The Role of Nutraceutical Plants in Diversifying Food Source and Healthcare in Lare District, Gambella Regional State, Southwest Ethiopia

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The Role of Nutraceutical Plants in Diversifying Food Sources and Healthcare in Lare District Gambella Regional State, Southwest Ethiopia

By

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Dedication

This thesis is dedicated to my Family in general and to my youngest sister Nyabuay Kuet.

Statement of Author

First, I declare that this thesis is my own work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc. Degree at Jimma University and is deposited at the University Library to be available to borrowers under rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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Biography of Author

The author was born in Gambella Regional State in Jekow District in Feb 19, 1984. He first attended his Grade one in Nipnip Primary School since 1995 in Jekow Distirict and took his Ethiopian School Leaving Certificate in Gambella Senior Secondary and Preparatory School (9^{th} – 12^{th}) in Gambella town from 2003 – 2006.

He passed his Preparatory Entrance Exam and joins Awassa University, Wondo Genet College of Forestry and Natural Resources and graduated with BSc in farm forestry (agro-forestry) in 2009. After graduation he was employed in agricultural office in Jekow District and worked there for one year. He then competed and joined Gambella Agricultural Research Institute (GARI) in 2011 and was assigned as a researcher. After serving GARI for three years, his office sent him to pursue his post graduate study program in Jimma University leading him to Master of Science (MSc) in Natural Resource Management (Forest and Nature Conservation). Moreover, the author is a married candidate.

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List of Abbreviations

CSA	Central Statistical Agency
DA	Development Agency
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GARI	Gambella Agricultural Research Institute
GAZ	Gambella Agro-pastoralist Zone
GRSBoLR	Gambella Regional State Bureau of Land Resources and Environment Protection
HH	Household
ICT	Information Communication Technology
IWFP	Indigenous Wild Food Plants
KA	Kebele Administration
KI	Key Informants
NTFP	Non-timber Forest Products
SPSS	Statistical Package for Social Science
USAID	United State Agency for International Development
WB	World Bank
WEFT	Wild Edible Fruit Trees
WFP	World Food Programs
WHO	World Health Organization

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Abstracts

Gambella Regional State in general and specifically Lare District has a huge potential of useful plants which provide food, healthcare and other multi-purpose benefits to local people. However, information on different type of plants, their use and utilization were inadequate. The purpose of this study was to identify the nutraceutical plants, their role in diversifying food sources, healthcare and other socio-economic contribution to households in the area. Three Kebeles were Selected purposely, based on the local people knowledge on the use and consumption of these plants. Semi-structured questionnaire, focus group discussion, key informants interview, ranking method on species, based on their multi use, taste and perceived threats were used. One hundred twenty informants were interviewed. Thirty eight plants were identified. Among these, 39.47% were herbs, 31.57% were tree, 21.05% were shrubs, 5.26% were climber and only 2.63% were vegetative part of plant used. The listed plants were used for home consumption, healthcare though some other multi-purpose uses were reported. These were collected in different habitat. Most of them were collected during dry and on set of rainy season. Females collect them more than men, and children collect and consume them more than their elders in the household as shown by the results. Leaf, roots, fruits, bark, stem, and seed were the parts used for food and medicines. Their consumption correlates strongly to the size of household members and decrease in total household income at 5% significant level. The study identified the threats faced by vegetation in the area. Fire, agricultural expansion, fuel wood collection, timber collection and drought were among the threats mentioned. In conclusion, this study reveals that knowledge about edibility, habitat distribution and other uses of nutraceutical plant species is still maintained among the study community. As a result, the study recommends that, nutritional aspects of these plants need to be studied for further use. The existing district decision makers and other stakeholders in the area should design an all-inclusive and participatory management strategy that involves the local people in managements of these plants in order to address the mentioned threats on these plants.

Key Words: Nutraceutical, Diversifying, Food, Healthcare, Lare.

1. Introduction

1.1. Background of the Study

Since the prehistoric time, humans have always depended upon the plants for food, shelter and health. So the relationship between humans and plants is as old as history of humankind and indigenous knowledge about the plants is as old as human civilization. The study of direct interaction between humans and plant population through its culture is made an ethno-botany. Each human population classifies plants, develops attitudes and beliefs and learns the use of plants. While human behavior has a direct impact on the plant communities with which they interact, the plants themselves also impose limitations on humans. These reciprocal interactions are the focus of academic field of ethno-botany. The fundamental structure of ethno-botany is the dynamic relationship between human population, cultural values and plants, recognizing that plants permeate materially and metaphorically many aspects of culture, and that nature is by no means passive to human action but interacted with each other (Mohamed and Mushtaq, 2004).

Globally, humankind is dependent on a handful of widely cultivated plant species for food security. During the course of history, some 12,000 plant species have been used as food, but only 2,000 have been domesticated and only about 150 are commercially cultivated. About 30 species of plants have been reported to provide about 90% of the world's nutritional needs, and only 12 crops are known, to contribute between 85–90% of world's caloric intake. By contrast, wild foods provide a greater dietary, nutritional and medicinal diversity. Millions of people in developing countries depend on wild resources, for wild medicinal and edible plants. A food plant may be used for medicine, and to treat ill health or to maintain wellness. Hippocrates, 400–377 B.C. is famously quoted to have said 'let food be your medicine and medicine be your food' (Godin *et al*., 2014). Those plants which were used for both food and medicinal value were called recently, "Nutraceutical Plants". The term "Nutraceutical" was coined by Dr. Stephent L.Defelice in 1989 as a product isolated from food and sold in medical forms (Swati *et al*., 2011).

According to the World Health Organization (WHO) about 65-80% of the world's population in developing countries depends essentially on plants for their primary healthcare due to poverty and lack of access to modern medicine (WHO, 2013). Wild plants may be defined as those that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action. Despite society's primary reliance on crop plants, the tradition

of eating wild plants has not completely disappeared. In many societies, a large number of wild edible plants are regarded as emergency or hunger gap or famine foods. Wild food plants are accepted by rural communities through custom as appropriate and desirable (Godin *et al.*, 2014).

As the value of the useful plants to humans has been recognized in the world, similarly in Ethiopia a country with varied topography and a wide spectrum of habitats presenting a large number of endemic plants and animals has been practicing consumption of these plants which has been used in other part of the world. The country has about 6000 higher plant species of which about 10% are endemic (Hedberg *et al.*, 2009**)**. Currently, there is a global outcry over food insecurity. This is worsened by the soaring food prices in which Ethiopia is not an exception. Each year, on the average, about five million people have problems securing enough food for them and need assistance. According to Getachew Olani (2000), factors that are often mentioned as the principal causes of inadequate growth in food production and increasing food insecurity are: inadequate and variable rainfall, soil degradation, conflict, transport infrastructure, land tenure, storage, and poor nutrition. Though it is an important problem, the limited and selective food sources used by the people, together with absence of effort to diversify, has not been mentioned.

Despite food insecurity in many part of the country, rural people of Ethiopia are endowed with a deep knowledge concerning the use of wild plants. This is particularly true for the use of medicinal plants but also for wild plants some of which are consumed at times of drought, war and other hardship. Elders and other knowledgeable community members are the key sources or ‘reservoirs’ of plant lore. Wild food consumption is still very common in rural areas of Ethiopia, particularly among children. Among the most common wild plant fruits consumed by children are, for example, fruits from *Ficus spp, Carissa-spinarum* and *Rosa abyssynica* plant species (Guinand and Dechassa Lemessa, 2001).

In addition to their food value, traditional medicinal practices are common in Ethiopia in which about 80% of the population in the country use plant based traditional medicine by indigenous knowledge as their major primary healthcare system. Traditional knowledge of medicinal plants and their use by indigenous healers and drug development in the present are not only useful for conservation of cultural tradition and biodiversity but also for community healthcare and drug

development in the local people (Kalayu Mesfin *et al*., 2013). Damtew Bekele *et al*. (2012) point out that knowledge of traditional plants in Ethiopia has been available. The research result have reveal that traditional plants were not used only for their food and healthcare to human, they has been used in diverse ways for treating livestock. This suggest that, though, there has been some health centre in some areas peoples still use biomedical treatment of wild useful plants.

Gambella regional state has rich natural resources, particularly forest resources, from which useful plants are collected, and are of a high value of economy in the region. The region is actually still virgin of local economical tree species which farmers at the community level recognize for food security during normal and hardship. Renewable natural resources of the region, i.e. land, water, forest, and tree as well as other form of biodiversity, which meet the basic need for food, water, clothing and shelter, are available. Forest lands are the most frequently determined on economic criteria such as the demand for timber and agriculture. Forest are used to provide a whole range of benefits including wildlife, wild edible fruit trees, medicinal plants, watershed protection, construction materials, fire wood, and spiritual values (Paul *et al.,* 2012).

1.2. Problem Statement

The Gambella Region as whole and specifically Lare District has a huge potential of nutraceutical plants. These plants have a potential in supplementing available food crops that are cultivated on farms. They are importantly used as a medicine traditionally in addition to their supplementary role of diversifying food sources. However, these plants suffer from the declines of the forest cover in the district due to various human activities.

The problems for the decrease of these important nutraceutical plants are mostly anthropogenic activities, such as increased demand on them due to agricultural expansion through investment and shifting cultivation, abandoning previous farmland for other virgin soil in the forest, wild and intentional fire, for grazing domestic animals in need of generating new palatable grass and driving out tsetse fly away from domestic animals. Moreover, natural hazards such as climate change cannot be without effect in changing the status of these plants.

Despite the huge potential of nutraceutical plants in the area, no adequate research has been conducted on the use and sorting the types of these plants, their utilization and their status as means of income generation, their role in diversifying food sources and their contribution to healthcare. Therefore, this research was proposed to identify nutraceutical plants used in this regard to fill these information gaps in the area. The study contributes to documentation of relevant findings and also to suggesting the recommendations for improving the future use and managements of these important plants.

1.3 Objectives of the Study;

1.3.1 General objective

The general objective of this study was to assess the nutraceutical plants, their status as food source, healthcare and other utilization of these species at household level in the wood land of Lare District, Gambella Regional State.

1.3.2 Specific objectives'

The specific objectives were;-

- To identify nutraceutical plants in the study area;
- To identify parts of these plants used and mode of their preparation in the area;
- To determine the utilization and the socioeconomic contribution of nutraceutical plants to household in the study area;
- To identify gender and age role in collecting them in the household; and
- To find out the threats and local methods used by indigenous peoples to conserve the useful plants.

1.4 Research questions

The following were the major research questions that had been addressed by the study:

1. What are the nutraceutical plants that are consumed in the area?
2. What are the reasons of their use?
3. Who collects them, in term of gender and age equity in the wild?
4. What are the roles of nutraceutical and other useful plants in households in terms of their economic contribution?
5. Which plants and parts of the nutraceutical plants are used for food and healthcare, mode of use?

1.5 Significance of the study

Nutraceutical plants are sources of human food, nutrition and others use of household that are practiced traditionally. They are used as traditional medicines, and the sources of many modern medicines in pharmaceutical manufacturing. Every rural resident has got traditional knowledge of practicing and using nutraceutical plants in many ways. They are the sources of income for rural poor living adjacent to or inside the forest in all season of the year. They are even used when there is food shortage as food supplements in rural areas.

Nutraceutical plants are very important in bridging the gaps of food and medicinal shortages when there is a natural hazard such as drought or flooding in rural setting far from urban areas. This research was proposed to recommend the future use of nutraceutical plants, their management, and how further research would be conducted related to other issues on their consumption and contribution to household diet and healthcare of those living around the area and in the region as a whole. Therefore, this research noted the importance of nutraceutical plants, their contributions in various livelihood aspects in the household in different season in the area. The data generated and the analysis made are expected to be picked up by the regional and local administration and concerned stakeholders to carry out holistic management that would ensure sustainable use and development of the resource in collaboration with local communities in the area.

1.6 Scope and delimitation of the study

The research was conducted in Southwestern Ethiopia, Gambella Regional State, in Nuer Zone, Lare District. Three Kebeles were selected purposively based on the knowledge of members of the local community, accessibility to the forest resources and their sensitivity to other related environmental issues. The research was limited on survey questionnaires and other ranking methods. However, laboratory analysis on nutritional aspects of these plants, diversity of the species in the area was forwarded as a recommendation for further study.

2. Literature Review

2.1. Relation of Wild Useful Plants Use with Agriculture Components

Throughout the world, agriculture is the site of a great diversity of managed and collected plants and animal foods. Traditional agricultural research and extension, focused only on the main food crops, such as cereals, roots and domestic livestock, thus ignored the diversity of other plants and animals found in wild that also contribute the gene pool of agricultural systems. Structure or settled agriculture worldwide, whether arid or semi-arid, temperate or humid setting on the plain or mountains areas, show that hunting and gathering remains an important component of the livelihoods of agricultural peoples. There is no progressive evolutionary mechanism to divert such an act in those rural far distanced areas in using other means of diversifying their livelihoods. Although the greatest diversity of wild food plants is found in the multi-layered, complex agro-forestry systems and home gardens, wild foods are still important in apparently simple, monoculture systems. Wild food are not only associated with the systems that replicate the ecological diversity of the unclear forest, they are also found in the degraded sites. Sometimes disturbance increase the diversity of wild products, because their seeds and any other dispersal way for their reproductive system are scattered through this (Ian *et al*., 1992).

The use of these foods, which has evolved over the decades, has served to provide food and maintain general health among populations. In fact, many of the food plants are used for both nutrition and medicine: to satisfy the needs of an active individual and to provide elements which act to prevent ill health and have healing properties. In most traditional societies, there is usually no clear demarcation between what is taken for food and what is taken for medicinal purposes as the two generally overlap. Thus, the nutritional and medicinal importance of indigenous food plants can be considered in the light of maintaining good health and preventing ill health or healing (USAID, 2001). Wild edible fruit trees are plants that are found in the wild not cultivated, but are sources of food diversification. They are loved by any society living in the forest adjacent or inside forest in the world. The reason why they are loved so much is because; they are easy and free to get as a source of food with no restriction at any time. However, the most dependency on staple agricultural crops, the cultural use of eating them continued from the past up to present. Wild edible plants play an

important role in maintaining livelihood security for many people in developing countries in addition to their role in closing food gaps during periods of drought or scarcity (Ermias Lulekal *et al*., 2011).

Wild food plants (‘liim’ in Monjeng) are seen in South Sudan as something you can get free from the environment. The community perception of indigenous wild food plants is that they are there to help people through the ‘hunger gap’, and there is little appreciation of the full value of these foods in terms of nutrition (WFP, 2001**).** Getachew Olani (2001) explain that food insecurity arises through several reasons; it could be through natural hazard, such as drought and flood, and in other way, it can be through human made activities, such as war. The coping mechanisms are either through borrowing from your close kin, selling domestic animals and surplus crops, collecting wild foods, or selling assets, such as farm lands out migration from original home lands to neighborhood as one way in Ethiopia and some other country in the world and any more. It is obvious that most of these mechanisms have irreversible and harsh consequences. Even though they are friendly to the environment and they can contribute to future sustainability, alternative coping mechanisms like food source diversification have been discouraged or have not been encouraged in the Ethiopia in the past decades.

2.2. Contribution of Nutraceutical Plants to Food Security

Food security is a concept that evolved over time. There are many definitions of food security (Ahmed, 2006); the most widely used definition of food security is given as, access by all people at all times to enough food for an active, healthy life. In particular, food security will be achieved when the poor and vulnerable, particularly women, children, and those living in marginal areas have secure access to the food they want. According to human development reports for World Bank (1996), food security is when an individual or household access food items and consumes them without any hindrance.

The first international scientific symposium on biodiversity and sustainable diets, held at FAO in (2010), defined sustainable diets as: Those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural

and human resources. According to Vinceti *et al*., (2014), these sustainable diet includes; 1. Food and nutrient needs, food security and accessibility, 2. Well-being and health, 3. Biodiversity, environment and climate change, 4. Eco-friendly, local and seasonal foods, 5. Cultural heritage and skills, 6. Equity and fair trade.

The use of wild food as a component strategy of reducing food insecurity is widely documented in many books. Wild food/fruit trees are consumed during the time when staple agricultural crops fail to support livelihoods in households or when flood consumed up all belongings of the community living in the certain area or when people are displaced from their original resident. Famine food includes those of wild vegetables, fruits, berries, roots and tubers, leaves, etcetera (Ian Scoones *et al*., 1992). Wild food plants are able to fill a variety of food gaps. If, for example, the previous crop harvest was not able to provide enough food to last through to the next harvest, wild leafy vegetables, cabbage and tuber- type famine food plants will be consumed to fill the gap after the first rains, when farmers are preparing their fields (Gruinard and Dechassa Lemma, 2000). Compared to domestic crops and animals, wild edible fruit trees are over looked. However, their potential in contributing in the food insecurity during scarcity is confirmed high in the worlds, (Ermias Lulekal *et al.*, 2011). Their ease of access and collection in natural habitat and the deep knowledge that is possessed by indigenous peoples make them to be a good source of food.

According to Ermias Lulekal *et al*. (2011), fifty percent of world's daily requirement of protein and calorie is limited only to three domestic crops, maize, wheat and rice. This has also limited the dietary and other nutrient available to wild edible plants, which are neglected in the wild though, they are easily accessible. Thus, wild edible plants are important during stress. Their 'safety-net' function has been noted previously. In Niger, 83% of informants reported increased reliance on wild foods during drought in the east usambara mountains (Tanzania). Wild foods were consumed more frequently in the wet (food insecure season) than the dry season (when wild foods were less available) in Thailand, but food insecurity is highest (WHO, 2013). All these findings suggest that wild and forest foods are important as a source of resilience in the food diversification (Debela Hunde *et al*., 2014).

2.3. Contribution of Nutraceutical Plants to healthcare

Nutraceuticals may be divided into herbal/ natural products, dietary supplements and functional foods. Out of these, most rapidly growing segment is herbal/ natural products followed by dietary supplements. High dietary intake of fibers in the form of fruits, vegetables, whole grains is strongly linked to a reduced risk of chronic diseases like cancer and cardiovascular diseases. Cancer development is a chronic, stepwise complex process culminating into metastasis if not tackled in time. Epidemiological studies now provide convincing evidence that dietary factors may modify carcinogenesis. From a nutritional perspective, forests and trees offer sources of many micronutrients commonly lacking from diets in developing countries and which have important health and developmental functions (Vinceti *et al*., 2013). For example, vitamin A plays a key role for proper immune function deficiency causes blindness in up to 500,000 children every year and is associated with higher rates of infection (diarrhea, measles, respiratory tract infections, *etc.*). Good dietary sources of vitamin A are green leafy vegetables and orange-colored fruits and vegetables. Iron, zinc and vitamin B12 deficiencies can impair growth, cognitive development and school performance, with life-long implications for health and socio-economic success (Vinceti *et al*., 2013).

The contribution of local plant foods to reducing health risks has always been recognized as part of the local knowledge which forms a greater part of the complex cultural system. Research has shown that many edible plants are rich in specific constituents, referred to as phytochemicals, which may have health promoting effects (Dlamini *et al.,* 2014). The major plant-derived chemical groups now recognized as having potential health promoting effects, at least under some circumstances, are the flavonoids, alkaloids, carotenoids, pre- and pro-biotics, phytosterols, tannins, fatty acids, terpenoids, saponins and soluble and insoluble dietary fibers. These phytochemicals have the potential to be incorporated into foods or food supplements as nutraceuticals (Dlamini *et al.,* 2014). The definition of nutraceuticals can thus be summarized as “any non-toxic food extract supplement that has scientifically proven health benefits for both disease treatment and prevention” (Dlamini *et al*., 2014). It has been generally stated that the health promoting effects of nutraceutical and other functional foods are likely due to biochemical and cellular interactions, which together promote the overall health of an individual (Table 1).

Table 1: Nutrient content of selected African indigenous and exotic fruits per 100 g edible portion

RE= retinol equivalents

Species	**Energy (Kcal)**	**Protein (g)**	**Vit C (g)**	**Vit A (RE)** (µg)	**Iron (mg)**	**Calcium (mg)**
Indigenous fruits:						
Adansonia digitata L	**327**	**2.5**	**126 - 509**	**0.03– 0.06**	**6.2**	**275**
*Grewia tenax (*Forrsk). fiori	**N.A**	**3.6**	**N.A**	**N.A**	**7.4 - 20.8**	**610**
*Scelerocaria birrea.*Hochst	**225**	**0.7**	**85- 319**	**0.035**	**3.4**	**35**
Tamarindus indica .L	**275**	**3.6**	**11 - 20**	**0.01– 0.06**	**3.1**	**192**
Ziziphus mouritania. Lam	**184**	**0.4**	**3 - 14**	**0.07**	**0.8**	**23**
Exotic fruits						
Guava (Psidium guajava L)	**68**	**2.6**	**228.3**	**0.031**	**0.3**	**18**
Mangifera indica L	**65**	**0.5**	**27.7**	**0.038**	**0.1**	**10**
Orange (Citrus sinensis L. Osbeck	**47**	**0.9**	**52.0**	**0.008**	**0.1**	**40**
Pawpaw (Carica papaya L.)	**39**	**0.6**	**62.0**	**0.135**	**0.1**	**24**

Source: Vinceti *et al., (*2013).

2.4. Economic Value of Nutraceutical Plants

Wild food plants are important in household economic back up. They are traded and sold in markets for the exchange of money in parts of Africa, such as Tanzania, Kenya, Uganda, Sudan and South Sudan and even in our country Ethiopia (WFP, 2001). According to Gruinard and Dechassa Lemessa (2000) wild edible fruit trees or shrubs are traded in Ethiopia either for exchange of other house hold consumption or for direct trading in Northern parts of the country. Nevertheless, in Southern Ethiopia, wild food plants are mostly used for home consumption and if traded on the market, they are most likely not traded for money but exchanged for other goods and food stuff. In Western Ethiopia (Jimma and Illubabor) as well as in remote areas in the Tekeze River lowlands and in the Simien Mountains of North Gonder and Wag Hamra, a considerable variety of wild food plants are offered on local markets. These marketed wild food plants include wild fruits trees and shrubs. An example of a traded and exchanged wild food plant is *Opuntia ficusindica,* a cactus plant.

According to Kajambe *et al*. (2000) wild plants are sold in nearly every marketplace in Africa, the Caribbean and the Pacific, but little is known about their contribution to the national economy of the countries. Few countries register the species that are sold, and where, in what quantities and at what prices. Even less is known about who harvests and sells them, and who buys them. Unlike timber and agricultural products, no regular monitoring or evaluation of the resources, market chains and socio-economic contribution of NTFPs at national level is done anywhere. Only exported non-timber forest products sometimes appear in national statistics. Few countries, like Cameroon, Guyana and South Africa, more research groups and NGOs have been active in Non-Timber Forest Product research than elsewhere. These countries are often cited here simply because their statistics are available (Van Andel, 2006). FAO and WHO (2013) point out that forest incomes can be diverse, including: the sale of firewood, charcoal, timber, crafts and tree products such as fruits, oils, nuts, medicines, vegetables, employment in forest related industry such as timber, and the sale of agricultural produce produced under agro-forestry systems (coffee, cacao, rubber, etc).

2.5. Social Implications of Useful Plants Consumption

Traditional food systems are defined by the natural and social, economic and cultural contexts in which they occur (WHO, 2013) in forest areas, forests are a central aspect of traditional food systems. These social and cultural characteristics of traditional food systems, contribute to the social, cultural, emotional, mental and spiritual aspects of well-being (FAO and WHO, 2013). Different types of wild harvest are used by different people at different times, and so contribute to livelihood strategies in a complex mode of living. Understanding how collection, use and marketing of wild resource products are differentiated by wealth, gender, age and ecological situation is important. Wild resources are particularly important for poor, women and children, particularly at the times of stress (drought, changing land availability, ecological change). With less access to land, labor and capital resources, these groups are particularly reliant on wild resources use (Ian *et al*., 1992).

For people outside rural areas, indigenous wild foods are usually considered obscure, unpalatable, only eaten by the poor or eaten during times of famine. Moreover, the people who eat these foods do not usually mention them in nutritional surveys. In fact, early anthropologists were surprised that some communities did not show symptoms that would have been apparent from lack of certain foods in their diet. Fruits and nuts eaten as snacks during herding or fruits and tubers used to quench hunger and thirst on the way were not usually revealed for total daily food intake. Another factor could be that compared to what was accepted elsewhere as food, these foods were inferior and thus not worth mentioning as part of their diet (USAID, 2001).

According to Guinand and Dechassa Lemessa (2000) wild foods are often considered a low-status food and its consumption regarded as a source of shame. In normal times only children, youngsters and the poorest families regularly collect and consume wild food. However, for the poorest, collection and consumption of wild food may make up an important portion of their daily dietary intake. Not all people encountered were willing to provide information about wild food and particularly famine food. Some of the farmers when questioned obviously felt ashamed and maybe offended by outsiders asking questions about such sensitive issues as the consumption of famine food (Getachew Olani 2000). Moreover, religions are the factors that cause significant variation in the normal food habits and dietary patterns of the different regions of Ethiopia. Religions determine

not only the type of foods that could be eaten and that could not, but also when the edible ones could be eaten and when they could not (Guinand *et al*., 2000).

Cultures and traditions determine what people will or will not eat and dietary patterns remain strongly influenced by the history of peoples and their culture. In Ethiopia, it seems that next to religion, culture and tradition have caused people to narrow their food habits. For instance, there is no religious limitation on consumption of roots, tubers, vegetables, some wild animals, rodents, fish, insects, reptiles and birds. These have not been eaten in Ethiopia principally due to culture and tradition of the people. In traditional communities, many forest products play an important role in social and ritual activities. Frankincense resin, for example, is widely used in religious ceremonies in Ethiopia and Eritrea. In Southern Cameroon, a wide range of forest products is commonly used in traditional ceremonies like marriages, funerals, inauguration ceremonies of chiefs, initiations, birth celebrations and conflict resolution (Van Andel, 2006).

Personal characteristics like age and sex also determine food habit of and food materials used by the different members of certain community. Often traditionally, children are forbidden to eat certain food materials. Similarly, adults drop some food materials, which they ate when they were younger. In the rural areas, children eat a number of wild fruits, roots, leaves, twigs or other plant parts, but they avoid all or most of them when they grown-up. Further, in urban settings, children raise and eat domesticated pigeon, but they avoid the practice when they become adults. This indicated that as people get older and are more exposed to the culture of their society, they avoid certain foods. This also indicates that children and adults have different coping mechanism to famine (Getachew Olani, 2000).

2.6. Threats and Conservation of Nutraceuticals plants

Like other plant species, wild edible and medicinal plants are threatened due to various human activities and natural causes such as land use change (expansion of agricultural lands, developmental activities); habitat destruction (timber harvest, fuel wood collection, forest fire); over-harvesting; over-grazing; and invasive species (Yadav Uprety *et al*., 2012). According to Tena Regassa *et al.* (2014), the habitats of these valuable plants were increasingly threatened by continued destruction of natural vegetation. The fact that most wild food and medicinal plants have multipurpose uses, posed a big threat to their existence due to destruction of their habitats and overharvesting.

Ecological degradation, loss of traditional knowledge, Loss of cultural assets, Danger on medicinal plant through smuggling and misuse of resources, Lack of suitable scheme for equitable sharing of benefits arising from biological resources, poor market situation may prevent enthusiastic cultivators from producing medicinal plants for the market, traditional healers may not participate fully and collaborate (Endashew Bekele, 2007). Rapid increase of population, urbanization, multi-purpose use of timber products were human threats, and while, frequent fire (intentional and bush fire), pest and disease, climate change (re-current drought) were reported as a natural threats to existence of wild edible and medicinal plants in Ethiopia (Kebu Balemie and Fasiil Kebebew, 2006).

Both ex-situ and in-situ conservation acting are needed to achieve the target (Cotton, 1996) and they will need to be used in complementary ways to maximized diversity conservation. The specific combinations are likely to differ substantially depending on the species. Crops are likely to involve substantially more ex situ conservation than other socio-economically valuable species. However, some countries already have experience of in-situ conservation of wild species (including forestry pecies) through forestry management zones which can be utilized by others. In general, ex-situ conservation is one of the practices which involve conservation outside of the natural environment, which can contribute to the conservation of cultivated and non- cultivated plants in farming system. Martin (1995) revealed that farming systems are able to maintain a rich diversity of genetic resource of food species and other crops as the people who use them have develop sophisticated mechanisms of selection, maintenance in their farmland as a measure conservation measures. This can be enhanced through awareness raising of the users and in the area (Tigist Wondimu *et al.,* 2006).

3. Materials and Methods

3.1. Description of Study Area

The Gambella People's Regional State (GPNRS) is located in south west Ethiopia between the geographical coordinates of $6^{0}28'38''$ to $8^{0}34''$ North Latitude and 33^{0} to $35^{0}11'11''$East Longitude, which covers an area of about 34,063 km^2 about 3% of the nation. The Region is bounded to the North, North East and East by Oromia National Regional State, to the South and Southeast by the Southern Nations Nationalities and People's Regional State and to the Southwest, West and Northwest by the Republic of South Sudan (GRSBoLR., 2011).

3.1.2. Description of the Study District

The study has been conducted in Lare District. Lare is one among the 13 Districts in the Gambella Regional State. It's part of the Nuer Zone. Lare is bordered on the south and east by the Anuak Zone, on the west by the Baro River which separates it from Jekow, and on the north by the Jekow River which separates it from South Sudan. Towns in Lare include Kowergeng. The terrain in Lare consists of marshes and grasslands; elevations range from 300 to 400 meters above sea level. A notable landmark is Gambella National Park, which occupies part of the area south of the Baro. At some point between 2001 and 2007, the eastern Kebele of Jekow was split off to create Lare (Dereje, 2003**).**

3.1.3. Demographics

Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this district has a total population of 31,406, of whom 16,145 are men and 15,261 women; with an area of 685.17 square kilometers. Lare has a population density of 45.84, which is greater than the Zone average of 23.79 persons per square kilometer. While 6,549 or 20.85% are urban inhabitants, a further 156 or 0.50% are pastoralists. A total of 5,432 households were counted in this district, which results in an average of 5.8 persons to a household, and 5,217 housing units. The majority of the inhabitants are Protestant, with 86.81% of the population reporting they observed this belief, while 7.48% practice traditional religions, 2.69% are Catholic, and 1.79% of the population practice Ethiopian Orthodox Christianity (CSA, 2007).

3.1.4. Ethnicity, Livelihood System and Culture of Lare People

The people of Lare are Ethnic Nuer, which are living in the western part of the region. Their mother tongue is Thok-Nuer/Nuergna or Nuer language. The main categories of the livelihood are agro-pastoral (livestock and crop production), fishing, hunting and wild food collection in which the livelihood of the community depends on (GRSBoLR, 2011). The disputes between tribal sections are very often about cattle, and cattle are the compensation for loss of life and limb that is so frequently their outcome. Leopard-skin chiefs and prophets are arbiters in questions in which cattle are the issue, or ritual agents in situations demanding sacrifice of ox or ram (Evans-Pritchard, 1948).

According to Evans-Pritchard, (1948). The importance of cattle in Nuer life and thought is further exemplified in personal names. Men are frequently addressed by names that refer to the form and color of their favorite oxen, and women take names from oxen and from the cows they milk. Even small boys call one another by ox-names when playing together in the pastures, a child usually taking his name from the bull-calf of the cow he and his mother milk. Often a man receives an ox-name or cow-name at birth. Sometimes the name of a man which is handed down to posterity is his ox-name and not his birth-name. This is also supported by Peter (2010), their traditional world view usually is that of a Herdsman, and prestige is measured by the quantity and quality of the cattle owned. “Both men and women take the names of their favorite oxen or cows in ritual of honor and most typically prefer to be greeted by their “cattle names.

Cattle have historically been of the highest symbolic, religious and economic value among the Nuer. Cattle are particularly important in their role as bride wealth, where they are given by a husband's lineage to his wife's lineage. It is this exchange of cattle which ensures that the children will be considered to belong to the husband's lineage and to his line of descent (Evans-Pritchard, 1948). Marriage among the Nuer is brought about by payments of bride-wealth, and by performance of certain ceremonial rites. It is often clear that payments should reach a certain point before a certain rite is held, and the performance of the rite is usually in the recognition of the transfer of cattle, an estimate of 40-100 cows depend on the more cattle of the bridegroom has and the quality of the girl (Peter, 2010). They regard milk as essential for children, believing that they cannot be well and happy without it, and the needs of children are always the first to be satisfied even if, as happens in times of privation, their elders have to deny themselves. In Nuer eyes the happiest state is that in

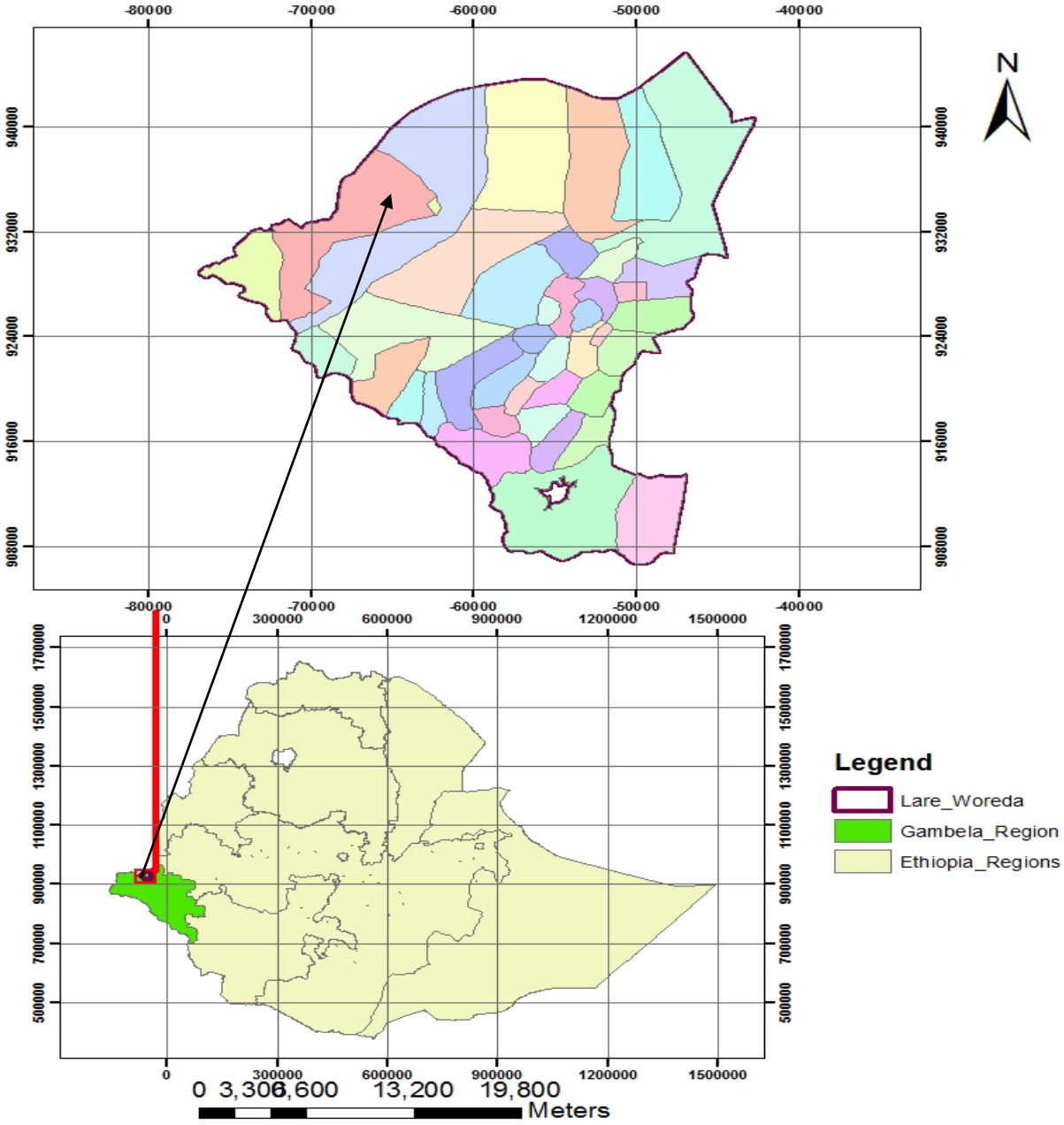
which a family possesses several lactating cows, for then the children are well-nourished and there is a surplus that can be devoted to cheese-making and to assisting kinsmen and entertaining guests (Evans-pritchard, 1940).The Nuer establishes contact with those ghosts and the spirits by rubbing ashes along the back of oxen or cows dedicated to them through the sacrifice of cattle." There is no important Nuer ceremony of any kind that is completed without such a sacrifice of cow or goat/sheep in Nuer Land. Cattle in traditional setting were used to buy everything from food to bride, and to pay for anything from personal debts to fines (Peter, 2010)

3.1.5. Climatic Condition

Lare is situated in the low lying plain and agro-ecology described as *Bereha*/extremely hot. The climate of the District is formed under the influence of the tropical monsoon from the Indian Ocean, which are characterized with high rainfall in the wet period from May to October and has little rainfall during the dry period from November to April. The mean annual temperature of the District varies from 17.3^0C to 28.3^0C and annual monthly temperature varies throughout the year from 27^0C to 38^0C. The absolute maximum temperature occurs in mid-March and is about 45^0C and the absolute minimum temperature occurs in December and is $10.3^{\mathbf{0}}$C. The annual rainfall of the District varies from 900-1,500mm with highest in July to September and lowest in November (GRSBoLR, 2011).

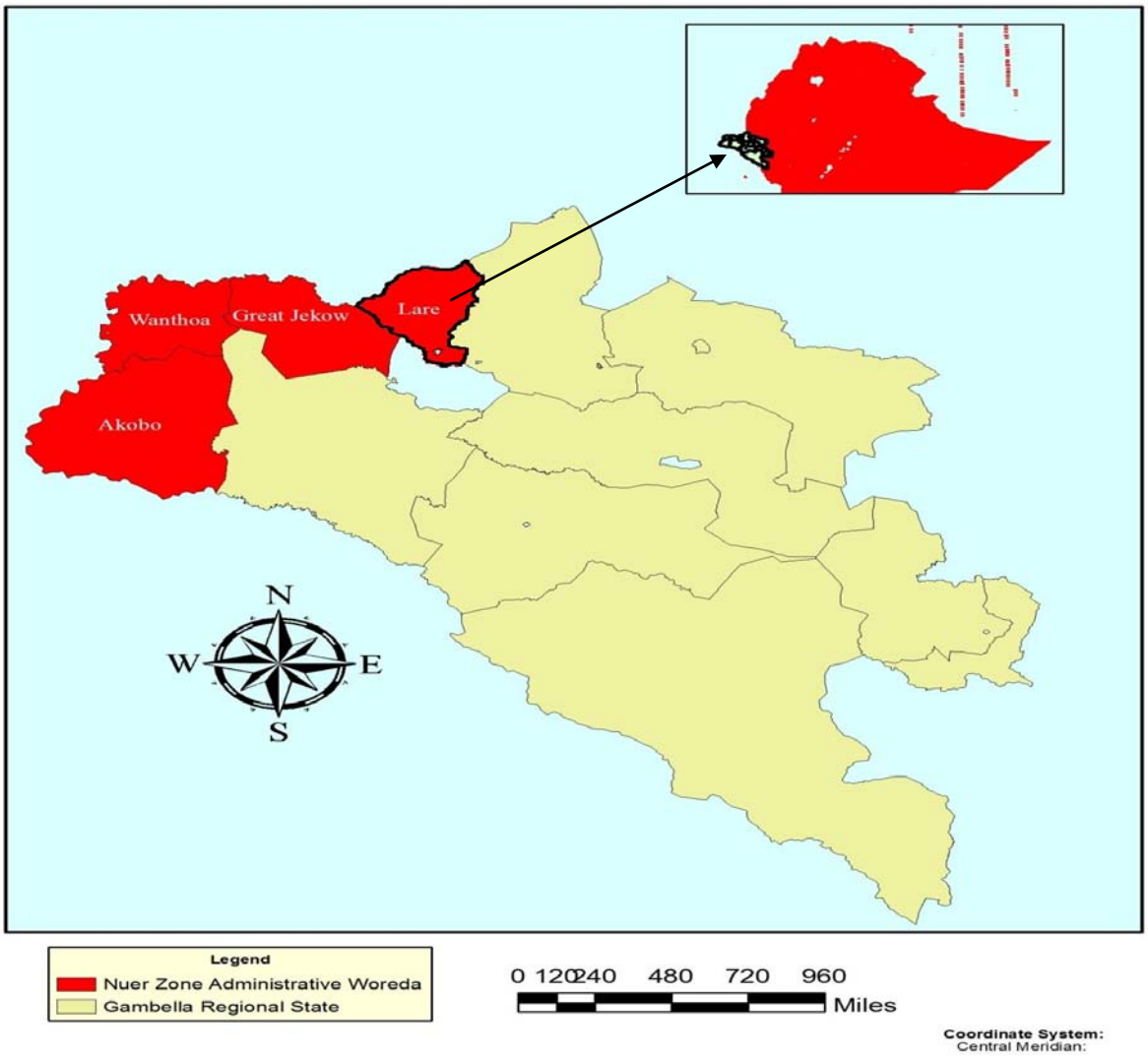
3.1.6. Vegetation of District

The natural (i.e. undisturbed) vegetation patterns are closely related to patterns of rainfall and temperature, with local variations due to soil and drainage factors. In the upper parts of the foothills a mixed broadleaf montane forest occurs, with increasing species diversity to the west between 600 and 450masl a lowland forest occurs which has affinities with the Guinea-Congo plant realm (GRSBoLR, 2011). Forest and grassland are the vegetation types of the low land in the region. The vegetation of the Lare District were categorized under wood land of sorghum purpureo-sericeum-pennisetum thunbergii community, scattered individual of *Balanites aegyptiaca* (L) and different *Acacia species*, mixed with tall elephants grass and *Hygrophila auriculata* (Schum).Heine in the district (Tesfaye Awas *et al*., 2001). Though, the vegetation of the District has begun to decrease, there is some remained dense, scattered and shrubs of the woody forest resources in the district.



Source: - (GRSBoLR, 2011)

Figure 1: Map of Gambella Region, Ethiopia



Source:- (GRSBoLR, 2011)

Figure 2: Map of the study District in Gambella Regional state

3.2. Methods

3.2.1. Study Design

During design of study, both purposive and systematic simple random sampling was used to get the required information in the study district.

3.2.2. Study Area Selection

After study design, three Kebele administrations (Bilimkun Kebele, Kutoch Kebele and Ngor Kebele) were selected from 26 total kebeles of district purposively base on the influence of better

vegetation cover, the occurrence of famine and disease and present of local healer who collect these useful plants in the area.

3.2.3. Sampling size determination

In this study, a total of 120 informants (73 males and 47 females (in the age ranges from 24 to 60)) from different demographic groups were chosen for interview following procedure of Krejcie and Morgan, (1970). The sample size was determined by the following formula; and the proportion of sample size under each kebele is described (Table 2).

Sample size = $X^2NP(1-P)/ C^2 (N-1) + X^2P(1-P)$

Where: X^2 = A constant value of 3.841 (the square of the Z value of 1.96 for 95% confidence level);

N = the population Size;

P = the population parameter of 0.5 and

C = A 95% confidence interval (0.05), a probability that the samples represent the population

Table 2: Proportion of Sample Size under Selected Kebeles

Total household number under each Kebeles									Tot. hh for all Kebele
Bilimkun Kebele			Kutoch Kebele			Ngoor Kebele			
M	F	S.S	M	F	S.S	M	F	S.S	
425	339	42	297	232	29	501	402	49	
764			529			903			2196

Sources: from Woreda Agricultural Office, S.S = Sample Size

In order to get 120 respondents, a total un ordered list of 170 household number was received from 2,196hh in the three study kebele by the use of systematic random sampling method where every 4th hh was chosen for inclusion in sample starting from 3rd hh in the list following the methods and tabulated sample size of Krjcie and Morgan (1970). This made the total household number to be sampled 118 and these participated in the interview. The remaining two respondents were randomly selected by the use of random number table, and generated from excel. However, the sample proportion under each household was stratified in order to get the sampled interviewee under specific kebele before key informants and focus group members were selected using formula SS = N(P), were N = required sample size, and P = proportion of total household number of kebele to the total hh.no of all kebele (Table 2), (Kothari, 2004). The focus group discussion participants and key

informants were purposively selected from these respondents based on their age, traditional knowledge of wild edible plants use, and longer residence time in the study area. Moreover, selection of key informant was made by elder peoples in the community. These were selected from the sample household size in three kebeles. Fifteen key informants in which five KI per kebele, six FGD two per kebele in which one FGD consist 10 participants were conducted.

3.3.4. Method of Data collection

3.3.4.1 Ethno-botanical information collection

Ethno-botanical techniques were employed to collect data on the utilization and management of wild edible plants. The socio-economic survey involved various techniques, such as designed semi-structured questionnaire for interview, focus group discussion, and pair wise ranking, direct matrix ranking, preference ranking as described by (Martin, (1995); Alexiades, (1996); Cotton, (1996)). Most of the interviews and focus group discussion were held in local language " called thok Nuera" means Nuergna. Key informants interview and direct field observation were also conducted.

3.3.4.2 Focus Group Discussion

The participants for the focus group discussion were purposively selected from different socio-demographic groups (Sex and Age) based on the recommendations given by district agricultural office officials, kebele administrative and elder community members of the village. The main criterion for their selection was knowledge on the use and utilization of wild edible plants. This was carried out based on the prepared semi-structured discussion guidelines and semi-structured interview questions (Appendix 1). The informants were asked to name the nutraceutical plants they gather, purpose of their collection, who gather them, habitat of collection, part of plants consumed, preparation method, their healthcare for both human and livestock, which are responsible for treating which particular disease from either human or domestic animal, their frequency of consumption in the household, other socio-economic benefits, threats perceived and management options and what activities promote their consumption following the procedure of (Cotton,(1995); Alexiades, (1996)).

3.3.4.3. Habitat of collection and plant Identification

A reconnaissance survey on vegetation characteristic of the study area, where nutraceutical plants are found was conducted by transect walk, together with knowledgeable people. This was conducted through field observation in order to obtain information on the types of habitat where these plants are collected following the procedure of Kent and Cooker (1992). In addition to field observation, taking picture of the plants in the field and later converted to scientific name by a means of tree identification manual/Flora of Ethiopia and Eritrea volume 1 to 7 (Mesfin Tadesse and Hedberg (1995); Edwards *et al.,* (1997); Edwards and Sileshi Nemomissa (2003)). Moreover, identification was done also in the field mainly based on the works of published guides of useful trees and shrubs of Ethiopia for plant botanical name confirmation which are locally confirmed by key informants (Azene Bekele *et al.,* 2007). However, one plant vernacular names was difficult to identify in the tree identification manual. As a result, I enlist it as un-identified.

The secondary data was collected from the different literature, written documents related to the proposed works in the internet as well as in the library, journal articles on the website, published books and reports related to the current issues about wild harvest (nutraceutical plants) in our country as well as in other countries.

3.4.5. Method of Data Analysis

3.4.5.1. Descriptive statistics

The data collected by field observation, group discussion and semi-structured questionnaires interview, in selected three kebele were entered into excel spreadsheets and analyzed by using descriptive statistics, and SPSS (Statistical Package for Social Science) version 16, and summarized in frequency, table and graph forms in order to get the percentages of the use of the plants, the percentages of the socioeconomic status observed in the field.

3.4.5.2. Direct Matrix Ranking (Use diversity ranking) Method

Direct matrix ranking was done following the procedure of Martin (1995) in order to compare multipurpose use of a given species and to relate this to the extent of its utilization versus its dominance. The use categories included were edibility, medicinal value, construction, agricultural

tool, fuel wood, furniture and shade. Each key informant was asked to assign and give value about the importance and usefulness of each nutraceutical plant species on the basis of the following rating as 4= Excellent 3= very good 2= good, 1= least used 0= not used. Accordingly, each key informant used such ratings to assign the eight multipurpose wild edible plant species in each category.

3.4.5.3 Preference Ranking Method

Preference of five nutraceutical plants used for their leaves was identified by the focus group discussion participants for their taste and aid in food digestion. Of the 60 participants of FGD, 10 representatives KI were selected to identify the best preferred plant species used for household food supplements. Each informant was provided with the five leafy plants and were asked to assign the highest value (6) for plant species best preferred and the lowest (1) value for the least preferred plant. These values were summed up and ranks were given to each plant species.

3.4.5.4. Pair wise Ranking Method

Pair-wise ranking was conducted on the perceived threatening factors to nutraceutical plants and the number of possible pairs was calculated using the relation: Y= N (N-1)/2 following the procedure of (Ertug, 2004). Where 'Y', is the sum of all factors rated by respondents in each sites, 'N' is the number of factors (activities). Accordingly, many threatening factors were identified by the community. The total number of factors was determined using the above formula and then the ten pairs were arranged and presented to the key informant to choose one from the two threats at a time.

3.4.5.5. Correlations of Household Parameters with Use Purpose

Pearson's Correlation coefficient was used to test household variable with the use and consumption of the nutraceutical plant species in the study sites, which are used as a food or medicines. Other socio-economic contributions to households were also tested in order to know the strength and links of local community with their surroundings. Significance was tested at 5% level to compare relation between household parameters with nutraceutical plants consumption in the area.

4. Result and Discussions

4.1. Household Socio-economic Characteristics

4.1.1. Household Characteristics

Among the sampled household, (60.8%) were Male and (39.2%) were Female household heads. The average family size of informants in the area was 7, and the average age of the sampled household head was 41.5 with minimum of 24 and maximum of 60 ages. Their means and standard deviation were 2.30 and 8.89. About 29.2% of respondents did not attend formal education, the rest of 30.8%, 22.5%, 13.3% & 4.2% were found to have some school background from grade one up to diploma (Fig. 4).

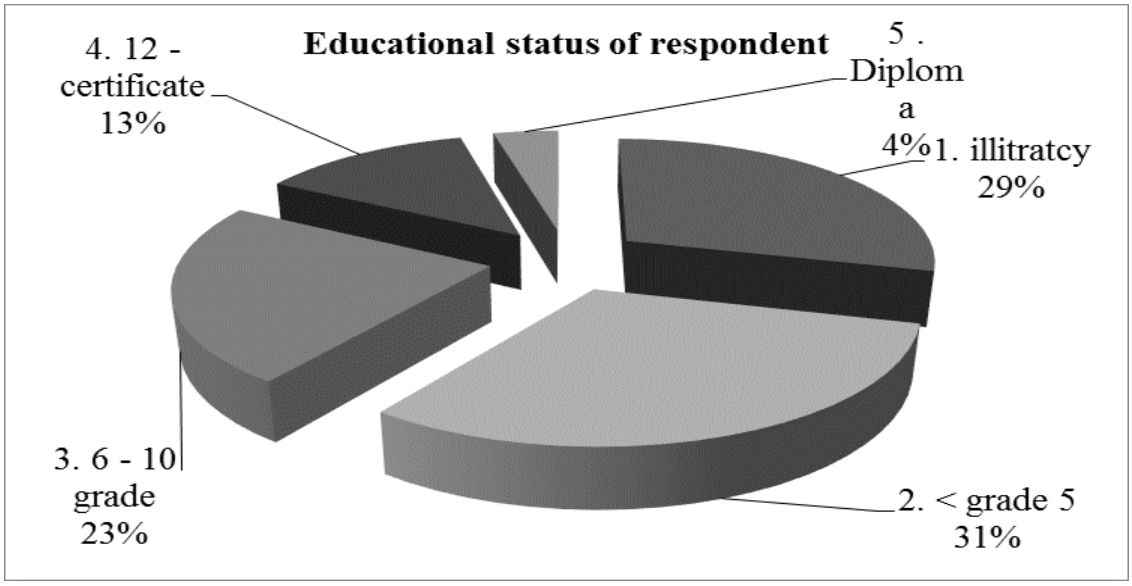


Figure 3: Educational status of the respondent

The respondent indicates that, the consumption of these plants was increased on the household with low level of education. The reason mentioned was, family with high education profile secure government employment compared with low and illiterate family. They can seal some gap of food insecurity in the household by buying necessities those support livelihood in the household, because, they have money to access some material lacked. However, the educated household heads were few compared to low educated and illiterate families in the area. Due to the low educational status, many household uses these plants for their livelihood support. These are in line with the finding of Tesfaye Awas (2007) in Beneshangul Gumuz in his desert on different ethno-botanical study of medicinal plants herbs and other more. His result reveals that, the increase of educational status decrease the use of wild plants in the area.

4.1.2. Socio-economic Characteristics

4.1.2.1. Wealth Status

In terms of comparing the present situation with 15 year back, most of the respondents' livings in the area were found to be under subsistence level, followed by medium, with proportion of 38.33% and 35.0% respectively (Table 3). This was because; the traditions of self-reliance of these peoples were affected by new developments and technological progress. For instance, many of the young active aged men dislike working in household, vacating the villages for towns' life, though some went for educational purpose. This posed work load to their parents which affected production of livelihood activities in the household. According to informants despite that, some parents in the area left their home to live between towns and village. This type of social change in the study site affected livelihood activities, which forces peoples to consume wild edible plants in the household as a means of diversifying income for food, though they are used in normal condition previously.

Rich = a H.H which practice crop production and possess more than 10 heads of cattle)
Medium= (a H.H who practice crop production and possess 1 -10 head of cattle)
Low/subsistence = (H.H with few to none domestic animals and practice low crop production).

Table 3: Wealth categories

S/N			N = 120	Percent
1	Wealth status of hh	Rich	32	26.7
2		Medium	42	35.0
3		Subsistence level	46	38.3
1	Source of Income	Crop Production	18	15.0
2		Livestock Production	37	30.8
3		Both Crop & LS	65	54.2

The source of wealth in the area was reported to come from crops production, livestock rearing and both crop and livestock raring with proportion of 15%, 30.8% and 54.2% respectively. This explained that, most sources of income have been practicing livestock and crop production with some few farmers who practice only crops production. However, the crop production is not sustainable, because the harvested yields do not last long and were reported to exhaust or be finished before land preparation for next harvest. Moreover, consumption of these plants reduced in rich family compared to low income level of household as reported by informants in the area.

4.1.2.2. Land holding Capacity

Most of the cultivated field crops have been found within the proportion of 21.7%, 26.7%, 31.7%, and 20% respectively from informants (Fig.5). However, the study noted that, the mentioned number of ha was based on the farmers' estimating, because there was no clear sign of exact measure of their cultivated field crops by government in the area. In fact, there is no land problem for sowing/cultivating in the area. But, the cultivation processes is poor which led to low yield income in the area. Moreover, this cultivation method was mostly affected by seasonal climate change, especially occurrence of re-current drought and high rainfall showering in the study site.

Figure 4: The size of cultivated field crops in the farm

The farmer or household who commits to cultivate his field crop whole heartily in the area were reported to harvest more yield. Pending to this high harvest, it was reported that they consume less wild edible plants compared to those with low yield harvest in the area. Similarly, some people diversify their food source through mini trade, by selling livestock to the Region's capital Gambella and buy others more in local village in Lare District. It was also revealed that they consume nutraceutical plants and other useful plants in the area in less quantity compared to low income household.

4.2. Ethno botanical information of Identified Plants

Based on the willingness of each household heads and other respondents, 38 nutraceutical plants were enlisted. Among the reported plants consumed for food and medical care, 39.47% were herbs, 31.57% were trees, 21.05% were shrubs, 5.26% were climber, and only 2.63% were vegetative parts of plant used. More food/fruits value of these plants was reported to be harvested or collected from trees compared to the other life grower forms in the area. The fruits from *Balanites aegyptiaca, Tamarindus indica, Celtis toka, Ficus sycomorus, Adnsonia digitata, Piliostigma thonningii, Sclerocarea birrea, Ziziphus spina-christii, Diospyrus mispiliforms,* were reported as tree and fruits from *Grewia abutilifolia, Flueggea virosa, Acacia farinesia, Ximenia americana* and many more were collected from shrubs. The results revealed that fruits are used for many overlapping purposes.

They are used as food supplements, snacks, medicines and in juice forms. These were harvested more from trees. This is in agreements with research done by Assegid Assefa and Tesfaye Abeba (2011), which stated that fruits are harvested mostly from trees than shrubs, but disagrees with the report from Tilahun Teklehaimanot & Mirutse Giday, (2010), Kebu Balemie & Fassil Kebebew, (2006), which discovered that wild edible fruits are mostly collected from shrubs. However, most of the herbs and shrubs were reported to have a high medicinal use, compared to trees and parts of plants used. Those identified useful plants were categorized under 27 families. Among the families reported, Fabaceae was found to have the highest species 4 (15.4%) followed by Apocynaceae, with 3 species. Amaranthaceae, Asteraceae, Menispermaceae, Capparidaceae and Euphorbaceae with 2 species and the rest of other family consists 1 species among each (Appendix, 2).

4.2.1. Seasonal Availability, Habitat, and Month of Collection

The study has shown that the edible plant parts are gathered from the wild at different times of the year. Some are collected in Bega (‘May’ in Nuer Language, which means “dry season”), and Kiremti (‘Ruel’ and Tot’ in Nuer, which means rainy season). Because of their fruiting time variability and seasonal availability, more of the wild edible plant part are gathered and consumed from December to March and May to July. While, the smallest number of wild edible leafy plants were gathered in November and in September as the amount of rain fall decreases during this time. This depends up on the climatic condition and adaptation of these useful plants in the study area. Most of green leafy nutraceuticals are available only during rainy season and when humidity is available whereas edible

fruits from trees as well as shrubs flowered almost during and after rainy periods. In addition to the mentioned growth forms, vegetative parts were reported by informants to be harvested after rain fall stopped. The period of their harvest was said to be “Jiom ” in Nuer, means beginning of dry season, mostly starting from the end of October up to December. Thus, this result indicates that the local people exactly know when the wild edible plants produce their edible parts in their surroundings.

Generally, as the fruiting and ripening seasons of the wild fruits appear to vary among the different localities due to climatic and ecological variations, this research revealed the similarity which has been observed to exist in the area as reported by informants. Some species ripe at narrow ranges of time (e.g. *Grewia abutilifolia, Ziziphus spina-christii* and many other more), which flower from October and ripe early in November to December in most; others stay longer at fruiting (eg. *Tamarindus indica, Balanites aegyptiaca*), flowers starting from May and July respectively, and *Tamarindus indica* produces un-ripe fruits from July which were reported to be eaten as a snack as well as treating malaria ailments, according to respondents. Similarly, *Balanites aegyptiaca* ripe starting from end of November up to March and sometimes April. Some plant fruits also ripe twice per annum (e.g. *Ficus sycomorus*). As a result of this, some fruits are available almost throughout the year as compared to the plants used for their leaves, and the majority of them ripe from December to January and a few produce fruit in November. This variation of seasonal availability of the edible plants was observed as advantageous to the local community in the area. This was because, there are seasons in which the main food crops in the area dwindle or nearly got to exhaust, so that, local people turns or support their small available food with these plants as reported. Two bad or hardship seasons were mentioned by informants, “Jiom (beginning of dry season)” and “Ruel (beginning to mid rainy season)” seasons. At these periods, especially starting from November to January in jiom season and May to June in on set of rainy season were peoples goes to river side and up land of Lare for the purpose of preparing their field crops to sow new upcoming food crops was mentioned as the month in which main cultivated food crops exhausted or nearly goes empty (Fig. 6). At this time edible fruits and vegetative parts of nutraceutical are consumed too much, according to respondents. This coincide with finding of Getachew Olani (2001) which stated that most parts of the Ethiopia faces challenge of food shortage from July to September, the time stored crops go empty and newly sown ones are unready to help. For the use and the month of collection of these useful plants, see Appendix (4).

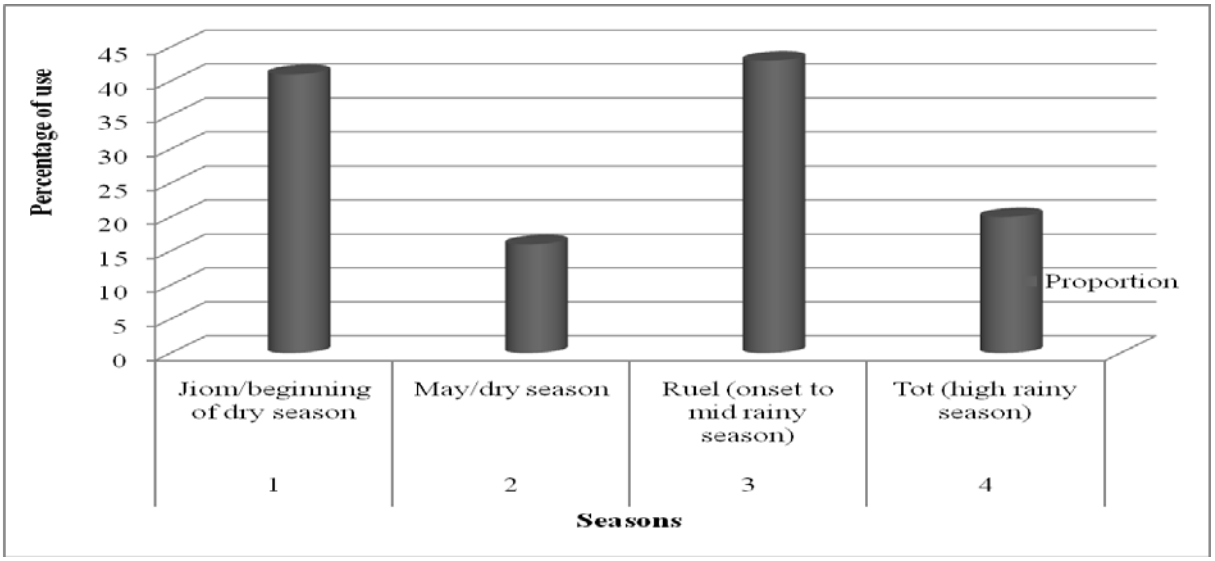


Figure 5: Seasonal consumption rate of wild edible plants

After the seasonal availability was confirmed from informants, interview result made from focus group discussion revealed that, most of these useful plants or nutraceutical plants are collected in dense woody forest area, which constitute the proportion of 33.33% followed by scattered wood land, road side and shrub land with 28.33%, 21.67% and 16.67% respectively. Some are also collected in the home garden after crops are harvested or in the left over field crops. And this coincides with the research result done by Getachew Addis *et al*., (2005; and Tigist Wondimu *et al*., (2006).

Table 4: Distribution of nutraceutical plants in different Vegetation Types

S/N	Habitat type	N = 60	Percent
1	**Dense woody area**	20	33.33
2	**Shrubby land**	10	16.67
3	**Scattered Wood land**	17	28.33
4	**Road side and home garden**	13	21.67

The fruits of *Balanites aegyptiaca, Tamarindus indica, Diospyrus mispilformis, Scelerocarya birrea, Adansonia digitata, Ziziphus spina-christii, Acacia farinesia* and many more were reported to be collected in the dense forest of wood land, as well as in open scattered wood land in Lare districts.

Moreover, the fruits of *Flueggea virosa, Grewia abutilifolia*, *Ximenia americana, Ziziphus spina-christii, Piliosthigma thonningii* and many others are collected in scattered woody area, shrubby area and road side. Fruits of *Ficus sycomorus* mostly on river side, and many herbs plus vegetative parts of plants i.e. *Scadoxus multiflorus* were collected on road side, shrubby area and termite hill respectively. More importantly, since the study district is in wood land, most of the mentioned plants are collected in the various vegetation types in the area, (Appendix, 3, 4, 5 & 6). One species can be collected in different habitat.

4.2.2. Gender and Age Role in Nutraceutical Plants Collection

The research revealed that nutraceutical plant collection by the local communities is gender and age dependent. The majority of the community agreed that nutraceutical plant species are consumed by all household members and largely collected by women (56.7%), while male's role is very low with only 17.5% proportion. Men are less interested in collecting these plants fearing culture of dishonor in the community. Some of the respondents during the study mentioned that there is a traditional belief among the community members that if a man collects these wild foods, he can be regarded as a man ruled by his wife. In this regard, women were considered as the only expert in collecting these plants in the study district compared to their male mate.

As a result, the collection of nutraceuticals is considered as a task of women (Fig.7). This coincides with the research result in Tanzania done by Kajambe (2000), which stated that, women are the real experts on the collection, processing, preservation of non-wood forest products for the household foods. Peasant women know the nutritional needs of their families as well as the nutritive content of the wild foods they collect from the bush, since they are responsible for sustaining the livelihood of the family. This indicates how women still play great role in different house hold activities in the area than men. This also in other way is workload discrimination to the women which need to be corrected by gender works regulation.

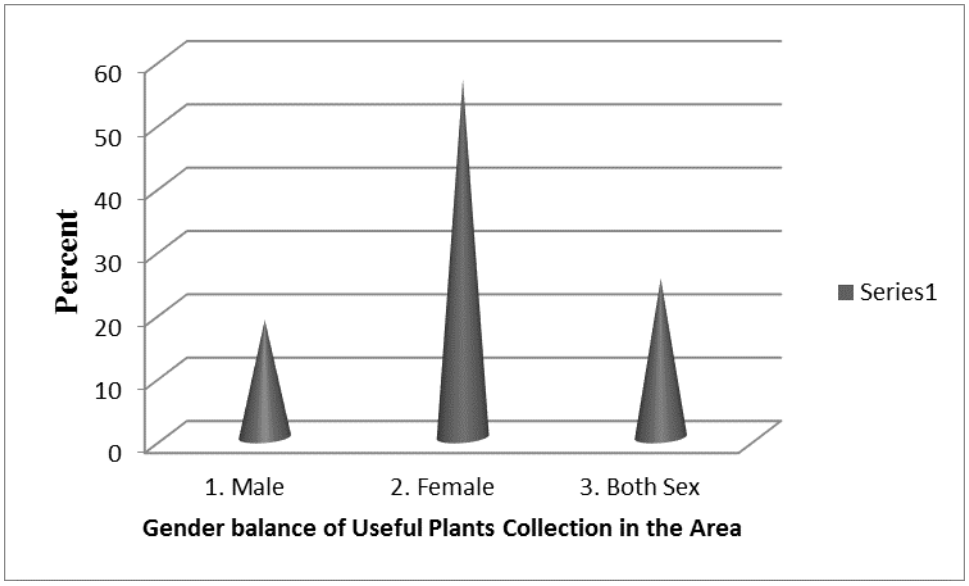


Figure 6: Gender Role in Nutraceutical plants Collection

Moreover, the age range of collecting nutraceutical so often in the household was recorded based on the informants' response as shown Table 5. Most of the primary school students, who are aged between 10 and 15 years old, were reported to have great role in this act, followed by secondary school students with proportion of 35.0% and 31.7% respectively. The reason was because, the livelihoods of these peoples were connected to their surroundings and younger age people frequently go to forest for edible plant collection than their elders.

This was also based on their peer and other socialization link to their surroundings. They reported that they exercise different activities in the bush related to the area's culture and social expression, such as folk lore about forest resources, which they inherited from their parents. Moreover, they consume them in the form of snack, quenching thirsty and as a play toy while on their leisure in the forest (Fig 8). No elder in the household frequently order the young people to go in the surrounding for collecting these plants with an exception of seasonal change of climate that affect the production of agricultural crops in the area, though some of them are being used as in normal food. Children know their surrounding and they go consume what they see to be good in their eye even without recommendation from their parents.

Figure 7: Gender and age role in nutraceutical plant collection

Children aged from 10 up to 15 in the area consumed more nutraceutical plants compared to their parents. Despite that, children's culture of eating these plants decreases as they grow up without any order from their family members. For instance, newly sprouting leaves of *Tamarindus indica*, leaves or young shoot/twigs of *Piliostigma thonningii*, wild fruits, roots and other many more nutraceutical plants were reported to be consumed most regularly by boys and girls when they are in the bush for either looking after their cattle or for recreation than their elders in the household with an exception of emergency times. They eat the edible plants in the bush as a form of snack. This doesn't means they are not consumed by all household members in household. But, the frequency of young peoples in the forest is high due to the fact that they don't have too much task at home that could limit their mobility in the wild. Most of their activities in the household are connected to their surroundings. For instance, boys are reported to be responsible for looking after their small ruminants (goats and sheep), and cattle, a task which is conducted in the wild (bush) where these plants are found. Similarly, girls are responsible for collecting fire wood, leaves and vegetative part of nutraceutical plants that can be cooked in order to support main meals and also herd their domestic animals in the bush with boys if it's a family without boys born, according to respondents (Table 5). These activities are in agreement with the previous finding of Guinand and Lemssa Dechassa (2000); and Fenthahun Mengistu *et al*. (2005); Sharmila (2012), in different parts of Ethiopia and other Country in the world in that the consumption of wild edible plants tends to decrease as the people are growing up.

Table 5: Age factors in collecting wild edible plants

S/N	Age Classes	N = 120	Percent
1	pre-school student age level (< 10)	12	10.0
2	Primary School age Level (11 - 15)	42	35.0
3	Secondary School age Level (16 - 18)	38	31.7
4	Adults (18+)	28	23.3

Parents follow the secondary school age between “16 and 18” in the area. They mentioned that they are involved in collecting timber, fire wood, leafy nutraceuticals, and medicinal plants. Identification of medicinal plants was reported to be carried out by elder in the family. The reason mentioned was that the elder members of the community have got the required experience and knowledge on these plants than the younger ones. They collect medicinal plants based on instruction from their elder through folk lore compared to collection of fruits from different life forms of the mentioned plants. Though their role was appreciated, women play great role compared to men in the task as mentioned by men themselves in the area.

4.2.3. Instruments used for nutraceuticals collection

The instruments used during collecting of nutraceutical plants were dominantly traditional tools though some application of hands, agricultural sharp tools were reported. Such tools used were; Dieny, Lieer, Tuok, Cuk or thak, and recently modern utensils (Fig 9). These traditional tools took proportion of 75.8% followed by hands with 16.7% and agricultural tools (hoe, axe, panga) 7.5% proportion each (Table 6).

Table 6: Tool Used for Collecting Nutraceutical Plants

S/N	Instrument	N = 120	Percent
1	Agricultural Sharp tools	9	7.5
2	Traditional tools	91	75.8
3	Hands	20	16.7

Hoe, a sharp agricultural material, was reported in collecting the wild tuber, known as "Lew" (*Scadoxus multiflorus*) which are found around termite hills. This tuber was reported to be consumed mostly during famine time. It's called Lew in "Nuer" Language due to its bitter taste and it's irritation of the throat when un-cooked well. It was reported to be cooked for a long time in the pot almost four to six hours, to be consumed as a food. Respondents reported that, most small animals for instance, Anubis baboon likes this part of the plant very much. It's reported to be found mostly where there are more termite hill in the forest. Moreover, application of hand in collecting these useful plants was reported on some specific time. This was almost when a collector goes in the forest/bush while carrying out another of his duty. For instance, men if they go for timber collection, hunting and many others more, they collect fruits and eat them as snack. However, collection of medicinal plants were reported to be conducted purposively, either for treatment of ailment of either human or domestic animal or for commercial purpose if need be, according to the respondents.

Figure 8: Women in Bilimkun Kebele showing tools for collecting nutraceutical plants

In addition to gender, age and instrument used for these plants, informants were interviewed on storage process of the listed plants. The storage duration of the nutraceutical plants was not for all plants listed according to discussion made. Accordingly, it was indicated that products from majority of the plants do not have long storage duration. Only products from three of all the mentioned plants have long storage duration according to respondents. These plants reported to have duration in storage were from fruits plants. Such plants were the fruits of; *Balanites aegyptiaca, Tamarindus indica,* and *Zizphus spina-christii.* In addition to their consumption and fresh, they were reported to be stored for some month after collection or dried out on sun light.

4.3. Role of Nutraceutical Plants in Household

The purpose of use and consuming nutraceutical plants in the area were reported as home consumption, medicinal care and lastly but not least commercial purpose. Among the mentioned plants, 50.00% were used for food and medicine, 36.84% were used for healthcare only and 13.16% were used for food only in the area according to respondents.

4.3.1. Role of Collected Plants as Nutraceutical and Food only

The research reveals that, the listed plants are used for food as well as medicinal purpose. Most importantly, all food uses reported were classified in 4 uses categories based on the local perception. One, ripe fruits or seed such as; *Tamarindus indica, Ziziphus spina-christii, Balanites aegyptiaca, Diospyrus mispiliformis, Adansonia digitata, Flueggea virosa, Grewia abutilifolia, Piliostigma thonningii, Ximenia americana, Acacia farinesia, Ficus sycomorus, Celtis toka, Scelerocaria berrea, Annona senegalensis,* and many mores, (2) leafy or vegetative parts of edible plants which are consumed by their leaves, stem or shoots, such as, *Amaranthus spinosus, Portulaca oleraca, Cadaba farinosa, Creteva adansonii, Nymphae nuchalii* and many other more (3) plants used for seasoning other food, such as *Hygrophila auriculata* and (4) those used for their parts, such, *Scadoxus multiflorus* were reported as part of food consumed for its root or tuber as nutraceutical plants in the area. Thirteen plants, 23.68% tree and 10.52% shrubs were used for their fruits as food, 18.42% were used as food for their leaves and only 2.63%) for its part as food. These plants have been studied by many scientists in different countries, all over the world. Their contribution to diets and nutrition plus wellbeing (health) they provide and sealing the gap of malnourishments was reported by FAO, (2014).

As the use for food value was confirmed from these plants, estimation of quantities consumed was made during focus group discussions. This was conducted by estimating the quantity of these plants in household per year locally. Most of the families consume amounts of nutraceutical plants from 25 lieeri (a unit of measure of consumption equal to a Kilo gram) up to 1 Tuok (a unit of measure, compared to a 50Kg) of nutraceutical as the result revealed. However, these were based on the status of famer's income and source of his/her wealth in the area. If it's time when drought occurs, more than 50Kg were reported as consumable of wild nutraceutical plants, but in normal time, when there is no shortage of main staple food crops, it was reported to be less than 10 Lieeri of nutraceutical plants in particular household and they are consumed as food supplements or as snack (Table 7).

Table 7: Quantity of edible fruits of nutraceuticals as a food source in Household/year

S/N	Quantity of nutraceutical consumed/yr	N = 60	Percent
1	< 25 Kg use of nutraceutical plants/hh/yr	16	26.67
2	25 Kg- 50Kg use of nutraceutical in hh/Yr	20	33.33
3	50 Kg – 100Kg use of nutraceutical plants/hh/yr	13	21.67
4	100Kg+ eating of nutraceutical in hh/Yr	11	18.33

Note: 1lieri = 1Kg, 1Tuok = 50Kg, 1Dieny = 100Kg. Kg = Kilo gram

The result reveals that each and every household in the area consume the quantity of these plants based on economic status and income sources. This was because; economic status of particular household determines what they can eat and what they cannot. Households with good economic status consume these plants as snack mostly compared to low income farmers in the area. For instance, for those households with low income sources, it was reported they consume these plants in many diverse ways. In one way, the head of family can directly collect the fruits and prepare for consumption as sauce, juice to drink or some time pounded in to flour and cooked as porridge (fruits of *Diospyrus mispiliformis*, vegetative parts of *Nymphae nuchalii*) but almost during hardship, leafy/vegetative nutraceutical as food supplements, parts of the plants, such as S*cadoxus multiflorus*, chopped and dried, then mixed with flour of cultivated crops then cooked as porridge. Also, the low income farmers sell them on the local market for cash return to buy salt, soap and many others. On this version, the quantity consumed in household per month was measured and showed the proportion in household per month to be 33.33%, followed by 26.67%. The highest proportion indicates highest dependency or consumption of these useful plants in the household per month. This dependency on nutraceutical plants explained that, wild nutraceutical plants are parts of food menu at household levels but with varying degrees of consumption in different seasons due to variation in their availability. And this is in agreement with the finding of Zemede Asfaw and MesfinTadesse (2001).

4.3.1.1. Preference Ranking on Selected Food Plant

Preference ranking was conducted with key informant interview based on the selected five plants. The selection was made on their taste compared to other plants. The plants selected were leafy or vegetative plants. The reason of selecting leafy plants was their dominance use as food supplements,

by the local community in the area. The group discussion as well as key informants' interview revealed that these plants have been used normally in supporting main meals. Even those with good number of livestock consume them normally according to key formants. However, they are consumed daily by those who don't have domestic animals in order to support their main meals in the household.

Ten informants were selected for preference ranking of mentioned plants. Index was given and made available to the seven selected key informants. The value was from 1 – 6, which represent less tasty up to excellent or the most delicious tasty recommended by informants. Each key informant was asked individually to name and give value to the selected species based on the plant taste status. According to the informants the wild green leafy nutraceuticals have high nutritional composition, and preference by the local people. The results reveal that green leafy/vegetable nutraceutical plants species, aids in digesting food, because of their supplementary role as stew to main food in the household. There were many plants reported to be used this way. However, only five plants were identified for their taste quality and flavor by the local community and are top ranked (Table 8). Among these; *Nymphae nuchalii, Amaranthus spinosus and Portulaca oleracea* were ranked first up to third respectively.

Table 8: Preference ranking on leafy nutraceutical plants

Species	Respondents Selected(N = 10)										Score	Rank
	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}		
Amaranthus spinosus	6	3	4	4	5	5	5	6	6	6	50	2
Cadaba farinosa	6	6	3	5	6	4	5	2	5	1	43	5
Creteva adansonii	6	5	3	4	6	6	4	3	4	5	46	4
Nymphae nuchalii	6	4	4	6	6	6	6	3	5	6	51	1
Portulaca oleracea	5	6	3	6	5	6	6	5	4	3	49	3

Key: R = respondent and the number behind letter represent interviewee.

Preference of this ranking was made after the estimation of consuming nutraceutical plants was conducted. The results show that the local community of the area still has knowledge of using these plants in many ways. This knowledge was reported to be passed orally from one generation to next generation. Consumption of these plants supports their daily dish as well as it contributes to their health in various ways. The fiber obtained from these plants is high compared to domestic crops. It can help them to digest and assimilate the nutrients in their food, which are other health benefits they

gain. Moreover, these plants are non-toxic, because no fertilizer reaches where they are growing. So for this case, they have many effects in health as reported by many scientists in other parts of the world as well as in the country (Debela Hunde *et al*., 2014).

4.3.2. Role of Nutraceutical Plants as Medicine

The roles of nutraceutical plants are not limited to only sources of wild foods. Nutraceutical plants in the area were reported to have medicinal values for curing ailments for either human or livestock. Among the identified 38 plants in the area, 52.63% of them were reported to treat different ailments of livestock and human in the area. Of the mentioned plants by informants, most of them were used both as food and medicine. Ten more visible health conditions that are cured by nutraceutical plants from both livestock and human were reported (Table 10). Among the mentioned ailments were; stomach ache, malaria, constipation, delayed umbilical cord delivering, limited milk production, wounds, gastric, serious illness, adultery of cow, and coughing. Of the human ailments identified in the area, gastric was rated most with the proportion of 21.7% and followed by stomach ache, malaria, constipation with proportion of 20.8%, 17.5% and 15.8% respectively. However, most of the plants responsible for medical care were found under herbs and shrubs category. For instance, roots of *Ziziphus spina-christii* were believed to heal coughing, root of *Calotropis procera* and *Chlorophytum tuberosum* were reported to have value of removing the delayed umblical-cord from the domestic cows, while seed and fruits of *Solanum incanum* were reported to heal constipation. This result indicated that people rely more on useful plants because they are relatively common in the area. Not only these, there was a lot of function both for food as well as medicine. Juice of many fruit trees and shrubs were reported to heal the stomach pain. For instance, juice of *Tamarindus indica, Balanites aegyptiaca* was few to mention. This is in agreement with the findings of Bayafers Tamene *et al*. (2000); TilahunTeklehaymanot and Mirutse Giday (2010) in southern Wello Chefa area and Debub Omo Zone respectively

As the different use of these plants was confirmed, estimation of quantities used was conducted on the medicinal use in the area. It was conducted through focus group discussion in three kebeles. This was to cross-check the use and in what quantity these plants are consumed in the household with its medicinal purpose. Though, availability of modern health centers constructed by government through viligization, use of traditional plants has been reported to be practiced by local healers. They use these plants and said they are effective in treating particular ailments according to respondents.

The plants' consumption in the household was estimated by local weighted measurements (Table 9). The use of these medicinal plants as an effective means of curing diseases was in line with the finding of research result done in Zimbabwe by Ephraim, 2011 which stated that traditional medicine, is preferred as local farmers consider it to be cost effective and efficient.

Table 9: Annual consumption of medicinal plants

S/N	Quantity of medicine used	N = 60	Percent
1	<1 Kg faggot medicinal care in hh/yr	14	23.3%
2	1 - 10 Kg faggot of medicinal plants in hh/yr	21	35%
3	10+ Kg use of medicinal care in hh/yr	25	41.7%

Note: Faggot here represent the smaller size (30 cm in length) compared to faggot of fire wood, (1m).

Consumption of the medicinal plants as measured above was a traditional way of life. People mostly consume above 10+ Kg bundles of medicinal plants with proportion of 41.7% followed by 35% and 23.3% of 1 – 10 kg and < 1Kg of medicinal care respectively. This used was accelerated by use of treating domestic animals as well as human ailments. Local peoples of the selected kebele are connected to their surroundings. They have an effect on each plant they identified to be medicinal plants as reported by Paul *et al*., (2012). This is what is termed in many literatures as an ethno-botany, i.e. relation between man and his surrounding, or a relation between indigenous peoples with the plants, animals and other environments they are situated as reported by Tena Regassa *et al*., (2014). Of the mentioned ailments of livestock, boosting up of Milk production was rated high with proportion of 25% followed by delivering of delayed umbilical-cord from the cow's womb and constipation with 21.7% & 18.3% proportion respectively, while serious illness (rheumatic fever) curing, was rated with 11.7% (Table 10) and (Appendices 4 & 5).

Table 10: Medicinal plants for curing either human or livestock

Type of ailments	Plants responsible	Part Used	Use for		N = 60		Proportion %	
			L.S	H	L.S	H	L.S	H
Malaria(head ache)	*Tamarindus indica,*	L, R, S		X		11		18.3%
Coughing	*Ziziphus spina-christii*	R		X		8		13.3%
Gastric problems	*Carissa spinarum, Celosia trigyna, Pyrenacantha kaurabassana*	R, L		X		13		21.7%
Wounds	*Adansonia digitata, Annona senegalensis, Piliostigma thonningii*	S	X	X	7	7	11.7%	11.7%
Constipation	*Solanum incanum, Bull thistle*	F, S	X	X	11	9	18,3%	15%
Milk boost up	*Euphorbia tirucalli, Acokanthera schimperi*	L	X		15		25%	
Delayed umbilical cord	*Calotropis procera, Chlorophytum tuberosum*	R, B	X		13		21.7%	
Stopping adultery	*Saba florida, Vernonia amygdalina*	R, L, St	X		5		8.3%	
rheumatic fever	*Saba florida*	B, L	X		9		15%	
Stomach ache	*Mimosups kummel, Pyrenacanthera kaurabassana*	B, R	X	X		12		20%

Note: L.S = Livestock, H = Human, X = indicate use for either livestock or human, B = Bark, L = leaf, S = Seed, R = Root, F = Fruits, ST = Stem.

The good thing for traditional medicinal preparation was reported to be simple. This was because; there has been no complicated procedure to follow like what is in modern pharmaceutical medication process. The healers go into the surrounding vegetation for search of particular medicinal plants and give to patients. The procedure of its use has been reported to be simple, because, it's transferred orally by word of mouth in the form of folktale from healer/elder to their children instead of taking note of all procedure. For instance, if a child has a constipation that stops him to go natural call/excretion, the healer can direct everyone to go and search fruits of *Solanum incanum* to treat this ailment. This medicinal use of nutraceuticals for both human and livestock coincides with research report by Damtew Bekele *et al*., (2012); and Jasvinder, (2014).

4.3.3. Processing and Utilization of Nutraceutical Plants

The study has identified different modes of consumption of the plants. Accordingly, 32% of the edible plant parts were reported to be consumed raw, 23% in juice forms, 18% has been used both as raw or in juice forms, 17% as boiled and only 10% as porridge. This research revealed that most of the edible plants such as *Ziziphus spina-christii, Tamarindus indica, Balanites aegyptiaca, Flueggea virosa, Celtis toka, Ficus sycomorus* are directly consumed as raw. Also *Tamarindus indica, Balanites aegyptiaca, Adansonia digitata,* were reported to be consumed in juice forms. However, most of the edible leafy plants such as; Creteva *adansonii, Cadaba farinosa, Nymphae nuchalii, Amaranthus spinosus, Portulaca oleracea* are consumed cooked/boiled. *Diospyrus mispiliformis* fruits are pounded with local mills, cooked and eaten as porridge, but mostly during emergency time. In the study site, the research note that wild edible fruits are eaten fresh or raw as it has also been reported by Guinand and Dechassa Lemssa (2000); Tigist Wondimu *et al*, (2006); Redzic , (2007).

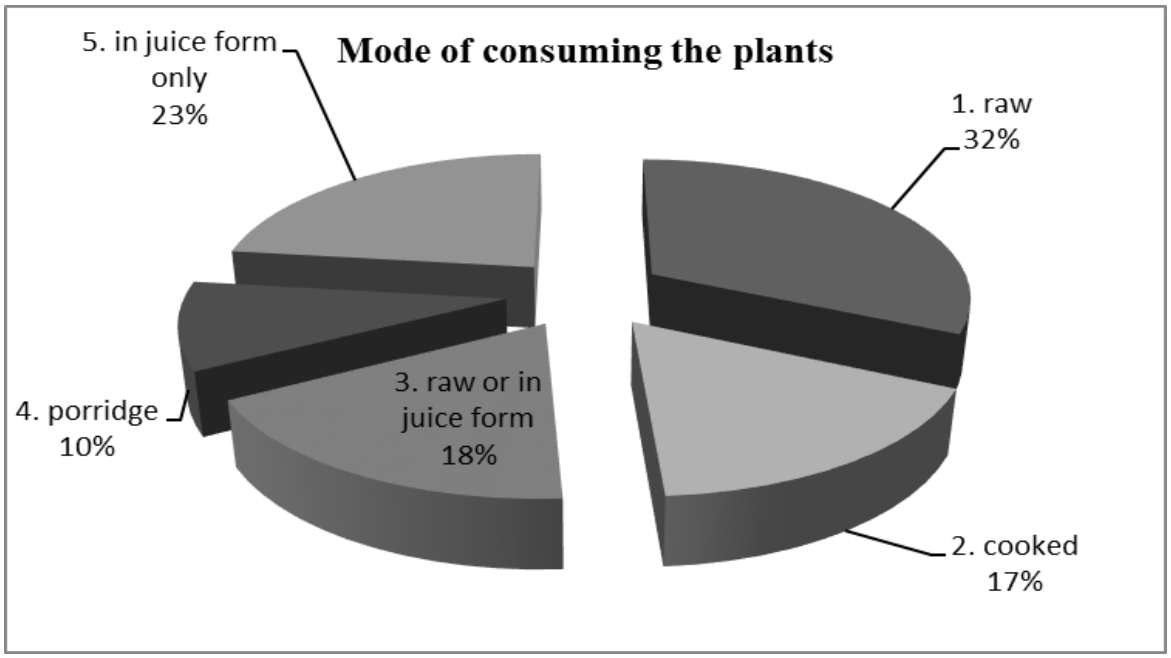


Figure 9: Mode of consuming parts of nutraceutical plants

In addition to their preparation and mode of consumption, the part used for food and medical care were reported as fruits, leaves, seed, root/tuber, bark and stem. The most eaten parts for food were fruits followed by leaves with proportion of 28% and 25.0% respectively. Whereas rural people usually consume wild fruits on a regular basis, most leafy wild edible plants draw attention mostly during critical food shortages as in famine periods according to (Zemede Asfaw and Mesfin Tadese,

2001). In addition to this, parts used for medical care were stem, barks, seeds, leaves, roots and fruit of particular plant species. Roots and leaves were reported high in medicinal use followed by stem and barks among the mentioned plant parts. This reveals that the local people in rural area have more knowledge in using plants in their surroundings. They know which is useful and which is toxic. They are the sources of modern biomedicine, which are used in factories. This knowledge of plants, used to treat different human and livestock ailments by different parts of plants, is in agreement with research finding in Uganda by Godin *et.al.* (2014), which stated that the most frequent part used for medicine was roots, but disagree with part used as food which was leaves. Despite all these healing capabilities of nutraceutical plants, some of them have negative effects to human, and that is why caution is needed for their use. Elders know them because of their long stay in the area compared to young men/women. Such negative effects for instance, were reported as poison, abortion, allergic, are among few to mention. Plants such as milk of *Calotropis procera, Euphorbia triculali* and *Ficus sycomorus* can cause skin allergic reaction, *Carissa spinarum* a shrubs which can remove fetus/abort child from a pregnant woman if care is not taken on their uses and application.

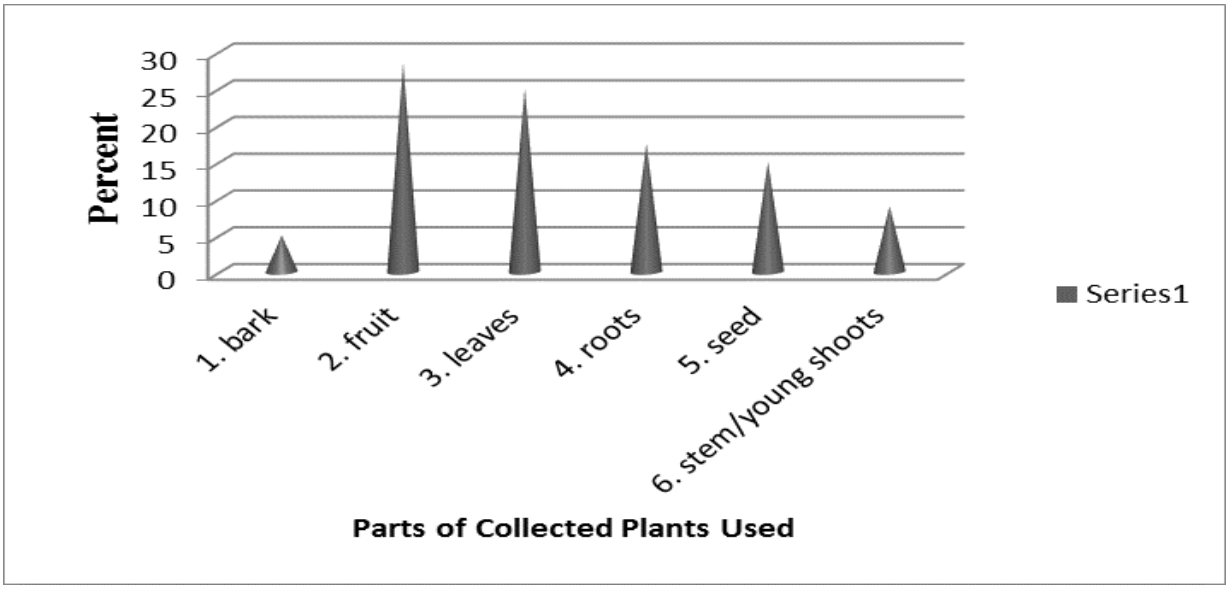


Figure 10: Parts of Nutraceutical Plants Used

4.3.4. Other Socio-economic Roles of Nutraceutical Plants

Nutraceutical plants are considered as multi-purpose plants having so many functions that they can provide to local people in the study area. They are used for construction, shades, fuel-wood, aesthetics, furniture making, spiritual and other environmental services. One of the multi-purpose

uses of nutraceutical plants is fuel wood consumption. In the area there are no any other means of cooking local meals. If a household lack fire wood, even cooking the main meal was reported to be skipped because there is no any other energy source. Plants responsible for this were mentioned (Appendix 6). Every household consumes faggot of fire wood enough for them which are based on the size of family in the area (Fig. 12). This is related to the research done by Kajambe *et.al*. (2000) in Tanzania.

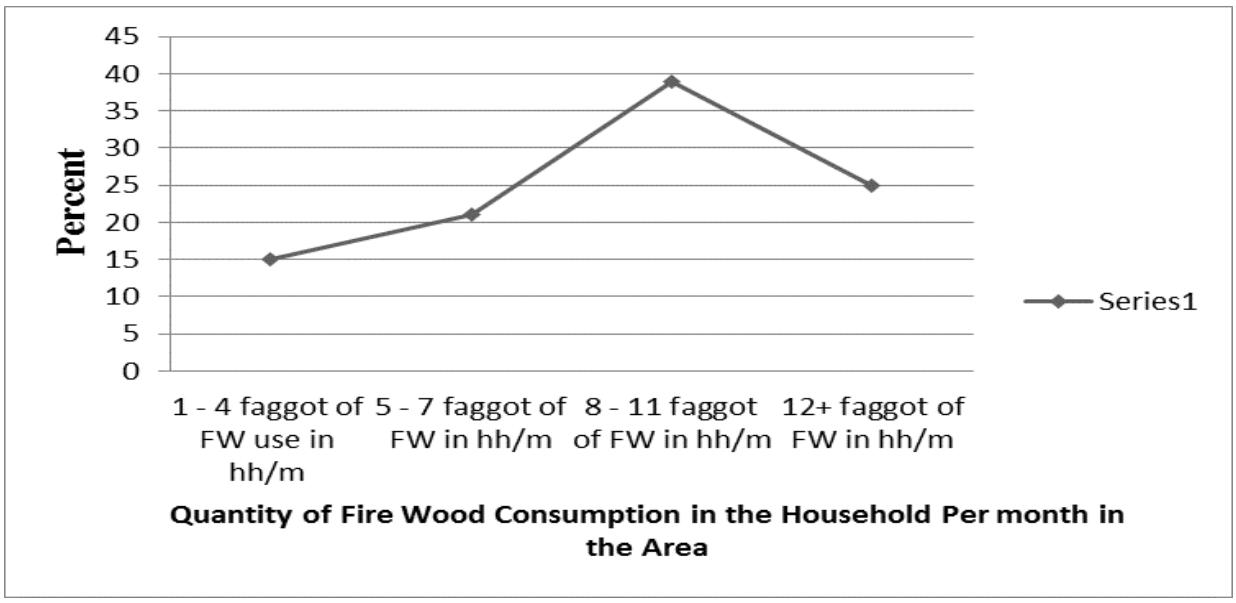


Figure 11: Fire Wood Sale and Consumption in the Household/Month

Note: faggot = a unit of fire wood, which is 1m in length, 0.5 in width and 0.6 in height ($0.35M^3$).

In addition to the above mentioned benefits, marginalized people can get cash returns by selling fuel wood and other timber products as a means of diversifying their livelihood in the area according to respondents. Market assessment of these plant species showed that most of the edible plants are not consumed as food only but also sold for other purposes such as for timber, agricultural tools, construction, and fuel wood purposes. Women with low income in their household go to the bush for collecting fuel wood, which are used either as household energy or sale in market for cash return. Also, some men practice selling fire wood and sack of charcoal in the markets as means of getting cash to buy the things they lack in the household, though women dominated the vulnerability of these kinds of works compared to their male mates. In fact, timbers are collected dominantly by men in the area, which are used for different purposes in the household. They can be used for

construction of tukul (resident house), tool of agriculture, furniture making, and as a stick supporting aged peoples. They are used by every household every year, because of the above mentioned benefits they provide. Hard working men use them as a means of getting cash. Most of those who practice these works collect a head load of 30 – 60 stack of stem per day and get cash return of 60 – 100 Ethiopian birr, according to informants. The uses of timber in household were investigated based on the respondent's measure (Table, 11). Informants mentioned that 150 stack of stem could make one small sized tukul (traditional local house), while 300 stack of stem can make medium sized tukul and 600 stack of stem can make a big house. However, timber products collection is somewhat difficult, because of the far distance they are gathered from. Due to this, it's too difficult for women to participate in collecting them, because of the long distance to be travelled.

Table 11: Quantity of Timber Products Consumption by Households

S/N	Annual consumption of timber product in household	Sample Size = 120	Percent
1	150 – 300 stack of timber in hh/yr)	29	24.2
2	301 – 600 stack of timber in hh/yr)	37	30.8
3	600 + use of stacked timber product in hh/yr	54	45.0

Note: Stack of stem = long faggot of stem (2m in length x 0.5m in width x 0.6m in height) = $0.6m^3$

In addition to the use for timber, edible fruits are sold in local markets by low income peoples in the area, though there was no good estimation of how much they got from selling these edible plants. Fruits of *Tamarindus indica*, *Ziziphus spina-christii* and *Balanites aegyptiaca* were seen in the market (Fig.11). However, their cash return was not much enough compared to their income for fuel wood and other timber products, according to respondents. This market result is in line with the finding of FAO and WHO (2013), which stated that the income of wild edible plants is low compared to the agricultural crops and domestic animal because there has been less records of their income in many literature. This was not because of lack of nutrient value of wild useful plants, rather, it has been an attitude of people in many urban compared to rural people to ward these useful plants. This research revealed that, the selling of these useful plants were carry out by low income household as a means of food diversification.

Figure 12: Socio-economic Benefit of Nutraceutical Plants

4.3.4.1. Direct matrix ranking of nutraceutical Plants

Direct matrix ranking was undertaken in order to evaluate these multipurpose tree species and their relative importance to the local people and the extent of the existing threats related to their use values. This was conducted on those plants which serve multi-purpose function in the different portion of household livelihood activities. It was carried out with key informants and group discussions in all Kebeles. The most ranked plants were reported as *Balanites aegyptiaca* ranked first followed by *Ziziphus spina-christii* and *Diospyrus mispiliformis*. This ranking was not only about their fruit and medicinal products (nutraceuticals), but also their socio-economic benefits (opportunities) they provide to household in the area. For instance, *Balanites-aegyptiaca* was ranked first, because, of its use as a food, medicine, fuel-wood, furniture making, construction purpose, shade service in the area. Similarly, *Ziziphus spina-christii* ranked second for its use as a food and medicines, timber for construction, pole, and fuel-wood (Table 12).

This was conducted based on the 7 purpose use criteria on 8 plants species with five rating value given from 0 – 4 (use given from 0 to 4, 0= not used, 1= least used 2= good, 3= very good 4=excellent). The species which was found to have a high rating based on the purpose of its use was rated first and followed by others which followed the criteria given above. However, there was

certain use purpose which was not given a value during rating. This was explained as if the purpose of use for certain plants does not qualify such use. The un-qualified use for plants was dashed or made to appear as in zero forms. Moreover, the number 1 indicates the least use of species based on the value given by knowledgeable peoples/key informants, which were selected purposively. Despite the least use for certain criteria of mentioned species, it was reported it has another important use on other use purpose.

Table 12: The average score for direct matrix ranking of the 8 wild edible plant species on seven use criteria

Purpose of use	**Use criteria of Plant SPP & ranking (N = 15)**								**score**	**ranks**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
Edibility	4	4	3	4	3	4	3	4	29	1
Medicine	2	3	2	2	1	2	3	4	19	4
Fuel wood	3	0	0	3	2	2	4	4	18	5
Construction	4	1	0	2	3	3	4	4	21	3
Agricultural tool	4	1	0	1	1	3	0	4	14	7
Furniture	3	2	2	0	2	4	3	1	15	6
Shade	3	4	4	4	4	2	0	2	23	2
Total	23	15	13	16	16	20	17	22		
Rank	1	6	7	5	5	3	4	2		

Note: 1 = *Balanites aegyptiaca*, 2 = *Tamarindus indica*, 3 = *Adansonia digitata*, 4 = *Celtis toka*, 5 = *Ficus sycomorus*, 6 = *Diospyrus mispiliformis*, 7 = *Flueggea virosa*, 8 = *Ziziphus spina-christii*.

The importance of these plants for the top ranked uses such as edibility, shade, construction, fuel wood, and furniture are linked with the daily life activities of the community. The ranks were in down word order or columns based.

4.3.5. Correlation of Household Parameters with Nutraceuticals Consumption

The analysis result of nutraceutical plants consumption with household socio-economic characteristics showed that, the increase of family size has a positive correlation with the

consumption of nutraceutical plants together with their multi-purpose use in the household (Table 13). On the other hand, the decrease of total income in household has a positive correlation with consumption of fire wood, timber products, edible fruits and medicinal plants in the area. The reason of this positive correlation of household parameter and nutraceuticals was based on the continuous reliance on the nutraceutical plants in the area both in normal and during the time of food shortage by the local community on their surroundings. Livelihood activities of these peoples almost depend on these plants, because they use them as food, medicine, local resident house, cash return, shade, furniture and handcrafts.

Moreover, if a household head has got less income, he/she has to consume a lot of wild fruits and leaves, fire wood and other timber products. However, an increase of total household income and diversified sources of wealth decrease the dependency on wild food plants, sale of fire wood and timber product because he/she can have other alternative means of survival. This also decreases the pressure exerted on forest resources. Access of households to other sources of income is, therefore, negatively correlated to consumption of edible fruits tree/shrubs and leafy nutraceutical plants.

Table 13: Correlation of forest and tree products consumption with household characteristics

Variables		EWF	MP	VPN	FW	TP
SFM	Pearson correl^{n}	0.68	0.23	0.43	0.30	0.76
	Sign.(0.05)	0.461	0.800**	0.641**	0.688**	0.412
SCF	Pearson correlat^{n}	-0.004	0.080	-0.072	-0.024	-0.005
	Sign.(0.05)	0.966***	0.384	0.434	0.797**	0.957***
THI	Pearson correlat^{n}	0.045	0.096	-0.039	0.082	0.027
	Sign. (0.05)	0.628**	0.298	0.670**	0.371	0.769**
	Pearson correlat^{n}	-0.005	0.159	-0.133	-0.143	0.088
SI	Sign. (0.05)	0.957***	0.83**	0.147	0.120	0.341

Note: SFM = Size of Family Members, SCF = Size of Cultivated Field Crops, THI = Total Household Income, SI = Sources of Income, EWF = Edible Wild Fruits/shrubs, MP = Medicinal Plants, VPN = Vegetative part of nutraceuticals (leafy), FW = Fire Wood, TP = Timber Products.

From the above table, size of cultivated field crops has the strongest correlation with the use and consumption of edible fruits, fuel-wood, and timber product use while it has weak correlation with medicinal plant use. However, the weakest correlation appears in the sources of income with the sale of fire wood, vegetative part of nutraceuticals and timber product. This also appears in total household income with medicinal plant use, and fire wood consumption. The reason of weak correlation between sizes of cultivated field crops with consumption of medicinal plants was due to fact that, the accessibility of the land is not the problem in the area rather it's based on the family's capacity of cultivating a size enough for them. Also the weak correlation between source of income of household with fuel wood use, vegetative part of nutraceutical and timber products depend on the household's wealth status. The result shows that if a household has a good wealth status (rich or medium), too much dependency on these plants was reported to decrease. The result of the correlation was in line with the finding of Paul *et al*. (2012), which said an increase of household income and increase of family size has a positive correlation of wood land resources consumption.

4.3.6. Conditions Enhancing the use and Consumption of Nutraceutical Plants

Table 14: Conditions Enhancing the use and consumption of nutraceutical plants in the area

S/N	Factors or conditions	N = 45	Percent
1	Climate Change (drought)	14	31.11
2	High market price of main food sources	9	20.00
3	Less intensive works on field crops	11	24.44
4	Agricultural land degradation	7	15.56
5	Simply as a food supplement	4	8.89
	Total	45	100.0

Most importantly, drought (climate change), is a dominant factor which almost forces people to consume these plants in the area, though they are continuously eaten throughout the year. This is because drought dried out the agricultural land leading to less to none harvest from main food crops. As harvest from agricultural crops failed, people look for means of diversifying their livelihood condition in order to cope up with the situation. Among the coping mechanisms, selling of domestic animals and collecting of wild fruits/vegetables were reported. Furthermore, the research noted that nutraceutical plants are collected and used as food during the time when drought occurs as means of relieving hungry, which agree with the research findings from Zimbabwe by Ephraim (2011). In

addition to drought, un-willingness to work on farm whole heartedly was the second reason which forces people to use and consume these plants (Table 14). This lack of committing in domestic works in the area was reported to be affected by western life adaptation plus urbanization in the area. Most of the young men abandon rural life for urban life. They began it as the way of going to urban areas for the sake of pursuing education and change their life there. However, most of them failed to come back home during vocation time in order to help their parents for livelihood activities as expected, rather they adopt and stick in towns when schools are closed.

The reason was reported as the hate of works, such as agricultural field crop cultivation and herding of domestic animals, which are the main source of livelihood income, while there are a lot of cattle raiders according to informants. In spite of mentioned social change of young men, some parents were reported to live between urban and rural area. This also affects the production of livelihood activities in the household in the area. As a result, the agricultural activities decreased and yield reduced in the area which forces people to depend mostly on market seller crops. Some peoples even have gone to refugee camps for better life. As local community in the area become more dependent on the market for food, they are increasingly exposed to the effects of a volatile market. This particularly affects the low income farmers. These low income farmers' have to sell proportionately more of their belonging on the market to obtain food or go for wild food resources. In times of drought, this dependence is worsened which in turn speed up the processes of economic differentiation within society. It makes the rich richer mostly the small number of traders in the area and immigrants from high lands. This increases the susceptibility of low income farmers to food insecurity in the area. This is in agreement with the research finding by Ahmed *et al*., (2002).

Lastly but not least, these useful plants are eaten as food supplement, even those people who have good possession and number of cattle, because cattle have a season of producing milk. At the time when the cattle weans their calf for next birth, people have no any option to wait for the next calf to be born and to get milk rather than opt for leafy or vegetative part of nutraceutical plants which are prepared in order to form a local dish or in the form of stew, that was reported to supports main meal or food prepared from maize flour in the area as reported also by Assegid Assefa and Tesfaye Abeba, (2011). In most cases the wild green leafy nutraceuticals are parts of food menu at household levels but with varying degrees of consumption in different seasons due to variation in their availability. Thus, the present study indicated that *Cadaba forinosa, Creteva dansonii, Amaranthus*

spinosus and *Portulaca oleraceae* are the most preferred wild Green leafy vegetables, by the local communities in terms of theirs taste and edibility (Table 8). The above finding is in agreement with research done by Getachew Olani (2000), which state that factors that are often mentioned as the principal causes of inadequate growth in food production and increasing food insecurity are: inadequate and variable rainfall, soil degradation, land tenure system, storage.

4.3.7. Threats and Management of Nutraceutical Plants

Situational analysis was made with selected respondents for comparing the present situation of nutraceutical plants with that in the past (10 – 20 years back). Majority of them (69.2%) indicated that availability of nutraceutical plants and forest status has declined through time. On the other hand, some respondents (30.8%) mentioned that they have no idea about any increase or decrease of these resources. The study generally revealed that there are various threats to the forest resources in the area. The threats identified include frequent fire, land use change, fuel wood collection, timber collection and settlements, and lastly recurrent drought/climate change. However, the investment which is inclusive of land use change and settlement programs are government planned programs. Even though, they were purposively designed, they pose some negative impacts on the useful plants in the area. These threats are attributed mainly to human pressure and its associated effects. Among these threats, frequent fire, land use change (with local agricultural & investment activities included) and timber collection (habitat destruction), were ranked first up to third (Table 15). These were rated based on their degree of destructive effects (values 1-5) were given: 1= the least destructive threat and 5= the most destructive threat.

Table 15: Priority ranking on perceived five factors of threats to nutraceutical plants

Factors	Respondent From Each Kebele (N = 10)										Score	Rank
	B1	B2	B3	B4	K	K	K	N1	N2	N3		
Land Use Change	5	4	4	4	2	3	3	2	3	2	32	2
Frequent Fire	3	3	4	3	4	4	3	4	4	4	36	1
Fuel Wood Collection	2	2	2	3	2	3	3	3	3	3	26	4
Timber Collection	4	3	5	2	2	2	3	4	2	4	31	3
Drought	1	3	2	4	2	2	3	3	2	3	25	5

Key: B = Bilimkun Kebele, K = Kutoch Kebele, N = Ngor Kebele and the number after letter

represent respondents from the Kebele.

The level of threats of nutraceutical plants varies among the different studied villages of the district. Accordingly, informants from Bilimkun Kebele mentioned that agricultural expansion and investment activities are the most destructive threats to wild edible plant species followed by timber collection. This is mainly due to increasing demand for arable land resulting from increasing investment in the area. In Kutoch and Ngor Kebele, Timber and Fire wood collection are the major threats. The reason behind that was, timber were used for many purpose; such as, household resident construction, making of furniture, tool for agriculture materials, stick that supports elderly peoples, making store of harvested maize. In addition to the mentioned uses, cutting mother trees for the traditional canoe and local maize and sorghum pounding mortar and pistil constructed from *Diospyrus mispilformis*, *Balanites aegyptiaca*, *Ziziphus spina-christii*, *Creteva adansonii* were observed to be the most destructive. This is because, selecting of species plus competition on these species for making the mentioned furniture, threaten the future existence of these useful plants. Fire woods are used as energy for cooking meals as well as warming the body during cool temperature. Their collection contributes to threaten the existence of these useful plants.

Above all, frequent fire in all study districts was reported. The fire might be a method of managing the re-growth of plants as perceived by pastoralist and hunters in forest resources in the area. It may not be the most destructive in the area as in their view. This is because; the plants in the area have their natural ability of adopting it since they are situated in wood land. However, some important useful plants, which might be neglected such as herbs are not much resistant to fire compared to woody plants. As a result, fire has been considered as destructive threat.

In addition to the destruction made by fire and habitat destruction, other ways of management of these plants were investigated. In the area, the people apply traditional management option of these plants based on the services the plants can give. Though, the management was a specific purpose based to their view, it was observed that they use some managements way indirectly. For instance, some fruit trees were observed around home for their shade and other multi-purpose use. Similarly, some herbs were observed to be retained in the left over home garden for temporary need of their leaves, such as stew to support main meal. For instance, *Amaranthus spinosus, Protuloraca orleracea* and many others were reported for this use.

Also, some species were observed scattered on the agricultural field of farmers, for instance, *Cretva adanonsin, Balanites aegyptiaca*, and many other more. The management option was not purposively designed for the use of plants given. However, local peoples usually target their management around severally purposive at a time, though some maybe more in household. This is because, those plants around their house, scattered in their agricultural crops were not planted purposely, rather they grow naturally or dispersed by wind or birds and animals in the area. They retain them mostly for the food value, timber value, and shade service. If they know other environmental value of these plants, even they can make their home garden or woodlot full of different plant species, which can be used for diverse purpose. Therefore, there is a need of making conservation such as in-situ and ex-situ management method of these plants in order to serve them for future use in their area.

Moreover, there was some nutraceutical plant mentioned for their cultural importance in the area other than their food and medicinal use. For instance, piliostigma thonningii was reported to have a very important cultural favoritism due to its gum. The gum of piliostigma thonningii was reported to be use for preventing evil eye person to take away milk from either domestic cow or not to do harm to any part of human in particular household. It was also mentioned to heal the person who has been tried by local magician to kill him. Local peoples report that if any person found such gum, he can be regarded as lucky because of it is role in healing the mentioned cultural taboos in the area. Informants said if anyone found this gum, he store it and hide it incase if the above incident happen to any family or to his family and make healing. If it happen that someone in other household has been tried by evil eye or local magician or his cow's milk, then this person with this gum is called and make healing to victim. As a result, this plant called piliostigma thonningii or ngoany in thok-nuara/nuergna has been reported to be conserved for this purpose if it's found growing in the proximity of the house or in the wild due to its gum. It was reported that this gum is not easily found, rather by chance. This motivates local people in managing this plant with an exception of wild fire plus other threats such as land use change in the area. However, these all activities were reported to be practiced by those who still believe in traditional gods, because, many peoples change from traditional belief to Christianity in the area.

5. Conclusion and Recommendations

The findings of the research have revealed 38 plants used as nutraceutical, food, and medicine and other multipurpose in the area. This study revealed that knowledge about edibility, habitat distribution and other uses of nutraceutical plant species is still maintained among the study community. The preservation of this knowledge appears to be the result of continuous reliance of local communities on nutraceutical and other useful plant species both during normal and food shortage periods. However, there is a decline in the utilization of some nutraceutical and other useful plant species use. Mode of preparation includes crushing of seed for kernel and grinding of seed together with fruit pulps of *Balanites aegyptiaca* and *Ziziphus spina-christii.* This has gradually led to the declining away of the previous indigenous knowledge associated with plant species. The study also clearly indicated that the time of harvesting and frequency of use of nutraceutical and other useful plant species varies depending on fruiting time variability and seasonal availability. These plants in the study area are harvested from December to January and from May to June, when the storage of grain crops has gone empty and the growing crops are not ready to harvest. Thus, wild edible plant species are potential alternative food sources during times of food shortage to contribute to the food security of the community in the study area.

Apart from their food and medicinal values, most of the identified nutraceutical plant species in the study area are used by the community for other different purposes. The local people harvest the wild edible plants not only for food but also for construction, fire wood, and furniture. For instance, the wild edible plant species such as *Ziziphus spina-christii, Balanites aegyptiaca* and *Celtis toka* are multipurpose plant species widely used by the local community for food, construction, furniture, shade and , fuel wood. As there is no any other means for energy and construction in the area, local communities have to go in the forest for search of these plants and other livelihood activities. This has resulted in high threats to these species of wild edible plants in the study area. Almost all threats were reported as anthropogenic and socio economic factors. The major threats identified are frequent-fire, land use change (agricultural expansion), fuel wood gathering, timber collection and settlements in the area.

In order to address the major threats identified and thereby enhance the socio-economic contribution of the nutraceutical plants, the following recommendations are suggested:

- Forestry and environmental professionals, as well as other concerned natural resources experts should be included in impact assessments associated with habitat destruction, frequent fire and any investment activities in the area.
- The existing District decision makers and other available stakeholder in the area should design an all-inclusive and participatory management strategy that involves the local people in managements of these plants in order to minimize the anthropogenic pressures or threats and their associated consequences.
- More research on identification of nutraceutical plants, species composition and diversity in this area need to be conducted for further use and prevention of threats and rarity of certain species.
- Further research on medicinal plants use on livestock as well as human need to be conducted in advance.
- Chemical and nnutritional aspects of nutraceutical plants need to be studied further in the area for better consumption in addition to local diet quality and healthcare.
- The use and consumption of these nutraceutical plants should be integrated with the plans of agricultural activities for improving conservation means in the region.
- Encouraging farmers through awareness raising and community sensitization schemes to protect and conserve edible and medicinal wild plants that grow around their back yard.
- To encourage people of the area through community mobilization in all productive age about importance of self-reliance and household working activities that boost up their economic and other food diversification.

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Appendices

Appendix 1: Interview guides for Household Survey

I. General information

1. Woreda: _____
2. Kebele (KA): _____ Tot.HH no _____ Male _____ Female _____
3. Altitude _____
4. Name of enumerator: _____Sig._____
5. Questionnaire number (code): _____
6. Date: _____ starting time _____ ending time _____

II a. Personal information / household characteristics

1. Name: _____ Sex: _____ (0) Male (1) Female
2. Age: _____ Marital status: ____ (0) Single (1) Married (2) Divorced (3) Widowed
3. Educational level: _____years (0) = for illiterate,(1) ≤5 grade (2), ≤10 (3), 12 _ certificate (4) diploma and above, (5) other specify the grade /year of Education)
4. Member of household: _____Male and _____Female _____Total.
5. How long have you lived in this area: _____
6. Do you have a social position in the community? (0) Yes (1) no
7. If 'yes', specify the position _____
8. Land holding, tenure and allocation

Table.1: land holding

Number	Type of land use	Owned	Tot in (ha)
0	Crops lands		
1	Other lands use		

9. General division of labor at household, who do what?

Table.2: Responsibility of collecting nutraceutical plants in the household

Number	Activities	Sex	Age	Time/Frequency
0	Collection of nutraceutical in the forest			
1	Preparation of food product or edible parts of plants			
2	Preparation of medicines of these plants			
3	Other activities related			

II b. Socio-economic characteristic.

10. What is your annual income look like? 1) High 2) Medium 3) Subsistent (low)

11. What is your Main Source of Income? 1) Crop Production 2) Livestock raring 3) both

12. What if any Income for Forest Product? 1. Edible Plants, 2. Medicinal Plants, 3.Fuel-wood, 4. Timber Products.

13. Any off-farm activities income? 1. Yes, 2. No

III: Role of Nutraceuticals in Household in Diversifying Food Sources & healthcare

1. What nutraceutical plants are in the vegetation area? List them
2. What is the Purpose of Using Nutraceutical Plants in the Household/area? 1. Home consumption, 2. Commercial Purpose, 3.both, 4.Medicinal Purpose.
3. What are those Plants responsible for Food?

4. What Are those Plants Responsible for Healthcare?

5. What is the Diseases Treated for Human by these Plants in the area?

6. What is the Diseases Treated for Livestock by these Plants in the area?

7. What are other uses of nutraceutical plants have (Multipurpose use) in Household to diversify livelihood activities? For instance, use for shade, fuel wood, construction and furniture, and other environmental service.

8. What promote the consumption of these Plants in the area?

9. What is the Consumption rate of Edible fruit in household per year look like?

1 < 10 Lieeri consumption of useful plants in hh/yr

2 10 Lieeri - 1Tuok consumption of useful plants in hh/Yr

3 10 Tuook - 1 Dieny consumption of useful plants in hh/Yr

4 1Dieny+ eating of useful plants in hh/Yr

10. what about the Consumption rate of Medicinal Plants in household per year?

1 <1 Kuom(bundle) of Medicinal care in hh/yr

2 2 - 10 Kuom (bundle) use of Medicinal Plants for trts in hh/yr

3 10+ Kuom use of Medicinal care in HH/Yr

11. What is their Consumption rate for Vegetable/leafy Nutraceutical per Month in hh?

1. 1kg - 20 kg of vegetable/leaves in hh/Month

2. 21 - 30 kg consumption of v.t/l in hh/Month

3. 31k -40kg of v.t inn hh/Month

4 41+ consumption of leafy vegetable in hh/Month

12. Where are this Plants Collected? 1. Tree zone, 2. Open woody land, 3. Grass land 4.Home garden, 5. Road side

13. What quantity of Fuel-wood consumed in household per month in the area for fuel and sale?

1 1- 4 faggot of fire wood in hh/Month

2 5-7 faggot of fire wood in hh/Month

3 8-11 faggot of fire wood in hh/Month

4 12+ faggot of fire wood in hh/Month

14. What about Timber Use? in What quantity?

1 150 - 300 timber use in hh/yr

2 3001 - 600 use of timber product in hh/yr

3 600+ use of timber product in hh/yr

15. Which Edible Fruit trees were Preferred in the study area (direct-matrix ranking, pairwise ranking of perceived threats, species preference based on its taste)?

16. How do people manage nutraceutical plants?(0) by planting in home garden (1) by leaving the forest to naturally regenerate (2) by relocating the dwellers from the forest area (3) life fence (4)other specify

17. How do they store them (storage techniques)? (0) drying them on sun light (1) keep those away from sun (2) put them on cool storage material (3) other

18. How long (time or duration) do they store edible fruits? (0) week (1) a month (2) quarter of year (3) whole year (4) more than a year (5) eaten up immediately after collection.

19. What are the instruments used during collection (harvest)? (0) panga (1) axe (2) traditional tools (3) hands (4) other specify.

20. How do you compare the present status of nutraceutical plants with that of **10 – 20**year back? (0) increasing (1) decreasing (3) same as usual

21. Is there any threats on nutraceutical plants? (0) Yes (1) No, if yes, list them from series threats to least one.

Appendix 2: List of Identified Species and their Families

S/N	Scientifical name	Family Name	frequency	Proportion (%)
1	*Hygrophila auriculata*	Acanthaceae	1	2.7%
2	*Amaranthus spinosus, Celosia trigyna*	Amaranthaceae	3	8.11%
3	*Calotropis procera*	Asclepiadaceae	1	2.7%
4	*Balanites aegyptiaca*	Balanite taceae	1	2.7%
5	*Cadaba farinosa, Creteva adanonsii,*	Capparidaceae	2	5.4%
6	*Diospyrus mespiliformis*	Ebenaceae	1	2.7%
7	*Flueggea virosa, Euphorbia tirucalli*	Euphorbaceae	2	5.40%
8	*Piliostigma thonningii, Tamarindus indica, accacia furinesia, Senna obtusifolia*	Fabaceae	4	10.81%
9	*Ficus sycomorus,*	Moraceae	1	2.7%
10	*Nymphae nuchalii*	Nymphaeaceae	1	2.7%
11	*Ximenia Americana*	Olaceae	1	2.7%
12	*Portulaca oleraceae*	Portulaceae	1	2.7%
13	*Ziziphus spina-christii*	Rhamaceae	1	2.7%
14	*Celtis toka*	Ulmaceae	1	2.7%
15	*Grewia abutilifolia*	Tilaceae	1	2.7%
16	*Adansonia digitata*	Bombacaceae	1	2.7%
17	*Scadoxus multiflorus*	Amaryllidaceae	**1**	2.7%
18	*Solanum incanum*	Solonaceae	**1**	2.7%
19	*Annona Senegalensis*	Annonaceae	**1**	2.7%
20	*Cissamplose mucronata, Stephenos abyssinica*	Menispermaceae	**2**	5.4%
21	*Chlorophytum tuberosum*	Anthericaceae	**1**	2.7%
22	*Strychonos spinosa*	Loganiaceae	**1**	2.7%
23	*Pyrenacantha kaurabassana*	Icacinaceae	**1**	2.7%
24	*Vernonia amygdalina, Bull thistle(Silybum mariacum)*	Asteraceae	**2**	5.4%
25	*Saba florida, Carissa spinarum, Acokanthera Schimperi*	Apocynaceae	**3**	8.11%
26	*Mimosops kummel*	Sapotaceae	**1**	**2.7%**
27	*Sclerocarya birrea*	Anacardiaceae	**1**	**2.7%**
Total			**37**	**100**

Appendix 3: Plants Used for Food and Medicines (Nutraceuticals)

Key: - habitat of collection; Tz = tree zone (dense woody forest), Shl = Shrubs lands, Lhg = Left over home garden, Ros = Road site, Op = Open scattered woodland. SW = Swampy area, Tm = Termite mound/hill, Rs = River side

Habit of plants; T = tree, Sh = shrubs, Climb = Climber, H = herb, S/H = shrubs or herb.

Month of the year; J = January, **F** = February, **M** = March,**Ap** = April, **Ma** = May, **J** = June, **Ju** = Jully, **Au** = August, **S** = September, **O** = October, **N** = November, **D** = December.

Uses of Plants: 1= food, 2= medicine, 3= fuel-wood, 4= construction & agricultural tool, 5= shade, 6= handcrafts or furniture making, 7 = seasoning into other food

S/N	Scientific Name	Local Name	Part Used	Growth form	Habitat	Preparation Method	Mode of Consumption	Administration
1	*Acacia farinesia* L.(Wild)	Kuech	F, B	T	Op,	Fruits, bark burned to form ash	Fruits eaten as snack, ash used as salt, and treats worms in stomach	Oral
2	*Adansonia digitata* (L.(baobab)	Gayneen	F,	T	Op, Tz	Fruits rubbed in water or pounded	Eaten raw or in juice, seed pounded for wound healing, stomach pain, snake bites…	Oral
3	*Annona senegalensis.* (per)	Thok	F	T	Op, Tz,	Fruits pounded, & concocted	Eaten Raw as snack, the pounded fruits are used for wounds cure for both Human & Livestock	Oral
4	*Balanites aegyptiaca* (L).Delile	Thow	F, L, S	T	Tz, Ro, Op	Feel the fruits and make concoction, dried fruit, crush for kernels use of food	Fruits eaten raw or in juice form, the kernel is mixed with cooked maize as beans, leaves are used for curing stomach pain	Oral
5	*Cadaba farinosa* (forssk*)*	Net	L, Br	Sh	Op, shl,	Leaves are chopped, roots are dried & crushed, branched are used as toothbrush	Boiled as a stew for food, branch are used as tooth brush to treat tooth decay and gum health, crushed leaves treats cough.	oral
6	*Carissa spinarum* L.	Chagiy	F, R, B	Sh	Shl Op, Ro	Fruits,Bark,root & leaves dried, crushed	Ripen fruit eaten raw, bark, root & leaves are Boiled in water for curing gastric in human, treat muscle pain.	Oral
7	*Celosia trigyna* (L)	Magak	L	H	Hg, Op	Leaves are chopped	Boiled, rubbed for food and	Oral

							medicine for gastric in human	
8	*Creteva adonansonii*.(DC*)*	Kech	L	T	Op	Leaves are chopped	Boiled & rubbed to supplement main food, & boiled water for curing common cold.	oral
9	*Diospyrus mespiliformis* Hochst. ex A. DC.	minychol	F, B, R	T	Tz Op	Fruits are pounded, or decocted	Eaten Raw or as porridge, decoction of Bark & Root for cough treatment	Oral
10	*Ficus sycomorus* L.	ngop	F, R	T	Op,Shl, Tz, Rs	Fruits dried, latex removed, root	Eaten raw, dried & latex used for wound healing, washed roots for hunch back treatment	Oral
11	*Flueggea virosa* (Wild).Voigt.	waak	F, R	Sh	Shl, Op, Tz	Fruits, roots & bark dried and crushed in to piece	Fruits eaten raw, root chewed for gastric & stomach pain	Oral
12	*Grewia abutilifolia* (Wild*)*	poor	F, Br, R	Sh	Shl, Op, Tz,	Fruits and roots are used as food and medicines	Fruit eaten as snack, root for cure of stomach ache, infusion	oral
13	*Hygrophila auriculata* (Schumach*)*	thiel	Flo, St	H	Op, Ros,Shl	Stem is burned in to ash for use both as food or medicine	Seasoning in other food in salt forms, treats worms and heal gastric	Oral
14	*Piliostigma thonningii* (Schum.) Milne-Redh	Ngoany	F, L, B	T	Shl, Op	Fruits and seed dried & pounded, gum	The dried and pounded is Boiled applied to wounds, newly grown shoots/twigs are chewed by boys/girls as snack gum is used in traditional ways.	oral
15	*Portulaca oleraca*.(Linn*)*	lumkoor	W	H	Op,Lhg	Leaves are chopped, Boiled in water	Eaten as a food supplements &, open appetite	Oral
16	*Strychonos spinosa* (L)	Kot		T/Sh	Shl, Op, Ros	Fruits & seeds are crushed, dried and soaked in water	Infusion for treating rheumatezia, insects and snake bites	Oral
17	*Tamarindus indica* (L)	Koat	F, L	T	Op, Ros, Lhg	Sauce or juice form	Eaten raw, leaves & twigs chewed as snack, treats malaria	oral
18	*Ximenia Americana* (L)	wuleng	F, R	Sh	Tz, Op, Shl	Fruits are dried, roots are chopped	Fruits eaten raw as snack, roots chewed for stomach pain	Oral
19	*Ziziphus spina-christii* (Willd) Desf.	Buaw	F, R	T	Tz, Ro, Op	Pounding, dried,	Eaten Raw as snack , root chewed for medicinal curing of cough	Oral

Appendix 4: Plants used for Medicine

S/N	Scientific Name	Local Name	Part Uses	Growth form	Habitat	Preparation	Uses Method	Administration
1	*Acokanthera Schimpera* (A. DC.) Schweinf)	Kooch	R, L	Sh	Shl Op	Leaves & roots are dried, pounded then boiled	Infusion/decoction used to boost up lack of milk in cow	Oral
2	*Silybum marianum (Bull thistle).(*L.Gaertn*)*	Yong	F & S	H	Lhg Ros	Seeds, fruits are dried, pounded	Soaked in water for use as a cure for serious constipation in domestic animals	Oral
3	*Calotropis procera* (Aiton).W.T.Aiton	Pak	B & R	Sh	Shl, Op	Bark & roots are dried, then chopped/crushed	Soaked in water for treating delayed umbilical cord of Livestock after delivering	Oral
4	*Chlorophytum tuberosum*.(Roxb).Baker	Toaar	R	H	Shl, Op	Roots chopped	Soaked in water for medicinal extracts & cure delayed umbilical cord of cow	Oral
5	*Cissamplose mucronata*.(A.Rich)	Depgany	B, R & St	H/C	Tz, Shl, Ros	Stem, roots chopped, dried & decocted	Soaked in water for treatments of constipation mostly in livestock, malaria, cough	Oral
6	*Euphorbia tirucalli* (L)	Tobow	Twigs	T	Lhg, Op	Leaves & new twigs cuts, dried, chopped	Soaked in water for treating milk lacking of domestic animal	Oral
7	*Mimosops kummel* (L)	Puth	B	T/Sh	Op, Tz, Shl	Barks removed & dried	Crushed and boiled in water before use of curing stomach ache and joint pain in human	Oral
8	*Pyrenacantha kaurabassana*.(Bail)	miadol	B & R	H	Op, Shl, Ros	Roots are chopped in piece, then dried	Soaked in water for medical extract & treat gastric	Oral
9	*Saba florida* (Bojer.Pichon)	nhiany	B	Sh	Ros, Op	Bark and roots dried	Boiled, decoction, treats gastric	Oral
10	*Senna Obtusifolia* (L.) H.S.Irwin & Barneby (Lapirondyek	Miaar	F,L,R	Sh	Ros, Shl, Op	Leaves, roots & barks dried	Put in water, rubbed for curing gastric in human, relieve fatigue	Oral
11	*Solanum incanum* (L)	Tangloar	F & S	H	Ros, Lgh, Op	Seeds and Fruits crushed together for use	Concoction, by mixing in water for curing constipation of children	Oral
12	*Stephania abysinica* (Dill. & Rich.)Walp.	Kolpiow	R & St	C /sh	Shl, Op, Ros	Barks/stem , and leaves are chopped, dried	Decoction of leaves, diarrhoea, vomiting, stomach complaints	Oral
13	*Vernonia amygdalina* (Del)	Nomloy	B	Sh	Op, Ros,	Leaves, Roots & barks removed, dried	Chopped, crushed, soaked in boiled water for high fever and malaria related disease	Oral
14	-	Reep	L, S & R	H	Lhg, Op	Leaves, seeds & roots are chopped,boiled	Decoction, or infusion for curing malaria & stop stomach ache	Oral

Appendix 5: Plants Used for Food

S/N	Scientific Name	Local Name	Part Used	Growth ss form	Habitat	Preparation	Mode of Use	Adminstration
1	*Amaranthus spinosus* (Linn.)	Doing	L	H	Lhg, Op, Ros	Leaves chopped, boiled & rubbed	Eaten as stew to supplement main food	Oral
2	*Celtis toka* (Forssk.) Hepper & Wood.	Riek	F	T	Tz, Op,	Fruits are peeled	Fruits are eaten raw as snack,	Oral
3	*Nyhmpae nuchalii* (L)	Key	V.P	H	SW	Leaves, vegetative parts are chopped, pounded & dried	Eaten boiled, raw as snack, or as porridge after pounding mostly during lack of food	Oral
4	*Scadoxus multiflorus*,(Martyn).Raf.	Lew	V.P	Tuber		Vegetative parts chopped, dried or used after collection	Boiled or eaten as food after being cooked well for 4 – 6 hours in the pot	Oral
5	*Sclerocarea birrea* (A. Rich.) Hochst	Kamel	F	T	Tz, Op	Flesh of fruits removed	Fruits are eaten raw as snack	Oral

Key: V.P = vegetative part

Appendix 6: Multi-purpose use of plants

Key: - habitat of collection; Tz = tree zone (dense woody forest), Shl = Shrubs lands, Lhg = Left over home garden, Ros = Road site, Op = Open scattered woodland. SW = Swampy area, Tm = Termite mound/hill, Rs = River side

Habit of plants; T = tree, Sh = shrubs, Climb = Climber, H = herb, S/H = shrubs or herb.

Month of the year; J = January, **F** = February, **M** = March,**Ap** = April, **Ma** = May, **J** = June, **Ju** = Jully, **Au** = August, **S** = September, **O** = October, **N** = November, **D** = December.

Uses of Plants: 1= food, 2= medicine, 3= fuel-wood, 4= construction & agricultural tool, 5= shade, 6= handcrafts or furniture making, 7 = seasoning into other food, x = none

S/N	Plan Species		Month of collection	Habitat	Growth form	Uses of plant
	Scientifical name	Local name				
1	*Acacia farinesia* L.(Wild)	Kuech	J, Ju, Aug, S	Shl, Op,	T	3,
2	*Acokanthera schimpera* (A. DC.) Schweinf)	Kooch	All season	Ros, Shl, Op	S/H	3
3	*Adansonia digitata* (L.(baobab)	Gaayneen	J F M	Tz, Op	T	5
4	*Amaranthus spinosus* (Linn)	Diong	Ma J Ju N	Lhg, Op, Ros	H	
5	*Annona senegalensis* (Per)	Thok	D, J, Aug	Op, Tz,	T	2,3,
6	*Balanites aegyptiaca (*L).Delile	Thow	N, D, J, F	Tz, Ro, Op	T	3,4,5,6
7	*Cadaba farinosa* (forssk*)*	Net	N, D, Ma, J, Ju, S	Shl,Tz, Op,Ros	sh	3,
8	*Calotropis procera* (Aiton).W.T.Aiton	Pack	All moth	Ros, Lhg,Shl	sh	3
9	*Carissa spinarum (*L)	Chagiy	Ap, Ma, J Ju Aug	Shl, Ros, Op	Sh	x
10	*Celosia trigyna* (L)	Magak	M, J Ju Au	Ros, Lhg, Op	H	x
11	*Celtis toka*(Forssk)	Riek	J, Ju, Aug	Tz, Op,	T	1,3,4,5,
12	*Chlorophytum tuberosum* Roxb).Baker	Toar	All season	Lhg, Shl, Op	H	x
13	*Cissamplose mucronata* (Lam)	depgany	Ma, J, Ju, aug, S, O	Shl, Op, Ro, Tz	Climber	4

14	*Creteva adonsonia* (DC)	Kech	Ma, J, J, Aug	Tz, Ro, Op, Shl	Sh	3,4,5,6
15	*Diospyrus mespiliformis*	Minychol	D,J,	Tz, Op,	T	5,6
16	*Euphorbia tirucalli*.(L)	Tobow	All month	Shl, Op,	T/sh	5
17	*Ficus sycomorus* (L)	Gnop	Ap, M, J,	Op,Shl, Tz, Rs	T	3,4,5
18	*Flueggea virosa* (Wild).Voigt	Waak	N, D, J,	Shl, Op, Tz	Sh	3,4,6
19	*Grewia abutilifolia (*Wild)	Poor	J, Ju, Aug	Shl, Op, Tz,	Sh	3,4
20	*Hygrophila auriculata* (Schumach*)*	Thiel	Ja, F M	Op, Ros,Shl	H	3,4, 7
21	*Mimosops kummel* (L)	Puth	All month	Ros, Op, Shl	Sh	3,4
22	*Nyhmpae nuchalii* (L)	Key	N D Ma J J	SW	H	x
23	*Piliostigma thonningii* (Schum.) Milne-Redh	Gnoany	Ma,	Shl, Op	T/Sh	4
24	*Portulaca oleraca*.(Linn)	Woor/lumk.	M, J Ju	Op,Lhg	H	x
25	*Pyrenacantha kaurabassana* (Bail)	Miadol	All Month	Op, Ros	Sh/H	x
26	*Saba Florida* (Bojer.Pichon*)*	Nhiany	All Month	Ros, Op, Shl	Sh	x
27	*Scadoxus multiflorus* (Martyn).Raf.	Lew	O, N, D, J	Op, Tz, Shl, Tm	Tube	x
28	*Sclerocarea birrea*(A. Rich.) Hochst	Kamel	J, Ju	Tz, Op	T	5
29	*Senna Obtusifolia*.(L)	Miaar	N D Ma J, Ju Aug S O	Op, Ros, Shl	Sh	x
30	*Silybum mariacum .(*L.Gaertn)	Yong	Ma, J Ju N D	Ros, Lhg	H	x
31	*Solanum incanum*.(L)	Tangloar	N D Ja J Ju	Op, Shl, Ros, Lhg	H	3
32	*Stephania abysinica* .Dill. & Rich.)Walp.	Mene/kolpiow	All month	Shl, Op	Cl	4
33	*Strychonos Spinosa.* (L)	Kot	Ma J Ju Aug S	Shl, Op, Ros	Sh	3
34	*Tamarindus indica* (L)	Koat	M, J, Ju, Aug, S,	Op, Ros, Lhg	T	5
35	Un-identified	Reep	Ma, J Ju Au, S O N D Ja F	Shl, Op, Lhg	H	x
36	*Vernonia amygdalina*.(Del)	Nomloy	All month	Op,	Sh	x
37	*Ximenia Americana* (L)	Woleng	D, J, F	Tz, Op, Shl	Sh	3,4
38	*Ziziphus spina-christii* (Willd) Desf.	Buaw	N, D, J	Tz, Ro, Op	T/Sh	3,4,5,6