Addis Ababa University

Study on Wild and Semi-wild Edible Plants in Wukro Kilte-Awulaelo Eastern Zone of Tigray Adminstrative Region, Ethiopia

By:

Mezgebe Habtu

Addis Ababa, Ethiopia

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By:

Mezgebe Habtu

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Declaration

This is to certify that thesis entitled "**Study on Wild and Semi-wild Edible Plants in Wukiro Kilte-Awulaelo Eastern Zone, Tigray Regional State, Ethiopia**" prepared and submitted by Mezgebe Habtu with the regulation of the University and meets the accepted standard with respect to originality and quality.

Name Mezgebe Habtu

Signature_____

Names and Signatures of the Examining Board:

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2.	_____(Examiner)_____		_____
3.	Prof. Legesse Negash (Advisor)_____		_____
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Abstract

Wild and semi-wild edible plant species (WSWEPs) are important resources in combating food insecurity. The present study was conducted to identify and document WSWEPs and to assess their role in food security in Kilte-Awulaelo Wereda, Eastern Zone of Tigray. Data were collected using semi-structured interviews, group discussions, guided field observations and local market surveys. A total of 66 respondents were selected by means of simple random and purposive methods. A total of 30 WSWEPs were identified and documented. Of these 3, 2, 2, 2 and 16 species belonged to *Ficus, Cyperus, Ziziphus, Rumex,* and others, respectively. These species were distributed in 22 different families, including Polygonaceae, Rhamnaceae, Rosaceae, Cyperaceae, Moraceae and others. *Cordia africana* Lam., *Opuntia ficus-indica* L., *Ziziphus spina-christi* L., were found to be highly popular species cited by the respondents. WSWEPs are consumed in the mode of non-cooked, cooked, and dried. The present study found that WSWEPs in the study area were threatened by anthropogenic factors including agricultural expansions, overgrazing, selective harvesting and construction. WSWEPs are mainly harvested in spring and summer seasons, and the most frequent gatherers and consumers are children, entire households, youngsters and poor members of the communities. The frequently consumed parts of WSWEPs were found to be fruits (66% of the total WSWEPs), while the remaining edibility is attributed to various plant parts, including flowers, leaves and stems. WSWEPs of the studied area were composed of trees (53.3%), shrubs (33.3%) and herbs (13%). Main sources of knowledge for the studied WSWEPs were reported to be grandparents (34.9%), parents (27.3%), self-taught individuals (19.7%), churches and schools (18.7%). The study found that WSWEPs are mainly conserved in home gardens as live fences, in farm land peripheries, as well as in protected areas such as churches. We recommend that, along with sustainable utilization and conservation of the existing germplasm, of *Cordia africana*, *Opuntia ficusindica* and *Ziziphus spina-christi* require urgent selection, domestication, propagation and cultivation.

Keywords/phrases:-Consumption, Managements, Marketability, Multi-purpose, Threat factor

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Table of Contents

List of figures

List of tables:-

List of Appendices

List of Acronyms

CIDA = Canadian international development agency

CRS = Catholic relief services

CSA = Central statistical Agency

FAO = Food and agricultural organization

IBC = Institute of biodiversity conservation

SNNPR = Southern Nations and Nationalities and people Regional state

USAID = United State and Agency for International Development

M.A.S.L. = meter above sea level

MoARD = Ministry of Agriculture and rural development

WSWEPs = Wild and semi-wild edible plants

Chapter one

1. Introduction

1.1 Background

Wild food is considered as all the non-domesticated plant and Animal resources that are collected and hunted from forests, fallow land and farm lands for the purpose of human extensive meal and semi-wild refers to partially wild (Menendez-Baceta *et al.,* 2012) .Wild and semi-wild food plants (WSWEPs) have significant cultural, biological and economic value at local, regional and national levels (Agea *et al*., 2013). People who utilize WSWEPs to meet these needs often rely on organized exchange systems to obtain those (Scoons, 1992).

Indigenous people throughout the world have their own distinct linguistic, cultural values and beliefs. Similarly the rural people of Ethiopia have deep knowledge about the names and classification of their environment plants species in their surroundings and their value for the local people. Wars and times of famine were periods when the knowledge of such plants is especially important for communities (Guinand and Dechassa Lemessa, 2000). Most people have the knowledge of wild edible plants are acquired through, observation, imitation and oral history from older and transferred through, songs folklore and riddles in local language at different time.

Some studies in Ethiopia indicated that many rural people are endowed with deep knowledge on how to use plant resources, However the level of knowledge differ by cultural identity, economic status, educational level, age and sex (Birhane Kidane *et al*.,2014). The rapid decline of traditional knowledge about wild edible plants is due to: the appearance of industrial agriculture and modern food industry, associated with shifts in dietary, habits and preference of food, negative perceptions of WSWEPs, time of consumption associated with WSWEPs collection, and lack of interest among young generations (Ladio, 2001).

Ethiopia is a country with a land of different nations, nationalities and groups that have their own food materials, food habits, cultures and values; therefore people in rural area of Ethiopia has indigenous knowledge on preparation, consumption and side effect of WSWEPs (Balemie and Fassil Kebebew, 2006). However the level of knowledge differ by cultural identity, economic status, educational level, age and sex (Berhane Kidane *et al.*, 2014).

Wild edible plants can consume trough the mode of cooked, raw/fresh, nectar, and barks as well as eating the different parts of edible plants. WSWEPs species, also seen as medicinal substances having their own qualities and influence, which originate from their elementary

Composition and form other criteria related to plant place of growth, intrinsic nature. So wild food plants, including in the category named as life sustaining diets can be used to neutralize different types of diseases (kakudidi, 2015).

The farmers in Tigray Regional State faces a number of challenges or tests including deforestation, drought, land degradation, food insecurity and climate change (MoARD, 2007) which result in serious food insecurity among the households. Thus, in most cases, rural communities depend on wild edible plants (Lulekal *et al.*, 2011) due to easy accessibility. Given climate change, level of poverty and environmental degradation there are high increased risks of biodiversity loss at large scale food insecurity.

Full studies on WSWEPs are required for full conservation of these natural resources and the indigenous knowledge of rural communities (Abraham Demekiristos, 2016). Unfortunately there was no botanical studies had been previously carried out in Kilte-Awulaelo Wereda Eastern Zone of Tigray Regional State. The study area is one of the unexplored parts of the Regione and that is why research is so crucial in the area which would help to identify as well as conserve these resources and the knowledge of the local community. Finally both saving WSWEPs species, documenting and preserving indigenous knowledge are fundamental urgent issues in the study area.

1.2 Statements of the problem

WSWEPs have multiple functions like shelter, medicine, source of oxygen, live fences, recreational value, and other benefits to the locale people and other life (FAO, 2004). However, the WSWEPs in the wereda are affected by the major natural factors and continuous human threats such as: Erosions, drought, and population growth, deforestation, construction, urbanization, and mode of life style, overgrazing and land degradation. Based on these threats WSWEPs were not considered as food of educated people or modern life styles and the eating habit of local people changes from time to time and knowledge transfer to the coming generation is losing gradually. In response to this problem, the research aimed to conserve the loss of biodiversity.

The main purpose of the present work is specifically to identify, assess and document indigenous knowledge related to the use and management of the most endangered WSWEPs through multi stage sampling technique. Before this collection, no special conservation action, and/or data documentation of indigenous knowledge of WSWEPs of the area have been under taken in the study area.

1.3 Research questions

- What are the WSWEPs and who collects them in the study area?
- What parts of the plants are edible and how these collected, prepared and consumed?
- What are the threats and traditional conserving measures of WSWEPs in the district?
- Who has more knowledge on WSWEPs?
- Which WSWEPs are highly marketable?

1.4 Objectives

1.4.1 General objective

The General objective of the present work was to: document indigenous knowledge related to the use and management of WSWEPs and to assess conservation potentials for the future in Wukiro Kilte-Awulaelo Wereda, Eastern Zone of Tigray Regional State.

1.4.2 Specific objectives

The specific objectives of the present work were

- To identify WSWEPs, and develop an in-depth understanding of the role of indigenous knowledge and usage in improving the unsustainable harvesting of WSWEPs and document these by the communities.
- To identify parts of WSWEPS, method of preparation and mode of consumption
- To identify gaps in knowledge of the community on WSWEPs.
- To assess the major threats and conservation methods of WSWEPs, and to identify the linkages including these to the communities' socio-cultural, nutritional, and marketing and other factors that contribute to WSWEPs strategies.

Chapter two

2. Literature review

2.1 Wild and semi-wild edible plants: their status and their benefits

2.1.1 Status of WSWEPs in the world

Wild and semi-wild edible plants are plants that grow in natural or semi-natural ecosystems and can exist with no direct human action and semi-wild refers to plants that are partially wild and are gifted with one or more parts for food (Menendez-Baceta *et al.*, 2012). In some areas it may grow wild, while in other areas it can be protected and managed by farmers. Many WSWEPs can be found in different cultivation stages. This results from human selection (Heywood, 1999). Those WSWEPs include roots, shoots, leafy greens, fleshy fruits, nuts, grains, seeds and other species. Cultural knowledge is important for the harvest and preparation of these plants (Turner *et al*., 2011). Investigation on WSWEPs is characterized by their multidisciplinary, involving nutrition, ethno-botany, medicine, anthropology, analytical chemistry and phytochemistry (McBurney, 2004). While food research and policy tend to distinguish between wild and cultivate foods, local communities rarely consider these terms separately (Bharucha and Pretty, 2010).

All over the world, the decline in the habits of wild edible plants caused the loss of the knowledge and the natural habitats of WSWEPs (MoARD, 2007). Altitude, rainfall, temperature and soil types are important in distribution of WSWEPs (Dogan and Ugulu, 2013).

2.1.2 Cultural identity

Concerning benefit for cultural identity for the communities that traditionally use WSWEPs, this often represents a key element of their culture and a link with the land of origin (Pilgrim and Pretty, 2010). Cultural identity and agro biodiversity are strongly linked (Howard, 2010).

2.2.1 The role of WSWEPs in food security and during the time of famine

The role of WSWEPs as a supplementary to nutritional requirements, coping food shortages and emergency, Since a long time wild foods have been a hidden harvest to farmers. Many WSWEPs can be found within or around their fields (Bharucha and Pretty, 2010). According to several studies of WSWEPs, populations can become heavily dependent on the

free, readily accessible in times of food insecurity due to natural or man-made disasters. This association led to the development of the term famine foods. The potential importance of WSWEPs during times of low agricultural productivity is also rooted in their innate resilience to short-term climate change. Exotic species are often not that resilient as reported by Fantahun Mengistu and Hager (2009). Even if WSWEPs cannot completely bridge the gaps of demand and Food insecurity in many rural region of the world was caused by deforestation, drought and climate change. Thus, rural communities are dependent on WSWEPs to meet their nutritional needs and income (FAO, 2004).

Famine food plants are only eaten at time of food stress (Guinand and Dechassa Lemessa , 2000). For instance WSWEPs in Mexico were harvested and consumed when household cultivated food crops were decreased (LaRochele, 2003). The WSWEPs are consumed at time of starvation in Libo Kemkem (Getnet Chekole, 2011). In India most of the rural people depend on WSWEPs to fulfill their needs in period of food crisis (Rana *et al*., 2012). Similarly in Botswana, Wolayta of North Omo Zone indigenous vegetables secure the food gap for rural communities (IBC, 2012). Based on the report of CIDA (2010), showed in Niger, 83% of informants reported that increased number of dependent on WSWEPs food during the drought time as well as in Tanzania, wild foods were consumed more in food insecure season. According to Akinnifesi, (2004) report 60-80% of the rural people in South Africa was encountered food shortage for 3-4 months in a year and consumes WSWEPs to survive the problems. Accordingly in Botswana around 1500 WSWEPs are consumed all the time or particularly during famine. The use of wild food increased from 10% in normal time up to 40% in famine period (Dandena Gelmesa, 2010). In addition to this as Zemede Asfaw and Mesfin Tadesse (2001) reported that 15% of WSWEPs were used during the famine period as a foods in Ethiopia. The most common and well-known typical famine food plants in south Ethiopia like *Balanites aegyptiaca, Cyperus bulbosus and Urtica simensis* (Dechassa Lemessa, 2001). The role of WSWEPs like *Ziziphus spina-chrsti* and *Balanites aegyptiaca* were important in fruits in reduction of poverty to reach 42% and 26% respectively in south of Kordofan (Adam, 2011). WSWEPs were also consumed at normal time to supplement, war and other hardship (USAID and CRS, 2000). In its state of food insecurity in the world report estimated that around one billion people use wild plants in their diet (FAO, 2009)..

2.3 Economic value and marketability of WSWEPs

Local people of the world do not collect WSWEPs not only to directly use as food source, but also they were gathered to increase income of the communities through sales (Debela Hunde *et al*., 2011). The market use of WSWEPs was influenced by type of species, income status of the community, geographical location of the area and price (Berhane Kidane *et al.*, 2014). WSWEPs were equally collected from their natural habitats and the income gained is for individual use but if they were from home garden of the individual, they were only be used by the owners (Rana *et al.*, 2012). The sale of WSWEPs fruits was found to contribute to 50-60% and 75-100% of the total annual family income in Wad-Abib, Abu-Karshola and Rashad (Salih and Ali, 2014). The fruit or seed of some WSWEPs were used for more complex use in other countries, for example the seed of *Balanites aegyptiaca* are crushed and the kernels are boiled with water to extract oil for cooking purpose in Sudan (Salih and Ali, 2014).

In Ethiopia as a whole and particularly in the study area a number of WSWEPs have economic value and are traded in markets in certain areas for example *Opuntia ficus-indica* L., *Ziziphus spina-chrsti* and *Ximenia americana* in Tigray region. In addition fruits of *Cordia africana* Lam. and *Ziziphus spina-chrsti* L. are also on market in Jana Mora district. The widely sold wild species at local level are *Opuntia ficus-indica, Balanites aegyptica, Ximenia americana* L., *Carissa spinarum* L., *Balanites aegyptiaca and Prunus persica,* where as *Ziziphus spina-chrsti* is marketed at national level while *Balanites aegyptiaca* is marketed internationally (Guinand and Dechassa Lemessa , 2000). The economic or multipurpose use of *C. africana* is for food, medicine, building, house hold use, agricultural tool, fuel wood, and fodder as well as income generation. *X. Americana* L. and *C.spinarum* L. are marketable in Tsemay and Benna distict (Assegid Assefa and Tesfay Abebe, 2011). The oil from the seed of *X. americana* is also used as cosmetic (Debela Hunde,*et al.,* 2012). WSWEPs also have several indirect benefits such as sources of genetic diversity encourage agro forestry practice in dry land areas habitat for different organisms. Rehabilitation of degraded lands soil and water conservation as well as provide adaptation to climate change (IBC, 2012).

2.4 Edible parts and habitats of WSWEPs

Wild edible plants are plants with one or more parts that can be used for food (Kalle and Soukand, 2012), reported that the edible parts of WSWEPs were leaves, roots, flowers, barks, fruits stems and inflorescence. Most local people consume fruits and fresh leaves immediately from collection area (Tena Regassa *et al.,* 2014). In contrast Sansanelli and Tassoni (2014) in Uganda and Italy reported that leaves were the most used parts of the plants as food followed by fruits. Edible parts of WSWEPs are leaves, whole parts, rhizomes, fruits leaf petiole in Turkey (Debela Hunde,*et al.,* 2012). The dominant edible part in Bulgaria is leaves (Nedelcheva, 2013).

In many part of Ethiopia, different parts of trees and shrubs are often consumed fresh by children, herders and hunters (Fantahun Mengistu and Hager 2008). Fruits were the most commonly used parts of WSWEPs while the others were the least used parts (Mekuanent Tebkew *et al.,* 2014.). In addition in other country like Obalanga sub-country fruits were the major plant parts consumed (Ojelel and Kaudidi, 2015). In other countries like Poland studied by Lentini and Venza (2007), reported that fruits were the second most important plant parts used.

The habitat types, of WSWEPs on the land are found in short supply due to the high population in most highland areas of Ethiopia. High population has lead to environmental degradation and many highland areas have lost their biodiversity. The WSWEPs species are found in home garden, farmland, roadside, church and in forest in Ethiopia and India (Getnet Chekole, 2001). Of the habitats of the WSWEPs, forests were 102 species, woodland 99 species, and grassland 83 species, bush land 52 species rocky and dry areas 47 species, cultivated places 41 species respectively and followed by riverbanks and roadside 31 species as reported by Zemede Asfaw and Mesfin Tadesse (2001).

2.5 Mode of consumption and habit of WSWEPs

Wild and semi-wild edible plants were consumed in non-cooked, cooked and dried mode as reported by Getachew Addis (2013). Most of the WSWEPs species were eaten immediately from their collection areas as Nedelcheva (2013).

The majority of wild and semi-wild edible plants as reported by Tena Regassa (2014), were consumed as fruits, in the form of fresh or dried and the leafy vegetables were consumed as cooked or boiled in Chelia district. The consumption of many WSWEPs was strongly linked to livestock, charcoal burns, herders and field workers, and children as reported by Mekuanent

Tebkew (2015). Based on the habits WSWEPs are classified as trees, herbs, shrubs and climbers (Getachew Addis *et al*., 2013).

2.6 Nutritional potential of WSWEPs

Thousands of species of WSWEP fruits, leaves, seeds, roots and tuber are consumed as food world wid. Some of these WSWEPs are used as primary food sources for indigenous people, while others are used as secondary condiments in dishes prepared from domesticated cultivars (Grivetti and Ogle, 2000). These plants play an important role as a source of energy and micronutrients (Afolayan and Jimoh, 2009).

In developing nations, numerous types of WSWEPs are exploited as sources of food, because these species provide that an adequate level of nutrition to the residents. These wild food sources can also be termed as wild vegetables because they are nutritionally viable and have the ability to grow in the wild and semi-wild. They are important elements of natural ecosystem and agriculture because they have necessary nutritious qualities such as micro and macronutrients, vitamins, proteins, fats, and fiber content as well (FAO, 2004). These are often considered as green factories that nature has provided us, and since ancient times they are playing role in improving human health as well as in maintenance of balance agricultural productivity. The dietetic values of edible wild and semi-wild plants are prevention of malnutrition and contribution to food security (Getachew Addis, 2013).

The current consumption pattern of wild and semi-wild edible plants enabled getting high nutritional value from the plants without altering the chemical nature of fruits. The consumption of wild and semi-wild edible plants for biological security of food sources and prevention of malnutrition are tested they increase diversity of income, food, and healthcare system. Hence, increase biological insurance for food and local healthcare system being year round available. The different parts of lots of edible wild and semi-wild plants are still consumed for their dietary value in many communities around the globe. Based on local uses WSWEPs are cooked as vegetable, eaten as fruit, drink as nectar, prepared as pickle and use as spice (Getahun, 1974). These plants play an important role as a source of energy and micronutrients (Afolayan and Jimoh, 2009).

Malnutrition is a major health burden in developing countries, and the recognition that nutritional security and biodiversity are linked is fundamental for enlisting policy support to secure wild food use and preserve habitats for wild edible species. Comprehensive food

composition data is a critical first step. This is especially important for communities most vulnerable to malnutrition. However, understanding of wild foods' micro and macro-nutritional properties currently lags behind that of cultivated species (MoARD, 2009).

2.6.1 Source of income

WSWEPs also have another safety net function in terms of money earned from their sale for poor communities. This is especially important in isolated regions without insurance mechanisms, but with high price health and environmental risks. According to several studies wild fruits are an important source of income through commercialization. Even though there are no global estimates of the economic value of wild foods, there is no doubt that their use and trade becomes important during economic hardship (Bharucha and Pretty, 2010). These days an increased attention on the contribution of wild foods to rural livelihood and poverty reduction can be observed. In some communities in southern Africa, the sales of WSEPs can accounted to 50% of the total net income (Wiesum and Shackleton, 2005).

2.6.2 Diverse uses

WSWEPs provide both direct uses like supplying fuel wood, timber, fibers, foods and medicine as well as indirect uses like: balancing carbon dioxide concentration, and protecting erosion to human beings. WSWEPs are also offer an alternative source of cash income for poor communities and used as medicine, spice, building material, tools, nectars and for chewing (Bharucha and Pretty, 2010). They can also be used as fodder and fertilizer or for crop pollination and pest and predator control. The wild relatives of cultivated plants offer genetic diversity that can be applied in crop improvement (Ju *et al*., 2013).

2.7 Harvesting seasons and main gatherers of WSWEPs

Time and frequency of harvesting of WSWEPs depends on the plant parts and varies from place to place (Balemie and Fassil Kebebew 2006). Our knowledge of plants today is the result of the historical property of our ancestors, who learned based on experience by trial and error (Agea *et al*., 2011). There are several species occurring widely and collected and being consumed from various sources according to their availability (Singh, 2011). WSWEPs were important as food in the dry season and at the beginning of the rain seasons (Birhane Kidane *et al.,* 2014). Similarly Mekuanent Tebkew (2015), reported that the edible plant parts were gathered from the wild at different time of the year and the majority were gathered and consumed from March to May and from August to November in Chliga. As Jeeva (2009),

reported that flowering of majority of WSWEPs starts between January and March; however, the fruiting time varies from species to species. For instance *Opuntia ficus-indica* and *Carissa spinarum* were harvested during the rainy season/July, August and September/ but *Balanites aegyptiaca* and *Ximenia americana* are harvesting in February, April and May. In Spain wild fruit were mainly harvested at the end of the summer and autumn (Tardio *et al*., 2006). The main gatherers of WSWEPs were women, children followed by men and all household members respectively as Birhane Kidane *et al.(*2014) reporte showed. The study of Jeeva (2009), reported that mostly women and children were main gatherers of WSWEPs. Demele Teketay (2010), reported that in normal time collection of WSWEPs is mainly carried out by children, livestock herder, youngsters and poor communities. Many of the WSWEPs are eaten outdoor in agricultural fields, during cattle keeping and travelling (Getachew Addis, *et al.*, 2013).

2.8 Threat factors for accessibility and use of WSWEPs

Some of the reasons for the limited availability of wild foods are changes in land use, loss of local ecological knowledge's which is important for identification, collection and preparation of wild foods, lifestyle changes, urbanization, large-scale farming and lesser contact with nature and many other reasons (Luzaj, 2011). The factors that increase the utility of WSWEPs are food insecurity caused by drought, land degradation and climatic changes (Assegid Assefa and Tesfay Abebe, 2011). However, as Mekuanent Tebkew (2015) reported that utility of WSWEPs reduce that when feeding habit changes, cultural ignorance occurs, difficult for collection (climbs), under-valuation and, uncontrolled fire setting as well as unsustainable use of traditional WSWEPs species were happened. As Bharuch and Pretty (2010) reported that the main hinderers to use WSWEPs worldwide are declining of availability, local people perception as being food for poor, loss of knowledge, high work load to collect, process and prepare. As Menendez-Baceta, *et al.(* 2012), reported that WSWEPs are considering as old fashion or food of old people as well as too time-consuming and famine food. In normal time only children, youngsters, women and the poorest families gather and consume WSWEPs (Zemede Asfaw and Mesfin Tadesse, 2001).

According to Guinand and Dechassa Lemessa (2000), dependence on some limited cultivated crop, modernization culture and religion are factors influence in utility of WSWEPs. (Bharucha and Pretty, 2010), reported the main constrains to use WSWEPs worldwide declining availability, local people perception as being food for poor, loss of knowledge, high work load to

collect, process and prepare. (Menendez-Baceta, *et al.,* 2012), also reported that considering as old fashion or food of old people, too time-consuming, famine food, in Gorbeialdea. In normal time only children, youngsters, women and the poorest families gather and consume WSWEPs (Zemede Asfaw and Mesfin Tadesse, 2001).

2.9 Conservation measures of WSWEPs

Conservation is defined here as; the management of human uses of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration and enhancement of the natural environment. WSWEPs are important to house hold food security, income generation and others. It is essential that the natural habitat make, appropriate protection and managements to avoid the destructive factors of the WSWEPs species (Dbela Hunde, *et al* 2011). WSWEPs species are conserving in home garden as live fence, farm land and protected areas and understanding the role of WSWEPs are necessary. For natural resource management, sustainable use and even increases their positive impact (Fantahun Mengistu and Hager, 2009). Conservation measures in Libo Kemkem district were the natural forest and thse were protected by the local communities in collaboration with the government as well as planting the threatened plants in their home garden and enclosure in their natural habitat (Getnet Chekole, 2011). Simiarly as (Ojele and Kakudidi 2015) reported that the conservation measures recorded in Obalanga showed that trees around home garden, school and churches were free areas from fire and regulation of cutting.as (Arenas and Scarpa 2007), elaborated that conservation measure of WSWEPs includes agro-forestry; tree around homesteads, school and churches, protection from fire and regulation of cutting in Chorote Indian, Gran chacho and Argentina. The knowledge and benefit of these edible plant species increase community interest in conservation. But this neglects species with little known values and yet they could become very useful with increase in our knowledge and technology (Birhane Kidane *et al.,* 2014). Based on this Getnet Chekole (2011) reported that strategy for preventing threats to WSWEPs and medicinal plants as increase awareness of people to use wise native edible and medicinal plants. Encourage the population to plant trees and protect natural regeneration as well as formulation of rules is very important conserving methods.

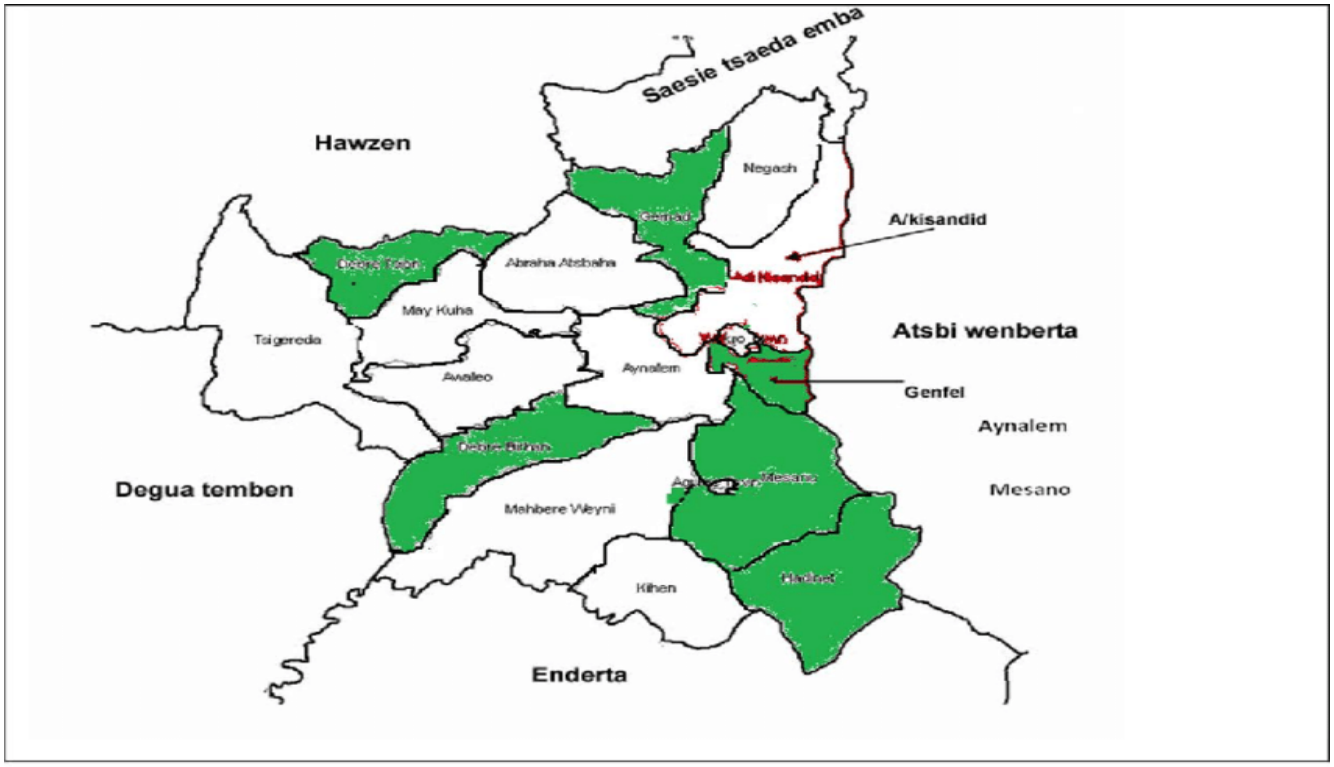
Chapter Three

3. Materials and methods

3.1. Description of the study Wereda and population

3.1.1 The research site description

The present study was conducted in Wukiro Kilte-Awulaelo Wereda of the Eastern Administrative Zone in Tigray Regional State. Kilte-Awulaelo Wereda is located at about 825 km ($12^0$55 N and $39^0$06 E) north of Ethiopia's capital city, Addis Ababa, and its altitudinal range is between 1,900 and 2,500 m.a.s.l. The Wereda is composed of 18 administrative *kebeles* (Note: A *Kebele* is the smallest administrative unit in Ethiopia). The Wereda shares borders with the Weredas of Hawzien and Seasie-Tsaedamba in the north, Atsbi Womberta in the east, Doga-Tembien in the west and Enderta in the south.



Source: Kilte-Awlaelo *Woreda* Office of Finance and Economic Development, 2016

Figure 1. Map of Wukiro Kilte-Awulaelo and its boarder Weredas, in Tgiray Regional State

The Wereda covers an area of 101,758 hectares, of which 21,620 farmlands, 7,930.85 grazing areas, 44,134 enclosure areas and 28,073.15 hectares are occupied by hills and residential areas (Kilte Awulaelo Plan and Finance Office, unpublished data, 2010).

3.1.2 Climate

According to 2001-2010 rainfall data, the Wereda has a high rainfall distribution between July and August as well as a smaller in March and June. The mean monthly and annual rainfall of the Wereda is 50.14 mm and 601.68 mm, respectively and the air condition is weyna dega. (National Metrological Service Agency, Mekelle Branch Office, unpublished data)

3.1.3 Demography

Based on the population census of 2007 by the Ethiopian Central Statistical Agency (CSA), the total population of the Wereda is 99,708 of which 45,602 (48.89%) are males and 54,106(51.11%) are females. Tigrigna is the official language of the community in the Wereda.

3.1.4 Vegetation cover

The area was covered with many vegetations of different indigenous species .According to the local community the natural trees are exploited and deforested by the people for the purpose of house construction, wood charcoal, land agriculture as well as for house materials, and animal foods. The Wereda contains natural high tree-plants, bushes, shrub spots agricultural plots and settlement areas. Most part of the land is dominated by *Becium grandiflorum, acacia etbaica, Ziziphus spina-christi,* and *Cordia Africana* and *opuntia ficus-indica*.

3.1.5 Farming system

The farming system of the community is mainly crop cultivation, namely: barely, wheat, teff, bean, pea, maize and sorghum growing on the rainy seasons. In addition to this live stock maintenance are available in the Wereda, such as: poultry, cattle, honey bees, goats, and sheep. Of these poultry has the population, estimated to be 62,610 heads, followed by cattle (61,864), goats (56,042), and honey bees (54,217) as reported by the MoARD (2007).

3.2. Study Methods

3.2.1 Site selection

A reconnaissance survey of the study area was done from October 01 to 30, 2018, before conducting field studies, basic information was exploring from the administrative *kebeles*, agricultural experts, as well as local leaders and knowledgeable local peoples. This gave me general information to identify the study sites. Accordingly, a total of 3 *kebeles* (study sites),

namely: Abrha-Atsebaha, Agulae and Tsigereda were selected for data collection purposively. Study *kebeles* were selected based on existing vegetation types, natural resource managements, and indigenous knowledge on wild plants, as well as practices associated with conservation.

3.2.2 Informant selection

After selection the study sites, a total of 66 informants (40 males and 26 females) aged 22-72 were selected. A total of 22 individuals were selected from each study *Kebeles.* Out of this, 12 key informants were purposively selected from each study sites by using the information and recommendations from the *kebelle* agricultural officials, knowledgeable peoples, religious and local leaders as well as the local communities. The remaining 54 informants were selected by random lottery method. In the study, only a few women were participate, due to lack of permission from their family, husband or other socio-cultural reasons. Sample size was calculated using the equation of Cocharn's (1997) as indicated by Bartlett and Higgins (2001)

$$n = \frac{N}{1+N(e)2}$$ Where:-

n=is number of informants (sample size)

N=is the total number of population of the wereda

e=Confidence interval (5% /)

1=probability

3.2.3 Data collection methods

The research applied both quantitative and qualitative methods to clarify concepts, descriptions and measures as well as to demonstrate implications of the issue under question. Data were collected through, semi-structured interview, guided field observations, focused group discussion, informant consus and Market survey with randomly picked and key informants were applied based on a check list questions. All inter viewees were prepared in Tigrigna and translated to English and conducted on a 'one-to-one' basis and asked the same standard (open and close ended) questions using the local language (Tigrigna), based on their permission, including explanation or clarifications as needed.

3.2.4 Market survey

Market assessment of underutilized edible plants was conducted in Wukiro, Agulae, Abrha-atsibha and tsigereda local markets, which are the nearest markets to the study sites to assess market availability of edible plants. All encountered plants were identified and recorded by their vernacular names. Later, converted to their botanical names using flora of Ethiopia and Eritrea (Hedberg and Edwards, 1995) and own experience and internet as well as asking agricultural experts and higher ranking staff mates.

3.2.5 Group discussion

A focused group discussion was also conducted at each study site to verify the data and identification of plants. All wild and semi-wild edible plants listed in the socio-economic survey were verified and personal ideas (ideas only raised by one individual and were rejected by the group discussion) were removed from the data. To cross-check the recorded plants, there were three groups in each *Kebele,* which consisted of four individuals that included community leaders, knowledgeable persons so. The numbers of discussions conducted were three per study site.

Figure 2. Photos showing group discussion of key informants in the selected study *kebeles*

3.2.6 Field observations and interviews

Repeated field observations were also conducted using transect walk where most of the WSWEPs are grown/cultivated. The purpose of the field observation was to obtain actual information of occurrence, growth habit, habitat characteristics and identification of edible plant species mentioned during the interviews. WSWEPs, as well as data were collected by walking through the forests, churches and home gardens in the selected study areas.

3.3 Data analyses

The data collected through semi-structured interview, guided field observations and unstructured or informal open-ended discussions were analyzed using percentages and descriptive statistics. The scores given to each species as the preferences of the informants were recorded and ranked. Analytical tools such as direct matrix, pair-wise comparison and preference ranking were used for comparing the results. Short descriptions of each of the analytical are provided below.

3.3.1 Preference ranking

Indicates the relative importance of items; it can be used to identify, list and prioritize problems and possible solutions and is important to decision making as described by (Martin, 1995)

3.3.2 Direct matrix ranking

Communities multiple uses of selected species were evaluated according to (Martin, 1995). To achieve this; direct matrix ranking was used to assess the relative importance of WSWEPs to the local communities.

3.3.3 Pair-wise comparison

Pair-wise comparison was applied to determine the most factors that threaten WSWEPs based on the information received from the informants.

3.3.4 Informant consensus

This method was used to confirm the validity and reliability of information given by the informants on the wild and semi-wild edible plants recorded during the interview. This was carried out by contacting the key informants, focus group discussions more than once for the same issue and the reliability and validity was checked and recorded. This ensures whether or not the idea of the informant was the same. When the idea of the key informant differed from the original information, data were rejected; only the accepted ones were taken into consideration and were analyze according to Alexiades (1996)

Chapter Four

4. Results

4.1. Number of WSWEPs species used in the study area each families

The present study indicated that the numbers of plant species used as a source of food vary from family to family (Table1 & Appendix 4). Polygonaceae, Moraceae and Rhamnaceae contained the highest number of species with 3 species (10%) each, followed by Rosaceae, as well as Cyperaceae, represented by 2 species (6.67%) each. The other remaining 17 families were represented by one species (3.33%) each (Table 1). The study also illustrated that the number of plant species belonging to each genus vary from genus to genus (table & Appendix 4). In the study area *Ficus* contributes the highest number of species consisting 3 (10%) and followed by *Cyperus*, *Rumex* as well as *Ziziphus* each represented by 2 species (6.67%).

Table 1. Number of plant species belonging to each family and genera with their corresponding percentages and ranks in the study area

Name of families	**No of species**	**%**	**Ranks**	**Name of genera**	**No of species**	**%**	**Ranks**
Polygoneceae	3	10	1	*Ficus*	3	10	1
Moruceae	3	10	1	*Cyperus*	2	6.7	2
Rhamnceae	3	10	1	*Rumex*	2	6.7	2
Rosaceae	2	6.7	2	*Ziziphus*	2	6.7	2
Cyperaceae	2	6.7	2	Others	21	3.3	
Others	17	3.3					_
Totals	**30**	**100**		**Total**	**30**	**100**	

4.2 Habits of WSWEPs in the study area

The current findings revealed that growth habits of WSWEPs of the study area were dominated by trees 13 (43.3%), and the other remaining showed in (Figure 2).

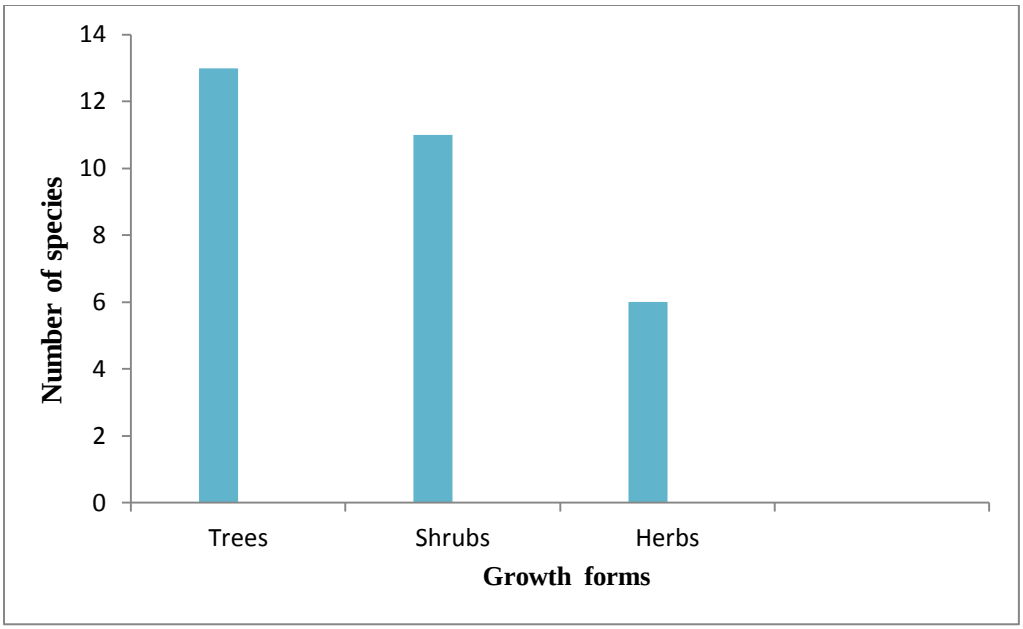


Figure 2. Growth forms of WSWEPs found in Wukiro Kilte-Awulaelo Eastern Zone, Tigray Region

4.3. Main sources of knowledge and taxonomic diversity of WSWEPs in the study area

The result showed that WSWEPs were reported to be grandparents (34.9%), parents (27.3%), self-taught individuals (19.7%), churches and schools (18.7%). Are main source of knowledge in the study area. A total of 30 WSWEPs species were recorded under 25 genera and 22 families (Appendix 3).

4.3.1 Harvesting periods and consumption times of WSWEPs

Most WSWEPs were ripened and collected in spring season 10 (33.3%) species and followed by autumn 9 (30%). The remaining were ripened and collected during winter (December-February) 5 (16.6%), summer 4 (13.3%) as well as 2 at any times (6. 67%) species were harvested (Table 2).

The result of this study showed that WSWEPs play an important role in maintaining food security (Table 2). In the study area, about 27 (41%) and 25 (37.8%) of the respondents mentioned that WSWEPs species were consumed during the famine/drought situations to fill food gaps and at normal and drought times respectively. Also 14 (21.2%) of the respondents consume during the normal time for supplements.

Table 2. The number of species, harvesting seasons as well as consumption times of WSWEPs, corresponding to their percentages in the study area

Harvesting seasons	No. of species	%	Consumption times	No. of respondents	%
Spring	10	33.3	Famine/Drought	27	41
Winter	5	16.7	Normal time	14	21.2
Summer	4	13.3	Normal &Drought	25	37.8
Autumn	9	30.0	**Total**	**66**	**100**
Any time	2	6.7			
Total	**30**	100			

Key: Autumn = September, October and November. Summer = December, January and February. Spring = March, April and May. Winter = Jun, July and August

4.3.2 Main gatherers and consumers of WSWEPs species

The result of the current study indicated that the main gatherers of the recorded WSWEPs were children and herders 40 (60 %), youngsters 11 (15.5 %), low income or landless peoples 8 (13 %) and by the remaining others (Figure 3). Most of the recorded edible plant species were consumed by children 22 (78.57 %) species but 6 (21.43%) were consumed by all communities and 2 by others. The various age group communities are participating in the gathering of the ripen plants and consumed by all peoples.

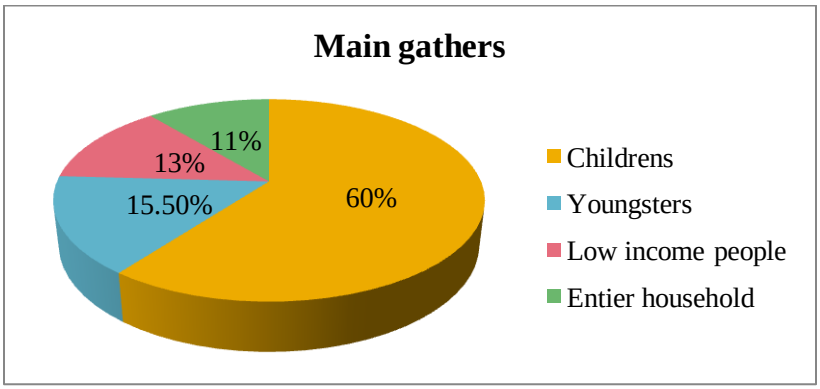


Figure 3. Main gatherers of WSWEPs in Wukiro Kilte-Awulaelo Wereda, Eastern Zone Tigray Region

4.3.3 Challenges (problems) of collection of WSWEPs in the study area

The result here shows that consumption of WSWEPs was affected by deterioration (drop, spoil), easily cultural ignorance, difficulty for collection (climbs) and being choice foods. 24

(36.4%) and 17 (25.7%), 13 (19.7%) and 12 (18.2%) percent of the respondents said that WSWEPs were difficult to harvest in respectively.

4.4. Source and habitats of WSWEPs in the study area

WSWEPs are obtained from different sources. Most of the WSWEPs species were obtained from the various types of habitats. Of these 16 (53.3%) species were found in all habitats, 5 (16.7%) in forests, 4 (13.3) in farm lands, and2 (6.7%) road sides respectively as well as the remaining 3(10%) others (Table 3). Of all the recorded edible plant species *Opuntia ficus-indica, Cordia africana*, *Rumex nervosus* L and *Ziziphus spina-christ* L. were widely distributed However, *Ficus vasta* Forssk, *Rumex*, *Ficus sur* Forssk have low distribution in the area, they were found in home garden or church or other enclosed habitats. However, others like *Ximenia americana* and *Euclearacemosa.*Murr. (ADC) were found in the forest only.

Table 3. Sources, number of species and corresponding percentage of WSWEPs in the study area

Sources	**Number of species**	**Percentages**
Forest	5	16.7
In all habitat	16	53.3
Farm lands	4	13.3
Road sides	3	10
Others	2	6.7
Total	**30**	**100**

4.5. Nature of edible plant parts used as food and mode of consumption.

4.5.1 Parts of WSWEPs used as food

The edible plant parts consumed by the local community include fruit 20 (66%), and followed by leaves and flowers 2 (6.7%) each, and the remaining other edible plant parts (Table 4).

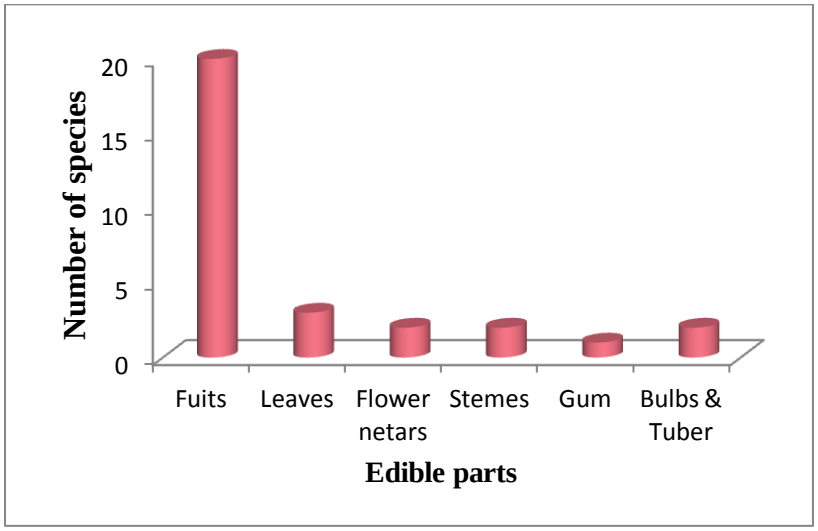


Figure 4. The most commonly reported WSWEP parts and corresponding percent used as food by the community of the study area.

4.5.2 Preparation and Consumption mode of WSWEPs in Kilte-Awulaelo Wereda

In the study area, the local community reported that about 26 (85.7 %) of wild edible plants consumed as fresh (raw), while 1 (3.6 %) of them were consumed by cooked 3 (10.7 %) of them as dried and cooked (Figure 5).

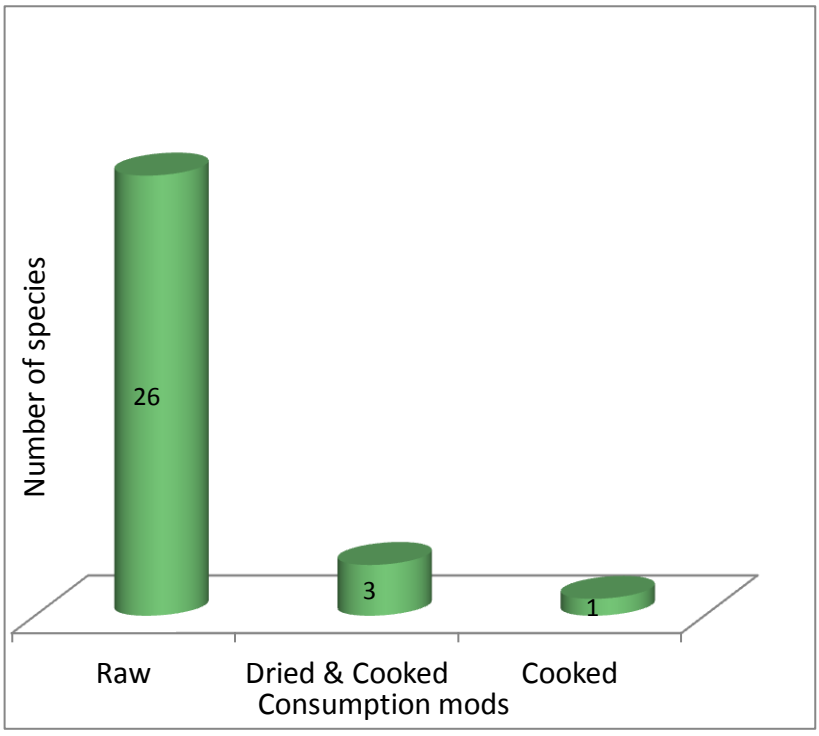


Figure 5. Utilization mode of WSWEPs and corresponding numbers in the present study area

4.5.3 Altitudinal distribution of WSWEPs in Wukiro Kilte-Awulaelo Wereda

The result of the current study showed that the wild edible plant species are distributed in different altitudinal range. Most of the wild and semi-wild edible plant species were harvested from altitude of 1900-2000 m.a.s.l accounting 23 (75%) and followed by 7 (25%), above 2000 m. a.s.l.

4.6. Ranking and scoring

4.6.1 Preference ranking of WSWEPs based on their taste quality in Wukiro Kilte-Awulaelo Wereda

The local people found in the study area have appreciated some edible plants over the other in their taste quality and income source. The result of this study showed that, the most popular preferred species in the study area includes *Opuntia ficus-indica, Cordia africana, Ziziphus spinachrist, Carissa spinarum, Casmiroa edulis* and *Zizphus abssynica* respectively from high to low taste quality .

Table 4. Informants preference ranking of 6 most common WSWEPs based on their taste quality in the present study (5-most preferred, 4-commonly preferred, 3-prefered but not common, 2-less preferred, 1-least and their ranks

WSWEP	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	Sum	Rank
Opuntia ficus-indica	5	5	5	5	5	5	4	5	5	4	48	1
Cordia Africana	4	5	3	3	5	4	4	5	3	5	41	2
Ziziphus spina-christi	4	5	3	3	5	4	5	5	3	3	40	3
Carissa spinarum	5	4	4	4	2	3	4	3	3	2	34	4
Casimiroa edulis	5	4	3	4	3	2	3	3	3	4	34	5
Ziziphus abssynica	2	2	4	3	3	3	3	3	3	2	28	6

Key:R1_R10 (refers to respondent from 1 up to 10)

4.6.2 Direct matrix ranking for multiple uses of WSWEPs in Wukiro Kilte-Awulaelo Wereda

In the present study, 9 commonly reported multipurpose species under 6 use-categories were used for direct matrix ranking exercise. A group of nine key informants were asked to rank with different uses through discussion based on their perceived level of usefulness using numerical scale (0 for no value, 1 for lowest value, 3 low value, 4 middle value and 5 the highest value. Values assigned for each plant were added together to determine its rank. Among the very common WSWEPs plants showed that *Ziziphus spina-christi,* followed by *Cordia Africana, Ficus sur, Carissa spinarum, Ficus vasta* and *Acacia etbaica* were ranked as a multipurpose from the most to the least (Table 5).

Table 5. Direct Matrix ranking of 9 WSWEPs based on multipurpose uses under 6 use categories in Wukiro Kilte-Awulaelo Wereda (5=best, 4=very good, 3=good, 2=less used, 1=least used, 0=no value)

WSWEPs species	**Multipurpose uses categories**							
	Medicine	**Food**	**H.U &chair**	**Cons &Ft**	**Fence**	**Fw &Char**	**Total**	**Rank**
Ziziphus spina-christi.	4	5	3	4	4	5	25	1
Cordia Africana	4	4	4	5	3	4	24	2
Ficus sur	3	2	2	4	3	5	19	3
Carissa spinarum	3	3	4	5	4	2	17	4
Acacia etbaibca	2	1	3	4	3	4	17	4
Ficus vasta	3	2	3	2	3	3	16	6
Opuntia ficus-indica	3	5	0	0	5	4	17	7
Carissa spinarum	2	2	3	1	2	3	13	8
Rhus retiorrhoea	1	1	3	1	3	3	12	9

Key; H.U-house Utensils (such as bowls, strings stick, chair, sofa table, hand spoon etc) CON. and FT: construction and farm tools. (Such as: house floors pillar, door and yolk, stick as well as other instruments) FW and CH – Fire wood and charcoal,

4.6.3 Informant Consensus of WSWEPs

Based on the informants the result of the study showed that some WSWEPs are common or more popular than the others. The WSWEPs that are more popular in the study area listed by more informants were mentioned in (Table 6). The main popular WSWEP species in the study area includes *Opuntia ficus-indica, Ziziphus spina-christi* L *Cordia africana* and *Carissa spinarum, C asimiroa edulis Ficus sur* Forssk (Table 6) from high to low.

Table 6. Top eight popular WSWEPs cited by the informants and their percentages in Wukiro Kilte-Awulaelo Wereda

WSWEPs	**Number of informants Cited the plant**	**Percent out of total informants (66)**
Opuntia ficus-indica	65	98.43
Ziziphus spina-christi	62	93.9
Cordia africana	60	90.9
Carissa spinarum	56	84.8
Casimiroa edulis	44	66.7
Ficus vasta	40	60.6
Ximenia americana	39	59.09
Ficus sur	36	54.5
Aloe megalacantha	25	37.8

4.6.4 Pair-wise of ranking threats of WSWEPs

To check the local community perception on the threatening factors, pair-wise ranking of 6 threat factors were selected with 3 key informants from each site, 15 possible pairs-were made from **n (n-1)/2**, where n-is the number of factors following Martin (1995). According to the participants the main threat factors in the present study ranked as follows agricultural expansion, overgrazing and browsing, firewood and charcoal, construction and farm tools and drought as well as selective harvesting (Table 7).

Table 7. Pair- wise ranking of factors considered as threats to WSWEPs in Wukiro Kilte-Awulaelo Wereda, Eastern Zone of Tigray Region

Threat factors to WSWEPs	**Respondents (R 1- R 9)**										**Rank**
	R1	R2	R3	R4	R5	R6	R7	R8	R9	**Total**	
Agricultural expansion	4	5	2	2	5	5	3	3	2	31	1
Over grazing and browsing	5	4	5	4	1	3	3	2	2	29	2
Firewood and charcoal	5	3	3	3	3	3	1	3	2	26	3
Construction and farm tools	2	2	4	5	3	2	1	2	2	23	4
Drought	3	5	3	3	1	0	1	0	2	18	5
Selective harvesting	1	1	1	1	3	1	2	1	3	14	6

4.7. Conservation measures of WSWEPs in the district

The local people of the study area have traditional knowledge to conserve WSWEPs through traditional knowledge; those plants were conserved in different ways. Most of those plants are conserved in church and school, in live fence and farm land. If the government has not made a good strategic plan to conserve WSWEPs it may lead to extinct of the species of these plants. The major conservation method of the WSWEPs in the current study area and their ranks are given in table 8 showing that Church stands first 25 (37.8%) and live fence second 15

Table 8. The major traditional conservation methods of WSWEPs listed by participants and their ranking in Wukiro Kilte Awulaelo wereda, Eastern zone, Tigray Region

Conservation measures	**Participants**	**Percentages**	**Ranks**
Church and school	25	37.8	1
Home garden (live fence)	15	22.7	2
Farm land	14	21.2	3
Natural forest (protected areas)	12	18.2	4
Total	**66**	**100**	

4.8. Marketability of WSWEPs in Wukiro Kilte Awulaelo wereda

The majority of wild and semi-wild edible plants in the study area are not common to sell in the local market except *Opuntia ficus-indica, Balanites aeygitiaca, Carrissa spinarum, Ziziphu spina-christi, Ximenia americana, Prunus persica* and *Balanites aegyptica* (Table 9).Commonly those edible plants are sold by youngsters (female and male) in the local markets.

Table 9. The most known marketable wild edible plants in Wukiro Kilte-Awulaelo Wereda Eastern Zone, of Tigray Region

WSWEPs	Local name	Parts sold	Units	Sex
Opuntia ficus-indica	Beles	Fruit	Number	Both
Cordia africana	Awuhi	Fruit	Cup	Both
Ziziphus spina-christ	Eigam	Fruit	Cup	Female
Carissa spinarum	Geba	Fruit	Cup	Both
Ximenia americana	Muluo	Fruit	Cup	Both
Rhus retinorrhoea	Gesho	Leaves	Kilo	Both
Balanites aegyptiaca	Mekie	Fruit	Cup	Female

Ziziphus spina-christi

Balanites aegyptiaca

Cordial-africana

Opuntia ficus-indica

Figure 6. Market survey in Agulae, Negah, Tsigereda and Wukiro, near the study area

Chapter Five

5. Discussion, Conclusions and Recommendations

5.1. Discussion

5.1.1 Communities' classification of WSWEPs based on habits/ Growth form

Local communities living in the present study have a long last experience of relationship with each other and with the natural resources that exist there so the local communities classify the wild and semi-wild edible plants in to four categories based on habits, namely Tsahyay (herbs), Hareg (climbers), Qutquat (shrub) and Om (trees). Of these trees and shrubs together make the woody plants were dominant in the study area. Studies elsewhere in Ethiopia also explained in similar way of the current study. As reported by (Endalew Amenu, 2007), the local communities of Ejaji (Chelya) classify their plants into four based on dominating trees and of the plants that cover the lands trees and shrubs were dominant.

5.1.2 Taxonomic diversity of WSWEPs and number of plant species belonging to each family as well as genera in the study area

High number of WSWEP species were recorded and identified in the present study area. A total of 30 plant species that belongs to 25 genera and 22 families were identified and documented as a source of food (Appendix 3). In line with this study 30 plant species were identified in Bena Tsemay district in the semi-arid low lands of southern Ethiopia, as reported by Tesfay Abeb (2011). Similarly a total of 37 wild edible plants were identified for food and other purpose uses in the Semi-arid, east Shewa, Ethiopia reported by Debela Hunde (2011). However, 77 plant species in Bullen district North West Ethiopia, as reported by Mekuanent Tebkew *et al*. (2018) were higher number of wild edible species than the current study. This shows us the number of WSWEPs varies from place to place. This may be due to deference in conserving them.

The study also discovered that the number of plant species belonging to each family which are used as a source of food vary from family to family. Moraceae, Polygonaceae and Rhamnaceae are highest number in the study area represented by 3 (10%) species each, and followed by Apocynaceae, and Lamiaceae represented by 2 species (6.7%) each. In line with the present study botanical studies on WSWEPs conducted by Tena Regassa *et al*. (2014) implies that Moraceae was the dominant family contributing the highest number of edible

plants. Conversely, various studies showed that the dominant families which contribute edible plant parts vary from area to area. For instance the work of Tinsae Bahru *et al*. (2013), showed that Fabaceae is dominant in and Buffer area of Awash National Park, (Tilahun Teklehaymanot and Mrutse Giday, 2010), also reported that Tilaceae is dominant in Kara and Kewego Semi-pastoralist people in Lower Omo River valley, in addition to this SNNP, Ethiopia and Nedelcheva (2013), showed that family Rosaceae was the dominant family contributing the highest number of species in Bulgaria which covers 18 (20.45%) species. This variation of distribution of number of the plant species may be due to soil type or climatic change or the altitudinal deference and so on.

Trees and shrubs (Woody plants) are dominant together contributing to 80% of the WSWEPs in the study area.

The main source of knowledge held by various informants of the current study implies that grandparents play great role on the transmission of knowledge from generation to generation. This significant variation in the knowledge of wild and semi-wild edible plants species indicates a little bit problems on knowledge transfer in the communities of the study area. In contrary study reported by Mengstu and Hager (2008), who found that, Amhara youngsters were more knowledgeable on edible wild and semi-wild plants than older. The continuity of knowledge faced with some problems this due to change in the feeding habit of the people and lack of awareness as well as undervaluation of WSWEPs in the study area

5.2 Harvesting period and main gatherers

The finding of the current study indicated that WSWEPs were harvested and consumed in different seasons of the year in (Table 4), however the majority were harvested and consumed on spring (March-May) and followed by autumn (September-November) seasons. Similar to this study as reported byBerhane Kidane *et al .(*2014), in Maal and Ari *Ficus sur* was harvested in January and February but *Carissa spinarum* during June-September. Wild fruits were mainly harvested at the end of the summer and autumn and most species used as vegetables were collected during spring in Spain. Parallel to the present findings, as Mekuanent Tebkew (2015), reports indicated that more edible plant species were harvested during autumn and summer in Boosat, other similarities to the current findings were found in Fantalle botanical reports. In addition *Ximenia americana* was harvested from September to November in east Shewa

(Debella Hunde *et al*., 2011), but May-July in Chilga district by Mekuanent Tebkew (2015). Ethno-botanical study carried out by Tilahun Teklehaymaynot and Miruts Giday (2010), reported that most are harvested from March-May and August-November in Kara Kwgo (Tardio *et al*., 2006).

In the study area WSWEPs were mainly collected by all age groups and sexes for the purpose of recreation and to fill the food gap, but the main participants were: children and herders, youngsters as well as poor families as shown in (Figure 3). In relation to this study botanical study by Tinsae Bahru *et al.* (2013), showed that collection of WSWEPs was done by children, youngsters, livestock herder and low income families in Awash National Park. But Tena Regassa *et al*. (2014) reported that women and children were the major gatherers followed by men and all household in Chelia district. Tilahun Teklehaymanot and Miruts Giday (2010), reported that mostly children and herdsmen gather and consume fruits at time of the year when food is plentiful, but both genders and all age groups gather and consume during food shortage. Harvesting was done by all groups of people in Debub Ari and Maale (Berhane Kidane *et al.*, 2014). This implies, that gatherers of wild and semi-wild edible plants vary from area to area but, similar in consuming them during the famine period to fulfill food gaps.

5.3 Source and habitats of WSWEPs

The study result indicated that most wild edible plants are found in all habitats (53%) and home garden, road sides as well as forests. Similar to this, an ethno-botanical study conducted by Mekuanent Tebkew *et al*. (2014) refers that natural forest, farmland and river line were the habitats of edible plants in Chilga district, north western Ethiopia. Furthermore, Agea *et al*. (2011) reported that most edible plants are found in pure wild species, while some are in semi-wild states. WSWEPs were harvested from different habitats. Of all the recorded edible plant species *Opuntia ficus-indica, Becium grandiflorum, Rumex nervosus, and Carissa spinarum* were widely distributed but like *Ficus vasta, Ficus sur* Forssk had low distribution in Kilte-Awulaelo Wereda. They were found in home garden or church or other enclosed areas. However, others like *Ximenia americana* L.val and *Argemone mexicana* were found in the forest only. The result shows that the WSWEPs are found in various habitats.

5.4 Nature of WSWEP, parts used as food and mode of consumption

5.4.1 Nature of edible plant parts used as food

The analaysis revealed that fruits were the dominant edible plant parts followed by the various parts, including leaf, flowers and stems. This agrees with other findings of the study reviewed by Ermias Lulekal *et al (*2011) in Ethiopia and Tena Regasa *et al. (2014*) in Boosat and Fantalle. But this is contrasted with other studies, as Tilahun Teklehaymanot and Miruts Giday (2010), studied in southern Ethiopia indicated that leaves and stems are more dominant. According to Hinnawi (2010) indicated that most of the edible plant parts were leaves which were consumed after cooking. In Uganda leaves were most used as food next to fruits as reported by Agea *et al.* (2011) and Anywar *et al*. (2013).This indicated that the study area is well organized by trees than the remaining parts.

5.4.2 Consumption mode of WSWEPs

A total of 30 WSWEPs were reported as edible by the district community. High number of species is consumed either at the house hold or at their collection site to fill food gap and also to supplement the nutrition of staple foods. This study shows that the community share relatively similar knowledge on WSWEPs utilization and practice of identification, preparation and consumption of similar WSWEPs. The study showed that most of the WSWEPs parts were found to be consumed raw (fresh) as snacks to fill food gap and also supplement role, such as *Opuntia ficus indica, Z.christ*, Tamarind, *Ficus* and *Cordia africana* species are eaten at their fresh or dry states. Only few plants were consumed by cooking and drying. Farmers and herders go distant areas for farming activities and grazing of Animals. These communities consumed Fresh and raw WSWEPs when they feel hunger in their working area.

Ethno-botanical study conducted by Getachew Addis *et al*. (2013) showed that most (55%) were eaten as raw or not prepared in Konso and Hammer people. Acording Mekuanent Tebkew *et al*. (2014) 79% of the reported edible plant was consumed as raw or fresh in Cheliga district, and according to the report of Tariku Berihun and Eyayu Molla (2017), fruits (56%) were consumed as raw or fresh. Salih and Ali (2014) showed that fruit of nearly all of the recorded were consumed as fresh in Sudan. Getnet Chekole (2011) also reported that most such edible plant species were consumed fresh but very few cooked. In addition Ojelel and Kakudidi (2015) reported that most were eaten uncooked in Uganda. Tinsae Bahru *et al*. (2013) showed that most (66.2%) edible plant species were eaten raw by the Oromo and Afar community and

(Tigist Wendimu *et al.*, 2006), reported that almost all (95%) 0f the recorded wild edible plants are eaten raw without any processing around "Dheeraa" town. Most fruits were consumed fresh or raw but some cooked with maize and sorghum flour. Few processed in to juice in Ari and Maale (Berhane Kidane *et al. (*2013).

5.4.3 Altitudinal distribution of WSWEPs

The altitudinal distribution of WSWEPs in the study district is almost in similar way. The result of the study showed that most plants are distributed in altitudinal range of 1900-2000 m.a.s.l. However botanical study of Tinsae Bahru *et al*. (2013) showed that WSWEPs were found in a wide altitudinal distribution, for instance most are found in the range of 750-2007 m.a.s.l others found in the range of 895m.a.s.l in Awash National Park. In addition Assegid Assefa and Tesfaye Abebe (2011) reported more WSWEPs were harvested from the altitudinal range of 500-1500 m.a.s.l in Tsemay and Benna district. *Ziziphus spina-christi* and *Balanites aegyptiaca* are widely distributed in the altitudinal range of 0-1900 m.a.s.l in east Shewa (Debela Hunde *et al*., 2011). WSWEPs in Amhara region were harvested from high altitude they grow above1500m.a.s.l. as reported by Abraham Demekirstos (2016).

5.5 Ranking and scoring

5.5.1 Preference ranking of WSWEPs based on their Taste

Selection and ranking of the most preferred WSWEPs, by the local people have appreciated on some edible plants over the other in their taste quality. The most popular preferred species from high to low in Wukiro Kilte-awulaelo wereda were as follows; *Opuntia ficus-indica* was first ranked and followed by *Cordia africana, Ziziphus spina-christi, Carissa spinarum, Becum grandiflorum and Ziziphus abssynica respectively (*Table 4*).* Botanical study conducted by Bayafers Tamene *et al. (*2000) and Getachew Addis *et al.* (2013), ranked *Opuntia ficus-indica* highest in Cheffa and in Konso respectively similar to the present study. However, species preference varies from area to area or from region to region. For example, the fruit of *Balenites aegyptiaca* is the most preferred edible fruit by the local community of Afar and Oromo communities and in the buffer area of Awash, (Tinsae Bahru *et a*l., 2013). Studies by Tigist Wondimu *et al*. (2006) also indicated that *Balanites aegyptiaca* ranked the highest preferred edible plant species in Dheera town, Arsi, Ethiopia.

5.5.2 Direct matrix ranking for multiple uses of WSWEPs

Matrix ranking of the multipurpose of WSWEPs under 6 use categories of 9 WSWEPs was carried out by 10 informants. *Ziziphus spina-christi* was the first rank as a multipurpose followed by *Cordia africana, Carissa spinarumFicus sur* and *ficus vasta* (Table 5). The multipurpose of WSWSEPs is differing from area to area according to the availability of the edible plant species is the arts of the communities. For instance *Cordia africana* was the highest multipurpose in Tara Gedam and Amba forest as reported by Getnet Chekole (2011) and in Chelia district (Tena Regassa *et al*., 2014). A study conducted by Mekuanet Tebkew *et al. (*2014), reported the multipurpose nature of *Carissa spinarum* for fence, medicine, fuel wood, farm and household tools and *Balanites aegyptiaca* used as fence, fuel wood, charcoal, fodder, soil conservation in Chilga district. In addition to this in Sudan (Salih and Ali 2014), reported the multipurpose nature of *Balanites aegyptiaca, Cordia africana* and *Ziziphus spina-christi* for food, medicine, construction, fuel wood, fodder, furniture and for agricultural tools, Berhanu Abraha *et al*. (2015), stated that *Opuntia ficus-indica* is used for human consumption and animal food first followed by fence and source of income in Wukiro Kilte-Awulaelo district.

5.5.3 Informant Consensus of WSWEPs

Based on the informants consensus the result of the current study showed that some wild edible plants are common or more popular than the others. The WSWEPs that are more popular in the study area includes *Opuntia ficus-indica, Ziziphus spina-christi, Carissa spinarum, Ficus sur* Forssk *and Balanites aegyptiaca* as mentioned in (Table 7). Some of the WSWEPs listed by the individual informant as edible food were rejected by others during group discussion as they are not common edible plants in the study sites by the key informants and only 30 of them were accepted as edible in the 3 study sites. The popularity of the 30 edible plants according the key informants is due to their multipurpose use and their abundance in the area. Botanical study conducted by Mekuanent Tebkew *et al.* (2018), *Ziziphus spina-christi, Ximenia americana* and *Balanite*s *aegyptiaca* were more popular wild edible plants in Quara district northwest Ethiopia.

5.5.4 Pair-wise of ranking threats of WSWEPs

The main factors that decrease for WSWEPs may differ from area to area, from region to region, from community to community and from plant types to plant types. According to the participants the main threaten factors in Wukiro Kilte-Awulaelo Wereda ranked agricultural expansion, fuel wood collection, over grazing, selective harvesting, house building and drought (Table 7). Similar to this result and botanical study carried out by Tariku Berihun and Eyayu Molla (2017), in Bullen district, (Tena Regassa *et al.,* 2014), in Rashad reported that agricultural expansion was ranked the major threaten factor. In addition Mekuanent Tebkew *et al.,* 2014), reported that fuel wood collection was the major threat, Dinkissa Bech *et al.* (2016) reported that population pressure ranked the major threaten factor. In Botswana, (Nuedeck *et al*., 2014), reported that wild animals like elephants have a big role in threaten of WSWEPs. However Hinnawi (2010) reported that insecticides are more threaten factors in Palestine. Mekuanent Tebkew *et al*. (2018) reported that fire is the most threaten factor in Quara district northwest Ethiopia.

5.5.5 Conservation measures

Despite their importance, WSWEPs face serious anthropogenic and environmental threats that harbor use full WSWEPs. Many threats are similar those that affect plant diversity as a whole. The most common threats reported were Agricultural expansions, over grazing/ overstocking, deforestation and urbanization. The loss of these species was also limited the benefits gained from the WSWEPs and indigenous knowledge associated with these species. The continuity of knowledge on utilization also faced problems because of change in the feeding habit of the people as reported by T/haimanot and Gidey (200).

The output of the research in the wereda on WSWEPs indicate that the need for conservations as well as documentation, effective protection or sustainable management have play a great role in conserving a great number of WSWEPs in the study area, since the local people of the wereda obey traditional knowledge to conserve WSWEPs. Through traditional knowledge those plants were conserved in home gardens as: live fence, farm lands and protective areas like churches, schools and regulation of cutting. Most of those plants are conserved in school and church (Table 8). If the government has not made a good strategic plan to conserve WSWEPs it may lead to loss of the WSWEPs species of the study area. Assegid Assefa and Tesfaye Abebe (2011) reported that the preventing from cutting for fire in Benna and Tsemay district. Natural forest protection, planting the threaten plants in the home garden was the conservation method (Getnet Chekole 2011), in Tara Gedam and Amba remnant forest. (Mekuanent Tebkew *et al*., 2014), reported that the local people of Cheliga district conserve these plants in home garden as: Live fence, protecting from cutting through traditional regulation of cutting protective areas. More ever effective protection or sustainable management of priority areas of the study area will play a major role in conserving greater number of the WSWEPs.

5.5.6 Marketability of Wild Edible Plants

Two daily and two weekly markets from the wereda and nearby town were selected for market survey.during the study *Opuntia ficus-indica, Balanites aeypitiaca, Carrissa spinarum, Ziziphu spina-christi, Ximenia americana, Prunus persica* and *Dovialis abyssinica* sell in the local market like (Table 9) and the rests are not common source of market. *Opuntia ficus-indica, Cordia Africana, Carissa spinarum* L. and *Ziziphus spina-christi* L. are high marketable. Commonly those edible plants are sold by both sexes in the local markets. However, many of the WSWEPs were reported to be consumed as raw and outdoors (in agriculture fields, during

cattle keeping and visiting fields) and some other parts that require processing were brought home for preparation prior to consumption.Conversly to this study botanical study carried by Dinkisa Bech *et al*. (2016) showed that *Ximenia Americana* L. is high marketable in and around Awash National Park, as well as *Balanites aegyptiaca* and *Ziziphus spina-christi* were high marketable in Sudan (Salih and Ali, 2014) in and Buffer area of Awash National park (Tinsae Bahru *et al.,* 2013). Market survey carried by Guinand and Dechassa Lemessa (2000), reported, that *Balanites aegyptiaca* is internationally marketable and *Z. spina-christi* is nationally marketable. *Opuntia ficus-indica* was also traded in Cheffa, Konso, Benna and Tsemay Assegid Assefa and Tesfaye Abebe (2011). *Ximenia americana* and *Ziziphus spina-christi* were marketed in east Shewa as reported by Debela Hunde *et al*. (2011). *Balanties aegyptiaca* were also marketed in other African country like Uganda Agea *et al.* (2011). In Sudan edible plants serve as an alternative income source as reported by Salih and Ali (2014). Most of the edible plants in Cheffa district sold byoungsters as Mekuanent Tebkew *et al*. (2014), all household members participate in collecting, preparing for home consumption, managing and selling of WSWEPs in east Shewa Boosat and Fantalle as reported by Debela Hunde *et al*. (2011).

5.2. Conclusions

The present study indicates that, about 30 WSWEPs were identified and documented under 25 genera and 22 families. Regarding the difficulties in knowledge variation and ignorance/ lack of awareness/ of new generation towards traditional knowledge, there seems lead to losing the WSWEPs.

The main collector and consumer of the WSWEPs in the study area were children and herders as well as poor families this shows that the various age group communities participated in the collection and consumption. The top popular WSWEP species were *Opuntia ficus-indica* L, *Ziziphus spina-christi* L, *Cordia africana* L., *Carissa spinarum* L., *Balanites aegyptica L. and Ficus sur* Forsk. These are found and cultural rooted in the study area. The major plant parts consumed by the communities were fruits and various parts some of the WSWEPs species were contributed as additional income sources for instance in the study area the result showed that *Opuntia ficus- indica, cordia africana* and *Ziziphus spina-christi* fruits were harvested and sold in local markets. The WSWEPs species are used for various purposes for instance *Ziziphus spina-christi and Cordia africana* have multipurpose uses than the others, these plants are growing at high altitude above 1800 m.a.s.l. Habitats of the WSWEPs constitutes forests, home garden and all habitats as well as other habitats. The main threat factors of WSWEPs in the study area were agricultural expansion and fuel wood collection followed by over grazing in addition to this changing of eating habit from time to time and loosing transfer of knowledge from generation to generation. The removal of forests has a direct impact on ecosystem diversity this is due to poor knowledge of management and use of WSWEPs in the study area. This study indicated that most of the WSWEPs in the study area need protection and conservations.

5.3. Recommendation

Based on the results of the study, the following recommendations were forwarded.

- Culture and Tourism office of the district should encourage people to protect some cultural believes and traditional practices associated with WSWEPs.
- Encouraging people to grow WSWEPs in home garden mixing with cultivated plants in order to improve household food security.
- Need to improve market structure for the local communities to realize their full market potential of these plant species.
- Appropriate rules on conservation, food security and agriculture need to be integrated to recognize and preserve the important of wild edible plants.
- Raising awareness of the young generation to avoid negative impact on the wild food plants and association knowledge.
- It is recommended that more research should be carried out the nutritional and medicinal properties of wild edible plants.
- We recommend that, along with sustainable utilization and conservation of the existing germplasm, WSWEPs require urgent selection, domestication, propagation and cultivation of the endangered once.

References

Abraham Demekiristos (2016). Collection and identification of wild fruits trees/shrub species Amhar Region, Ethiopia:*Journal of Science Research*.

Adam, O. (2011). *Contribution of local level trade in non-timber forest products to rural development in Rashade locality of Nuba Mountains.* Kartum: Sudan.

Afolayan, A. and Jimoh, F. (2009). Nutritional quality of some wild leafy vegetables in South Africa. *International Journal of Food Science and Nutrition* ,**60**: 424-431.

Agea, G., Okia, A., Abohassan and Zewge Teklehaymanot (2011). Wild and semi-wild edible food plants of Bunyoro-Kitara Kingdom of Uganda: Growth forms, collection niches, parts consumud, consumption patterns, main gatherers and consummers. *Jouranl of Environmental Research, **5**:74-86.*

Agea, G., Kimondo, J.M., Okia, A. and Zewge Teklehaymanot (2013). Use and potential of wild and semi-wild food plants in alleviating household poverty and food security. *School of Environment, natural resours and Geography,Bongor University*, 360.

Akinnifesi, F.K. (2004). Ethinobotany of Wild and semi-wild edible plant fruit species. *Ethino botany Research and Application* pp 455-471.

Alexiades, M. N. (1996). Collecting ethnobotanical data and introduction to basic concepts and technique. Selected guidelines for ethnobotanical research: A field manual pp. 53-94 New York botanical garden press.

Arenas, P. and Scarpa (2007). Wild edible plants of Chorote India, Gran Chacho and Argentina. *Journal of the Linnean Society*, **153**:73-85.

Assegid Assefa and Tesfaye Abebe (2011). Wild edible plant trees in the semi-arid low lands of Southern Ethiopia. *Journal of Science* and *development* ,**1**:5-19 .

Bartlett, E., Higgins, C., (2001). Organizational Research: Determining Appropriate Sample Size in Survey Research

Bharucha, Z., and Pretty, J. (2010). The roles and values of wild foods in agricultural systems. *Journals of philosophical Transaction Royal society*, **365**:2913-2926.

Birhane Kidane, L.J.G., Maesen, V., Andel, T.V. and Zemede Asfaw and Sosef, M.S.M. (2014). Ethno botany of Wild and semi-wild edible fruit speciese used by Maale

and Ari Ethinic community in south Ethiopia. *Ethno botany Research and Application* ,pp 455-471.

CIDA (2010). Food security from the forest*:* Regulating wild edible plants for household food security in Su-Sahara.

Dandena Gelmesa (2010). Shifting to alternative food source: Potential to over; Malnutrition and poverty problems*:* Innovation and sustainable development in Agriculture and food *(*ISDA). Retrieved June 28-30, 2010, from Montpellier, Haramaya University, Local Seed: http://www. Haramaya University, Local Seed.com

Debela Hunde Feyssa, Njoka, T., Zemede Asfaw and Nyangito M.M. (2011). Wild edible fruit important for Human nutrition in semi-arid parts of East Shewa Zone, Ethiopia: Associated indigenous knowledge and implication to food security. *Pakistan Journal of Nutrition,* **10**(1): 40-50.

Debela Hunde, Njoka, J.T., Zemede Asfaw and Nyangito (2012). Comparative analysis of indigenous knowledge on use and management of wild edible plants: *The case of central East Shewa of Ethiopia. Ethno-botany research* and *Application* **10**: 287-304.

Demele Teketay, F. S., (2010). *Edible wild plants in Ethiopia.* Addis Ababa University Press.

Dogan, Y., Ugulu, I., Durkan, N. (2013). Wild edible plants sold in the local markets of Ezmir Turky. *Pakistan Journal of Botany., **45**(SI);177-188.*

Ermias Lulekal,Zemede Asfaw and Ensermu Kelbessa (2011). Wild edible plants in Ethiopia: *a review on thier potential to combat food insecurity.* International Society of ETHNOBIOLOGY **24**(2): 71-121.

Fantahun Mengistu and Hager, H. (2009). Exploiting locally available resources for food and nutritional security enhancement: Wild Fruits Diversity, Potential and State of Exploitation in the Amhara Region of Ethiopia. Food Security , **1**(2):207-219.

Fantahun Mengistu and Hager, H. (2008). Wild edible fruit species cultural domain, informant species competence and preference in three district of Amhara Region, Ethiopia. *Ethnobotany Research and Applications, **6:** 487-502*.

FAO. (2004). *The state of food insecurity in the World. Rome*: Monitoring the progress towards the World food summit and millennium development goals.

Getachew Addis, Zemede Asfaw and Zerihun Woldu (2013). Ethnobotany of wild and semi-wild edible plants of Konso Ethinic Community, South Ethiopia. *Ethnobotany Research and Aplications,* **11**: 121- 141.

Getnet Chekole (2011). An ethno-botanical study of plants used in traditional medicine and as wild foods in and around Tara Gedam and Amba Remnant Forest. Addis Ababa: Ethiopia.

Grivetti, L. and Ogle, B. (2000). Value of traditional foods in meeting macro and micronutrient needs: the wild plant connection. *J.Nutr. Res. Rev.***13**: 31-46.

Guinand, Y. and Dechassa Lemessa (2000). Wild food plants in Ethiopia reflection on the role of Wild–Foods and famine-Foods at a time of drought UNDP-EUE field mission Report Addis Ababa: Ethiopia.

Guinand,Y. and Dechassa Lemessa (2001). A practical field guide to wild-food plants in Ethiopia: General Description, Edible parts, preparation methods and palatability. Addis Ababa: UNDP emergency Unit for Ethiopia.

Hedberg, I. and Edwards, S. (1995). *Flora of Ethiopia and Eritrea (eds.)* Vol. 7, Pp. 420. *Poaceae (Graminaceae)*. Ethiopia and Uppsala. The National Herbarium Addis Ababa University.

Heywood VH. (1999). Use and potential of wild plants in farm households. Italy: Rome.

Howard, P. (2010). *Culture* and *agro-biodiversity In nature* and *culture* . London, UK: Earth scan, London.

IBC (2012). *The state of food insecurity in the World.* Economic Growth is necessary but not sufficient to Accelerate Reduction of Hunger and Malnutrition Rome, Italy. FAO (Food and Agriculture Organization of the United Nations),.

Jeeva, S. (2009). Horticultural potential of wild edible fruits used by the Khasi tribes of Meghalaya. *Journal of Hort-culture and forestry* , 1(9):182-192.

Ju, G.H. (2013). Eating from the wild. diversity of wild edibl plants used by Tibetans inshangri-largion,yunnan,china. *Journal of Ethionobiology and Ethinomedicine,* 9:28.

Kalle, R., Soukand, R. (2012). Historical ethnobo-tanical review of edible plants of Estonia (1770s-1960s). *Act as Societatis Botanicorum Poloniae* , **81** (4): 271-281.

Kebu Balemie and Fassil Kebedew (2006). Ethnobotany study of wild edible plants in Derashe and Kucha district .South Ethiopia. *Journal of Ethnobiology and Ethnomedicine* , **2**:53.

Ladio, A.H. (2001). The maintenance of wild edible plant gathering in a Mapuche. *community of Patagonia. Econ Bot.* **55**:243–54.

LaRochele, S. B. (2003). Traditional ecological knowledge and practice for edible wild plants: Biodiversity use by the Raramuri in the Sierra Taraahumara, Mexico. *International Journal of Sustainable Development and world Ecol* .

Lentini, F., and Venza, F. (2007). Wild food plants of popular use in Sicily. *Journal 0f Ethinobotany and Ethinomedicin,* **3**:1-12.

Luzaj, L. (2011). Ethno-botanical review of wild edible plants of Slovaki. *Acta Societatis Botanicorum Poloniae,*381-396.

Martin, G.J. (1995). *Ethnobotany A method manual.* London.Chaman and Hall U.K.

McBurney *(*2004). *International Journal of Scientific* and *Research Publications*, Issue April 2013 ISSN 2250-3153

Mekuanent Tebkew, Zebene Asfaw and Solomon Zewudie (2014.). Underutilized wild plants in the Chilga district Northwest Ethiopia; Focus on wild woody plants. *Agriculture and food security*, 3; 12.

Mekuanent Tebkew (2015). Wild and semi-wild edible plants in Chilga district, Northwestern Ethiopia; Implication for food security and climate change adaptation. *Global Journal of wood Science Forestry and wild life* , **3**(3): 072-082.

Menendez-Baceta, G. Aceituno-Mata L. (2012). Wild edible plants traditionally gathered in Gorbeialdea (Biscay, Basque country). *Genetic Resource and Crop Evolution (in press)*, **59**:1329-134.

MOARD (2007). *Horn of Africa counsulation of food security counter report*. Addis aAbaba Ethiopia: Ministry of Agricultur and Rural Development.

Mondal, T. (2012). Ethno-botanical investigation on important wild edible plant edible herbs of Siliguri Sub division of Dajeeling District, West Bengal, India. . *Journal of Today's Biological Science: Research and Review,* **1**(1): 16-19.

Nedelcheva, A. (2013). An ethnobotany study of wild edible plants in Bulgaria. *Eurasia Journal of Biological Science,* **7**: 77-84.

Ojelel, S. and Kakudidi, E.K. (2015). Wild edible plant species utilized by subsistence farming community in Obalanga sub-country, Amuria district, Uganda. *Journal of Ethnobiology and Ethnomedicine*, **11**:7.

Rana J.C.Pradheep, K., Chaurasia, O. P., Sood, S. Sharma, R. M., Singh, A. and Negi, R. (2012). Genetic Resources of Wild Edible Plants and their Uses among Triba Communities of Cold Arid Region of India. *Genetic Resources Crop Evolution*, **59**:139-149.

Shaheen S (2017). Retrieved 3 xvii, 2017, from Edible Wild Plants: An alternative approach to food security: http://www.springer.com

Salih N. and Ali Hirsa (2014). Wild food trees in eastern Nuba Mountains, Sudan: Use diversity and threatening factors .*Journal of Agriculture* and *Rural Development in the Tropics and Subtropics,* **115**(1):1-7.

Sansanelli, S. and Tassoni, A. (2014). Wild food plants traditionally consumed in the area of Bologna (Emilia Romagna region, Italy). *Journal of Ethnobiology* and *Ethnomedicine, ,* **10**:69-76.

Satheesh, N. (2015). Review on distribution, nutritional and medicinal values of CasimiroaEdulus LIave An underutilized fruit in Ethiopia. *America-Euraian Journal of Agriculture and Environmental Science,* **15**(8): 1574-1583.

Scoons, I. (1992). *The hiddenharvest;Wild foods and Agricultural systems.* Lendon, Literatur Review and Annotated; Biblography;International Institute for Environment and Development,UK.

Singh, R. (2011). Wild edible plants: A Potential of source of nutraceuticals.*International Journal of Pharma Sciences* and *research,* **2**(12); 216-225.

Tardio J., Pardo-de, Santayana M., and Morales R., (2006). Ethno-botanical review of wild edible plants in Spain. *Botanical Journal of the Linnean Society*, **152**: 27-71.

Tena Regassa, Ensermu Kelbessa, and Zemede Asfaw (2014).Ethno-botany of wild and semi-wild edible plants of Chelia district, West-central Ethiopia. *Science, Technology and Arts Research journal, ,* **3**(4): 122-134.

Turner, G.G., D.M. Reeder, and J.T.H., Colman (2001). A five years assessment of mortality and geographic spread of White-nose syndrome in North American. *Bats* and *a look to the future Bat research news,* **52** (2): 13-27

USAID and CRS. (2000). Exploring the potential of indigenous wild food plants for livelihood Security in southern Sudan;Proceeding and an Overview of Workshops Held in Southern Sudan Draft Distribution paper for the Regional Workshop . *"Exploring the potential of Indigenous food plants held in Mombasa, Kenya"*, 22-26.

Wiesen and Shackleton (2005). Forest-people Interfaces: *Understanding Community Forestry and Bicultu.*

Zemede Asfaw and Mesfin Tadesse. (2001). Prospective for sustainable use and development of wild food plants in Ethiopia. *Economic Botany*, **55**(1): 47-62.

Appendixes

Appendix1. Semi-structured interview carried out in the study area

Part one: Personal information

1. Date_____ _Month_____ Year_____

2. Name of respondent_____

3. Respondent's sex: Male_____ Female_____

4. Age_____ _Language_____ Occupation_____

5. Respondent's address: *Kebele*

6. Respondent's religion: 1.Orthodox 2. Muslim 3. Others

7. Educational status: l. Literate 2. Illiterate 3.Read and write. 4, If others

8. Respondent's marital status: 1. Single 2. Married

9. The role of respondent in local communities? 1. Religion leader 2. *Kebele* official or representative 3. Knowledgeable elders 4. Student

Part two: Interview questions

1. Mention the most common WSWEPs found in your area?

2. of these WSWEPs fond in your resident which are the most popularly used by the local communities?

3. What parts of the WSWEPs are used as food by the local communities? Their roots,__, leaf___, bark___, stem___, flower____, seed___, or fruit___ or tuber__ or whole parts____? And when is the time of consumption?

4. Where is the growth habitat of WSWEPs? In forest, home, garden, roadside, farm land and fallowing area?

5. What is the mode of consumption and preparation? Fresh (raw), cooked, dried, nectar, beverage.

6. Is there any problems or challenges of collecting the WSWEPs in your resident? Yes___, No___

7.If your answer is yes list the type of problems?

8. List the popular marketable WSWEPs and source of income and which are more common in the market?

9. Where often these WSWEPs are sold? At the village, roadside, near local market, national market

10. Do you have a chance to see people who collect WSWEPs in your surroundings?

11. If your answer is yes which member of the community uses the WSWEPs frequently? Children, herders, younger, poor families or all house hold

12. Which age, sex groups, sells and exchanges them mostly?

13. How the indigenous knowledge of WSWEPs transfers and loss to and from the local community?

14. List the major threat factors of WSWEPs?

15. Mention WSWEPs that posse's multi-purpose uses, other than food in the sites?

16. What traditional management strategies commonly practiced by the local people to conserve WSWEPs in the study area?

17. Harvesting and fruiting seasons of WSWEPs? Summer, spring, winter, or autumn

18. What are the influencing factors to use or cultivated such as the domesticated crops? Change food habit, cultural ignorance, and loss of ecological knowledge, less price, difficulty for collection or others?

19. Main source of knowledge of WSWEPs in the study area?

20. Consumption role of WSWEPs in the study area is to: Supplemental, Recreational, Fill food gap, all situations Supplemental_____, Recreational_____, Fill Food gaps____, For all Purpose

Appendix 2 List of all the identified WSWEP species encountered by the local community of Wukiro Kilte-awulaelo wered, Eastern zone of Tigray

Sceintific Name	**Family**	**Local Name (Tig)**	**Habit**	**Habitat**
Acacia etbaica Schweif	Fabaceae	Seraw	Tree	Farmland, forest
Aloe megalacantha Bak.	Aloeceae	Eire	Shrub	Roadside,forest, home
Anethum graveolens L.(dill)	Apiacaeae	Shilan	Herb	Forest, Farm lands
Becium grandiflorum (L.) Pic.Serm	Lamiaceae	Tebeb	Shrub	Forest
Carissa spinarum L.	Apocynaceae	Eigam	Tree	Forest, roadside
Casmiroa edulis L.	Rutaceae	Kasmir	Tree	Home garden
Cordia africana Lam.	Boraginaceae	Awhi	Tree	Farm land, home garden
Cyperus bulbosus Vahl.	Cyperaceae	Kuenti	Herb	Farmland
Cyperus esculentus L.	Cyperaceae	Kurmta'e	Herb	Farm lands
Balanites aegyptica.	Balanitaceae	Mekie	tree	Farmland, garden forest
*Euclea racemosa.*Murr.(ADC)	Ebenaceae	Kuliaw	Shrub	Forest
Ficus palmata Forssk.	Moraceae	Beles adgi	Shrub	Forest, Farm lands
Ficus sur Forssk.	Moraceae	Sagla	Tree	Home, garden, farmland
Ficus vasta Vahl.	Moraceae	Daero	Tree	Home garden
Grewia trichocarpa Hochst.ex A-rich	Tiliaceae	Rowey/Tsmkuya	Tree	Forest
Opuntia ficus-indica (L.) Miller	Cactaceae	Beles(kulqual bahri)	Shrub	Home garden, forest
Oxygonum sinuatum (Meisn.)Dammer	Polygonaceae	Chewamrakut	Shrub	Farm land
*Phoenix reclinata.*Jacq	Arecaceae	Siye	Tree	Garden forest, farmland, River
Rhamnus prinoides L" Herit	Rhamnaceae	Gesho	Shrub	home garden
Rhus retinorrhoea Oliv.	Anacardiaceae	Atami/Tetaele	Tree	Forest, Farmland
Rosa abyssinica Lindley	Rosaceae	Chaga	Shrub	farmland, forest
Rubus steudneri Schweinf	Rosaceae	Mengolel	Shrub	home garden, forest
Rumex abyssinicus Jacq.	Polygonaceae	Mequmoko	Shrub	Farmland
Rumex nervosus Vahl	Polygonaceae	Hohot	Herb	Farmland
Schinus molle L.	Anacardiaceae	Tikur berbere	Tree	Home garden, Road side, Forest
Solanum americanum Miller	Solanaceae	Amalo Alalimo	Herb	farmland, home garden
Thymus serrulatus Hoch.st.ex benth	Lamiaceae	Tosno	Herb	Homegarden
Ximenia americana L.var.	Olacaceae	Muluo	Tree	Forest
Ziziphus abssynica Hoschst	Rhamnaceae	Abeter	Tree	home garden
Ziziphus spina-christi (L.) Desf.	Rhamnaceae	Geba	Tree	home garden, roadside

Appendix 3. Number of plant species and genus to each family and gathering time in the study area ranked by their numbers

No	Family	Number of species	%	Rank	No. of Genus	%	Harvesting Period
1	Rhaminaceae	3	10	1	1	4	Winter
2	Polygonaceae	3	10	1	2	8	Summer
3	Moraceae	3	13.3	1	3	8	Winter
4	Rosaceae	2	6.7	2	1	8	Witer
5	Cyperaceae	2	6.7	2	2	8	Witer
6	Apocynaceae	1	3.3	2	1	8	Any time
7	Fabaceae	1	3.3	3	1	4	Winter
9	Balanitaceae	1	3.3	3	1	4	Winter
10	Papaveraceae	1	3.3	3	1	4	Winter
11	Rutaceae	1	3.3	3	1	4	Spring
12	Boraginaceae	1	3.3	3	1	4	Spring
13	Lamiaceae	1	3.3	3	1	4	Winter
14	Tilaceae	1	3.3	3	1	4	Witer
15	Ebenaceae	1	3.3	3	1	4	Winter
16	Cactaceae	1	3.3	3	1	4	Winter
17	Anacardiaceae	1	3.3	3	1	4	July-
18	Solanaceae	1	3.3	3	1	4	July-August
19	Arecaceae	1	3.3	3	1	4	Summer
20	Olacaceae	1	3.3	3	1	4	Automen
21	Apiacaceae	1	3.3	3	1	4	Any time
22	Anacardiaceae	1	3.3	3	1	4	Automen
21	Aloeceae	1	3.3	3	1	4	Automen
22	Arecaceae	1	3.3	3			Automen
Total (22)		**30**	**100%**		**25**		

Key: december-feberuary=winter, march-May =spring, Jun-August = summer, September-November = autumn

Appendix 4. List of WSWEPs, parts used as food, marketing value, mode of consumption and other uses in the study area

Scientific name	**Parts used as food**	**Marketing value**	**Mode of Consumpti0n on**	**Other uses**
Acacia etbaica Schweif	Gum & nectar	None	Raw	Fw, shade, grass
Aloe megalacantha Bak.	Flower nectar	None	Raw	Fw, fence, , swc
Anethum graveolens L.(dill*)*	Stem	Rare	Raw	Fd, swc, shade,
Becium grandiflorum (L.) Pic.Serm	Flower	None	Raw	Fw,At, fence,
Carissa spinarum L.	Fruit	Rar	Raw	Fw, swc, forage
Casimiroa edulis L.	Fruit	Common	Raw	Fence, fw,swc,
Cordia africana Lam.	Fruit	Common	Raw	Fw, forage, Swc,
Cyperus bulbosus Vahl**.**	Bulb	None	Raw	Fodder
Cyperus esculentus L.	Tuber	None	Raw	Fodder
Balanites aegyptica.	Fruit	Common	Raw	At, swc, fw
*Euclea racemosa.*Murr.(A.DC.*)*	Fruit	None	Raw	Shade, fw, fodder
Ficus palmata Forssk.	Fruit	None	Raw	Shade, fw, fodder
Ficus sur Forssk.	Fruit	None	Raw	Shade, fw, fodder,
Ficus vasta Vahl.	Fruit	None	Raw	Fw,swc
Grewia trichocarpa Hochst.ex A-rich	Fruit	Rare	Raw	Swc, fodder, fence,
Opuntia ficus-indica (L.) Miller	Fruit	Common	Raw	Fodder, swc
Oxygonum sinuatum (Meisn.)Dammer	Fruit	None	Raw	Fodder ,fw, shade
*Phoenix reclinata.*Jacq	Fruit	Rare	Dried	Shade, medicine
Rhamnus prinoides L‟ Herit	Leaves	Common	Raw	Shade, fw,
Rhus retinorrhoea Oliv.	Fruit	None	Raw	Fence, fodder, fw
Rosa abyssinica Lindley	Fruit	None	Raw	Swc,
Rubus steudneri Schweinf	Stem	None	Dried	Fodder, swc,fw
Rumex abyssinicus Jacq.	Stem	None	Raw	Fw. fodder, swc
Rumex nervosus Vahl	Fruit	None	Raw	Fire wood,fence
Schinus molle L.	Fruit	None	Raw	Fodder,
Solanum americanum Miller	Leaves	None	Raw	Spice
Thymus serrulatus Hoch.st.ex benth	Fruit	Rare	Dried and cooked	Fodder
Ximenia americana L.var.	Leaves	Rare	Cooked	Fence, swc
Ziziphus abssynica Hoschst	Fruit	Rare	Raw	Fw, swc,
Ziziphus spina-christi (L.) Desf.	Fruit	Common	Raw	Fw, fence, fodder,

Key: fw-fuel wood, swc-soil and water conservation,

N.B; *Rhamnus prinoides* L‟ Herit its leaves and barks serve for making Tella

Appendix 5. GPs coordination of WSWEPs in the study area, Wukiro Kilte awulaelo werda

Scientific name	**Latitude(north)**	**Longitude(east)**
Acacia etbaica Schweif	13°46.498"	039°32.319'
Aloe megalacantha Bak.	13°46.886"	039°31.987'
Anethum graveolens L.(dill)	13°46.884"	039°31.978'
Becium grandiflorum (L.) Pic.Serm	13°46.839"	039°31.902'
Carissa spinarum L.	13°46.747"	039°32.913'
Casimiroa edulis L.	13°46.473"	039°32.237'
Cordia africana Lam.	13°46.485"	039°32.318'
Cyperus bulbosus Vahl.	13°26.841"	039°33.002'
Cyperus esculentus L.	13°46.227"	039°31.512'
Balanites aegyptica.	13°45.323"	039°31.537'
*Euclea racemosa.*Murr.(A.DC.)	13°45.726"	039°28.367'
Ficus palmata Forssk.	13°46.880"	039°31.970'
Ficus sur Forssk.	13°50.603"	039°33.244'
Ficus vasta Vahl.	13°28.498"	038°32.204'
Grewia trichocarpa Hochst.ex A-rich	13°30.736"	039°31.850'
Opuntia ficus-indica (L.) Miller	13°30.208"	039°31.978'
Oxygonum sinuatum (Meisn.)Dammer	13°30.486"	039°31.302'
*Phoenix reclinata.*Jacq	13°46.747"	039°32.913'
Rhamnus prinoides L" Herit	13°25.129"	039°30.843'
Rhus retinorrhoea Oliv.	13°28.400"	039°31.308'
Rosa abyssinica Lindley	13°27.246"	039°31.689'
Rubus steudneri Schweinf	13°46.227"	039°31.512'
Rumex abyssinicus Jacq.	13°50.603"	039°33.244'
Rumex nervosus Vahl	13°46.227"	039°31.512'
Schinus molle L.	13°46.880"	039°31.970'
Solanum americanum Miller	13°30.732"	039°31.060'
Thymus serrulatus Hoch.st.ex benth	13°29.929"	039°32.239'
Ximenia americana L.var.	13°25.630"	039°30.843'
Ziziphus abssynica Hoschst	13°50.603	039°31.970'
Ziziphus spina-christi (L.) Desf.	13°50.603	039°31.970'

Appendix 6. List of informant participated in the study area

Kebeles	Name	Sex	Age	Marriage	Education Level	Religion	Plant Mentioned
Tsigereda	HiwetH/Michael	F	26	Married	8	Orthodox	11
	Muuz Abrha	M	45	Married	12	Orthodox	13
	Abrha Teklay	M	30	Single	Degree	Orthodox	10
	Asmelash Abrha	M	29	Single	Illiterate	Orthodox	9
	Asefa H/silassie *	M	35	Married	Expert	Orthodox	12
	W/gebreal Hailu *	M	56	Married	Prest	Orthodox	11
	Selam Medhin	F	50	Married	Illiterate	Orthodox	10
	Lemlem Hagos	F	40	Married	Illiterate	Orthodox	11
	Araya Hailu	M	30	Single	Diploma	Orthodox	8
	Teberh Hagos	F	50	Married	Illitrate	Orthodox	7
	Belay Simur	M	40	Married	Illitrate	Orthodox	6
	GirmayAbrha	M	17	Singl	9	Orthodox	3
	G/gergs Hans	M	45	Married	Illitrate	Orthodox	2
	Birhane Abay	M	37	Married	Illitrate	Orthodox	5
	Azmera Kebede	F	23	Single	6	Orthodox	7
	G/her Birhane *	M	34	Married	Leader	Orthodox	9
	Birhane G/haweria *	M	50	Married	Illiterate	Orthodox	11
	Amete Kalayou	F	22	Married	Illiterate	Orthodox	8
	Abrha Tesfay	M	60	Married	Illiterate	Orthodox	12
	Berhan Hagos	F	27	Single	12	Orthodox	8
	Menbere Giday	F	22	Single	10	Orthodox	9
Agulae	Abrha Birey	M	24	Single	6	Orthodox	9
	G/her G/mariam	M	25	Single	7	Orthodox	8
	Bahre Teklay	M	24	Single	10	Orthodox	9
	G/wot Hagos *	M	30	Married	Expert	Orthodox	10
Agulae	Lemlem Haftu	F	40	Married	Illiterate	Orthodox	9
	Biri Zeray	F	27	Single	12	Orthodox	1
	Mikiyas Yalew *	M	60	Married	Prest	Orthodox	9
	Tsehaye Hailu	M	55	Married	Illiterate	Orthodox	4
	Berhane Seyoum	F	36	Single	Leader	Orthodox	9
	Zenebu Abay	F	21	Single	11	Orthodox	8
	Hagos Hailu *	M	45	Married	Msc	Orthodox	9
	Teame Hadush	M	35	Married	6	Orthodox	3
	Redae Haftu	M	60	Married	Illiterate	Orthodox	7
Agulae	W/gebreal Goytom	M	58	Married	Illiterate	Orthodox	8
	Welday Simur	M	56	Married	Illiterate	Orthodox	2
	Haftu Abrha	M	20	Married	12	Orthodox	1
	H/mariam Tesfay	M	38	Married	Degree	Orthodox	8
	Kiday Hans	M	45	Married	Illiterate	Orthodox	1
	Hailay Amaha	M	50	Married	Degree	Orthodox	5

	Appendix 6 Continued						
	Alemat G/medhin	F	22	Married	Illitrate	Orthodox	3
	Selam Hailay	F	68	Married	Illitrate	Orthodox	10
	Gebru Berhe	M	60	Married	Prest	Orthodox	9
Abrha Atsibha	Belaynesh Mehari	F	30	Single	11	Orthodox	7
	Terefe Derbew	M	26	Married	8	Orthodox	9
	Girmay Abreha *	M	54	Married	Leader	Orthodox	9
	Tsegay Beyene	M	56	Married	Illiterate	Orthodox	8
	Fetsegu Berhe	F	65	Married	Illiterate	Orthodox	6
	Equar Kebede	M	50	Married	Illiterate	Orthodox	9
	Meselu Hadebelo	F	29	Married	9	Orthodox	7
	Tesfay Kalayou	M	28	Single	8	Orthodox	7
	Mekdes Mehari	F	22	Single	12	Orthodox	6
	Alem Abadi	F	23	Single	9	Orthodox	7
	W/Abrha Alem	M	42	Married	Msc	Orthodox	9
	Samsom Ataklti	M	26	Single	9	Orthodox	8
	Abreha Giday *	M	33	Married	5	Orthodox	9
	Mehari Giday *	M	33	Married	5	Orthodox	9
	Girum araya	M	42	Married	Illiterate	Orthodox	1
Abrha Atsibha	Almaz Tesfay	F	52	Married	Illitrate	Orthodox	5
	Lemlem Hagos	F	60	Married	Illitrate	Orthodox	9
	W/hawerya Berhe	M	72	Maried	Illitrate	Orthodox	10
	Abrha Atsibha	M	25	Single	10	Orthodox	5
	Tsige Abrha	F	45	Merried	Illitrate	Orthodox	4
	G/medhin Hailu *	M	70	Merried	Prest	0rthodox	10
	Beyene Tesfay	M	18	Single	10	Orthodox	7

NB. * indicates key informants selected from the *kebeles*

Appendix 7. Some of the pictures of WSWEPs in Wukiro-Kilte awulaelo wereda are as follow

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Carissa spinarum

Aloe megalacantha

Cyperus esculentus

Cordia africana

Rhamnus prinoides

Rumex nervosus

Ficus vasta

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