs of selected items with all possible combinations was made and sequence of the pairs and the order within each pair was randomized before every pair was presented to selected informants and their responses recorded and total value was summarized. In this study, nine informants were to indicate the efficacy and popularity of five medicinal plant species used to treat stomach-ache and the rank was made based on the report of the respondents.

3.6.5 Direct matrix ranking

Direct matrix ranking was conducted in order to compare multipurpose medicinal plants commonly reported by respondents following Cotton (1996). Based on the relative benefits obtained from each plant, five multipurpose tree species were selected out of the total medicinal plants. Five key respondents were chosen to assign use values to each attribute (5 = best, 4 = very good, 3 = good, 2 = less used, 1 = least used and 0 = not used). The use-values include medicinal, construction, firewood, charcoal, bee forage, and furniture making. Based on information gathered from respondents, average values each species summed up and ranked.

CHAPTER FOUR

4. RESULTS

4.1. Species composition of wetland plants

A total of 50 species of herbaceous plants representing 45 genera and 23 families were recorded Appendix 2). The Families with the highest number of species (from highest to lowest) were Asteraceae with thirteen (26%) species, Poaceae with nine (18%) species and others are shown in the (Table 2).

Table 2: Family, genera and species of plants found in the wetlands of the study area

No	Family name	Number of Genera	% of total	Number of Species	% of total
1	Asteraceae	10	22.72	13	26
2	Poaceae	9	20.45	9	18
3	Acanthaceae	2	4.54	2	4
4	Polygonaceae	1	2.27	2	4
5	Primulaceae	2	4.54	2	4
6	Onagraceae	1	2.27	2	4
7	Gentianaceae	2	4.54	2	4
8	Cyperaceae	2	4.54	2	4
9	Adiantaceae	1	2.27	1	2
10	Fabaceae	1	2.27	1	2
11	Rosaceae	1	2.27	1	2
12	Ceratophyllaceae	1	2.27	1	2
13	Araceae	1	2.27	1	2
14	Commelinaceae	1	2.27	1	2
15	Solanaceae	1	2.27	1	2
16	Hypericaceae	1	2.27	1	2
17	Lythraceae	1	2.27	1	2
18	Lamiaceae	1	2.27	1	2
19	Apiaceae	1	2.27	1	2
20	Pteridaceae	1	2.27	1	2
21	Ranunculaceae	1	2.27	1	2
22	Typhaceae	1	2.27	1	2
23	Scrophulariaceae	1	2.27	1	2
Total	Families 23	44		50	

4.2. Endemic plant Species

A total of six endemic plant species were recorded from this study area representing 12% of the total species composition. The endemic plant species belong to the families Asteraceae, Poaceae, Primulaceae and Acanthaceae (Table 3),

Table 3 Endemic species of Wetland plants

Endemic Species	Families	Habits	Distribution in Ethiopia
<i>Cirsium schimperi</i> L.	Asteraceae	Herb	GD, SU, AR, BA
<i>Festuca macrophylla</i> Hochst. Ex A. Rich.	Poaceae	Herb	GD, SU
<i>Plectocephalus varians</i> (A. Rich.) C. Jeffrey ex Cufod.	Asteraceae	Herb	GD, GJ, SU, AR, WG, KF, GG, SD, BA, HA
<i>Primula verticillata</i> Forssk	Primulaceae	Herb	TU, GD , SU , HA
<i>Senecio ochrocarpus</i> Oliv. And Hiern	Asteraceae	Herb	GD, GJ, WU, SU, SD, BA, HA
<i>Thunbergia ruspolii</i> Lindau	Acanthaceae	Herb	SU, WG, IL, KF, GG, SD

4.3. Plant community types of the wetlands of the Wonchi District

Four community types were identified from floristic composition analysis of the wetland vegetation in the study area. Description of the identified four community types is given below.

1. *Schoenoplectus corymbosus* - *Hygrophila auriculata* community type

This community is distributed between altitudes 2871- 2875 m asl. The other dominant herbaceous plants found this community were *Rhynchospora corymbosus*, *Cyperus*

aterrimus, *Festuca macrophylla* and the less dominant *Cynodon dactylon*, *Acmella caulirhiza* and *Ranunculus multifidus*.

2. *Pericaria setosula* - *Typha latifolia* community type

This community type is distributed in the altitudinal range of 2875-2880 m asl. It was dominated by *Pericaria setosula*, *Typha latifolia* while *Veronica angallis-aquatica*, *Thunbergia ruspolii*, *Oenanthe palustris*, *Digitaria ternata*, *Mentha aquatica*, *Epilobium hirsutum* were the less dominant species in the area.

3. *Oenanthe palustris* - *Mentha aquatica* community type

This community was found at altitudes between 2882-2890 m and characterized by abundant species of *Oenanthe palustris*, *Digitaria ternata*, *Mentha aquatica*, *Epilobium hirsutum*, *Senecio lyratus*, *Cirsium schimperi* and, *Sphaeranthus suaveolens*. The less dominant species were *Sphaeranthus suaveolens*, *Ageratum conyzoides*, *Crassocephalum vitellinum*.

4. *Alchemilla pedata*- *Sphaeranthus suaveolens* community type

This community was found at altitudes between 2891-2900 m asl and relatively found at higher altitude. It was dominated by *Alchemilla pedata*, *Sphaeranthus suaveolens* and other minor wet land plant species.

Agglomerative Hierarchical Classification using SR

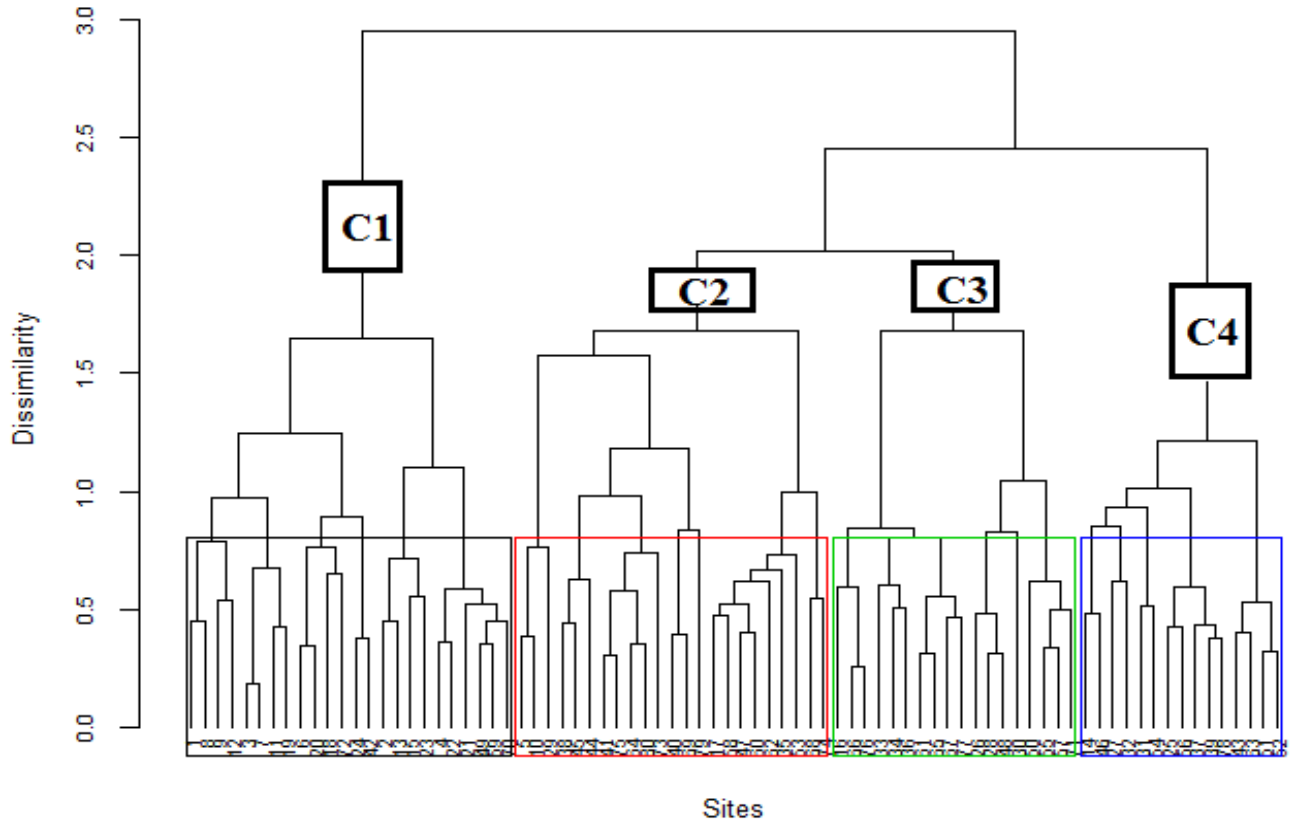


Figure 7: Dendrogram showing communities cluster analysis

Table 4 Community types and plots Arrangement along Dendrogram from left to right

Community type 1	Plots 1, 8, 9, 12, 3, 7, 11, 19, 6, 20, 18, 72, 24, 42, 2, 13, 15, 23, 4, 22, 21, 49, 69 and 70
Community type 2	Plots 5, 10, 29, 38, 45, 44, 41, 75, 64, 80, 73, 40, 69, 79, 17, 58, 47, 60, 62, 35, 53, 68 and 74
Community type 3	Plots 16, 66, 76, 33, 34, 36, 61, 65, 67, 77, 26, 28, 48, 30, 50, 55, 57, and 71
Community type 4	Plots 14, 46, 27, 32, 31, 64, 25, 56, 37, 39, 78, 43, 63, 63, 51 and 62

Synoptic cover abundance value for community types (value in bold shows characteristic species C1- community 1, C2- community 2, C3- community 3, and C4- community 4. Synoptic cover abundance values of species having a value of > 0.27 in at least one community type and values in bold refer to occurrences with higher synoptic values or the point at which species are confined to particular group of plot (Table 5).

Table 5: Synoptic cover abundance values for community types

Species	Community			
	C1	C2	C3	C4
<i>Schoenoplectus corymbosus</i>	5.17	0.26	0.53	0.38
<i>Rhynchospora corymbosa</i>	2.38	1.78	1.13	2.67
<i>Hygrophila auriculata</i>	2.75	0	0.26	0.17
<i>Cyperus atterimus</i>	1.08	0.47	0.2	0.16
<i>Cynodon dactylon</i>	0.71	0.13	0	0.11
<i>Festuca macrophylla</i>	0.37	0	0	0
<i>Persicaria setosula</i>	0.5	3.48	0.66	2.17
<i>Typha latifolia</i>	0.13	2.78	1.86	0.54
<i>Veronica angallis-aquatica</i>	0.54	1.04	0.6	2.77
<i>Thunbergia ruspolii</i>	0.37	0.78	0.4	0.16
<i>Oenanthe palustris</i>	0.16	0.17	6.2	0.22
<i>Digitaria ternate</i>	0.38	0.34	0.53	0.16
<i>Mentha aquatic</i>	0.25	0.35	0.73	0.11
<i>Epilobium hirsutum</i>	0.13	0.26	0.53	0.61
<i>Senecio lyratus</i>	0.12	0.13	0.66	0.27
<i>Cirsium schimperi</i>	0.62	0.86	0.86	0
<i>Alchemilla pedata</i>	0.12	0.17	1.4	4.22
<i>Sphaeranthus suaveolens</i>	0.25	0.43	0.2	0.50
<i>Ageratum conyzoides</i>	0.25	0.26	0.2	0.27
<i>Crassocephalum vitellinum</i>	0	0.26	0.2	0.16

4.4. Plant diversity analysis

Communities 1, 2 and 4 had the highest species richness while community 3 shown the least species richness. Community 2 had the highest species evenness and community 4 had the least species evenness, while the other two communities (communities 1 and 3) shown intermediate evenness (Table 6).

Table 6 Richness, diversity of the four community types identified in the study area

Community	Richness	Diversity index H'	Evenness
1	35	2.80	0.79
2	32	2.95	0.85
3	29	2.73	0.81
4	32	2.70	0.77

4.2 Ethnomedicinal plants

4.2.1 Local classification of agro climatic zones based on emic view

BADDAA /Highlands/ this agro- climatic zone was found between estimated altitude ranges of above 2500 m asl to 3387 m asl in the study area. Local elders characterized it as carrying relatively cool and dry climate with unimodal type of rainfall where rain fed agricultural production is the main economic activity. The major crop varieties in this zone were barley, wheat, peas, beans, potato and garlic where potato and garlic were the main commercial plant species in addition to home consumption.

BADDA DAREE/Midlands/ this agro-climatic zone is found between altitude ranges of 1700 m to 2500 m. It is characterized by relatively warm and dry climate with unimodal rainfall where both rain fed agriculture and some part is used for irrigation of fruit and vegetable includes production of cabbage, tomato, and potatoes were the main crop varieties of this agro-climatic zone were wheat, teff, beans, enset, maize, noug and linseed.

4.2.2 Indigenous knowledge on Soil classification

The local people of Wonchi District classify soil as ('Biyyee' in local Afan Oromo language) based on soil characteristics, colour of the soil and other criteria. The following soil types were identified by local people:

Biyyee Diimaa: This soil is red sandy soil type; it was reported as less fertile in comparison to the black soil. But, it was also mentioned for to grow crops of various types by applying fertilizer.

Biyyee Booralee: This type of soil is white soil which is unsuitable for crop production as well as for vegetation.

Biyyoo kotichaa: This soil type refers to black soil and with better fertility for crop production in comparison to other soil types. The people use this soil to grow crops like *Eragrostis tef*.

4.2.3 Land classification based on vegetation

Indigenous people of Wonchi district classify land based on the use of the land as agricultural land, grazing land, forestland and residential area.

Lafa qonnaa: - This is agricultural land that serves for cultivation of different crops.

Lafa bosanaa: - This is forest land where different plant species are found.

Miciree-Complex plant association of all growth forms where plants with dense shrubby growth habits from the base are dominating.

Lafa caffee: - This is marshland which is suitable for livestock grazing as well as some agricultural activities to take place.

Lafa dheedumsa horii: - open grazing land left by community for common livestock grazing

4.2.4 Vegetation classification based on indigenous knowledge

Bosanaa: it refers to forested lands composed of ranges of large trees.

Caffee: refers to herbaceous vegetation growing in wetlands or water logged areas in which some grasses, forbs and sedge species were more dominant in the area.

Daggala: refers to complex plant association in the wild, road side as well as for those plants grown in garbage area. The majority of plants observed in these areas are herbs and shrubs. According to informants the plants grown in this category have medicinal value

4.2.5 Socio-demography of Respondents

Respondents of the study area can be grouped by age from 29-49 and greater than 50 years old. Two hundred sixty Respondents were used for the study purposes. One hundred four (40%) were male and one hundred fifty-six were (60%) female participating in this study. Out of the 260 Respondents 116 (44.6%) of the Respondents are found between age 29-49, those with ages greater than 50 were 144 (55.4%) and much of the knowledge of the study area was obtained from this elder Respondents. Based on the educational status of the Respondents 180 (70%) were literate and 80 (30%) were illiterate (Table 7).

Table 7 Socio demography of Respondents (Sex, Age, Religion and Educational status)

Items	Category	Count	Percentage
Sex	Male	104	40
	Female	156	60
Age	29-50	116	44.6
	>50	144	55.4
Residence	Rural	246	94.6
	Town	14	5.38
Religion	Protestant	108	41.4
	Orthodox	152	58.4
Educational status	Illiterate	80	30.7
	4_1	65	25
	5_8	83	31.9
	9_12	35	13.45
Marital status	Married	180	69.2
	Divorced	45	17.3
	Widowed	25	13.46

4.2.5 Medicinal plants of the study area

In this study 68 plant species distributed into 62 genera and 34 families were recorded to have medicinal values. Of these, about (48, 70.6%), (14, 20.62%) and (6, 8.8%) were reported to treat only human, livestock ailments and both human and livestock ailments respectively. Family Lamiaceae was represented by the highest number of medicinal plants 9 species (13.23%), followed by Asteraceae 8 species (11.76%) (Table 8).

Table 8 Number of medicinal plant family, genera and species

No	Families	No. of genera	Genera in %	No. of plants Species	Species in %
1	Acanthaceae	3	4.83	3	4.41
2	Alliaceae	1	1.61	1	1.47
3	Araceae	1	1.61	1	1.47
4	Asteraceae	8	12.9	8	11.7
5	Apiaceae	1	1.61	1	1.47
6	Boraginaceae	1	1.61	1	1.47
7	Crassulaceae	1	1.61	1	1.47
8	Commelinaceae	1	1.61	1	1.47
9	Cucurbitaceae	2	3.22	2	2.94
10	Cupressaceae	2	3.22	2	2.94
11	Euphorbiaceae	2	3.22	2	2.94
12	Fabaceae	3	4.83	4	5.55
13	Flacourtiaceae	1	1.61	1	1.47
14	Lauraceae	1	1.61	1	1.47
15	Lamiaceae	8	12.90	9	13.23
16	Myrtaceae	1	1.61	2	2.94
17	Oleaceae	1	1.61	1	1.47
18	Oliniaceae	1	1.61	1	1.47
19	Poaceae	4	6.45	4	5.55
20	Plantaginaceae	1	1.61	1	1.47
21	Polygonaceae	1	1.61	2	2.94
22	Phytolaccaceae	1	1.61	1	1.47
23	Rhamnaceae	1	1.61	1	1.47
24	Rubiaceae	1	1.61	1	1.47
25	Rutaceae	3	4.83	4	5.55
26	Rosaceae	1	1.61	1	1.47
27	Scrophulariaceae	1	1.61	1	1.47
28	Simaroubaceae	1	1.61	1	1.47
29	Solanaceae	3	4.83	4	5.55
30	Urticaceae	1	1.61	1	1.47
31	Verbenaceae	1	1.61	1	1.47
32	Zingiberaceae	1	1.61	1	1.47
33	Chenopodiaceae	1	1.61	1	1.47
34	Ranunculaceae	1	1.61	1	1.47
	Total families 34	62	4.83	68	

4.2.6 Endemic plant species

Four endemic plant species were recorded from Ethnomedicinal plant study of the Wonchi District. The endemic species were found to represent families Lamiaceae, Verbenaceae, and Urticaceae were recorded (Table 9).

Table 9 Endemic species used for medicinal purpose in the study area

Species	Families	Habit	Distribution in Ethiopia
<i>Lippia adoensis</i> Hochst. ex Walp.	Verbenaceae	Herb	TU, GD, GJ, SU,AR, WG, AR, KF,GG
<i>Pycnostachys abyssinica</i> Fresen.	Lamiaceae	Shrub	IL, KF, GG, SD, WU, SU, AR, HA
<i>Thymus schimperi</i> Ronninger	Lamiaceae	Herb	TU, GD, WU, SU, AR, SD, BA, HA
<i>Urtica simensis</i> Steudel.	Urticaceae	Herb	TU, GD, GJ, SU, AR, BA, SD

4.2.7 Habitats of medicinal plants in the study area

Most of the plants were collected from the wild (22, 32.4%), followed by collections from home gardens 20 (29.4), Wetland area (12, 17.64%), crop field 9 (13.2%) and surrounding house 5 (7.3%) (Figure 8).

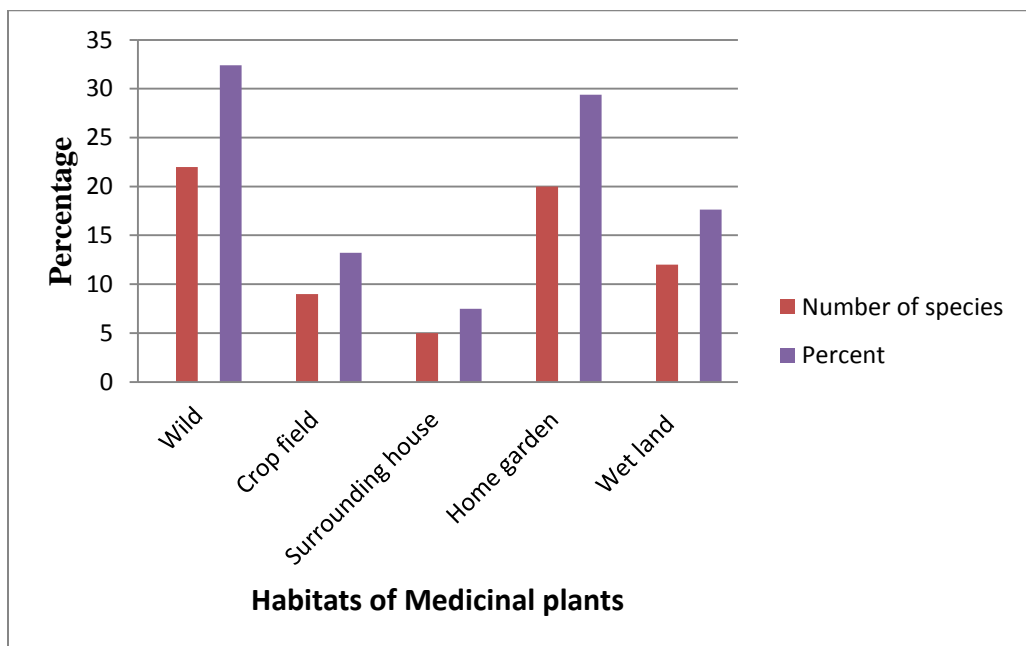


Figure 8: Habitats of medicinal plants in the study area

4.2. 8. Plant habit (growth forms)

Herbs were most frequently reported (37, 53.7%) species followed by shrubs (17, 25.4%) species, trees (12, 17.9%) and (2, 2.9%) climber (Figure .9).

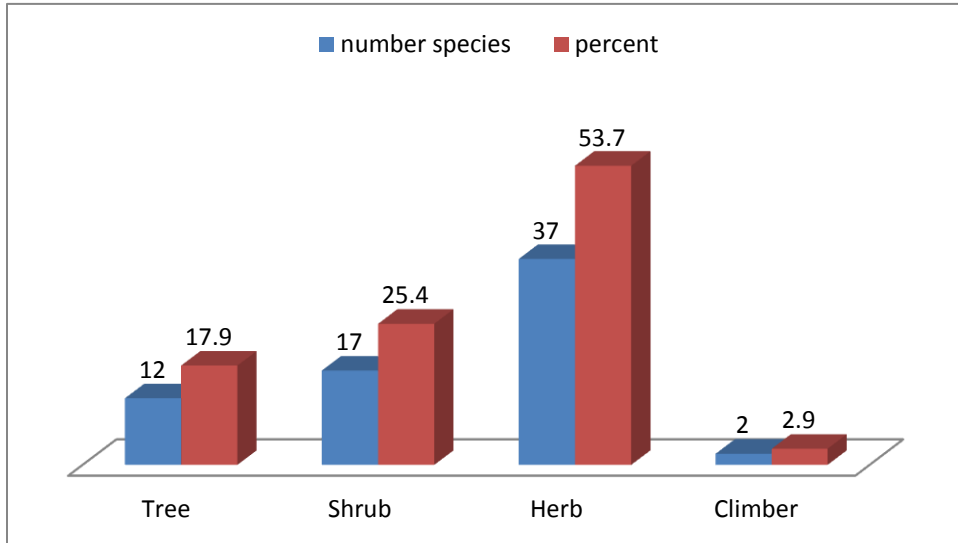


Figure 9: Habits of medicinal plants used for human and livestock

4.2.10 Parts of medicinal plants used

During the study different parts of medicinal plants were reported by respondents to be used for medicines. The most frequently utilized plant part was leaf with 45 (66.2%) followed by root that accounts for 12 (18%) as indicated in the (Figure 10).

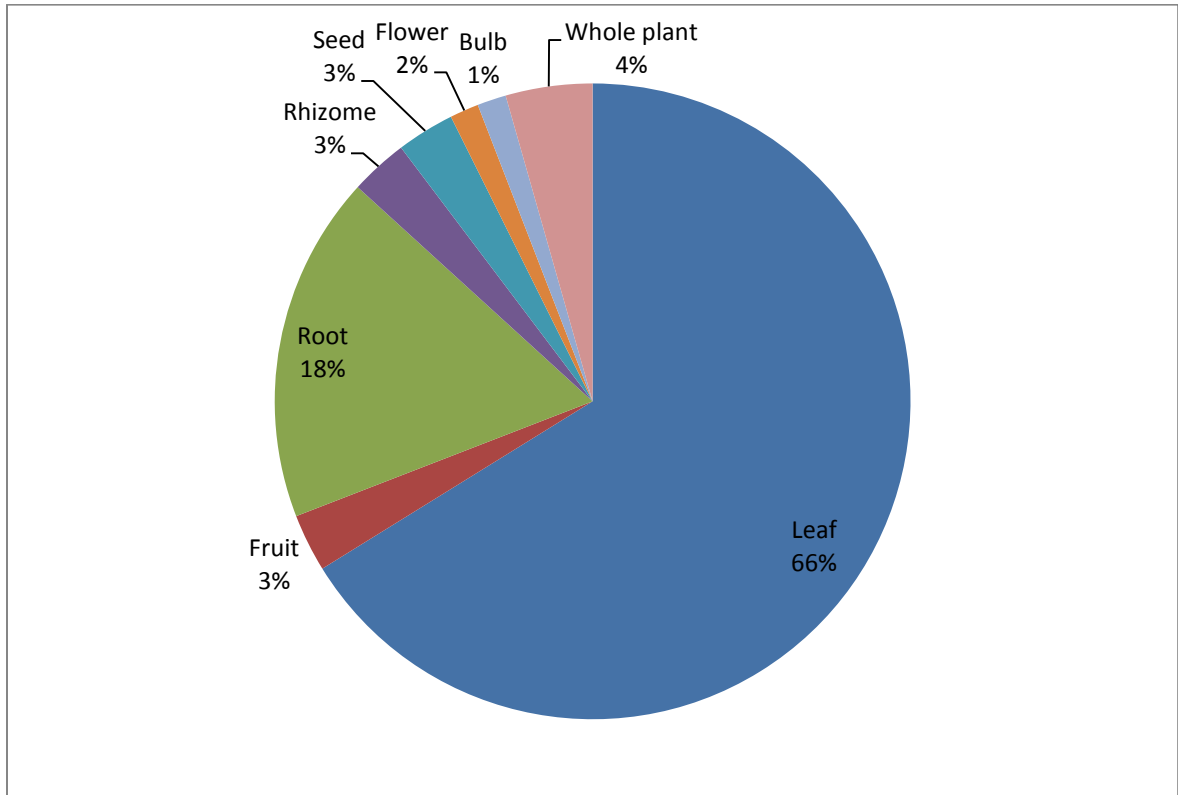


Figure 10 Parts of medicinal plants used

4.2.11 Method of preparation

People of the study area used various methods of preparation of traditional medicines for human and livestock ailments. The method of preparation depends on the types of disease treated. The major methods of preparation of medicinal plants were crushing (44.1%), pounding (36.7%), squeezing (8.9%), boiling (5.9), cooking (2.9%) and burning (1.5%) (Figure 11).

Indigenous people have Indigenous knowledge on the preparation of medicinal plants. Some of the traditional medicines had strong taste and bitter in order to reduce these they dilute them with honey, butter coffee, milk and salt. Taking this medicinal with these substances is important to minimize the bitter taste of medicine, improve taste and minimize the discomfort.

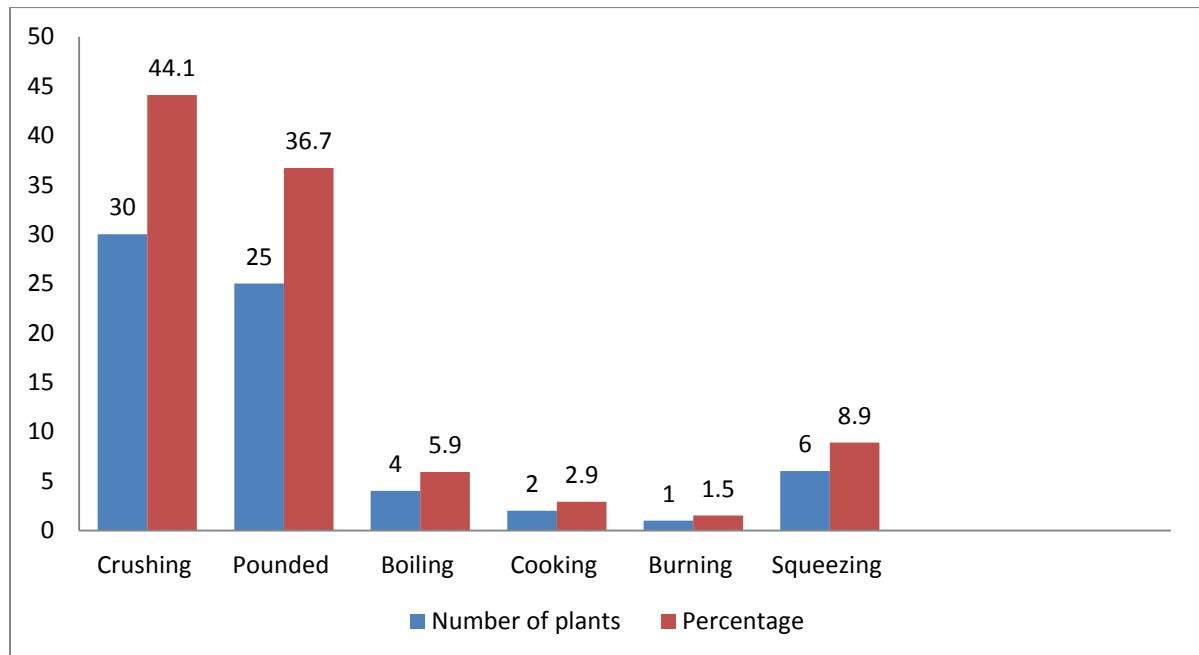


Figure 11 Method of Preparation of remedies

4.2.12. Route of administration of medicinal plants in the study area

The route of administration includes oral, dermal, nasal and optical. From the reported route of administration, the highest use was through oral (38, 55.9%), dermal (20, 29.4%) (Figure 12).

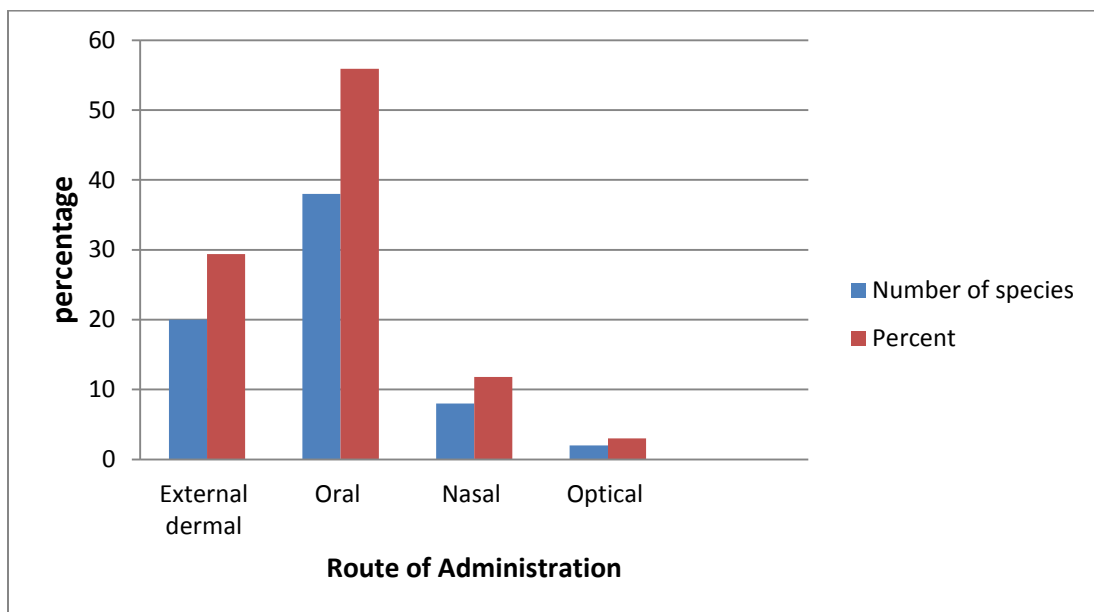


Figure 12: Route of Administration of medicinal plants

Dosage used

Traditional healer used different units of measurement used to measure the dosage of herbal traditional medicine. From these such as number of leaves and seeds, tea cup, meleka areke, coffee cup, glass, finger line and bottle half litre for cattle. Traditional healers give medicine by estimation and fix the dosage of medicine. This dosage based on age, physical fitness, stage of illness, pregnancy and the presence or absence of any disease other than the disease. The traditional healer recommended using antidotes for any adverse effect caused by some medicinal plants from these antidotes milk and red teff bread were used as antidote for rabbi's medicine were the common used antidotes.

Application of medicinal plants

The healers prepare medicinal plants in different ways and applied it in different method to the patients. There are two types of medicinal application in general. These are internal application of medicinal plants (drinking, chewing and swallowing) and external or dermal application of medicinal plants (painting, rubbing, bodycrame, and put on). The highest mode of application in medicinal plants reported from the area were taken internal or drinking (21, 29.4%), chewing (15, 19%) and dermal (18, 26.5%), body crame (8, 11.74%), put on (4, 5.9%) and rubbing (2, 2.9%). The finding shows that internal ailments were commonly treated by drinking and chewing, Skin infections used to treat method by using bodycrame, rubbing and painting on infected parts. Ailments like tape worm and internal disease were used through oral admisterated, Headache problem was used through nasal and smell, evil eye through oral admistration and smoking to patient. The application of medicinal plants applies through oral or internal was the dominant way of application of medicinal plants.

4.2.13. Preference ranking

Ocimum lamiifolium scored 44 and ranked first indicating that it is the most effective in treating febrile illness second by *Leonotis ocymifolia*, *Ruta chalepensis*, *Croton macrostachyus* and the least effective was *Eucalyptus globulus* (Table 10).

Table 10: Preference ranking of plants treating febrile illness

Medicinal plant species	Respondents coded (R1-R10)										Total	Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10		
<i>Croton macrostachyus</i>	3	2	3	1	2	3	5	1	3	3	26	4
<i>Leonotis ocymifolia</i>	4	5	2	2	4	1	1	4	5	2	30	2
<i>Ruta chalepensis</i>	2	1	4	3	3	5	2	2	1	5	28	3
<i>Ocimum lamiifolium</i>	5	4	5	4	5	4	4	5	4	4	44	1
<i>Eucalyptus globulus</i>	1	2	1	5	1	2	3	3	2	1	21	5

4.2.14. Paired Comparisons

A pair wise comparison was made among five medicinal plants. Nine key Respondents did the paired comparison of five medicinal plants and the value was summarized. *Ruta chalepensis* comes first for treating stomach-ache and *Ajuga integrifolia*, *Solanum incanum*, *Cymbopogon caesius* 2nd, 3rd, and 4th respectively. *Rumex nepalensis* was the least preferred species to treat the stomach-ache disease in the study area. This rank was because of the efficacy of the plant at least in the context of local people (Table 11).

Table 11: Paired Comparison of five medicinal plants reported against stomach-ache

Medicinal plants	Respondents coded (R1-R9)									Total	Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9		
<i>Ajuga integrifolia</i>	4	5	5	3	5	1	4	5	4	36	2
<i>Ruta chalepensis</i>	5	4	4	5	4	5	5	4	5	41	1
<i>Solanum incanum</i>	2	3	3	4	2	4	5	2	1	26	3
<i>Rumex nepalensis</i>	3	1	2	1	1	3	1	1	2	15	5
<i>Cymbopogon caesius</i>	1	2	1	2	3	2	2	3	3	19	4

4.2.15. Matrix Ranking

In the study area medicinal plants are used for various purposes such as medicinal, charcoal, construction, firewood, Bee forage, furniture making. To assess the relative importance and to check the major impact on such plants direct matrix ranking was preformed. In the area a number of medicinal plants were found to be multipurpose species being utilized for a variety of uses. Five commonly reported multipurpose species and six use-categories were involved in direct matrix ranking with five Respondents. Respondents evaluate their relative importance to the local people and use reports across the selected species were summed up and ranked.

Results of the direct matrix ranking showed that *Eucalyptus globulus* ranked first and hence it is the most preferred plant by local people for various uses. *Hagenia abyssinica* ranked second, *Croton macrostachyus* ranked as third, *Cordia africana* took fourth place and *Olea europaea* subsp *cuspidata* got the last fifth place (Table 12).

Table 12: Ranking of Multipurpose medicinal plants

Direct matrix ranking Mp-Medicine, Cons-Construction , FW-Fire wood , CH- Charcoal , FR-Furniture , BF- Bee forage RT-Total Respondants, R-Respondents

Use value	<i>Croton macrostachyus</i>					<i>Olea europaea</i> subsp <i>cuspidata</i>					<i>Hagenia abyssinica</i>					<i>Cordia africana</i>					<i>Eucalyptus globulus</i>					
	R					R					R					R					R					
R	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
MP	5	4	5	2	5	4	3	2	3	4	5	5	4	4	5	4	3	2	1	4	5	4	4	4	3	5
Cons	4	4	3	3	4	5	5	4	2	3	4	5	5	3	4	5	5	4	3	5	4	5	5	5	3	5
FW	3	4	2	3	5	5	4	5	1	5	4	3	3	2	4	4	3	4	1	5	5	5	5	4	2	5
BF	5	4	3	3	3	3	2	1	2	2	5	4	4	1	5	5	4	2	1	4	4	5	5	3	4	
CH	2	3	2	2	4	5	2	3	3	1	3	2	1	4	2	3	2	3	3	2	4	3	2	2	3	
FR	4	5	4	1	3	5	4	4	2	5	4	4	5	3	3	4	5	4	2	3	5	4	5	3	5	
RT	23	25	19	14	24	27	20	19	13	20	25	22	22	17	23	25	22	19	11	23	27	26	25	16	27	
GT	104					99					109					100					121					
R	3					5					2					4					1					

4.2.14. Informant consensus

Results showed that some medicinal plants were popular than others. In this study the highest informant consensus value was found for *Ocimum lamiifolium* which was cited by 56 respondents. The popularity of this medicinal plant was due to the preference of the species for treating febrile illness in the community for the disease and its easy access in the homegardens area. *Ruta chalepensis* was cited by 54 respondents for treating stomach-ache, *Acmella caulirhiza* was cited by 42 respondents for the treatment of tonsil, and *Rumex nepalensis* cited by 38 respondents for treating stomach-ache (Table 13).

Table 13: Informant consensus

No	Botanical name of Medicinal plants	Families	No. of Informants	Percent	Rank
1	<i>Ocimum lamiifolium</i> Hochst. ex Benth.	Lamiaceae	56	21.50	1st
2	<i>Ruta chalepensis</i> L.	Rutaceae	54	20.77	2nd
3	<i>Acmella caulirhiza</i> Del.	Asteraceae	42	16.20	3rd
4	<i>Rumex nepalensis</i> Spreng.	Polygonaceae	38	14.60	4th
5	<i>Allium sativum</i> L.	Aliaceae	36	13.80	5th
6	<i>Ajuga integrifolia</i> Buch,Ham	Lamiaceae	33	12.70	6th
7	<i>Premna schimperii</i> Engl.	Lamiaceae	32	12.30	7th
8	<i>Solanum incanum</i> L.	Solanaceae	30	11.54	8th
9	<i>Croton macrostachyus</i> Del.	Euphorbiaceae	27	10.40	9th
10	<i>Eucalyptus globulus</i> Labill.	Myrtaceae	25	9.60	10th
11	<i>Rhamnus prinoides</i> L.	Rhamnaceae	23	8.85	11th
12	<i>Cucumis ficifolius</i> A. Rich.	Cucurbitaceae	20	7.70	12th
13	<i>Leonotis ocyimifolia</i> (Burn.f) Iwarsson, var. ocyimifolia	Lamiaceae	19	7.30	13th
14	<i>Justicia schimperiana</i> (Hochst. ex Nees) T.Anders.	Acanthaceae	18	6.90	14th
15	<i>Hagenia abyssinica</i> (Brace) J.F.Gmel.	Rosaceae	17	6.50	15th
16	<i>Olea europaea</i> L. subsp Cuspidata (Wall. Ex G.Don) Cif.	Oleaceae	15	5.80	16th

4.2.15. Informant consensus factor for the given disease categories

Diseases in the study area were grouped in to different categories based on the conditions of the disease and treatment resemblance. The medicinal plants that were supposed to be effective in treating a certain disease had higher ICF values, which indicated that these diseases were more common than those with low ICF (Table 14).

Table 14: Informant consensus factor (ICF)

Categories	No. Species	Nur	ICF
Stomach ache , Gastritis	14	172	0.92
Head ache and Acute Febrile illness	6	106	0.95
Dermatological infection Wound, Swelling , Tumor, Dandruff, Body itching, stabbing , Roobbii	13	97	0.87
Internal and external parasites problems , Tape worm, Ascaries , Leeches, Blotting	7	75	0.91
Rabies, Diarrhea , Malaria, Horse disease, Black leg , Cattle cough	6	58	0.91
External injury and Poisoning problems Bleeding, Fire burn , Snake breath, Cataracts , Poison and Spider poison	8	81	0.90
Tooth ache, Tonsil, Evil eye , Cough	8	150	0.95
Internal disease problems, Blood pressure , Placenta and urine Retention and Gonorrhoea	6	60	0.92

The head ache and acute febrile, tooth ache, tonsil, evileye and cough scored the highest value (0.95) followed by stomach ache, internal disease problems; placenta and urine retention and Gonorrhoea that scored the second highest value (0.92). This indicates that informants used relatively few taxa to manage specific disease conditions as well as consistency in the use of plant species. Medicinal plants used to treat those ailments were more popular and effective to cure the ailments and the ailments were reported more common than the others in the area. Low value of ICF indicates that the informants disagree on taxa to be used in the treatment within a category of illness. In this study the lowest ICF value (0.87) scored for the category of diseases like wound, tumor, stabbing and swelling (Table 14).

4.2. 18 Marketability of medicinal plants

Medicinal plants in the study area were not sold in the market for particular purpose of medicine. But there were medicinal plant species that were reported mainly for the purposes of food, spice and firewood and construction. However, some medicinal plants include *Allium sativum*, *Rhamnus prinoides*, *Thymus schimperi*, *Carica papaya*, *Ruta chalepensis*, and *Zingiber officinale* traded in the market and others *Calpurnia aurea* and *Eucalyptus globulus* were used for fire wood and house construction.

4.2.19 Major threats to medicinal plants

Results from nine respondents (R1-R9) on priority ranking of six factors that are described as threats to medicinal plants areas based on their degree of destructiveness (1 = least destructive, 6= most destructive). This study identified six major threats to medicinal plants of the study area and based on the intensity of destructiveness in the area as reported by the Respondents. The result of priority ranking of threats to vegetation based on their destructiveness was done. The result of the present study show that agricultural expansion and deforestation were ranked 1st and 2nd factors respectively indicated in (Table 15).

Table 15 Major threats to medicinal plants

Threats	Key Respondents coded (R1-R9)										Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9	Total	
Deforestation	4	3	4	4	5	6	4	5	5	40	2nd
Agricultural expansion	5	6	4	6	4	5	6	5	5	46	1st
Fire wood collection	4	3	2	1	5	4	3	6	1	29	6th
Over grazing	6	4	5	3	2	1	5	3	6	35	3rd
Charcoal making	5	4	3	2	3	4	5	5	3	34	4th
Construction and furniture making	4	3	4	3	4	3	5	4	2	32	5th

CHAPTER FIVE

5. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

5.1.1 Vegetation composition of wetlands

Wetland ecosystems in total make less than 2% of Ethiopia's total land mass. However, some unpublished reports estimate the Wetland flora of Ethiopia at about 10 % of the total flora of Ethiopia (Haymanot & Bikila 2017, personal communication). In Wonchi district wetlands, a total of 50 plant species belonging to 45 genera and 23 families were identified. This confirms with the general notion of high plant biodiversity in wetland Ecosystems.

The plant families described for Wonchi district wetlands also conform to the general pattern discussed for wetlands in other wetland areas in Ethiopia. The finding agrees with Dikaso Unbushe (2013) describes that the majority of plant species in the Wetlands of Dabush swamp and other areas to comprise of Cyperaceae, Asteraceae, Onagraceae, Lamiaceae, Fabaceae, Hypericaceae, Poaceae, and Genitianeaceae. He found the highest number of species in Poaceae family while the finding of this current research shows the highest number species recorded in the family Asteraceae. Asteraceae is known to be the largest family throughout in the world and most species in Asteraceae family are also known to be herbaceous plants. Finding in this work showed that the collected plants are mostly herbs under the Asteraceae families, which is represented by thirteen plant species.

In terms of associations with other wetland communities within Ethiopia, the analyzed wetland has many species in common with the large wetlands in Omo, Dabus, Abaya and Kaffa wetlands in Ethiopia (Dixon, 2002). It is clear that many of the Ethiopian wetlands are dominated by Cyperaceae species and Wonchi wetlands also is dominated by Cyperaceae known as *chafe* in local Afan Oromo. Plant species collected from the study area belong to herbaceous growth form such as sedges, grasses and fern this result agrees with the findings of Dikaso Unbushe (2013) even though no shrub species were collected from this study area.

From 50 plant species recorded in the study area six were endemic. According to Flora of Ethiopia and Eritrea it includes endemic species *Cirsium schimperi*, *Festuca macrophylla*, *Plectocephalus varians*, *Primula verticillata*, *Thunbergia ruspolii* and *Senecio ochrocarpus*. These endemic species accounts for 12% of all plant species collected under this study. This indicates that area has the huge number of endemic species also adding the four endemic medicinal plants of the study areas and could be considered as an important habitat for conservation of endemic plant species. Some unpublished data show that there are about 32 endemic plant species in Ethiopian wetlands (Haymanot & Bikila 2017, personal communication) out of this Wonchi area has about 17% of them.

The four community types identified in this study were *Schoenoplectus corymbosus* - *Hygrophila auriculata* community types, *Persicaria setosula* - *Typha latifolia* community types, *Oenanthe palustris* - *Mentha aquatica* community types and *Alchemilla pedata*-*Sphaeranthus suaveolens* community types were recognized.

Dominant plant species identified from the study area include *Rhynchospora corymbosus*, *Cyperus aterrimus*, *Festuca macrophylla*, *Persicaria setosula*, *Typha latifolia*, *Veronica angallis-aquatica*, *Thunbergia ruspolii*, *Oenanthe palustris*, *Mentha aquatica*, *Digitaria ternata*, *Epilobium hirsutum*, *Senecio lyratus*, *Sphaeranthus suaveolens* dominant species found in the study area

The richness and evenness of species in the four different communities indicated that Communities 1 and 2 had the highest species richness while community 3 showed the least species richness. The reason why communities 1 and 2 have the highest species richness is that they are located in an undisturbed area. Community 3 with the lower species richness is due to overgrazing as it is found nearby settlement.

Relative abundance (evenness) from the four community types depicted that community 2 had the highest species evenness and community 4 has the least species evenness, while the other two communities (communities 1 and 3) had intermediate evenness. The communities showed some dynamics in species richness and evenness. The main causative agents for the dynamism of the communities were anthropogenic activities

Wetlands of the Wonchi District are highly disturbed due to disturbances including over grazing, farming and settlements surrounding the Wetland area. This can reduce plant species diversity by eradicating the species that were sensitive disturbance (Connell, 1978). Mitsch and Gosselink (1993) pointed out that the distribution and composition of the plant species is controlled primary by differential distribution of hydrologic regime. A change of evolution would result in changes in species composition, community and structure of vegetation result of greater fluctuation in hydrologic condition.

5.1.2 Medicinal plants

Respondents above 50 years old have much of knowledge obtained from these elder respondents. One hundred four (40%) were male and one hundred fifty-six were (60%) participated in this study. Out of the 260 respondents 116 (44.6%) of the respondents were found between age 29-49, above 50 years old ages were 144 (55.4%) much of the knowledge of the study area was obtained from these elder respondents. From 260 Respondents one hundred four were males and one hundred fifty-six were females. In comparison of educated status, non educated Respondents handled much knowledge of traditional medicine whereas educated Respondents had low knowledge of traditional medicine, which indicative of modern education. The transfer of knowledge of medicinal plants from generation to generation passed through orall.

A total of 68 medicinal plants belonging to 62 genera and 34 families were identified and documented in the study area during the study period. The families that have the highest number of medicinal plants were Lamiaceae followed by Asteraceae. This finding agrees with the research done in Fiche District, Central Ethiopia (Abiyu Enyehu *et al.*, 2014).

Four endemic plants were identified from the study area and these are *Lippia adoensis*, *Pycnostachys abyssinica*, *Thymus schimperi* and *Urtica simensis*. This endemic species *Lippia adoensis*, *Pycnostachys abyssinica* and *Urtica simensis*. These species were also reported by Zewdie Kasa (2009) ethnobotanical study of Jeldu Woreda.

In this study medicinal plants were reported to have been collected from the wild (32.4%), home gardens (29.4%), crop field (13.2%), surrounding house (7.3%) and wetland (18%). Tesfaye Awas and Zemedede Asfaw (1999) that reported about more

medicinal plants collected from medicinal plants are obtained from the wild vegetation on ethnobotanical study of the Berta people in western Ethiopia.

From the total collected medicinal plants 12 (18%) were recorded from wetland area these medicinal plants include. *Acmella caulirhiza*, *Ageratum conyzoides*, *Colocasia esculenta*, *Cyanotis barbata*, *Cynodon dactylon*, *Datura stramonium*, *Guizotia scabra*, *Hygrophila auriculata*, *Pennisetum sphacelatum*, *Plectranthus punctatus*, *Ranunculus multifidus* and *Thunbergia ruspolii* so that the wetlands serve as sources of medicinal plants for local communities.

Of the total 68 medicinal plants collected from the study area, 54% were herb species followed by 25.4 % shrub species, 18% tree species, and 3% climbers. This finding agrees medicinal plants recorded Ejaji area South wester Shewa Ethiopia (Endalew Amenu, 2007), Bale Menna Angetu (Ermias Lulekal, 2008), Boset area Debela Hunde (2004) in which herbs are the dominant growth form of medicinal plant.

During the study, different parts of medicinal plants were reported by informants to be used for medicines. The most frequently utilized plant part was leaf with 66.2% species followed by root which accoun for 17.6 %. The finding agrees with previous reports in Ethiopia have shown that leaves were the most commonly used and followed by roots to treat various health problems (Bayafers Tamene, 2000).

Roots were the most reported next to the leaf parts in the preparations of remedies. Such wide harvesting roots, which are important for the survival of plants has a negative influence on the survival and continuity of useful medicinal plants and hence affects sustainable utilization of the plants (Ahadu Ayehu and Dawit Abebe, 1993).

There are various methods of traditional medicinal plants preparation in the area. The most popular mode of preparation was in the form of crushed plant materials which accounts 44.1% followed by pounding 36.7% of pounding and squeezing (8.9%). This finding was in line with earlier results; in which crushing was the common type of preparation (Seyoum Getaneh, 2014). In the study area highest proportion of medicinal plants were prepared from fresh (85%) and followed by dry (15%). The report from the local people shows that people in the study area prefer fresh plant materials to dried ones for their high efficacy of curing the disease.

The identified routes of administration include oral, dermal, nasal and optical routes. From the reported routes of administration, the highest report was found for oral (55.9%) and dermal, (29.4%) application. This result agrees with similar studies in northern part of Ethiopia and Mena Angetu forest in Bale, (Dawit Abebe and Ahadu Ayehu, 1993; Tilahun Teklehaymanot and Mirutse Giday, 2007 and Ermias Lulekal, 2008). The dosage determination was the big problem in the study because there was no standized known unit of measurements of the plant remedies. How ever, the dosage was determined by glass, cup, finger line, meleke, were the identified means to treat human and livestock ailments in the study area.

Ten respondents were asked to compare the mentioned medicinal plants based on their efficacy of medicinal plant which the most effective in treating febrile illness. *Ocimum lamiifolium* scored 44 has ranked first indicating that it is the most effective in treating febrile illness (**Mich**) followed by *Leonotis ocymifolia*, *Ruta chalepensis*, *Croton macrostachyus* 3rd and 4th respectively while the *Eucalyptus globulus* was least effective.

In this study, medicinal plants that were identified by the respondents used for treating Stomach-ache disease patients used the traditional medicinal plants. A pair wise comparison was made among five of them. nine key respondents did the pair comparison of five medicinal plants and the value is summarized. Results of the pair wise comparison of five medicinal plants used for treating Stomach-ache showed that *Ruta chalepensis*, *Ajuga integrifolia*, *Solanum incanum*, *Cymbopogon caesius* and *Rumex nepalensis* were treating stomach-ache respectively. *Rumex nepalensis* was the least preferred species to treat the stomach-ache disease in the studies area. This rank is because of the efficacy of the plant at least in the context of local people.

In this study, a number of medicinal plants were found to be multipurpose species being utilized for different purposes. The common uses include medicine, firewood, building, furniture making, charcoal and bee forage. Five respondents ranked five commonly reported multipurpose species and six use-categories were involved in direct matrix ranking exercise in order to evaluate their relative importance to the local people related to their use values *Eucalyptus globulus* ranked 1st followed by *Hagenia abyssinica*, *Olea europaea* subsp *cuspidata*, *Cordia africana* and *Croton macrostachyus* ranked respectively.

The results showed that some medicinal plants were popular than others, in this study the highest informant consensus goes to *Ocimum lamiifolium* which was cited by 56 respondents. The popularity of this medicinal plant was due to the preference of the species for treating febrile illness in the community and its easy access at the home gardens. *Ruta chalepensis* was cited by 54 respondents for treating stomach-ache, *Acmella caulirhiza* was cited by 42 respondents for the treatment of tonsil, and *Rumex nepalensis* cited by respondents for treating stomach- ache. The medicinal plants that were supposed to be effective in treating a certain disease had higher ICF values, which indicated that these diseases were more common than those with lower ICF. Head ache and acute febrile, tooth ache, tonsil, evil eye and cough scored the highest value (0.95) followed by stomach ache, internal disease problem while the lower ICF value scored were recorded the category of diseases like wound, tumor and stabbing (0.87). The one commonly occur in the study area so that more number of people communicates on their remedies. According to Tilahun Teklehaymanot and Mirutse Giday (2007) medicinal plants that are presumed to be effective in treating a certain disease have higher ICF values. A high ICF value (values cloth to 1) indicates that the respondents rely most on the same taxa to manage specific disease condition, while low values of ICF indicates that the informants disagree on the taxa to be used in the treatment of a given ailment.

Medicinal plants in the study area were not sold in the market for particular purpose of medicine. But there were medicinal plant species that mainly serve for the p`urposes of food, spice firewood and charcoal. However, some medicinal plants including *Allium sativum*, *Rhamnus prinoides*, *Thymus schimperi*, *Carica papaya*, *Ruta chalepensis*, and

Zingiber officinale some were widely traded in the market and others *Calpurnia aurea*, *Eucalyptus globulus* were used for fire wood, charcoal and for house construction.

As population growth are increasing medicinal plants went under threat dueto destruction of their habitats. The result of the present study showed that agricultural expansion, deforestation ovar grazing was ranked the reported threats not only to medicinal plants but often plants of the Wonchi District as whole factors respectively. In this study information gathered from the key Respondents was indicted that the threats of medicinal agricultural expansion were the major medicinal plants treats followed by deforestation. The finding was in line with other finding (Mirutse Giday, 2001). Similar to other places in Ethiopia, people living in Wonchi District have traditional practices which they have accumulated for generations to treat both human and livestock ailments. How ever there are no written documents on traditional uses of medicinal plants. People in in the Wonchi District use medicinal plants for primary health care system

5.2. Conclusions

The study has resulted in documentation of 50 plant species representing 45 genera and 23 families. The Families with the highest number of species were Asteraceae followed by Poaceae. Six endemic species were recorded from the wetlands of the study area *Cirsium schimperi*, *Festuca macrophylla*, *Plectocephalus varians*, *Primula verticillata*, *Senecio ochrocarpus* and *Thunbergia ruspolii*.

The four community types identified *Schoenoplectus corymbosus* - *Hygrophila auriculata* community type, *Persicaria setosula* - *Typha latifolia* community type, *Oenanthe palustris* *Mentha aquatica* community and *Alchemilla pedata*- *Sphaeranthus suaveolens* community type.

Most of the medicinal plants were collected from the wild followed by home gardens. From the total of medicinal plants collected 12 (18%) species of medicinal plants found in Wetland area. Habits of medicinal plants reported as herbs were the widely use in preparation of remedies. From the study area 34 different ailments were reported by Respondents as human and livestock ailments. From these 70.6% treats human ailments, 20.6% treats livestock ailments and both for human and livestock ailment. The most common disease identified in the study area acute febrile, head ache, Diarrhea, Toothache, Tonsil, Black leg, Horse disease and Rabies. This indicates that the medicinal plants there in Wonchi District play greater role in primary health care delivery.

Like in the other parts of Ethiopia in the 13 kebeles of the Wonchi District medicinal plants were threatened by different factors including agriculture expansion, deforestation, over grazing, Fire collection and charcoal making.

The most important factors influencing the plant species composition of wetland plants were anthropogenic impacts followed by high population density of the district.

5.3. Recommendations

The present study contributes towards the understanding of herbaceous plant species diversity and composition and this has considerable contribution in understanding wetland plants, and their conservation status for sustainable use.

There is a strong need in raising awareness among the local communities and Administrators on the value of wetland resource and ecological consequences of the Wetland degradation.

Wetlands are used mostly as area of intensive grazing during dry seasons. Due to overgrazing, these wetlands are being degraded at an alarming rate. Therefore, there is a strong need for a management system where by wetland biomass can be harvested during dry seasons and used as a feed stock by the community instead of dispatching herds to graze in wetland habitats. This would reduce degradation of wetland ecosystems while it also helps the community to use the resource of wetland areas on sustainable manner.

There is an urgent need for awareness raising among the local people and local administrators with respect to the threats to local plant resources since gathering wild plants different purposes at this time is done with no consideration of their threats.

Government and non governmental organization should partner with the local community to enhance insitu conservation of medicinal plants.

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Appendices

Appendix 1: Checklist of Semi-structured interview items for collecting ethnobotanical data

I. General Information

1. Date: _____ Residence Area/village/ _____ kebele _____
2. Name of respondent _____ Sex _____ Age _____
 - 2.1. Marital status _____ Occupation/main job/ _____
 - 2.2. Religion: Orthodox _____ Protestant _____ Muslim.

Others _____
 - 2.3 Educational background illiterate, literate and grade attended?
 - 2.4. List the traditional way of classifying forests/vegetation/ and landscapes in your area?
 - Vegetation _____
 - Landscapes _____
 - Soil _____
 - 2.5 What are the most common diseases of humans in your area?
 - 2.6 What are the most common diseases of livestock in your area?
 - 2.7 What are the most common diseases of both humans and livestock in your area?
 - 2.8 List the signs and symptoms of a given diseases in your area?
 - 2.9 How do people prevent and control a given disease in your area?

II. Ethnobotanical Data

3. Mention plant types used to treat diseases in the study area?
 - 3.1 Plants used to treat human diseases?
 - 3.2 Plants used to treat livestock diseases?
 - 3.3 Plants used to treat both human and animal diseases?

No	Disease treated	Local Name	Plants	Parts used	Hab.	Habitat	Prep	Route of adm	Dose	Side effect	Anti dote	Other uses

4. Where are these plants obtained?
 - 4.1 In the wild?
 - 4.2 In home gardens?
 - 4.3. Crop field or Farm area, surrounding house, Wetland area?
5. What are the most common habitats of medicinal plant Mentioned?
6. What part of medicinal plant is used? Leaf, Root, Stem, Flower, Fruit, Seed, Whole plant?
7. What is the method/condition of preparation of the medicinal plant? Crushed, Powdered, Pounding, used alone, mixed with others Fresh, Dry, Fresh or Dry?
8. Dosage: Does it vary among age groups, sex? If yes, state for each?
9. Write the way of administration: External/dermal, oral, nasal, optical?
10. Any taboo/ restrictions in plant collections?
11. Any restrictions in taking remedies (pregnancy, age, etc.)?
12. Do you store the medicine? If yes, how and for how long
14. Are there medicinal plants easily accessible?
13. Is the medicinal plant marketable?
14. How does modernization interfere with traditional medicine?
15. Are community members who frequently depend more on medicinal plants than modern medicine? Why?
16. How does the knowledge transfer from the elders to younger generation?
17. What are the major threats to medicinal plants?
18. How do you conserve medicinal plants?
19. For what other purposes do you use the medicinal plants? Beside its medicinal values.

Thank you Very much!

Name of collector _____ Date _____

Appendix 2: List of Wetland plants scientific name, families and their habit

No	Scientific name	Families	Local name	Habit	Code No
1	<i>Acmella caulirhiza</i> Del.	Asteraceae	Gororsa	Herb	GD 03
2	<i>Adiantum capillus veneris</i> L.	Adiantaceae		Herb	GD 09
3	<i>Aeschynomene abyssinica</i> (A.Rich) Vatke	Fabaceae		Herb	GD 017
4	<i>Ageratum conyzoides</i> L.	Asteraceae		Herb	GD 036
5	<i>Alchemilla pedata</i> A. Rich.	Rosaceae		Herb	GD 06
6	<i>Andropogon abyssinicus</i> Fresen.	Poaceae	Marga	Herb	GD 010
7	<i>Ceratophyllum demersum</i> L.	Ceratophyllaceae	Saphaphu bishaani	Herb	GD 030
8	<i>Cirsium schimperi</i> L.*	Asteraceae		Herb	GD 041
9	<i>Cirsium vulgare</i> (Savi) Ten	Asteraceae	Qoree harree	Herb	GD 024
10	<i>Colocasia esculenta</i> (L.) Schott.	Araceae	Godarree	Herb	GD 015
11	<i>Crassocephalum vitellinum</i> auct., non (Benth) S. Moore	Asteraceae		Herb	GD 033
12	<i>Cyanotis barbata</i> D. Don	Commelinaceae		Herb	GD 029
13	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Coqorsa	Herb	GD 08
14	<i>Cyperus aterrimus</i> Steud.	Cyperaceae	Kunnii	Herb	GD 05
15	<i>Datura stramonium</i> L.	Solanaceae	Asangira	Herb	GD 037
16	<i>Digitaria dentata</i> (A. Rich.) Stapf	Poaceae	Ballamii	Herb	GD 021
17	<i>Epilobium hirsutum</i> L.	Onagraceae	Muka Mixii	Herb	GD 026
18	<i>Epilobium stereophyllum</i> Fresen.	Onagraceae		Herb	GD 031
19	<i>Eragrostis paniciformis</i> (A. Br.) Steud	Poaceae		Herb	GD 042
20	<i>Festuca macrophylla</i> Hochst. ex A. Rich. *	Poaceae	Leensa	Herb	GD 043
21	<i>Guizotia scabra</i> (Vis.) Chiov.	Asteraceae	Tufo	Herb	GD 020
22	<i>Helichrysum formosissimum</i> Sch. Bip. ex A. Rich	Asteraceae		Herb	GD 013
23	<i>Helichrysum splendidum</i> (Thunb.) Less.	Asteraceae		Herb	GD 011
24	<i>Hygrophila auriculata</i> (Schumach.) Heine	Acanthaceae	Arraba dubarti	Herb	GD 01
25	<i>Hypericum peplidifolium</i> A. Rich.	Hypericaceae		Herb	GD 50
26	<i>Lysimachia ruhmeriana</i> Vatke	Primulaceae		Herb	GD 04
27	<i>Lythrum rotundifolium</i> A. Rich.	Lythraceae		Herb	GD 019
28	<i>Mentha aquatica</i> L.	Lamiaceae	Qoricha laga	Herb	GD 028
29	<i>Micractis bojeri</i> DC.	Asteraceae			
30	<i>Oenanthe palustris</i> (Chiov.) Norman	Apiaceae	hori ajessa	Herb	GD 019
31	<i>Pennisetum sphacelatum</i> (Nees) Th. Dur. and Schinz	Poaceae	Migira	Herb	GD 023
31	<i>Persicaria amphibia</i> (L.) S.F Gray.	Polygonaceae		Herb	GD 047
32	<i>Persicaria setosula</i> (A. Rich.) K.L. Wilson	Polygonaceae		Herb	GD 034
33	<i>Plectocephalus varians</i> (A. Rich.) C. Jeffrey ex Cufod. *	Asteraceae		Herb	GD 012

34	<i>Plectranthus punctatus</i> (L.f.) L 'He'r.	Asteraceae		Herb	GD 016
35	<i>Polypogon schimperianus</i> (Hochst. Ex Steud.) Cope	Poaceae		Herb	GD 040
36	<i>Primula verticillata</i> Forssk *	Pteridaceae			
37	<i>Pteris dentata</i> Forssk	Primulaceae		Herb	GD 048
38	<i>Ranunculus multifidus</i> Forssk .	Ranunculaceae	Gashuwe	Herb	GD 038
39	<i>Rhynchospora corymbosa</i> (L.) Britt.	Cyperaceae	Abarsar	Herb	GD 045
40	<i>Sphaeranthus suaveolens</i> (Forssk.) DC.	Asteraceae	Kurkudiyiye	Herb	GD 02
41	<i>Schoenoplectus corymbosus</i> (Roem.and Schult.)	Cyperaceae	ketema	Herb	GD 044
42	<i>Sebaea brachyphylla</i> Griseb.	Gentianaceae		Herb	GD 046
43	<i>Senecio lyratus</i> Forssk.	Asteraceae		Herb	GD 014
44	<i>Senecio ochrocarpus</i> Oliv. and Hiern *	Asteraceae		Herb	GD 035
45	<i>Setaria incrassate</i> (Hochst.) Hack	Poaceae	Gosa migira	Herb	GD 039
46	<i>Sporobolus africanus</i> (Poir.) Robyns and Tournay	Poaceae	Xaafii ala	Herb	GD 07
47	<i>Swertia kilimandscharica</i> Engl.	Gentianaceae		Herb	GD 025
48	<i>Thunbergia ruspolii</i> Lindau *	Acanthaceae		Herb	GD 022
49	<i>Typha latifolia</i> L.	Typhaceae	Gedebirri/ Dhumugi	Herb	GD 018
50	<i>Veronica angallis-aquatica</i> L.	Scrophulariaceae		Herb	GD 032

NB: * Indicates the Endemic species

Appendix 3 Location of sample plots

Plots	Latitudes (N)	Longitude (E)	Altitude
1	38°2'721"	9°49'749"	2098
2	38°2'721"	9°49'754"	2098
3	38°2'722"	9°49'765"	2096
4	38°2'725"	9°49'776"	2097
5	38°2'731"	9°49'790"	2098
6	38°2'750"	9°49'734"	2094
7	38°3'626"	9°47'318"	2094
8	38°3'666"	9°47'243"	2048
9	38°3'573"	9°47'342"	2054
10	38°3'554"	9°47'371"	2053
11	38°3'633"	9°47'434"	2052
12	38°3'368"	9°47'820"	2069
13	38°3'366"	9°47'833"	2070
14	38°3'365"	9°47'863"	2068
15	38°3'370"	9°47'895"	2069
16	38°3'378"	9°47'928"	2066
17	38°3'380"	9°47'919"	2065
18	38°3'373"	9°48'073"	2069
19	38°3'371"	9°48'807"	2070
20	38°3'382"	9°48'203"	2070
21	38°3'394"	9°48'247"	2071
22	38°3'425"	9°48'364"	2077
23	38°3'334"	9°48'407"	2079
24	37°8'222"	9°69'963"	2808
25	37°8'230"	9°69'971"	2810
26	37°8'252"	9°70'008"	2810
27	37°8'302"	9°69'985"	2811
28	37°8'527"	9°70'095"	2815
29	37°8'527"	9°70'108"	2811
30	37°8'543"	9°70'117"	2809
31	37°8'554"	9°70'105"	2806
32	37°8'560"	9°70'099"	2813
33	37°8'621"	9°70'195"	2811
34	37°8'179"	9°72'768"	2880
35	37°8'157"	9°72'814"	2879
36	37°8'087"	9°72'804"	2880
37	37°8'062"	9°77'800"	2879
38	37°7'714"	9°72'700"	2879
39	37°7'790"	9°73'180"	2865
40	37°8'364"	9°73'260"	2892
41	37°8'646"	9°73'616"	2888
42	37°8'671"	9°73'522"	2887
43	8°80'285"	37°80'819"	2871
44	8°80'280"	37°88'947"	2875
45	8°80'292"	37°53'385"	2877

Appendix 3 ...

Plot	Latitude (N)	Longitude (E)	Altitude
46	8°48'147"	37°53'394"	2880
47	8°48'174"	37°53'447"	2881
48	8°48'190"	37°53'453"	2879
49	8°4 8'184"	37°53'501"	2880
50	8°48'204"	37°53'505"	2878
51	8°48'204"	37°53'505"	2881
52	8°48'211"	37°53'507"	2881
53	8°48'218"	37°53'533"	2872
54	8°48'225"	37°53'550"	2867
55	8°48'216"	37°53'561"	2872
56	8°48'261"	37°53'361"	2872
57	8°48'292"	37°53'589"	2878
58	8°48'338"	37°53'634"	2874
59	8°48'316"	37°53'638"	2877
60	8°48'322"	37°53'647"	2877
61	8°48'323"	37°53'700"	2878
62	8°48'314"	37°53'737"	2879
63	8°48'327"	37°53'768"	2878
64	8°48'329"	37°53'701"	2879
65	8°48'370"	37°53'790"	2873
66	8°48'390"	37°53'800"	2874
67	8°48'381"	37°53'806"	2881
68	8°48'351"	37°53'833"	2878
69	8°48'352"	37°53'833"	2878
70	8°48'348"	37°53'971"	2871
71	8°48'329"	37°53'975"	2872
72	8°48'303"	37°54'034"	2875
73	8° 48'335"	37°54'102"	2874
74	8°48'324"	37°54'121"	2872
75	8°48'305"	37°54'154"	2879
76	8°48'303"	37°54'156"	2876
77	8°48'264"	37°54'223"	2876
78	8°48'240"	37°54'260"	2872
79	8°48'242"	37°54'262"	2872
80	8°48'182"	37°54'264"	2871

Appendix-4 Lists of medicinal plants records in Wonchi District

key : T-Tree, S-Shrub, H-Herb, HBT-Habit, PU -Part Used, UT -used to treat, RA-Route of administration , L- Leaf, Br- Bark
F- Fresh, D-Dry, Ex-External/Dermal, O-Oral, Na-Nasal, Bn-Burn, Op-Optical, CP-Condition of preparation, Fr- Fruit

SN	Scientific name /Family/ Local name	HBT	PU	UT	CP	RA	Disease treated	Preparation and Application	Code.No
1	<i>Acacia abyssinica</i> Hochst. Ex Benth.	T	L	B	F	Ex	Snake breath	Fresh leaf is chewed with <i>Cynodon dactylon</i> spray on the body	GD 0035
	Fabaceae								
	Laaftoo								
2	<i>Acmella caulirhiza</i> Del.	H	L	Hu	F	O	Tonsilitis	The flower part is chewed and swallowed	GD 006
	Asteraceae						Toothache	Leaf chewed and put under tooth	
	Gororsa								
3	<i>Ageratum Conyzoides</i> L.	H	L	Hu	F	Ex	Blood clotting	Fresh leaf crushed and put on it	GD 0057
	Asteraceae								
	Qoricha michii								
4	<i>Ajuga integrifolia</i> Buch,Ham	H	L	Hu	F	O/Na/Ex	Stomach ache	Fresh leaf <i>A.integrifolia</i> are pounded with that <i>Vernonia amygdalina</i> is drunk	GD 002
	Lamiaceae						Mitch /Fever		
	Harma guusa/ Gondii						Gonorrhoea	Leaf of <i>A. integrifolia</i> and <i>Juniperus procera</i> pounded together drink one spon	
5	<i>Allium sativum</i> L.	H	Bu	Hu	F	O	Malaria	Bulb is pounded make soup and drunk	GD 0039
	Alliaceae						Stomach ache	Bulb is eaten or drunk as soup	
	Qullubbii Adii						Cough	Bulb is pounded with <i>Zingiber officinale</i> boiling is drunk	
							Blotting	Bulb is pounded with seed of <i>Ricinus communis</i> is givn to cattle	
							Evil Eye	<i>Allium sativum</i> , <i>Carissa edulis</i> and <i>Ruta chalepensis</i> pounded together dry smoked to patient	

NB: * Indicates the Endemic species

6	<i>Artemisia abyssinica</i> Sch. Bi. ex A. Rich.	H	L	Hu	F	O	Gastritis	Squeezed and drunk one tea cup	GD 0012
	Asteraceae						Used to clean eye	Leaf of <i>Artemisia abyssinica</i> is used to clean the eye	
	Caancee								
7	<i>Arundinaria alpina</i> K. Schum	H	L	Hu	D	Ex	Spider poison	Dry leaf of <i>A.alpina</i> burn ash mixed with butter used on it	GD 0061
	Poaceae								
	Shimela or Leemmee								
8	<i>Brucea antidysenterica</i> J.F.Mill.	Sh	L	Hu	F	O	Stomach ache	Leaf and seeds are crushed together decanted the liquid and drunk with honey	GD 0033
	Simaroubaceae						Diarrhea	leaf <i>B. antidysenterica</i> crushed and taken orally	
	Qomanyoo						Ticks	Red fruit of <i>B. antidysenterica</i> pounded painted on the area of affected cattle	
9	<i>Calpurnia aurea</i> (Ait.) Benth.	Sh	L	Hu	F	Na	Nose bleeding	Squeezed leaf on hand put in nose	GD 0032
	Fabaceae	Sh	L	Hu	F	O	Diarrhea	Fresh leaf <i>C.aurea</i> and root of <i>plantago lanceolata</i> pounded together liquid drunk with honey	
	Ceekaa			Ls	F	O	Leeches	Leaves and seed crushed togher spray external part and gives orally	
				Ls			Horse Disease	Leaf <i>C.aurea</i> and <i>Justicia shimperiana</i> pounded gives through left nose and ear	
				Ls		O	Rabies	Leaf of <i>C.aurea</i> and <i>Justicia shimperiana</i> pounded together given for cattle Orally	
10	<i>Citrus medica</i> L.	T	fr	Hu	F	O	Stabbing pain	<i>C. medica</i> Cooked and drunk the sap	GD 0067
	Rutaceae								
	Turungoo								
11	<i>Citrus sinensis</i> (L.) Osb.		L	Ls	F	O/E	Wound body	Leaf <i>C.sinensis</i> , <i>Citrus medica</i> pounded together	GD 0056
	Rutaceae								
	Burtukaana								
12	<i>Cymbopogon caesius</i> (Hook. And Arn.) Stapf	H	W	Hu	F	O	Stomach-ache	<i>C. caesius</i> , leaf of <i>Croton macrostachyus</i> , <i>Ruta chalepensi</i> , <i>Allium sativum</i> pounded taken orally	GD 0010
	Poaceae								

NB: * Indicates the Endemic species

13	<i>Clausena anisata</i> (Willd.) Benth.	Sh	L	Hu	F	O/Na	Acute fibrill illness	Leaf <i>C.anisata</i> , <i>Croton macrostachyus</i> , <i>Eucalyptus globulus</i> boiling smell steam	GD 0031
	Rutaceae								
	Ulmayi								
14	<i>Colocasia esculenta</i> (L.) Schott.	H	Rh	Hu	F	O	Ascaries	Rhizome is Cooked and eaten expel ascaries	GD 0028
	Araceae	H		Ls	F	O	Placenta retetion	Root <i>C. esculenta</i> is pounded given to cattle	
	Godarree								
15	<i>Cordia africana</i> Lam.	T	L	Hu	F	O	Stomach-ache	Leaf <i>C.africana</i> , <i>Rumex neplensis</i> , <i>Ruta chalepensis</i> and <i>Allium sativum</i> crushed and drunk	GD 005
	Boraginaceae						Expel internal parasite	Rapen fruit of <i>Cordia africana</i> eaten expel internal parasite	
	Waddessa								
16	<i>Croton macrostachyus</i> Del.	T	L	Hu	D	O	Cough	Leaf crushed dissolved drunk with salt	GD 0021
	Euphorbiaceae						Stomach-ache	Bark is crushed dissolved and drunk	
	Bakkannisa						Wound	Dry leaf is powdered put on the wound	
							'Roobbii' Chirt	Fresh leaf used for wound area	
17	<i>Cucumis ficifolius</i> A. Rich	Ci	R	Ls	F	O	Rabies	Root washed peeled by measuring finger line chewed	GD 009
	Cucurbitaceae						Tooth-ache	Root is chewed and put under affected teeth	
	Hiddii oolallo								
18	<i>Cupressus lusitanica</i> Mill.						Dhibee garaa keessa ' Biduu '	Leaf of <i>C.lusitanica</i> , <i>Croton macrostachyus</i> , <i>Justicia schimperiana</i> and <i>Rhamnus prinoides</i> crushing together washed body of patient and small dosage taken orally.	GD 0042
	Cupressaceae								
	Gatiraa Faranjii								
19	<i>Chenopodium ambrosioides</i> L.	H	L	Hu	F	Ex	Spider poison	Leaf crudhed and pasted on the affected area	GD 0060
	Chenopodiaceae								
	Qoricha Shararitii								

NB: * Indicates the Endemic specie

20	<i>Cyanotis barbata</i> D.Don	H	L	Hu	F	O	Naqarsa	Leaf crushed and 1 coffee cup taken by sugar	GD 0068
	Commeliaceae								
	Arama Dawaa								
21	<i>Cynodon dactylon</i> (L.) Pers	H	Wp	B	F	Ex	Snake breath	Fresh <i>C.dactylon</i> pounded with leaf of <i>Acacia abyssinica</i> sprayed on body	GD 0062
	Poaceae								
	Coqorsa								
22	<i>Datura stramonium</i> L.	H	L	Hu	F	Ex	Wound	Leaf is crushed put on the wound.	GD 0052
	Solanaceae								
	Asangira/ Manjii								
23	<i>Dovyalis abyssinica</i> (A.Rich.) Warb.	T	L	Hu	F	O	Internal parasite expel	Rapen Fruit of <i>D. abyssinica</i> are eaten orally	GD 0043
	Flacourtiaceae								
	Koshimi								
24	<i>Eucalyptus camaldulensis</i> Dehnh.	T	L	Hu	F	O	Stomach -ache	Fresh leaf of <i>E.camaldulensis</i> chewed	GD 0064
	Myrtaceae			Ls			Blak leg	Fruit <i>E. camadulensis</i> and <i>R. communis</i> pounded and gives orally for cattle	
	Bargamo Diimaa								
25	<i>Eucalyptus globulus</i> Labill.	T	L	Hu	F	O	Cough	Fresh leaf boiled smell the stem and drunk small amount	GD 0034
	Myrtaceae						Fever / Mich	Leaf boiled smell	
	Bargamoo Adii								

NB: * Indicates the Endemic species

26	<i>Foeniculum vulgare</i> L.	H	L	B	F	O	Urine retention	Leaf of <i>F.vulgare</i> and <i>Ruta chalepensis</i> pounded together is taken orally human and animal	GD 0011
	Apiaceae						Blood pressure	Crushed and drunk	
	Insilaalee						Stomach-ache	Squeezed with <i>Ocimum lamiifolium</i> and <i>Withania somnifera</i> and taken orally	
27	<i>Guizotia scabra</i> (Vis.) Chiov	H	L	Hu	F	Ex	Wound	Leaf <i>Guizotia scabra</i> squeezed added th wound	GD 0046
	Asteraceae								
	Tuufoo/ Hadaa								
28	<i>Hagenia abyssinica</i> (Brace) J.F.Gmel.	T	S e	Hu	D	O	Tape warm	Seed of <i>H.abysinica</i> dried crushed dissolved is drunk dossage base on age different	GD 0020
	Rosaceae								
	Heexoo								
29	<i>Hygrophila auriculata</i> (Schumach.) Heine	H	L	Hu	F	Ex	Wound	Leaf are crushed and added on the body affected	GD 0050
	Acanthaceae								
	Arraba dubarti								
30	<i>Juniperus procera</i> Hochst. ex Endl.	T	L	Hu	F	Ex	Wound	Leaf of <i>Juniperus procera</i> pounded and put on the wound area	GD 0030
	Cupressaceae								
	Gaattiraa habashaa								
31	<i>Justicia schimperiana</i> (Hochst. ex Nees) T. Anders.	Sh	L	Hu	F	O/Na/ Ex	Eye Evil	Leaf of <i>J.schimperiana</i> , <i>Eucalyptus globulus</i> , <i>Ocimum lamiifolium</i> boiling and washed body small amount take throu oral and nasal	GD 0024
	Acanthaceae	Sh	L	Ls	F	O	Cattle Blotting	Leaf of <i>J.schimperiana</i> and <i>Vernonia amygdalina</i> pounded togther gives through orally	
	Dhumugaa								
32	<i>Kalanchoe petitiiana</i> A.Rich.	H	L	Hu	F	Ex	Wound	Root of <i>Kalanchoe petitiiana</i> and <i>Plantago lanceolata</i> pounded put on wound	GD 0017
	Crassulaceae						Swelling Wound	Fresh leaf warm by heat placed on it	
	Bosogqee								

33	<i>Leonotis ocymifolia</i> (Burn.f) Iwarsson var. <i>ocymifolia</i>	H	L	Hu	F	Dr/Ex	Fever/ mich	Leaf crushed between hands and taken through nasal	GD 0018
	Lamiaceae								
	Bokkolluu								
34	<i>Lippia adoensis</i> Hochst. Ex Walp *	H	L	Hu	F	O	Cough	Fresh leaf pounded liquid part is taken orally	GD 0059
	Verbenaceae								
	Kusaaye								
35	<i>Momordica foetida</i> Schumach.	H	R	Ls	F	O	Cattle blotting	Root of <i>M. foetida</i> with root <i>Salvia nilotica</i> pounded together and gives orall	GD 0013
	Cucurbitaceae						Urine retetion	Root of <i>M. foetida</i> with <i>V. sinaiticum</i> pounded and given	
	Qorii sinbiraa								
36	<i>Ocimum basilicum</i> L.var. <i>basilicum</i>	H	L	Hu	F	O	Headache	Fresh leaf of is chewed and swallowed	GD 0066
	Lamiaceae								
	Bossobilaa								
37	<i>Ocimum lamiifolium</i> Hochst. ex Benth.	H	L	Hu	F	Na	Mich / fever	Leaf of <i>O. lamiifolium</i> crushed on hand taken liquid through nasal	GD 001
	Lamiaceae						Head ache	Squeezed and drunk one tea cup with coffee	
	Ancabbii								
38	<i>Olea europaea</i> L. subsp <i>cuspidata</i> (Wall. ex G.Don) Cif.	T	L	Hu	F	Ex	Headache	The oil is extracted mixed with powder of <i>Echinops kebericho</i> put on it	GD 0051
	Oleaceae								
	Ejersa								
39	<i>Olinia rochetiana</i> A. Juss.	S h	L	Hu	F	O	Toothache	Leaf of <i>O. rochetiana</i> crushed put under affected tooth	GD 0038
	Oliniaceae								
	Soolee								

NB: * Indicates the Endemic species

	<i>Phytolacca dodecandra</i> L. Herit	Sh	R	Ls	F	O	Rabies	Root of <i>P. dodecandra</i> and <i>J. schimperiana</i> pounded together given for cattle	GD 0022
	Phytolaccaceae								
	Handoodee								
40	<i>Plantago lanceolata</i> L.	H	L	Hu	F	Ex	Wound	leaf of <i>Plantago lanceolata</i> crushed put on it	GD 0055
	Plantaginaceae								
	Qorxobbee								
41	<i>Pennisetum sphacelatum</i> (Nees) Th. Dur. and Schinz	H	W	Hu	F	Ex	Body itching	Fresh <i>P. sphacelatum</i> chewed spray on the body	GD 0044
	Poaceae								
	Migira								
42	<i>Plectranthus punctatus</i> (L.f) Her.	H	L	Hu	F	Ex	Head ache	Leaf of <i>P. punctatus</i> and snifted through nasal	GD 0048
	Asteraceae								
	Dabasee								
43	<i>Persea americana</i> L.	T	Fr	Hu	F	Ex	Dandruff	Fruit of <i>P. american</i> used for hair fungal treatment	GD 0041
	Lauraceae								
	Avokadoo								
44	<i>Premna schimperi</i> Engl.	Sh	L	Hu	F	O	Toothache	Leaf of <i>Premna schimperi</i> is crushed and put under affect tooth.	GD 0015
	Lamiaceae								
	Urgeessa								
45	<i>Pycnostachys abyssinica</i> Fresen. *	Sh	L	Ls	F	Op	Affected eye	Leaf <i>P. abyssinica</i> squeezed adde in Sheep eye	GD 008
	Lamiaceae					O	Hen disease	Leaf <i>P. abyssinica</i> Crushed gives orally openig peak	
	Abba muddaa / Ajoo								
46	<i>Ranunculus multifidus</i> . Forssk	H	L	Hu	F	Ex	Urine of bat	Leaf of <i>R. multifidus</i> crushed and paint on it	GD 0065
	Ranunculaceae								
	Gashuwwe								

48	<i>Rhamnus prinoides</i> L.	Sh	L	Hu	F	O	Tonsillities	Fresh leaf of <i>Rhamnus prinoides</i> chewed and Swallowed	GD 007
	Rhamnaceae								
	Geeshee								
49	<i>Ricinus communis</i> L. Herit.	Sh	Se	Hu	D	Ex	Wound	Seed crushe and the oil is painted on wound	GD 0026
	Euphorbiaceae			Ls	F	O	Stomach cramp	Root of <i>R.communis</i> and <i>Momordica foetida</i> crushed given to cattle	
	Qobboo								
51	<i>Rubia cordifolia</i> L.	H	R	Hu	F	O	Diarrhea	Crushed the root and drunk the watery part	GD 0016
	Rubiaceae	H	R	Hu	F	O	Stomach- ache	Root of <i>R.cordifolia</i> pounded and drunk the water part	
	Hundee Diimaa								
52	<i>Rumex nepalensis</i> Spreng.	H	R	Hu	F	O	Stomach cramp	The root part of <i>R. nepalensis</i> washed and chewed drunk liquid	GD 004
	Polygonaceae								
	Tultii								
53	<i>Rumex nervosus</i> Vahl	H	L	Hu	F	Ex	Blood clotting	Fresh leaf of <i>R. nervosus</i> crushed and added on it	GD 0019
	Polygonaceae								
	Dhangaggoo								

NB: * Indicates the Endemic species

54	<i>Satureja abyssinica</i> (Benth.) Briq.	H	L	Hu	F/D	Na	Mich /Fever	Leaf crushed between hands taken through nose	GD 0037
	Lamiaceae								
	Xoosinyii harree								
55	<i>Senna didymobotrya</i> (Fresen.) Irwin & Barneby.	Sh	L	B	F	Ex	Poison	Leaf <i>S. didymobotrya</i> ponde added on affected area	GD 0063
	Fabaceae								
	Muka ajawa								
56	<i>Senna occidentalis</i> L.			B	F	Ex	Poison	Leaf <i>S. occidentalis</i> crushed and used	GD 0054
	Fabaceae								
	Sanamakii								
57	<i>Solanum incanum</i> L.	H	R	Hu	F	O	Stomach ache	Root of <i>S. incanum</i> peeled washed and chewed	GD 003
	Solanaceae						Tonsilities	The inside liquid is used for child tonsil	
	Hiddii								
58	<i>Solanum nigrum</i> L.	H	R	Ls	F	O	Cattle blotting	Root of <i>S. nigrum</i> and <i>Verbascum sinaiticum</i> pounded together well given to cattle	GD 0029
	Solanaceae								
	Abashurree								
59	<i>Tagetes minuta</i> L.	H	L	Hu	F	Ex	Swelling	Leaf of <i>Tagetes minuta</i> crushed and put on it	
	Asteraceae								
	Ajawa								
60	<i>Thymus schimperi</i> Ronninger *	H	L	Hu	F/D	O	Cough	Leaf is boiled drunk with sugar	GD 0027
	Lamiaceae			Ls		O/ Na	Cattle Cough	Leaf <i>T. schimperi</i> , <i>Nicotiana tabacum</i> and <i>Alium sativum</i> pounded dissolved ggives through nose	
	Xoosinyii Namaa								

NB: * Indicates the Endemic

61	<i>Thunbergia ruspolii</i> Lindau *	H	R	Ls	F	O	Urine retention	Root of <i>T. ruspolii</i> and <i>S. nilotica</i> pounded use it	GD 0059
	Acanthaceae								
	Hidda Bofaa								
62	<i>Urtica simensis</i> Steudel.	H	R	Hu	F	Ex	Kormomu /Tumor	Root pounded the solid part tid on it	GD 0045
	Urticaceae	H	R	B	F	O	Placenta retention	Root is pounded gives to cattle by salt while humans used by honey	
	Doobbii	H	R	Hu	F	O	Horse disease	Root of <i>U. simensis</i> and <i>Justicia schimperiana</i> pounded gives orally	
64	<i>Verbascum sinaiticum</i>	H	R	Ls	F	O	Cattle Blotting	Root of <i>V. sinaiticum</i> , <i>Cucumis ficifolius</i> and <i>Rubia cordifolia</i> pounded together given for cattle	GD 0023
	Scrophulariaceae						Urine retention	Root of <i>V. sinaiticum</i> is pounded mixed with water gives to cattle	
	Gurra harree								
65	<i>Vernonia amygdalina</i> Del.	H	L	Hu	F	O	Stomach pain	Leaf of <i>V. amygdalina</i> and <i>Justicia schimperiana</i> crushed together and drunk	GD 0025
	Asteraceae								
	Eebicha								
66	<i>Vernonia auriculifera</i> Hiern	Sh	L	Ls	F	O p	Cataracts	Leaf of <i>V. auriculifera</i> is pounded and added into affected eye	GD 0036
	Asteraceae								
	Reejii								
67	<i>Withania somnifera</i> (L.) Dunal in DC.	Sh	L	Hu	F	Ex	Blood clotting	Leaf squeezed and added on the bleeding area	GD 0014
	Solonaceae	Sh	L	Hu	F	O	Eye evil	Squeezed and leaf of <i>Ruta chalepensis</i> drink one spoon.	
	kumoo								
68	<i>Zingiber officinale</i> Roscoe	H	Rh	B	F/D	O	Cough	Rhizome pounded with <i>A. sativum</i> boiled drunk with sugar	GD 0058
	Zingiberaceae						Stomach- ache	Rhizome chewed and swallowed	
	Jinjibila								

NB: * Indicates the Endemic species

Appendix 5: Chitu and Haro Wonchi Market Survey for other uses of medicinal plants sold in markets

Local name	Scientific name	Families	Their uses
Tikur Asmud	<i>Nigella sativa</i>	Ranunculaceae	Cough
Kundo berbere	<i>Piper nigrum</i>	Piperaceae	Tonsil
Misira	<i>Lens culinaris</i>	Fabaceae	Spider poison
Jinjibila	<i>Zingiber officinale</i>	Zingiberaceae	Cough , Stomach ache
Karafaa/ kurufudi	<i>Cassya filiformis</i>	Lauraceae	Cough
Xoosinyii	<i>Thymus schimperi</i>	Lamiaceae	Spices, Cough
Ciraakkota	<i>Ruta chalepensis</i>	Rutaceae	Spice, Stomach-ache
Geeshee	<i>Rhamnus prinoides</i>	Rhamnaceae	Used for local beer
Qullubii Adii	<i>Allium sativum</i>	Alliaceae	Food , Cough
Papaya	<i>Carica papaya</i>	Caricaceae	Food , kidney problem
Kebericho	<i>Echinops kebericho</i>	Asteraceae	Eye evil
Avokado	<i>Persea Americana</i>	Lauraceae	Dandruff , Gastritis

Appendix 6: List of Informants, Sex, Age, Educational background and their Kebeles.

No	Name of respondent	Sex	Age	Education	Kebeles/ Key informants
1	Kebede Tilahun	M	65	Grade 6	Meti_Welga / Key informant
2	Mergitu Bekela	F	47	Grade 8	Meti_Welga / MW
3	Sufe Shugute	F	40	Grade 4	Meti_Welga / MW
4	Kebebu Koricha	F	60	Illiterate	Meti_Welga / MW
5	Mosise Beyena	F	67	Grade 5	Meti_Welga / MW
6	Adenu Alemu	F	56	Illiterate	Meti_Welga / MW Key informant
7	Rafera Beyisa	M	54	Grade 12	Meti_Welga / MW
8	Desta Bekele	F	38	Grade 6	Meti_Welga / MW
9	Mulu Mekonin	F	55	Illiterate	Meti_Welga / MW
10	Shifera Wehima	M	60	Grade 8	Meti_Welga / MW
11	Hundessa Kebeta	M	84	Illiterate	Meti_Welga / MW
12	Geshew Bekele	M	58	Grade 10	Meti_Welga / MW
13	Burtukan Bekele	F	35	Illiterate	Meti_Welga / MW
14	Bekelech Alemu	F	40	Grade 10	Meti_Welga / MW
15	Merga Dagne	M	32	Grade 6	Meti_Welga / MW
16	Bikiltu Wakuma	M	40	Illiterate	Meti_Welga / MW
17	Etenesh Wako	F	30	Grade 8	Meti_Welga / MW
18	Marishet Basu	F	55	Illiterate	Meti_Welga / MW
19	Zewdinesh Bekele	F	45	Illiterate	Meti_Welga / MW
20	Wektola Geruma	M	70	Grade 8	Meti_Welga / MW Key informant
21	Bekelu Tesisa	F	50	Illiterate	Haro Beseka /HB
22	Ayelu Regasa	F	50	Illiterate	Haro Beseka /HB
23	Bane Wolde	F	80	Illiterate	Haro Beseka /HB
24	Tadelu Kebede	F	32	Grade 3	Haro Beseka /HB
25	Tadelu Angesa	F	30	Grade 4	Haro Beseka /HB
26	Mekonnin Jabessa	M	65	Grade 6	Haro Beseka /HB
27	Milkessa Ajema	M	65	Illiterate	Haro Beseka /HB
28	Ayensa Midegsa	M	75	Illiterate	Haro Beseka /HB
29	Elfu Degu	F	40	Illiterate	Haro Beseka /HB
30	Teshale Chelchisa	M	35	Grade 4	Haro Beseka /HB
31	Kebede Feyisa	M	75	Illiterate	Haro Beseka /HB Key informant
32	Ayentu Negero	F	62	Illiterate	Haro Beseka /HB Key informant
33	Kumala Ana	M	55	Grade 8	Haro Beseka /HB
34	Hirphesa Tolera	M	89	Illiterate	Haro Beseka /HB
35	Ayensa Dabi	M	56	Grade 6	Haro Beseka /HB
36	Ayelu Robi	F	48	Illiterate	Haro Beseka /HB
37	Desta Kenea	F	65	Grade 10	Haro Beseka /HB
38	Chaltu Senbeto	F	35	Grade 8	Haro Beseka /HB
39	Kulani Diriba	F	59	Illiterate	Haro Beseka /HB Key informant

40	Simenesh Berecha	F	49	Illiterate	Haro Beseka /HB
41	Bedada Ayela	M	71	Illiterate	Dimtu_Godeti /DG Key informant
42	Desi Negera	F	56	Illiterate	Dimtu_Godeti /DG
43	Hirphe Idosa	F	60	Illiterate	Dimtu_Godeti /DG
44	Chimsa Merara	M	50	Grade 6	Dimtu_Godeti /DG
45	Bulo Terefa	M	39	Grade 8	Dimtu_Godeti /DG
46	Mulu Neda	F	45	Grade 4	Dimtu_Godeti /DG
47	Tejitu Hundessa	F	56	Illiterate	Dimtu_Godeti /DG Key informant
48	Bekelu Wekuma	F	70	Illiterate	Dimtu_Godeti /DG
49	Kumsa Chima	M	75	Illiterate	Dimtu_Godeti /DG
50	Guchi Wakene	F	40	Grade 8	Dimtu_Godeti /DG
51	Dewo Abdi	F	35	Grade 10	Dimtu_Godeti /DG
52	Refisa Angesa	M	81	Illiterate	Dimtu_Godeti /DG Key informant
53	Kenenisa Warkina	M	37	Grade 10	Dimtu_Godeti /DG
54	Chaltu Hunde	F	48	Grade 6	Dimtu_Godeti /DG
55	Lelise Hundera	F	32	Grade 8	Dimtu_Godeti /DG
56	Lilo Megersa	F	42	Grade 6	Dimtu_Godeti /DG
57	Demitu Beka	F	72	Illiterate	Dimtu_Godeti /DG
58	Teshale Diribsa	M	35	Grade 4	Dimtu_Godeti /DG
59	Bekeshe Wakgari	F	34	Grade 10	Dimtu_Godeti /DG
60	Terefa Bedasa	M	67	Illiterate	Dimtu_Godeti /DG
61	Leta Bedada	M	67	Illiterate	Belbela_Bulbulo/ BB
62	Gonfa Bore	M	96	Illiterate	Belbela_Bulbulo/BB Key informant
63	Mulunesh Tefa	F	34	Grade 10	Belbela_Bulbulo/ BB
64	Ayelu Seboka	F	56	Grade 6	Belbela_Bulbulo/ BB
65	Nedasa Mulisa	M	65	Illiterate	Belbela_Bulbulo/ BB
66	Sheleme Asefa	F	40	Grade 8	Belbela_Bulbulo/ BB
67	Demenes Alemu	F	32	Grade 10	Belbela_Bulbulo/ BB
68	Fikadu Tirune	M	50	Grade 6	Belbela_Bulbulo/ BB
69	Shitaye Shifera	F	36	Grade 8	Belbela_Bulbulo/ BB
70	Aregash Kumala	F	49	Illiterate	Belbela_Bulbulo/ BB
71	Kebeta Mirkena	M	75	Illiterate	Belbela_Bulbulo/BB Key informant
72	Dendeni Arersa	F	80	Illiterate	Belbela_Bulbulo/ BB
73	Tadelu Dendena	F	39	Grade 4	Belbela_Bulbulo/ BB
74	Tadela Ibsa	M	35	Grade 8	Belbela_Bulbulo/ BB
75	Zenebech Iticha	F	45	Illiterate	Belbela_Bulbulo/ BB
76	Bekelu Jote	F	56	Illiterate	Belbela_Bulbulo/ BB
77	Wakgari Bayera	M	42	Grade 6	Belbela_Bulbulo/ BB
78	Warkitu Neda	F	58	Illiterate	Belbela_Bulbulo/ BB
79	Elfu Humnessa	F	60	Illiterate	Belbela_Bulbulo/ BB Key

					informant
80	Dejene Yadeta	M	45	Grade 10	Belbela_Bulbulu/ BB
81	Mosisa Jiru	M	75	Illiterate	Merega_Abeyi/MA Key informant
82	Kumala Jima	M	58	Illiterate	Merega_Abeyi /MA
83	Jime Ayensa	F	59	Illiterate	Merega_Abeyi /MA
84	Kumsa Jote	M	70	Illiterate	Merega_Abeyi /MA
85	Bontu Regasa	F	35	Grade 8	Merega_Abeyi /MA
86	Dawit Awas	F	46	Illiterate	Merega_Abeyi /MA
87	Loko Bati	F	48	Illiterate	Merega_Abeyi /MA
88	Wagari Tola	M	75	Illiterate	Merega_Abeyi/MA Key informant
89	Iftu Oda	F	31	Grade 6	Merega_Abeyi /MA
90	Midegdu Tolera	F	74	Illiterate	Merega_Abeyi /MA
91	Feyera Senbeto	M	42	Grade 8	Merega_Abeyi /MA
92	Chaltu Rafera	F	29	Grade 8	Merega_Abeyi /MA
93	Degaga Jima	M	35	Grade 10	Merega_Abeyi /MA
94	Ibsitu Beka	F	53	Illiterate	Merega_Abeyi /MA
95	Aredo Liban	M	82	Illiterate	Merega_Abeyi /MA
96	Lelise Rabira	F	29	Grade 6	Merega_Abeyi /MA
97	Soreti Oda	F	56	Grade 6	Merega_Abeyi /MA
98	Geda Robe	M	61	Grade 6	Merega_Abeyi /MA
99	Burtukan Tulu	F	44	Grade 4	Merega_Abeyi /MA
100	Dimtu Beka	F	82	Illiterate	Merega_Abeyi/MA Key informant
101	Tsegaye Seboka	M	75	Illiterate	Chebo_Senseleti/CS
102	Gelana Jima	M	50	Illiterate	Chebo_Senseleti/CS
103	Ayentu Tolosa	F	37	Grade 8	Chebo_Senseleti/CS
104	Dadi Muleta	M	55	Illiterate	Chebo_Senseleti/CS
105	Lomitu Hunde	F	45	Grade 4	Chebo_Senseleti/CS
106	Oboro Nadi	F	72	Illiterate	Chebo_Senseleti/CS
107	Mengistu Jifar	M	40	Grade 8	Chebo_Senseleti/CS
108	Kulani Tulu	F	30	Grade 8	Chebo_Senseleti/CS
109	Girma Gelata	M	35	Grade 10	Chebo_Senseleti/CS
110	Biftu Geleta	F	60	Illiterate	Chebo_Senseleti/CS
111	Merertu Kebeda	F	28	Grade 10	Chebo_Senseleti/CS
112	Belete Tadesa	F	30	Grade 10	Chebo_Senseleti/CS
113	Bontu Obsa	F	34	Grade 8	Chebo_Senseleti/CS
114	Kebede Bedo	F	46	Illiterate	Chebo_Senseleti/CS
115	Birhanu Kenenisa	M	65	Illiterate	Chebo_Senseleti/CS Key informant
116	Sichale Geda	F	68	Grade 6	Chebo_Senseleti/CS Key informant
117	Teshoma Abdisa	M	58	Grade 6	Chebo_Senseleti/CS
118	Urji Beka	F	70	Illiterate	Chebo_Senseleti/CS

119	Besha Boru	M	78	Grade 4	Chebo_Senseleti/CS Key informant
120	Meti Urga	F	80	Illiterate	Chebo_Senseleti/CS
121	Aster Beyisa	F	40	Grade 10	Werabu_Mesi /MS
122	Doshitu Indale	F	35	Illiterate	Werabu_Mesi /MS
123	Demeke Seifu	M	50	Illiterate	Werabu_Mesi /MS
124	Birhane Desta	F	38	Illiterate	Werabu_Mesi /MS
125	Ayelech Beyisa	F	45	Grade 6	Werabu_Mesi /MS
126	Shitaye Terefa	F	56	Grade 8	Werabu_Mesi /MS
127	Tesema Negera	M	55	Grade 8	Werabu_Mesi /MS
128	Itenesh Abdisa	F	29	Grade 4	Werabu_Mesi /MS
129	Keneni Workina	F	60	Illiterate	Werabu_Mesi /MS
130	Tefera Adugna	M	56	Grade 10	Werabu_Mesi /MS Key informant
131	Desta Berecha	F	58	Grade 8	Werabu_Mesi /MS Key informant
132	Bekelu Workina	F	57	Illiterate	Werabu_Mesi /MS
133	Besheda Ireaso	M	45	Grade 8	Werabu_Mesi /MS
134	Teklu Haile	M	75	Illiterate	Werabu_Mesi /MS
135	Diriba Midegsa	M	60	Illiterate	Werabu_Mesi /MS
136	Birhane Lencho	F	38	Grade 8	Werabu_Mesi /MS
137	Ayelu Seboka	F	45	Illiterate	Werabu_Mesi /MS
138	Girma Guda	M	76	Grade 10	Werabu_Mesi /MS
139	Wakene Tolera	M	82	Illiterate	Werabu_Mesi /MS Key informant
140	Tejitu Rafera	F	56	Grade 8	Werabu_Mesi /MS
141	Bizunesh Gadisa	F	75	Illiterate	Haro Wonchi/HW Key informant
142	Alemu Buzuneh	M	45	Illiterate	Haro Wonchi/HW
143	Genet Seboka	F	65	Illiterate	Haro Wonchi/HW
144	Alemayehu Raguhel	M	30	Grade 6	Haro Wonchi/HW
145	Shewaye Dechasa	F	33	Grade 4	Haro Wonchi/HW
146	Birhane Absew	F	48	Illiterate	Haro Wonchi/HW
147	Niguse Gobu	M	50	Illiterate	Haro Wonchi/HW
148	Birhanu Ango	M	38	Grade 8	Haro Wonchi/HW
149	Abiye Meza	F	56	Illiterate	Haro Wonchi/HW Key informant
150	Desita Mirkansa	F	35	Grade 8	Haro Wonchi/HW
151	Keneni Ashenafi	F	32	Grade 6	Haro Wonchi/HW
152	Teshome Desalegn	M	52	Grade 4	Haro Wonchi/HW
153	Rafera Geleta	M	65	Illiterate	Haro Wonchi/HW
154	Nigistu Demeke	F	46	Illiterate	Haro Wonchi/HW
155	Genu Midegsa	F	29	Grade 8	Haro Wonchi/HW
156	Abebu Likasa	F	56	Illiterate	Haro Wonchi/HW
157	Ashenafi Buzuna	M	72	Illiterate	Haro Wonchi/HW Key informant
158	Birtukan Hailu	F	47	Illiterate	Haro Wonchi/HW
159	Tahitu Deme	F	51	Illiterate	Haro Wonchi/HW
160	Miliyon Kewota	M	49	Illiterate	Haro Wonchi/HW
161	Aster Bayu	F	48	Illiterate	Fite_Wato/ FW
162	Doshore Indale	F	39	Grade 8	Fite_Wato/ FW

163	Jarso Hambisa	M	57	Grade 8	Fite_Wato/ FW
164	Bekelu Abera	F	45	Illiterate	Fite_Wato/ FW
165	Aberash Taresa	F	52	Illiterate	Fite_Wato/ FW
166	Wakene Tola	M	73	Illiterate	Fite_Wato/ FW
167	Askale Negash	F	64	Illiterate	Fite_Wato/ FW
168	Miliyon Abera	M	52	Illiterate	Fite_Wato/ FW
169	Adenu Bekela	F	57	Illiterate	Fite_Wato/ FW
170	Birke Midegsa	F	47	Grade 6	Fite_Wato/ FW
171	Megersa Jeleta	M	40	Grade 10	Fite_Wato/ FW
172	Abebech Tesfaye	F	56	Illiterate	Fite_Wato/ FW
173	Mulu Tesfaye	F	60	Illiterate	Fite_Wato/ FW
174	Desita Hailu	F	39	Grade 4	Fite_Wato/ FW
175	Lema Angesa	M	74	Illiterate	Fite_Wato/ FW Key informant
176	Beka Bekela	M	60	Grade 6	Fite_Wato/ FW
177	Demitu Wakuma	F	32	Grade 8	Fite_Wato/ FW

Appendix ...

178	Tefera Bekela	M	75	Illiterate	Fite_Wato/ FW
179	Meskele Geda	F	65	Illiterate	Fite_Wato/ FW Key informant
180	Gemechu Kenea	M	80	Illiterate	Fite_Wato/ FW Key informant
181	Wedaje Tedle	M	75	Grade 6	Sonkole Kake /SK
182	Alemnesh Tsahu	F	48	Illiterate	Sonkole Kake /SK
183	Simenesh Wakuma	F	54	Illiterate	Sonkole Kake /SK
184	Gadise Wandu	F	45	Grade 4	Sonkole Kake /SK
185	Teshome Beyena	M	69	Illiterate	Sonkole Kake /SK Key informant
186	Chaltu Hundessa	F	52	Illiterate	Sonkole Kake /SK
187	Ayentu Jarso	F	40	Grade 8	Sonkole Kake /SK
188	Gashew Angesa	M	45	Grade 6	Sonkole Kake /SK
189	Almaz Wakgari	F	29	Grade 8	Sonkole Kake /SK
190	Asefu Girma	F	35	Grade 6	Sonkole Kake /SK
191	Wakgari Meza	M	40	Grade 8	Sonkole Kake /SK
192	Bulo Zeleke	M	60	Illiterate	Sonkole Kake /SK
193	Bekesh Yadeta	F	48	Grade 6	Sonkole Kake /SK
194	Sorse Mengistu	F	58	Illiterate	Sonkole Kake /SK Key informant
195	Dejene Kebede	M	49	Grade 4	Sonkole Kake /SK
196	Tirfessa Wedajo	M	85	Illiterate	Sonkole Kake /SK Key informant
197	Abera Teka	M	31	Grade 8	Sonkole Kake /SK
198	Tadelech Teshale	F	65	Illiterate	Sonkole Kake /SK
199	Tesfaye Kiflu	M	59	Illiterate	Sonkole Kake /SK
200	Alemitu Dejenu	F	37	Grade 8	Sonkole Kake /SK
201	Itenesh Shelema	F	29	Grade 8	Hodo_Fura /HF
202	Marishet Motuma	F	35	Grade 6	Hodo_Fura /HF
203	Birhanu Milkesa	M	45	Grade 9	Hodo_Fura /HF
204	Warke Warkina	F	38	Illiterate	Hodo_Fura /HF

205	Getacho Tilahun	M	56	Illiterate	Hodo_Fura /HF
206	Ararse Walde	F	39	Grade 4	Hodo_Fura /HF
207	Alemitu Dereas	F	58	Illiterate	Hodo_Fura /HF
208	Deresa Milkesa	M	50	Grade 8	Hodo_Fura /HF
209	Adenu Tedla	F	63	Illiterate	Hodo_Fura /HF
210	Tadela Edosa	M	60	Illiterate	Hodo_Fura /HF
211	Desita Dendena	F	42	Illiterate	Hodo_Fura /HF
212	Tilahun Kefeni	M	75	Illiterate	Hodo_Fura /HF
213	Chaltu Megersa	F	48	Illiterate	Hodo_Fura /HF Key informant
214	Burtukan Milkesa	F	51	Illiterate	Hodo_Fura /HF
215	Tesfaye Shifera	M	62	Grade 4	Hodo_Fura /HF
216	Aster Mamo	F	43	Grade 8	Hodo_Fura /HF
217	Beleli Terefa	F	71	Illiterate	Hodo_Fura /HF
218	Megersa Fana	M	76	Illiterate	Hodo_Fura /HF
219	Demenesh Tulu	F	65	Illiterate	Hodo_Fura /HF Key informant
220	Lomi Chala	F	53	Grade 4	Hodo_Fura /HF

Appendix ...

221	Askela Lema	F	61	Illiterate	Weldo_Telfam /WT
222	Gemeda Megersa	M	83	Grade 3	Weldo_Telfam/ WT Key informant
223	Alemitu Girma	F	52	Grade 4	Weldo_Telfam/WT
224	Daditu Tulu	F	49	Grade 6	Weldo_Telfam/WT
225	Guta Lemi	M	70	Grade 4	Weldo_Telfam/WT
226	Tolashi Kuma	F	63	Illiterate	Weldo_Telfam/WT Key informant
227	Demitu Regesa	F	32	Grade 8	Weldo_Telfam/WT
228	Gobane Nedi	M	65	Grade 6	Weldo_Telfam/WT
229	Bontu Geda	F	65	Illiterate	Weldo_Telfam/WT Key informant
230	Tulu Wako	M	68	Illiterate	Weldo_Telfam/WT
231	Demitu Tolosa	F	45	Grade 4	Weldo_Telfam/WT
232	Yami Borena	M	59	Illiterate	Weldo_Telfam/WT
233	Burtukan Bedane	F	52	Grade 6	Weldo_Telfam/WT
234	Aselefu Kebeda	F	29	Grade 8	Weldo_Telfam/WT
235	Workitu Regasa	F	58	Illiterate	Weldo_Telfam/WT
236	Beka Tolosa	M	72	Illiterate	Weldo_Telfam/WT
237	Dasita Gadisa	F	35	Grade 10	Weldo_Telfam/WT
238	Milkesa Obsa	M	46	Grade 8	Weldo_Telfam/WT
239	Keneni Wondu	F	31	Grade 6	Weldo_Telfam/WT
240	Ejersa Boku	M	45	Grade 4	Weldo_Telfam/WT
241	Nagesa Iticha	M	62	Illiterate	Chitu
242	Keba Ayane	F	59	Illiterate	Chitu
243	Gadise Guta	F	42	Grade 4	Chitu
244	Iftu Bacha	F	35	Grade 8	Chitu

245	Terefa Regasa	M	75	Illiterate	Chitu Key informant
246	Abebe Muleta	M	80	Illiterate	Chitu
247	Kebene Kena	F	44	Illiterate	Chitu
248	Wesene Shibiru	F	55	Illiterate	Chitu
249	Gelane Biyera	F	51	Grade 8	Chitu
250	Chemeda Mamuye	M	58	Grade 4	Chitu
251	Demitu Wakjira	F	57	Grade 6	Chitu
252	Bilise Megersa	F	32	Grade 10	Chitu
253	Fura Jira	M	78	Illiterate	Chitu Key informant
254	Bikiltu Jeleta	M	40	Grade 8	Chitu
255	Tesfaye Alemu	M	45	Grade 9	Chitu
256	Dawit Kure	F	62	Grade 4	Chitu
257	Alemayehu Terefa	M	48	Grade 10	Chitu
258	Jime Degaga	F	70	Illiterate	Chitu Key informant
259	Ayela Dejene	M	59	Grade 3	Chitu
260	Marta Abiyot	F	35	Grade 8	Chitu

Declaration

I, the undersigned declare that this Thesis my original work and it has not been presented in other universities , colleges and institute for a degree or other purpose. All sources of the materials used have been duly acknowledged.

Name	Signature	Date
Getu Dida Abdo	_____	_____

This work has been done under my supervision.

Name	Signature	Date
Dr. Bikila Warkineh	_____	_____

Prof. Sebsebe Demissew	_____	_____
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Dr. Ermias Lulekal	_____	_____
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