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COLLEGE OF NATURAL SCIENCES

SCHOOL OF GRADUATES

Assessment of Agrobiodiversity Focusing on Crop Plants and Associated Traditional knowledge in Dangur District, Benishangul Gumuz Region, North west Ethiopia.

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Contents **page**

List of Tables

List of figures

List of Appendices

List of Acronyms

ATK	Associated Traditional Knowledge
CBD	Convention on Biological Diversity
CBM	Community Biodiversity Management
CBDC	Community Biodiversity Development and Conservation
CBR	Community Biodiversity Register
DDARDO	Dangur District Agricultural and Rural Development Office
EARO	Ethiopian Agricultural Research Organization
EIAR	Ethiopian Institute of Agricultural Research
FAO	Food and Agriculture Organization
PGR	Plant Genetic Resources
IBC	Institute of Biodiversity Conservation

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Abstract

Agrobiodiversity is the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops. Assessment of Agrobiodiversity Focusing on Crop Plants and Associated Traditional Knowledge has been conducted in Dangur District, Benishangul Gumuz Region, Northwest Ethiopia, to assess the agricultural diversity of crop plants on farm lands and associated traditional knowledge of the community. Out of 29 total kebeles of the District, seven kebeles has been selected purposively that represent the agroecological zones of the District. Of seven purposively selected kebeles data were collected through guided farm land observation, semi structured interviews, and market survey. A total of 70 farmers have been randomly selected to check the agrobiodiversity of crop plants on farm lands and their associated traditional knowledge. Fourteen knowledgeable key informants have been selected purposively with the assistance of community elders and local developmental agents. A total of 55 crop plant species belonging to 25 families were identified and recorded from the two farming sites (homegarden and farm lands). The plants can grouped in to 4 major use categories i.e., 38 food plants, 8 spice plants, 3 stimulants, and 6 cash or income generating plants. Food plants are further classified into major classes as cereals, pulses, oil crops, fruits and vegetables. Preference ranking on major cereal crops and cash crops made, Zea mays and Sorghum bicolor comes first and second from cereal crops, Sesamum indicum and Arachis hypogea comes first and second from cash crops. Traditional practices like selecting the soil type, improving the fertility of soil, obtaining seeds through different methods, seed storage techniques and mixed cropping shows the farmers diversified knowledge in their farming system. The people of Dangur district should be encouraged to cultivate versatile crop plants and their traditional knowledge must be recorded for sustainable management.

Key words /phrases: Agrobiodiversity, Associated Traditional Knowledge, Dangur District

1. INTRODUCTION

1.1. Back ground of the study

Agricultural biodiversity includes the diversity of plants, animals, and microbes that are used directly or indirectly for food and agriculture (FAO, 2011). The human race could not survive without access to this diversity, which enables plant and animal species to evolve and adapt to different growing conditions. Yet we have both undervalued this critical resource and squandered it, with the result that agricultural biodiversity is at greater risk now than at any time in recent history (Rudebjer *et al.*, 2009). While the value of agricultural biodiversity is not widely known, over the past few decades a growing number of scientists and policy-makers have started to take it more seriously. Nowhere is this more evident than in the sector of crop diversity, where a lot of work has been done by various organizations and countries. However, even in the domain of crop diversity, a lot more effort has been put into *ex situ* conservation and much less on *in situ* conservation and use and the management of diversity on farms. There is also the matter of policy and public awareness in relation to advancing the causes of better management and use of agricultural biodiversity. All these are areas that require greater efforts in research, education and development (Rudebjer *et al.,* 2009).

In recent years, policy-makers and scientists have been paying increasing attention to agricultural biodiversity. The effects of climate change, actual and potential, have given even more weight to the importance of this resource and the urgency for its conservation. Climate change will have a great impact on biodiversity, including agrobiodiversity (Bekele Regassa, 2014). But agrobiodiversity also holds a key to strategies for adaptation to climate change; it encompasses the genes that will be needed to adapt varieties and species to the new conditions in any given future climate. Currently, agricultural biodiversity is a thematic programe under the Convention on Biological Diversity (Rudebjer *et al.,* 2009). The International Treaty on Plant Genetic Resources for Food and Agriculture, which entered into force in 2004, has secured the open access to germplasm of 64 of the world's most important food and fodder species and genera. On the conservation side, there is an increasing awareness that production landscapes – where farmers are custodians of agricultural biodiversity – will play a critical role in biodiversity conservation (Rudebjer *et al.,* 2009). With this aim this research has been assess the overall

agrobiodiversity of crop plant species management practices of local people and associated traditional knowledge in Dangur District, Benishangul Gumuz Regional State, Ethiopia.

1.2 Statement of the problem

The erosion of our agrobiodiversity is a silent tragedy which has disastrous consequences on food security, the environment, peace and stability and which goes virtually unnoticed by the mainstream local and international media and shows few signs of improving. In my study area (Dangur District) recently farmers depend on the production of market oriented crops especially sesame (*Sesamum indicum*) and groundnut (*Arachis hypogea*). This condition leads to a continued neglect of the agrobiodiversity from national or regional conservation efforts, and requiring due attention and improvements. In order to maintain the ecological equilibrium, conservation of plant genetic diversity and to meet the agrobiodiversity products for requirements of the people, scientific information is required. Without a full assessment of the structure, composition and diversity of crops and their relation to indigenous farmer knowledge and management cannot be fully explained. To my knowledge, there is no inventoried and documented scientific information on the agrobiodiversity of crop plants in Dangur District. This study have been attempted to gather information on agrobiodiversity of crop plant species by people in Dangur District and fill gap in knowledge and come up with plant communities and scientific names of farm land crop plant species.

The study was designed to answer:

- What is the agrobiodiversity of crop plants in Dangur District?
- What are local communities' contributions towards conservation of agrobiodiversity?
- What are scientific evidence, management practices and policy options to use and safeguard agrobiodiversity?

1.3 Objectives of the study

1.3.1 General objectives

- ❖ The main objective of this study was to assess the agrobiodiversity of crop plants of Dangur District along with farmers Associated Traditional knowledge.

1.3.2. Specific objectives

- To asses crop plant diversity in the study area.
- To identify local communities' knowledge and their contribution towards conservation of agrobiodiversity.
- To inquire and record the local knowledge of people on how to use agrobiodiversity in the study area.
- To forward appropriate recommendations for the responsible bodies based on conservation measure.

2. REVIEW LITERATURE

2.1. Definition of agrobiodiversity

Agrobiodiversity is the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fiber, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators) and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems (FAO, 2011). Agrobiodiversity is the outcome of the interactions among genetic resources, the environment and farmers' management systems and practices. It is the result of both natural selection and human intervention over millennia. The CBD's thematic programme on agrobiodiversity identifies four dimensions of agrobiodiversity (CBD, 2011):

• Genetic resources for food and agriculture including plants, animals and microbes. These include cultivated and domesticated species, managed wild plants and animals, and their wild relatives.

• Components of biodiversity that support the ecosystem services of agricultural systems. These include a wide range of organisms that contribute to water and nutrient cycling, pest and disease regulation, pollination, climate regulation, carbon sequestration and other processes.

• Abiotic factors, such as local climatic or chemical factors that affect agrobiodiversity.

• Socio-economic and cultural dimensions, including traditional and local knowledge of agrobiodiversity, cultural factors and participatory processes, as well as tourism associated with agricultural landscapes.

2.2. Benefits of agrobiodiversity

Agrobiodiversity at the local scale has a range of benefits. Biodiversity can increase productivity, food security, economic returns, and leads to diversity of products and improve income opportunities, human nutrition and contribute to sustainable agricultural production. Plants contain bioactive compounds with antioxidant activities that may potentially be chemo-protective against many diseases (Thrupp, 1997). Agrobiodiversity provides a foundation for ecologically sustainable development, economic development, food security and poverty alleviation and is also vital for human health. It is crucial for regulating the stability of natural and agricultural ecosystems that provide basic life support functions including air, water, soils and food (CBDC, 2009). Food security is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Agrobiodiversity in the home garden can improve both continuous access to foods and the nutritional quality of households. Home gardens are often known for accommodating a particularly rich diversity of crops and usually managed by women and most of the production is directly used for cooking benefits to the entire family (Lossau *et al.*, 2011).

2.3. Agrobiodiversity and agricultural intensification

The links between agriculture and biodiversity have changed over time and should be viewed in the context of global agricultural development trends. Agricultural intensification –increased output per unit area of land have been shaped by demographic pressures (high population growth rates, the migration of people into frontier areas, and imbalances in population distribution), and the predominant paradigms of industrial agriculture and the Green Revolution (Thrupp, 2004). These paradigms generally emphasize maximizing yield per unit of land, uniform varieties, reduction of multiple cropping, standardized farming systems (particularly generation and promotion of high-yielding varieties), and the standardized applications of agrochemicals. The widespread adoption of high yielding varieties and other technologies has led to reduction of biodiversity which in turn diminishes the ecosystem services provided by agrobiodiversity and, therefore, undermines ecosystem health.

2.4. Major reasons and consequences of loss of agrobiodiversity in Ethiopia

There are various factors that threaten Ethiopia's plant genetic resources base and causing genetic erosion (CBDC, 2009). These included repeated drought in some areas of high crop diversity, indiscriminate diffusion of uniform exotic crop varieties that displace the genetic diversity of indigenous crops, degradation of agro - ecological systems and land fragmentation. The reduction in diversity often increases vulnerability to climate and other stresses, raises risks for individual farmers, and can undermine the stability of agriculture. The impact of the threat has also been extended to the traditional knowledge and management systems of indigenous crop varieties by local farmers. With the disappearance of crop diversity, so does the associated knowledge and practices that aided the development and maintenance of the diversity. This implies loss of agrobiodiversity directly affects agricultural productivity which is the backbone of Ethiopian economic, social and political development.

2.5. Agrobiodiversity and climate change

Factors that predispose the agrobiodiversity to problems of climate change included decades of misguided aid -meaning installing dependency syndrome, trade and production policies (Gonzalez, 2011). The author stated that these factors (1) have resulted in an unprecedented erosion of agrobiodiversity that renders the world's food supply vulnerable to catastrophic crop failure in the event of drought, heavy rains, and outbreaks of pests and disease; (2) climate change threatens to wreak additional havoc on food production by increasing the frequency and severity of extreme weather events, depressing agricultural yields, reducing the productivity of the world's fisheries, and placing pressure on scarce water resources. Furthermore, the climate change crisis and the biodiversity crisis are occurring at a time of rising global food insecurity; (3) these problems increased the number of chronically undernourished people in the world that reached 1.05 billion people in 2009 – a figure that represents the then one sixth of humanity. The problems might have occurred because of the change in climatic patterns that stimulate change in the spatial distribution of agro ecological zones, habitats, distribution patterns of plant diseases and pests. These points to the fact that focusing to home garden agrobiodiversity would be very beneficial to the entire area of agrobiodiversity.

Agrobiodiversity has some potential benefits to fight problems of climate change (Kotschi J, 2006). First, biodiversity in all its components increases resilience to changing environmental conditions and stresses. This depicts the role of biodiversity in supporting the continuity of ecological processes at smaller and larger scales. Second, richness of species minimizes variations during change of climate with buffering capacity to crop species adds increasingly to climate change adaptation. Third, agrobiodiversity serves as an engine of ecosystem by contributing to the adaptive and mitigating measures to resolve and protect the negative impacts of climate change. Home gardens play crucial roles in this regard. Home gardens provided protection and enriched environments for varieties that may have been more susceptible to biotic and abiotic stresses in the fields (Adugna Abdi and Zemede Asfaw, 2006). Among the services home gardens provide are soil enrichment, improved water retention and as habitats for pollinators. Home gardens are good examples of how humans cause niche diversification that can increase the total productivity of agroecosystems. The knowledge of farmers is an important input to the building up of the scientific basis of in-situ conservation of agrobiodiversity (Mathewos Agize *et al.*, 2013)

2.6. Policy issues to mitigate agrobiodiversity loss in Ethiopia

Various policies, regulations and proclamations related to supporting the conservation and development of the national genetic resources wealth were formulated by the country. These included national seed policy, national environmental policy, national policy on biodiversity conservation and research, plant breeders' right proclamation and access to genetic resources and community knowledge, and community rights proclamation. The country is aiming for rapid and sustainable economic, social and environmental development through continues revising and implementing these policies and regulation in integrated manners. For instance, national seed policy was formulated in 1992 and reaffirms the integration of efforts in crop/plant genetic resources management and development with the overall national development and natural resources conservation strategies (National Seed Industry Policy, 1992; Sections 3.01 and 3.02). In this regards, the national government encourages active participations of local communities and indigenous people through promotion of a fair and equitable share from the benefits arising out of the use of their indigenous knowledge and genetic resources (LEAD, 2006).

2.7. Using farmers' traditional knowledge to conserve and protect biodiversity

Traditional knowledge (TK) is local knowledge that is unique to a culture and society. It is embedded in the community's practices, institutions, relationships and rituals. It is the total of the knowledge and skills that people in particular geographic areas possess and that enable them to get the most out of their natural environment. Or 'Traditional knowledge' refers to the body of wisdom, innovations and practices of indigenous peoples and local communities (CBD, 1992). We see in the world that young generations of farming communities are increasingly reluctant to learn about, or are simply not interested in understanding, plant genetic resources (PGR) and associated traditional knowledge (ATK), which may result in their loss. The risk of losing ATK appears either when an owner of ATK does not pass it on to a recipient (another generation or other interested persons); when the overall situation in which the knowledge is used changes; or when the material concerned is lost. If the information passed on is not useful, or if the related resource is no longer there, the ATK loses its purpose. When any of these conditions or combinations thereof occurs, we need to address this situation with a conservation action. After more than a decade of work at Local Initiatives for Biodiversity, Research and Development (LI-BIRD, Nepal), we have learned that a community biodiversity register (CBR) can contribute to the empowerment of community institutions. Through this practice of community biodiversity management (CBM), communities gain a better understanding of their own biological assets and values, and are better able to use those assets for livelihood development while appreciating and sustaining them for future generations (Walter *et al.,* 2013).

The CBR is a practice that addresses a range of objectives. A CBR is basically a farmers' information database on biodiversity and traditional knowledge. It documents and monitors ATK and PGR and thereby protects them from bio-piracy (Rijal *et al*., 2003; Subedi *et al*., 2005 cited in Walter *et al.*, 2013).

The achievements of early Ethiopian civilization are evidence of the culture's traditional knowledge. The domestication of certain crops like coffee (*Coffea arabica*), tef (*Eragrostis tef*), and enset (*Ensete ventricosum*) and the development of the bench terrace system by the Konso community are examples of important agricultural achievements. The country has had a written language for over 2,000 years; manuscripts over 500 years old deal with TK concerning public health and veterinary medicine (Tesfahun Fenta , 2000)

2.8 Traditional Farming System

The most familiar methods adopted to overcome the adverse effect of water logging in Ethiopia are improving surface drainage or reduce water logging through the application of flat bed planting, drainage furrows, ridges and furrows, handmade beds and furrows, post rain planting and soil burning (EARO, 2001). In high rainfall areas and lower slope highlands of Ethiopia; ridges and furrows having a width of 40 to 60cm and height of 10 to 15cm are maintained using traditionally made '*Maresha*' and oxen-drown plough on which durum wheat cultivation is common on top of the ridges (EARO, 2001). The traditional farming system, which contribute to the conservation of cultivated and non-cultivated plants in Ethiopia include: Traditional field crop practice, Traditional home-gardens, Traditional seed exchange, traditional soil and water conservation practices

2.8.1. Traditional field crop practices

The spatial and temporal distribution of crops (farmer's varieties) demonstrates farmer's active r ole in maintenance of indigenous crops and agricultural innovations, which survived for generati ons as distinct species, land races, practices and skills (Shewaye Derbie *et al.,* 2002). Farmers wh o have an array of crop selection criteria tend to maintain greater agrobiodiversty by planting dif ferent crops and varieties or land races to fulfill their diversified demands (eg, yield, early matur ity, drought resistance, market value, weed resistance, insect pest resistance, straw quality, there shability, and beverage quality (Kirose Melese, 2008)

Small scale farmers in various region of Ethiopia quite frequently practice intercropping (growing of two or more crops on the same land during the same season) or even grow their crops in mixture, to stabilize their crop production especially under adverse growing conditions (Melaku Werede *et al*., 2000). Crop rotation is also a very customary farming practice in various regions of Ethiopia with great emphasis in the study area due to the growth of cereals and pulse field crops (EARO, 2001).

Diversity of crops both in time and space is a traditional strategy to ensure harvest security or stability of production to promote diversity of diet and income sources, to minimize crop failure risk, to reduce insect and diseases incidence and to ensure efficient use of labor (Yemane Tsehay

et al., 2006). The foundation of Ethiopian farming is comprised of the traditional crops and land races which farmers have adopted over centuries of selection and use to meet dynamic and changing needs (Melaku Werede *et al*., 2000).

2.8.2 Traditional home gardens

The homegarden system differs from all agricultural production system by its major role for domestic use, location, diversity and its size. It is a fenced or protected area around homestead where crops, vegetables, fruits, medicinal plants, spices, fodder and other plant species are intensively integrated (Shrestha *et al*., 2004). In Ethiopia also the homegardens are described as highly managed, mixed gardens of trees, shrubs and herbaceous species close to home (Zemede Asfaw and Ayele Nigatu, 1995). The evolution of homegardens possibly started from shifting cultivation practices that were used to overcome problems of resources and to a certain rights to land resources. Hence, home gardens have been described as living 'gene banks' in which a variety of germplasm, in the form of indigenous varieties, land races and rare species thrive side by side and has been preserved through generations (Tesfaye Hailemariam *et al*., 2009).

Two types of home gardens are recognized on the bases of their contribution to the welfare of households (Tesfaye Abebe, 2005). The first one is small-scale supplementary food production system around houses in areas where livelihood of the owners is based on other land use or other activities. It is common in much of the tropics. The second category of home gardens is extended farm field around houses that form the principal means of livelihood for farming households.

2.8.3 Traditional Seed Exchange

Farmers potion of quality seed sources are dependent on the real situation of farmers localized environments such as; local source of own-saved seeds, social networks of relatives, neighborhoods, cultural practices, traditional relationships including shopkeepers and open-air grain market traders that play coinciding roles (FAO, 2002). Conversely, it is difficult in some areas to came seeds in the next cropping season by most households since they consume it in the dry season of March and April due to lack of any other source of grain for food (FAO, 2002). Local seed supply system or informal seed supply system or farmer seed system is defined as in which selection, production and exchange are integrated in to crop production and socioeconomic process of forming communities (Almekinders and Louwaars, 1999). It deals

specifically with the processes, which farmers use to produce, obtain, maintain, develop and distribute seed resources both from one growing season to the next in the long ran (Haimanot Reta, 2010).

2.8.4. Traditional soil and water conservation practices

Ethiopia has a long history of indigenous soil and water conservation technologies such as stone bunding (Alemayehu Mengistu *et al*., 2006) and other physical conservation structures traditionally built by farmers such as cheek dams and cut-off drains (Esser, *et al*., 2002). Farmers also practiced contour plowing, grass strips, tree planting, terracing, fallowing, mulching, and crop rotation to improve soil fertility and there by agricultural productivity.

Farmers practice crop rotation as a means to conserve soil fertility by planting legumes one year and non-legumes the following cropping seasons. Farmers incorporate legumes in their crop rotations approximately every four years (Esser, *et al*., 2002). In addition, farmers restore soil fertility and reduce nutrient lose by incorporating crop residues and dung in to the soil or using them as mulch (Tilahun Amede *et al*., 2001). Leaving cropland fallows is a common practice in many parts of Ethiopia. This is intended to allow the soil to rest and regain some of its fertility from the growing vegetation. However, due to scarcity of land resulting from population pressure in many areas, fallow periods have became very short and rare, if extent at all (Esser, *et al*., 2002).

2.9. Ethiopia as a world centre of crop biodiversity and associated traditional Knowledge

For a century, rural development policies and strategies have assumed that farmers mismanage their natural environment (i.e. soil and water). Farmers have been advised and educated (via lectures, payments and coercion) to adopt new soil and water conservation measures and practices. Many have done so, and for some time the environment and the economy benefited. But many problems have undermined these efforts in the name of conservation, with financial and legal incentives bringing only short-term conservation that is not sustainable. Some projects in rural areas were successful because they integrated traditional knowledge and practices into every stage of their planning and implementation.

Ethiopia is a major world center of genetic diversity for many important domesticated crop plant species such as sorghum (*Sorghum bicolor)* barley *(Hordeum vulgare*), tef (*Eragrostis tef*), chickpea *(Cicer arietinum*), and coffee (*Coffea arabica),* which are largely represented in the country by uniquely adapted land races and wild types and genetically diverse forms. The genetic diversity of Ethiopian land races has been used worldwide to develop new crop varieties and to address acute constraints affecting yield. Much of this crop diversity is found in the small fields of peasants who, aided by nature, have played a central role in the creation, maintenance, and use of these invaluable resources. In Ethiopia, traditional farming represents the centuries of accumulated experience and skills of peasants who often sustained yields under adverse farming conditions using locally available resources. Ethiopian farming has its foundation in traditional crops and land races that farmers have adapted over centuries on the basis of selection and use to meet changing needs. Ethiopian farmers are instrumental in conserving germplasm, since they control the bulk of the country's genetic resources. Peasant farmers retain some seed stock for security unless circumstances dictate otherwise. Even when forced to leave their farms temporarily by emergencies such as severe drought or other threats such as war, farmers have often kept small quantities of seed stocks. In addition to household storage, farmers in various regions of the country have well-established systems to ensure the security of the seed supply, and they often operate in networks. One of the principal networks involves the exchange of seed in local markets. Farmers exchange crop types representing a wide range of adaptation to diverse environments. In this way, planting material can be chosen to suit a particular set of agro-climatic conditions. Seed that is not exchanged or consumed can be saved for a more appropriate planting season. In some of the more developed regions of Ethiopia, such as the central highlands, this practice is becoming less and less common with the availability of new improved cultivars. In most of the drought-prone areas, particularly in the northern Shewa and Wello regions, farmers still depend largely on the above-mentioned traditional system for ensuring a sustained supply of adaptable planting material.

The broad range of genetic diversity existing in Ethiopia, particularly the primitive and wild gene pools, is presently subject to serious genetic erosion and irreversible losses. Recent droughts in the northern part of the country have directly or indirectly caused considerable genetic erosion, at times even resulting in massive destruction of animals and plants. The famine

that has persisted in some parts of the country has forced farmers to eat their own seed in order to survive or sell seed as a food commodity. This has often resulted in massive displacement of native seed stock (mostly sorghum, wheat and maize) by exotic seeds provided by relief agencies in the form of food grain. To counter losses in genetic diversity, the former Plant Genetic Resources Centre of Ethiopia (PGRC/E), now the Institute of Biodiversity Conservation and Research (IBCR), in 1987–88 launched rescue operations, including a strategic seed reserve programme, in areas subject to recurring drought.

In the context of peasant farms, in situ conservation is defined as the maintenance of traditional cultivars (or land races) in surroundings to which they have adapted or in the farming systems where they have acquired their distinctive characteristics. In view of this, land race evaluation and enhancement programmers will certainly be needed to promote more extensive use of germplasm resources that are already adapted to drought-prone regions of Ethiopia. In such extreme environments, locally adapted land races would provide suitable materials for institutional crop improvement programmers'. There is, therefore, a need to maintain land races under natural conditions in a dynamic state. In Ethiopia, maintaining land races is probably best achieved through farm- or community-based conservation programmes (Tesfahun Fenta , 2000).

2.10. Biodiversity loss and traditional knowledge

Many indigenous and local communities are situated in areas where the vast majority of the world's genetic resources are found (UNDP, 2011). Men and women have cultivated and used biological diversity in a sustainable way for thousands of years. Some of their practices have been proven to enhance and promote biodiversity at the local level and to aid in maintaining healthy ecosystems. However, the contribution of indigenous and local communities to the conservation and sustainable use of biological diversity goes far beyond their role as natural resource managers. Their skills and techniques, which can also be gender-specific, provide valuable information to the global community and a useful model for biodiversity policies. Furthermore, as on-site communities with extensive knowledge of local environments, indigenous and local communities are most directly involved with conservation and sustainable use.

The contributions of indigenous and local knowledge systems towards a better understanding of biodiversity and its sustainable use and management, has been documented in the scientific and gray literature in many domains: biodiversity conservation and wildlife management, customary marine resource management, rural development and agroforestry, traditional medicine and health, impact assessment; and natural disaster preparedness and response. (IPBES, 2013)

There is also a growing appreciation of the value of traditional knowledge in the potential to modern industry and agriculture. Many widely used products, such as plant based medicines, health products and cosmetics, have been developed using indigenous traditional knowledge.

As such, recognition of the links between traditional knowledge, sustainable customary use of biological resources as well as its wider potential benefits has led to international work on traditional knowledge in many areas – to ensure its recognition, continued vitality and protection from misappropriation. Traditional knowledge issues cross-cut across many domains in relation to global environmental issues, from biodiversity conservation and natural resource management, to use of genetic resources and to climate change observations, mitigation and adaptation. Work on indigenous knowledge provides support to understanding the role of customary livelihoods within sustainable development and the links between environmental management, science and well-being.

2.11 Agroecology of Ethiopia

Agro-ecology of Ethiopia is diverse being inhabited by diverse farming communities that employ varying agricultural practices. Farmers and local communities traditionally categorize agro-ecology based on the major agro-climatic conditions, considering the relationship between elevation and temperature (Table 1). This approach has enabled the communities to recognize broad vegetation types and environmental conditions, and to select crops and livestock best suited for each specific agro-ecological condition. Agro-climatic, socio-economic and cultural conditions of the local communities therefore, influence the types and genetic diversity of the crops grown. Traditionally, farmers select seeds for various traits and purposes, and also exchange seeds through locally established seed networking. Livestock rearing and production of major cereals, pulses and oil crops are the major agricultural activities.

Table 1 Traditional climatic zone and their characteristics

Traditional zone	Climate	Altitude (m)	Average Annual Temperature (^{o}C)	Average Annual Rain fall (mm)
Berha	Hot arid	< 500	>27	<200
Kola	Warm semi- arid	500 - 1500/1800	27 - 20	200 -800
Woyna- dega	Cool semi- humid	1500/1800 - 2400	20 -16	800 - 1200
Dega	Cool and Humid	2400 -3200	16 -11	1200 - 2200
Wurch	Cold and moist	Above 3200	<11	Above 2200

Source CBDC, 2009

The traditional categorization of agro-ecological systems groups the agro-climatic zones into five zones. However, this traditional grouping of agro-climatic zones does not put the exact distinction of the boundary limits to each zone. Discipline-oriented studies distinguish and define this traditional agro-ecological classification by linking it to abiotic factors such as annual rainfall, altitude and temperature. This provides a more descriptive summary of agro-ecological conditions and illustrates the socio-economic and cultural activities of the local communities.

3. MATERIALS AND METHODS

3.1. Description of the study area

This study was conducted in Dangur District, Metekel administrative zone, Benishangul Gumuz region. It bordered with Pawi District, Guba District, Amhara region, Bulen and Wombera District in the east, west, north and south respectively. It is located 22 km from the zonal capital which is Gilgel Beles and 379 Km from regional capital, Assosa and 560km from Addis Ababa to northwest. The geographical location of the district is 11^0 23' 56" N and 35^0 57' 50" E. The total land coverage of the district is about 838700 hectares, of which 587090 ha (70%) hectares are cultivable and 251610 (30%) hectares are not cultivable and out of this 8929 hectares are designated for grazing lands and the remaining are designated for protected forest land.(DDARDO, 2015)

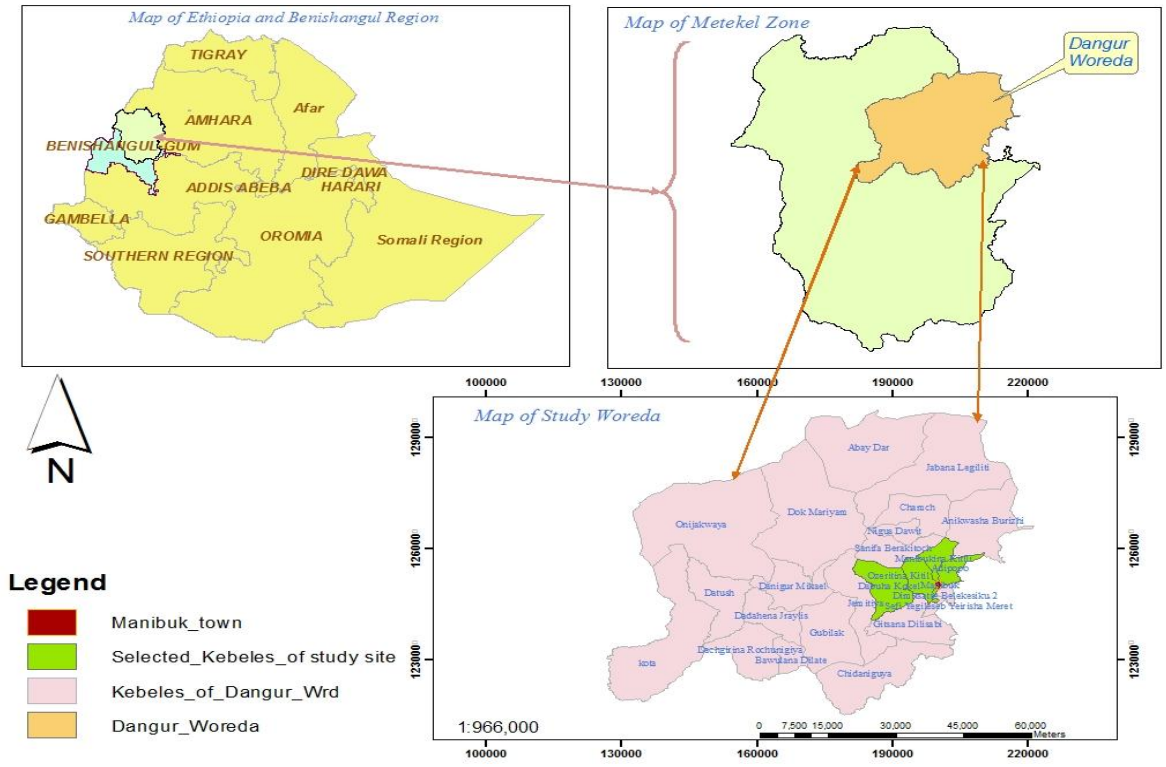


Figure 1 Map of the study area

3.2 Demographic Background of the Study Area

According to the population projection of 2016 by CSA, Dangur district has a total population of 65,469 of which 32,603 are male and 32,866 are female. There are 27 rural kebeles and 2 urban kebeles. About 80.08% (52,427) of the total population lives in rural areas. The Livelihood of the people in the District is mainly based on agriculture. There are a few people earning their income from livestock production and agriculture (mixed farming) (DDARDO, 2016).

3.3 Climatic and Agroclimatic condition of the study area

Topographically, the altitude of Dangur District ranges from 750 to 3131 meters above sea level. It has three major traditional agro-ecological zones: *Dega* (high land) (20 %,) *woina dega* (mid land), 5 % and *kola* (low land) 75%. The average annual rain fall is 1100 mm while the temperature ranges from 28 to38^0C. The soil types of the district include reddish (20%), black soil 75%), sandy soil (4%) and others (1 %) (DDARDO, 2015).

3.4. Socio-economic system of the study area

The economic base of the people in Dangur District is mainly dependent on agriculture. Raring animals especially goats are another sources of earning economy. During current past the indigenous people of the region (Gumuz and Shinasha) use backward ploughing system and harvest very low agricultural production on a given land, due to this it was difficult to feed their family by the agricultural production gained once in the year. To supplement agricultural production, the indigenous people have their own livelihood opportunities. The first is traditional gold mining which is mainly practiced during the winter region and traditional honey production. They sell gold and honey to buy food crops to satisfy the need of their family. And the next is hunting and gathering. The livelihood of the indigenous people has a great relation with the natural resources. The natural resources serve us a source of food, cultural medicine, belief and money for the community. Lowland bamboo, sisi, lalika and others are used not only to supplement food shortage but also part of their diet. Deforestation of wild life area is forbidden according to the culture of the native people. They live in the forest. Different wildlife is nearby their residence so they hunt them easily and used as a source of food. Currently traditional agricultural system of indigenous people of the District is being on the way of changing to better

way of agricultural practice that is ploughing by human power to ploughing by animal power. By using animal power, they cultivate better wide area than before and harvest enough food crops and cash crops like sesame and groundnut etc. the main cash crop in the region is sesame and covers huge area of land in the District. Generally, the livelihood of the community depends on agriculture, mining, livestock production and supplemented by the production gained from natural resources (DDARDO, 2015). Major crop category cultivated in the district during '*meher'* season along with its area of plough and amount produced is presented in Table 2.

Table 2 Major crop production in two years of the study area

		In 20014		In 2015	
No	Crop category	Cultivated area in hectare	Amount produced in quintal	Cultivated area in hectare	Amount produced in quintal
1	Cereals	43843	1183350	50264	924996
2	Pulses	17639	316402	17385	304868
3	Oil crops	56941	285683	52623	245995
4	Spices	697	9124	1030	11276
5	Vegetables	519	90273	461	77370
6	Fruits	52	14894	94	19206
	Total	119691	1989999	121857	1583371

Source: (DDARDO; 2016) annual report

3.5 Materials used for the study Purpose

The materials that were used during the actual agro-biodiversity data collection in the field are GPS, digital camera, scotch tape, bag, pen, pencil, questionnaires for data collection and field note book.

3. 6. Methods

3.6.1 Reconnaissance Survey

Reconnaissance survey was conducted in mid October, 2016 to have familiarity with the topography of the area, identify direction for appropriate sampling and to see whether the intended area is suitable to meet the objectives stated or not.

3.6.2 Sampling Design

Following the reconnaissance survey, overall information on the study area was obtained and representative sampling sites were identified by consulting the district agricultural and development office experts.

3.6.3 Sampling Techniques

The study was conducted in seven kebeles of Dangur District, Metekel zone, Benishangul Gumuz Regional state from October 2016 to June 2017. The District is subdivided in to 29 different kebeles with the range of 750 - 3131m a s l. Two kebeles, Belaya and Sanja bargitoch from *Dega* (high land), one kebele, from *Woina dega* (mid land) Borenja, and four kebeles from *Kolla* (low land) Misreta, Aypopo, Azartina kitili and Gitsi were selected. Of these seven representative purposively selected kebeles (study sites) 70 farmers (10 from each kebele) was selected randomly to check the agrobiodiversity of crop plants on their farm lands and their associated knowledge. Out of these 14 knowledgeable key informants (2 from each kebele) were purposively selected with the assistance of community elders and local developmental agents for ethnobotanical data collection. Agroecologicaly 75% of the district lies in the low land (*kolla*) and only 25% of the District lies in the mid land and high land (*woina dega* and *dega)* agroecological zones which make the selection difficult to use proportional allocation.

3.6.4 Data collection

The methods that were used for agrobiodiversity data collection were guided farm land walk for field observation, semi structured interviews, market survey, direct group discussion were made in association with purposively selected key informants with farm land owners in each site during ethnobotanical data collection. During walking along with the owner and key informants through the farm land, the informants were encouraged to discuss the cultural and ecological knowledge of the plants with their use. Note has been taken on local name of the plant with their use and sample specimens with appropriate photograph and representative sample were identified by referring other research papers because almost all crop plants were identified.

Semi-structured interviews are those in which some questions are pre-prepared and others arise during the time of conversation (Martin, 1995). These interviewing methods was let the researcher to inquire culturally appropriate questions in the course of conversation

Figure 2 Household interviews (Photo Yibeltal Demisew, 2017)

A market survey was also conducted to record the variety and amounts of food and other plant products that have market values in Manbuk town market by interacting with producers, sellers and consumers by using the starter questions given in Appendix 1.

Figure 3 Market survey of Manbuk town (Photo author, 2017)

3.6.5 Data analysis

The Ethnobotanical data were analyzed and summarized by using descriptive statistical methods such as percentages to describe the ethnobotanical information on the plants use. All the data has been compiled, organized into Microsoft Office Excel 2007. Finally results were presented in tables and figures.

Preference ranking

One of the simplest analytical tools involves inquiring respondents their favorite useful crop plants in the farm land or allows them to preferentially rank a few items in the category. Preference ranking is based on one dimension. In this study the respondents were asked to rank five cereal crops and five cash crops which are preferred in the study area by farmers.

4. RESULTS

4.1 Emic Categorization Systems and Practices in the Study Area

The local people of the study area have local categorization techniques that focus on various environmental components including soil, land, vegetation and season.

- **Local categories of soil**

The local categories of soil have their own peculiar sowing times. The local soil types with descriptions are presented in Table 3.

Table 3 Local soil types with their descriptions

No	Soil type	Description
1	*Mezega afer* (Black soil)	Highly fragile in texture and high water logging ability during rainy season.
2	*Keyate afer* (Red soil)	Heavy soil, well drained and aerated soil relatively fertile
3	*Chincha afer* (Sandy soil)	Very shallow less fertile soil

- **Local categories of arable land**

a. *Guaro*- refers to home garden (farm land near the home and its surroundings). It is the land where more manure is applied and more fertile. It is usually fenced, protected and more intensively cultivated.

b. *Massa*- refers to the main crop field. The remote open fields distant from the home stead and because of their location, sometimes full day's work have to be set aside to work on this farm. Generally these farms are less fertile, less or no manure applied and usually planted with single with diversified variety or more than one crop species but it is the bigger plot than *Guaro.*

- **Local categories of plants**

a. *Qut quato* (refers to shrubs) b. *Zaf* (refers to trees)

c. *Hareg* (refers to creepers and climbers) d. *Aremamo* (refers to herbs)

- **Local categories of season**

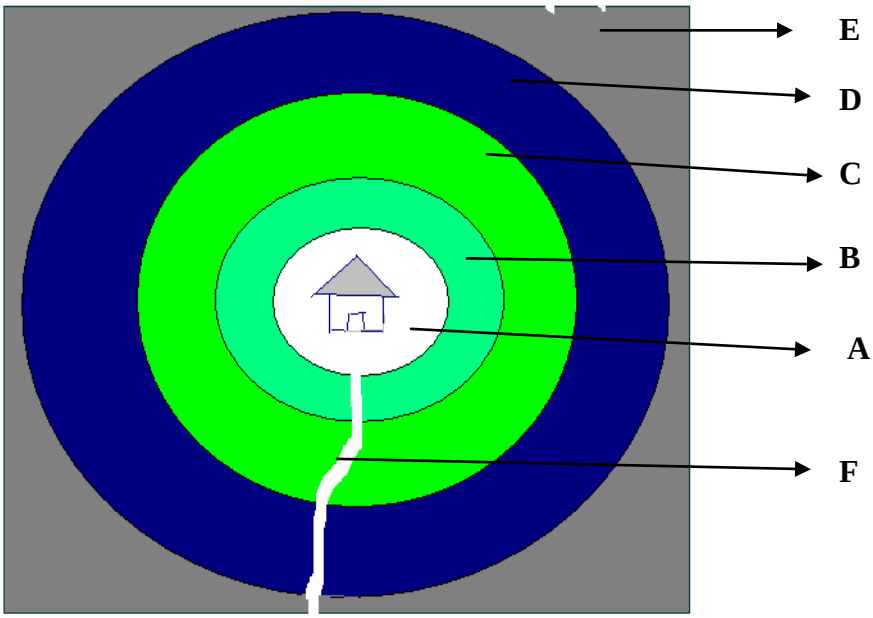
There are four seasons that can be recognized by the local people for doing agronomic activities. The seasons and durations arepresented in Table 4.

Table 4 Farmers categorization of season

Season	Duration	Remark
'Kiremt'	It lasts from June to September	The highest labor peak season(sowing and weeding)
'Meher'	It lasts from October to December	The second highest labor peak period
'*Bega'*	It lasts from mid December to mid March	Labor reached on its lowest peak
'Belg'	It lasts from mid March to May	Season of land preparation

4. 2. The spatial and temporal arrangement of crop plants in the farming site of high land areas of the study area

The spatial arrangements of plants in the two farming site (‘*Guaro’* & *‘Massa’*) centering living houses vary in composition and diversity based on ecological, socioeconomic, personal preference and availability of market. In average, most of the inspected plants in the farming site have a typical zonation. Look at (Fig.4).



A=Open space

B= Spice and Medicinal plants

C= Fruits and Vegetables at different proportion

D= Stimulants and different Trees and Shrubs

Home garden (*Guaro*)

E= Farming Fields (Massa)

F= Channel

Figure 4 Model showing crop zonation in the farming site of high land areas of the study site.

The spatial arrangement of plants follows certain pattern when observed. The patterns with reference to the living house became as follows. Cattles are penned on the dawn hillside of the house and a channel is cut in the ground to take the urine and droppings out and dumped to the nearest side yard. Zone B, C and D in the sampled study sites are considered as *Guaro* (homegarden). The last zonation is considered as *Massa* (farming fields) and mainly cereals, pulses, oil crops and trees that constitute the agroforestery system are present. The farming fields (*Massa)* and home gardens (*Guaro*) are separated by live fences.

Major use categories and number of species of crop plants in these two sites of study area is presented in Table 5.

Table 5 Major use classification and number of species of crop plants

No	Major use classification	No of species
1	Food	38
2	Spices	8
3	Stimulant	3
4	Cash (income generating)	6
	Total	55

4.3. Crop Plant diversity in the Farm site (*'Guaro' & 'Massa'*)

Crop plants are grown for food or other use on a large scale in farming site. Crop plants in the study area were classified by informants as cereals *('Ye-bir'* and*'Ye –ageda ihl'*), pulses (*'Ye-abeba ihl'*), oil crops (*'yekbat ihl'*), Vegetables ('*ktelakte'l*), roots and tubers *('srasr'*) and fruits ('*frafre'*). The primary uses of food plants with the exception of spices are for food. Spices are not considered as food; they give flavor to food and increase the appetite.

Local people in the study area give due attention for those plants that are deliberately cultivated or planted in their farming site and homegarden and those plants that can be grown spontaneously in the farming site. The plant that can be grown spontaneously in the farming site should be evaluated by farmers based on their use and these outlooks contribute for plant diversity in the study area. From the current study fifty five (55) crop plant species belonging to 25 families were documented in the study area. The representative families and numbers of species under each family are given in table 6.

It was found that the family Poaceae ranks top of the list (9 species) followed by Fabaceae (8 species) and Rutaceae (5 species). The detailed descriptions of these plants are presented in Appendix 2.

Table 6 Families with number of species recorded in the study area.

Family name	Species no	Family name	Species no
Poaceae	9	Malvaceae	1
Fabaceae	8	Convolvulaceae	1
Rutaceae	5	Linaceae	1
Solanaceae	4	Anacardaceae	1
Brassicaceae	4	Musaceae	1
Asteraceae	3	Lamiaceae	1
Alliaceae	2	Myrtaceae	1
Apiaceae	2	Euphorbiaceae	1
Zingiberaceae	2	Rhamnaceae	1
Chenopodiaceae	1	Polygonaceae	1
Caricaceae	1	Pedaliaceae	1
Celasteracae	1	Cucurbitaceae	1
Rubiaceae	1		

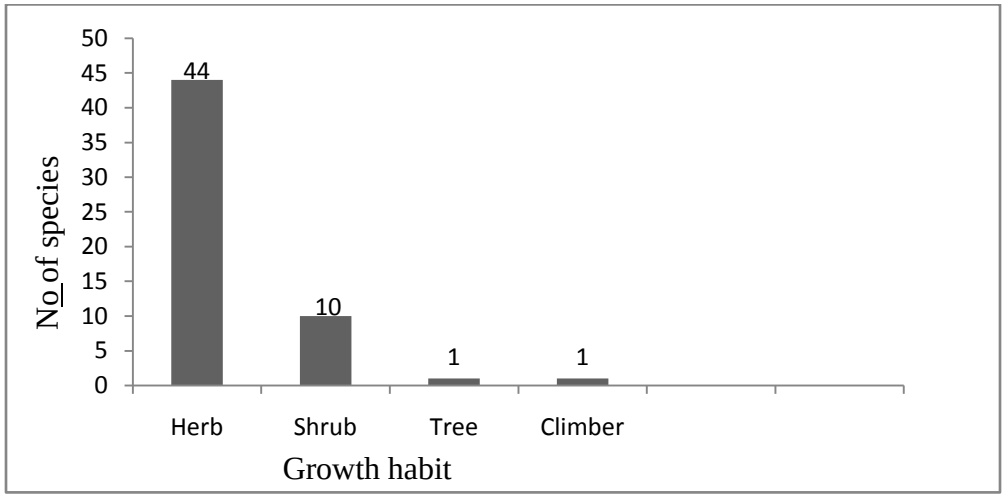


Figure 5 Habit of crop plants cultivated in the study area.

4.3.1. Cereals, pulses and oil crops

These groups of crops are grown due to wide range of agro ecology of the study area. The whole list of these crops is presented in Appendix 3. All of them fall under 6 families and 21 species. Their place of cultivation is mainly in farm lands (*Massa*). The major ones which are presented in figure 6 are able to fulfill cultural, religious, consumption, agronomic and economical requirements of the local communities. Generally the major cereal and pulse crops selected by many respondents were presented in figure 6.

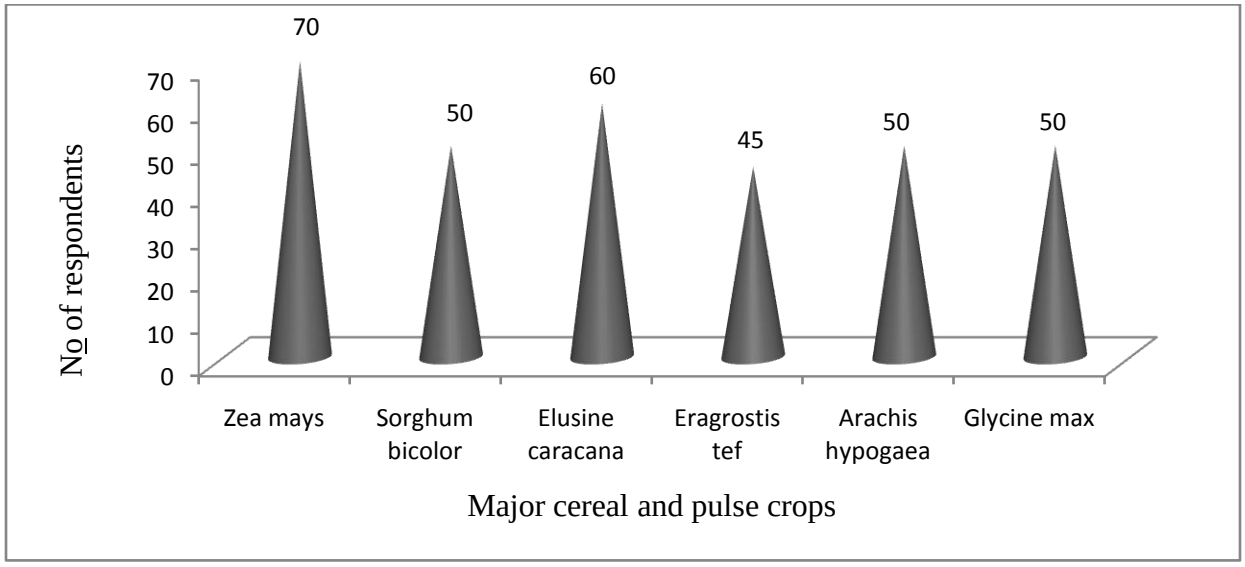


Figure 6 Major cereals and pulse crops with its total number of respondents

Table 7 Preference ranking of the top major crops grouped under cereals

Major cereal crops	**Respondents (1-14)**															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Total**	**Rank**
Maize	5	5	5	5	4	5	5	5	5	5	3	4	4	4	64	1
Sorghum	4	4	4	3	5	3	4	4	3	4	4	5	2	3	52	2
Finger millet	3	3	3	2	1	2	4	3	4	2	4	3	3	2	39	3
Tef	2	2	2	4	3	2	3	1	2	3	2	2	5	5	38	4
Rice	1	1	1	1	2	1	1	2	1	1	1	1	1	1	16	5

Table 8 Preference ranking of major cash crops

Major cash crops	Respondents (1-14)															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Total**	**Rank**
Sesame	5	5	5	5	4	5	5	5	5	4	2	3	4	2	59	1
Ground nut	4	4	4	4	5	4	4	4	4	3	4	5	3	4	56	2
Soybean	3	3	3	3	1	3	3	3	3	2	3	5	2	3	40	3
Red papers	2	2	2	2	2	1	2	2	2	5	5	5	2	5	39	4
Cotton	1	1	1	1	3	2	1	1	1	1	1	4	1	1	20	5

4.3.1.1The major cereal and pulse crop species and the locally preferred soil types

Soil preference of individual crop varieties is a natural reality; meaning, the type of soil in one area is amongst the key factors playing a progressive role in determining the productivity and survival of land races. The same principle applies in specific soil requirements of crops in the study area.

Table 9 The major field crops and their soil preference

No	Major crops	Soil type	Total respondent
1	*Zea mays*	Black	0
		Red	65
		Sandy	5
2	*Sorghum bicolor*	Black	0
		Red	35
		Sandy	15
3	*Eragrostis tef*	Black	30
		Red	10
		Sandy	5
4	*Arachis hypogaea*	Black	18
		Red	25
		Sandy	7
5	*Glycine max*	Black	17
		Red	28
		Sandy	5
6	*Elusine coracana*	Black	45
		Red	15
		Sandy	0

The preferred soil types are integrated with traditional soil fertility maintenance. All traditional soil fertility maintenance methods are vitally important for keeping land race diversities on their farm site so that one farmer uses more than one method. The methods of soil fertility maintenance are manuring (92.86%, crop rotation (100%), composting (42.86%), chemical fertilizers (57.14%) and others are presented in Table 9. Especially in farm sites of low land areas of study site farmers use chemical fertilizers for *Zea mays* because their farm site is far from their home stead while in highland and midland areas of the study site they use manuring. Traditional soil maintenance methods take the precedence as one of the grassroots practice to run the wheel of plant conservation in the farming system of the study area. Even though, composting and addition of chemical fertilizers are modern practices advertised by agricultural agents to increase agricultural product per plot.

Table 10 List of Traditional soil maintenance methods with their total number of respondents.

No	Method of soil fertility maintenance	No of respondents	% of respondents
1	Composting	30	42.85
2	Manuring	65	92.85
3	Crop rotation	70	100
4	Chemical fertilizers	40	57.14
5	Cheek dam	10	14.29
6	Terracing	25	35.71
7	Burning of plant remains	15	21.43

4.3.1.2 Seed source of cereals, pulses and oil crops

Obtaining local quality seed during each sowing period is mandatory to individual farmers in order to harvest a reasonable amount of production from a plot of land. Irrespective of other environmental, socio economical, political and natural factors: local quality seed by itself

determines the quantity and quality of production that is expected to be produced after the end of every cropping season.

Even if an area of farmer's possible quality seed obtaining methods are different for different seeds, the main ones for the main crop plants are selecting by looking crop from farm field for next sowing season, exchanging with like grain/ seed, exchanging with unlike grains/seed, purchasing from market and purchasing from quality seed enterprise.

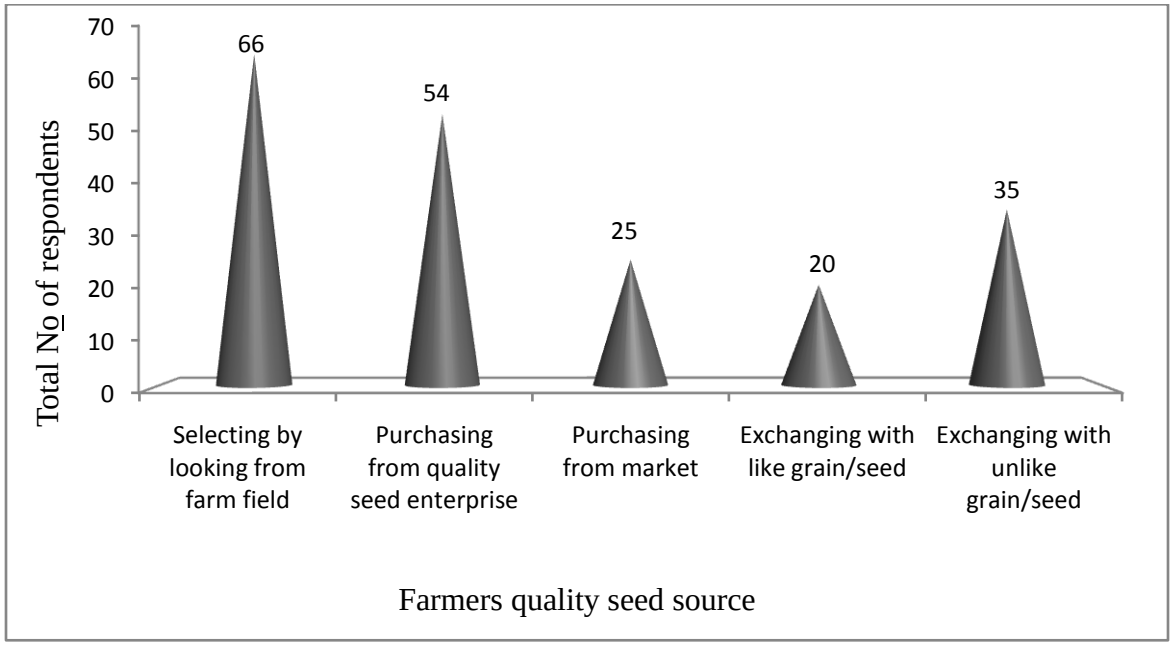


Figure 7 Number of respondents and traditional seed source of cereals pulses and oil crops in the study area.

4.3.1.3 Traditional seed storage techniques of cereals, pulses and oil crops

Indigenous knowledge related to seed storage in Dangur district is another appealing practice. Farmers are alert enough about how to store seed/grains in safe environment in order to protect its deterioration. This valuable traditional skill of seed storage and preservation technique parallel to other pre-harvest operations made them to be called 'custodians' of genetic diversity. In selecting quality seeds for the next harvesting season and maintaining it for long period is

mainly by women's in the survived study sites so that, women are instrumental for seed conservation and take the precedence in strategies of local crop environmental maintenance in the study area.

The best and the most well practiced seed storage methods are amongst the momentous cultural techniques pivoting the wheel of circumvention not to lose the agroecologically and the locally environmental situation adapted for indigenous crop species are mud pin *("goata"),* while in some cases hung on roof in order to reduce pest damage through smoking, refreshing under bed and leaving underground until the time of sowing in high land and mid land areas of the study site.

4.3.1.4. Traditional agronomic practices of cereals, pulses and oil crops after collecting Planting material

Farmers once obtain quality seed and plough the land, they sow following mixed (taking one dominant crop, using fast and slow growing crops simultaneously) or sole cropping techniques and cultivate properly by proper weeding. [The major weed and pest traditional management techniques are using frightening devices like scare crew (model of a person that is put in a field in order to frighten away birds during sowing time and maturing time of barely, wheat, tef, finger millet, maize, sorghum), slingshots (a Y-shaped stick with a piece of elastic material that can stretch, tied to each side that is used by children for shooting stone to control the effect of monkeys and birds on crops).] In addition to these farmers especially in low land areas of the study area also use modern herbicide chemicals to control weed before ploughing the farm land and weeding manually after the crop has been grown. (Fig 8)

After the seed mature, farmers collect the crops by cutting the part of the plant that contains the seed and collect it in places where it can be virgin land, far away from other crops or some times in the free space around their home in order to thresh the crop by using animals. Threshing differentiates the seed from non seed and finally the straw and the seed separated by using wind. This is a unique practice of farmers in the study area and has been transferred from the experiences of past ancestors and it is another side of traditional farmer agrobiodiversity quality maintenance techniques.

Figure 8 Weed controlling methods of the study area (Photo author, 2017)

4.3. 2 Fruit and vegetable production in the study area

Fruits and vegetables are cultivated in small-scale farmers in the study area at different agroecology. The taxonomic diversity of fruits and vegetables fall under 13 different families that contain a total of 21 different species of plants. Out of the total crop plants 16.07% can be considered as fruits and the remaining 21.43% are vegetables (it also includes roots and tubers) (Appendix 4). When we see the mode of consumption of these plants, all fruits can be consumed as raw and vegetables with the exception *Lactuca sativa* and *Capsicum annuum* can be eaten by cooking its parts. The parts to be eaten are diversified like root, bulb, leaf, and fruit. Growth form of fruits is perennials that can produce fruits ones per year where as vegetables are annuals, they can be cultivated in the absence of rain or rainy season. Use diversification of Fruits and vegetables in the study area mainly put under two categories i.e. for food and for means of

income (cash crop). Fruits and vegetables play a valuable role in food systems by diversifying diets and fostering increasing dietary consumption of micronutrients and other plant products known to benefit human health. Fruits in the study area consumed in the form of raw where as vegetables have diversified parts and eaten by the people mainly by cooking. The parts of vegetables eaten by the people are, root, leaf, fruits and bulb (Appendix 4).

Late alone farmers in the study area use fruits and vegetables as a source of food, they can be sold in the near market and get income out of it. People living in the high land of the study area mainly produce *Solanum tuberosum* and *Allium sativum* and from low land areas of the study area they mainly cultivate *Mangifera indica, Musa x-paradisiaca,Citrus sinensis* and *Lycopersicon esculentum.* Farmers sold these crops in the local market and purchase other cereal crops.

Table 11 Parts consumed by the people from fruit and vegetable

No	Kind of crop	Parts consumed
1	Fruit	Raw fruit
2	Vegetable	Root
		Bulb
		Leaf
		Fruit

4.3.2.1 Factors that hinder cultivation of fruit and vegetable food crops

The majority of fruits and vegetables food crops listed in Appendix 4 are grown in home gardens with the exception *Allium sativum, Allium cepa, Solanum tuberosum, Brassica oleracea, Lycopersicon esculentum* and *Daucus carota* that can be grown in home garden and field by market oriented farmers even though, market oriented agriculture reduce the agrobiodiversity. Scaling up of home gardening in comparable with suitability of the agroecology and untapped potential of the area is regrettably having its lowest position. Reasons proposed by the respondents to externalize the situation are of different in title and respondents face more than one of the constraints.

The major constraints of fruit and vegetable production in the study area are low level of information supply (About production, marketing, food preparation) low level of agricultural support system (High emphasis is given for cereals and pulses), small home garden size, water availability, absence of planting material, biological determinants i.e. insect pests, absence of improved varieties that swit to the District agroecology, relatively long gestation period to develop most fruit and payback period and poor pre and post harvesting management techniques.

4.3.3 Spices

A total of 8 species belonging to 7 different families were cultivated in the entire study area. *Rhamnus prinoides* is the main cash (income generating) spice which is cultivated in all respondents of mid land (Borenja) of the study area. Out of the total families, Zingiberaceae constitute 25% of the spice and the remaining others constitute 12.5% each other's and the rest are presented in Appendix 5. The different plant parts are served as a spice for example seed 25% fruit 25% rhizome 25%, leaves 12.5%.

5. DISCUSSION

5.1 Local Categories used by Indigenous People

Studying local people's categorization of natural resources in the study area was at the fore front of the research endeavor. Martin (1995) stressed that a good way to start an ethnobotanical study is to understand how local people classify rivers, hills, valleys and other geographical features that dominate the land escape. There are local system of classification and categorization of resources including land forms, soil type, season and vegetation. This system, which is a component part of overall traditional environmental knowledge of the local people, passed dawn over generations with its root firmly attached to the remote ancestors

5.2 Structure and Diversity of crop Plants in the Farming Site

The distribution of crops in the farmers farming site shows variation with distance from the dwelling in the study site. The same situation was reported by Ramaswamy and Sanders (1992), in Africa the distribution of crops in the farmer's village shows variation with distance and Okigbo (1994), the species diversity of crop plants decreases with increasing distance from the homestead. The study area home gardens similar to other traditional home gardens in the country mentioned by Zemede Asfaw (1997) and Tigist Wondimu *et al.*, (2006) houses diverse species of plants. This diversity is clearly visible in the model showing crop zonation in the farming site of the study area.

A. zone B

This zone contains spices, to the house surroundings. The majority of spices originated in the Asiatic tropics and was among the first objects of commerce between the East and the West. Their aromatic qualities were useful in overcoming the odors of bad food and unwashed humanity. They were used in beverages, in medicine and even in lieu of money. Spices cannot be classified as food for they contain little of nutrition value. They do, however, give an agreeable and aroma to food, and add greatly to the pleasure of eating. They stimulate the appetite and increase the flow of the gastric juice, for this reason they are often referred to as food accessories or adjuncts. Whatever value they have is due to the presence of the essential oils, and occasionally to other aromatic principles.

B. Zone C

This zone contains vegetables and fruits. The taxon diversity of fruit and vegetable can be fall down on 13 different families that contain a total of 21 different species of plants. Out of the total crop plants 16.07% can be considered as fruits and the remaining 21.43% are vegetables (it also includes roots and tubers). These groups of plants improve the health and nutritional status of the people. For example, Non-communicable diseases (NCDs), especially cardio vascular diseases (CVDs), cancer, obesity and type 2 diabetes mellitus, currently kill more people every year than any other cause of death can be controlled or reduced by eating fruits and vegetables (FAO/WHO, 2004).

Even though 100% of the respondents told that cultivation of fruits and vegetables is of for the purpose of food, the feeding culture in relation to its use for health is not well understood. This indicates that utilization of fruits and vegetables for food is much less than the required in take per day. In the same way farmers in the study area also have no well-established culture of eating fruits and vegetables as a result the scale of production is very low when we compare the land used for other food crops.

Reports from Dangur District Agricultural and Rural Development Office in the year 2015 indicates that from total arable land that is 121857 hectares 461 hectare were used for vegetable cultivation and 94 hectare were used for fruit cultivation. Totally 121302 hectares is served for cultivation of other food crop production. (DDARDO, 2016)

Fruits and vegetables are able to fill a variety of food gaps, for example if the previous crop harvest was not able to provide enough food to last through the next harvest, leafy vegetables cabbage and tuber type food plants will be consumed to fill the gap because leafy vegetables and tubers grow fast after the first rain showers, where as fruits usually mature only once a year, mostly coinciding with the growth cycle of cereal food crops, but where a dry spell exacerbates serious crop loses or even complete harvest failure, fruits would fill the immediate food gaps after a field harvest in the study area.

C. Zone D

This zone contains stimulants and other multipurpose trees that serve as shade partly. Farmers found especially in the mid land area, for example, in Borenja kebele cultivate *Catha edulis* and *Coffea arabica* extensively. These plants significantly improve the subsistence of the poor farmers at large and also act as a driving force to bring many multipurpose plants as shade and live fence to protect these crops and the home garden area. In some surveyed houses there is also another stimulant plant i.e. *Nicotiana tabacum* can serve as a smoke during cultural ceremonies and also means of income generating.

D. Zone E

This zone is the last farming zone in the study area and people mainly cultivate cereals, pulses and oil crops for food to their families and sold the extra products to the nearby market to conduct other cultural, spiritual and social affairs in their locality. Similar explanations were made by Tigist Wondimu *et al*., (2006) in the study of ethnobotanical study of food plants around 'DHEERAA' town, Arsi.

Plant biodiversity in and around homegarden is managed by arranging both in horizontal and vertical structure. In the hierarchical arrangements of species in height from home to out wards till to farming fields, the lower layer is rich in species diversity than the middle and the upper layers. Similarly the lower sides of home garden in horizontal arrangements are rich in species diversity than the last zone (farm field that mainly mono culture farming system takes place). The high diversity of plants in home garden is due to the fact that household wastes are hipped and spreaded near to the house on the lower side and hind of the houses and sometimes on the upper side of the house if possible. Therefore, plants those need manure for their growth tend to appear their and increase the species diversity besides the culture of the people to grow diversified plants in and around their home.

5.3 Farming System

The farming system has intensified by adopting the strategy of mixing compatible crops, the application of organic mannuring, and intensified labour input, all organized in space and time (Zemede asfaw, 2001). In the study area also the traditional farming system which starts knowing or understanding the nature of soil, farming seasons, planting material collection, different seed storage techniques, weeding, crop rotation, mixed cropping and protection of indigenous and exotic plant species due to their multidimensional use are the domain at which the local people practices throughout their life in the farming system

5.3.1. Mixed and inter cropping or crop association in the study area

According to Olasanta (1999) mixed intercropping is biologically a more efficient method than sole cropping because the intercropped plants can use the resources found above and below the ground in greater amount through spatial and temporal complementary. Moreover, in fields were crops of different life span are intercropped, the niche will be exploited sequentially. That is, ones the early maturing varieties are harvested, the medium and late maturing ones can take over the niche before they are harvested. Intercropping (multiple cropping system), which is the first form of organized agriculture in the history of man (Francis, 1998), is most prevalent in east Africa. The dominant crop association clearly visible in the study area and all respondents practiced are the following.

A. Taking one dominant crop

Taking *Zea mays* as a dominant crop and mixed with one or more than one other crops like *Brassica carinata* , *Solanum tuberosum*, *Cucurbita pepo* or and *Phaseolus coccineus* (bolekie) and mixing two species in one like *Elusine coracana* with *Heliaanthus annus* , and *Pisum sativum* with *Vicia faba* are supervised during plant collection. In some houses especially that have relatively large home garden can grow many vegetables in a single plot of land by growing one crop in one raw and another crop in the next row. The crops that can grow one over the other are *Beta vulgaris, Daucus carota*, *Brassica oleracea, Brassica rapa* and *Lactuca satia.*

B. Using fast and slow growing crops simultaneously

The local farmers have indigenous knowledge and age-old experience in the right mix of crops to get better yield and it is culturally believed that crops give better yield when they compete with each other. Intercropping between fast maturing and slow maturing crop varieties allows efficient use of resources for longer period. Furthermore, it reduces work burden by extending harvesting time (i.e. a farmer will get time to harvest crops that mature at different time interval). Example, in *Zea mays* field *Solanum tuberosum*, *Cucurbita pepo* and *Phaseolus coccineus* can be cultivated and the product is collected at different time.

C. Road side cultivation

Another cultural crop association is growing crops in fields that has road along its hedge. For instance, *Lepidium sativum*, *Linum usitatissimum* and *Lupinus albus* can be cultivated at the road side of *Hordeum vulgare*, *Triticum aestivum* and *Eragrostis tef* farm fields. Farmers told that those crops grown/ cultivated along road side control the effect of animals on other cultivated crops.

5.3.2 Soil management

In the study area farmers aware of the effects of soil erosion and traditionally they have created and applied different methods of controlling it. Burning of crop residues, manuring, crop rotation, terracing, cheek dam and chemical fertilizers are the listed soil management parameters in the study area. The above methods are also reported in the study conducted by (Hoben, 1997; Altieri and Merrick, 1987 and Ghadim *et al*., 1991). In the study area the proportion of farmers using chemical fertilizers in high land and mid land area is decreasing and utilization of organic fertilizers especially manuring is becoming the well practiced soil fertility maintenance method. The same idea is reported by Abenet Belete *et al*., (1992), the proportion of farmers using chemical fertilizers is decreasing in the high land of Ethiopia

A. Composting

Compost refers to biologically processed decomposed organic matter usually through speeded up natural biological process by piling, aerating and moistening. It contains balanced plant nutrients

including trace minerals and is rich in beneficial microbes that further improve the soil ability to nourish plants. In low rain fall areas where chemical fertilizers cannot be effectively used, compost is preferably used by farmers regardless of their financial capacity. Besides, it improves water holding capacity and drainage of soils (EIAR, 2009).

Compost improves organic matter content of the soil. Hence, compost can be used as fertilizer and soil conditioner. It contains good balance of essential plant nutrients in a stable form that will not easily leach away by rain and can be applied without danger of burning plants. It also increases the availability of existing soil nutrients besides supplying additional amounts already contained in the compost. Hence by using compost, one can not only improve the physical properties of the soil but also reduce up to half of the recommended chemical fertilizers (EIAR, 2009).

B. Manuring

In the highland and midland areas of the study areas ordinary informants told that using all domestic animal wastes to improve their soil fertility by direct application on their farmland before sowing any crop than using as a fuel. This attitudinal change acquired due to the expensive nature of chemical fertilizers.

In general the present day farmers attitudinal change for using organic fertilizers also open their eyes to look at the surrounding plants to use them as a row material for making organic fertilizers if and only if, their green leaves are decomposed and these idea increases the conservation dimension of different plants in the farming complex.

C. Crop rotation

Crop rotation is the easiest and applicable methods used to maintain the soil fertility in the study area. Farmers practices crop rotation in such a way that they can sow legumes at one year and cereals in the next harvesting season mostly legumes have nitrogen fixing capacity and increases the nitrate content of the soil. Cereals that can be harvested from legume farm fields give high yield. Pulses that farmers mostly use for farm land fertility maintenance for crop rotation purpose is *Lupinus albus* L., *Pisum sativum* L., *Vicia faba* L. in high land areas and *Arachis hypogaea* L *Glycogen max* (L.) Merr and *Crier arietinum* L. in low land areas of the study area.

5.4. Homegarden in the Study Area

In all homegardens of the study area a total of 26 crop plant species can be collected. Look at Appendix 2. The study area homegardens similar to other traditional home gardens in the country mentioned by Zemede Asfaw (1997) and Tigist Wondimu *et al.,* (2006) houses diverse species of plants but the space and diversity is tend to reduce due to urbanization and population growth(Zemede Asfaw, 1997). In the same way, in the study area those people that aware the situation are decide to resettle for seek of larger area for home gardening away from densely populated area and they have to develop home gardens having a desired farm size. Farmers establish new home gardens and they plant mainly vegetables and fruits that have market value. Even though market driven agricultural activities resulted in bulk production of few crops & reduced agrobiodiversity.

6 .CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Crop plants are grown for food or other use on a large scale in the farming site. From the current study of assessment of agrobiodiversity of focusing on crop plants and associated traditional knowledge of Dangur district fifty five crop plant species belonging to 25 families were documented and farmers of Dangur district were equipped with emic categorization of systems and practices that focus on various environmental components such as soil, land, vegetation and season. The spatial and temporal arrangement of crop plants both in the homegarden and farm site varies in composition and diversity. Crop plants in the study area were classified as cereals, pulses, oil crops, vegetables, roots and tubers and fruits. The preferred soil types for cultivation of crop plants are integrated with traditional soil fertility maintenance. Seed sources of crop plants of the study area are selecting by looking crop from farm field for next sowing season, exchanging with like grain/ seed, exchanging with unlike grains/seed, purchasing from market and purchasing from quality seed enterprise and also there are their own seed storage techniques such as using mud bin (*gotta*), hunging on the roof in order to reduce pest damage through smoking, refreshing under bed and leaving underground until the time of sowing.

Fruits and vegetables in the study area were cultivated at different agroecology but their production is less compared to cereals, pulses and oil crops. This is due to low level of information about production, marketing, food preparation, low level of agricultural support, small homegarden size, water availability and others.

However the composition of agrobiodiversity of this vicinity is tackled by various determinant factors as socioeconomic condition, limited agricultural support system, shifting of polycultural farming to few income generating crops due to market derives and lack of awareness. If these challenges are given due attention by the local government body and other concerned institutions the area is believed to maintain its present agrobiodiversity and is predicted to have a promising future prospects.

6.2 Recommendations

Based on the result of the study, the following recommendations are given

- Awareness creation of the local people and training on the sustainable utilization and management of crop plant resource is crucial.
- Effort of the study area farmers for making organic fertilizer (compost) is supported by scientific researches as to which identifying the plants that should use as a row material and contain higher proportion of nitrogen and phosphors in its part.

- In order to widen the home garden of the study area awareness creation should be done by the Agricultural office of the district.

- The presence of different plant in the farming complex should improve the soil fertility status and agrobiodiversity. Therefore, the agricultural extension workers should consider this fact and reshaped the farmers to practice and increase the crop plant knowledge through arranging training programs.

- Encourage and initiating farmer's morality by supporting with necessary infra structures such as provision of micro finance services, quality local seed varieties supply, experts follow up, training, rewarding for best performing ones is essential to bring radical change over home garden and field crop development in the study area.

- Young farmers in the study area mainly focus on commercial oriented company hybrid seeds rather than local varieties. Strategic reformation via arranging training programs has to be devised so as to attract the attention of the youth in to the previous intuitive wisdom of farmer's varieties' cultivation through conducting researches about these varieties and outline their use.

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8. APPENDICES

Appendix 1 Semi-structured interview items for ethnobotanical data collection from Dangur District farm lands

General information

1. Date_____ Kebele (specific site) _____

2. Name of respondent _____Sex _____Age___

Marital status_____ Occupation (specific job) _____

Religion_____

3. For how long have you lived in the area?

a) Since birth c) For the last 10 years

b) For the last 20 years d) For less than 10 years

4. Have you attended class? Yes/No_____ if "yes", what is the last grade you has attended_____?

Ethnobotanical Data

5. List the traditional way of classifying vegetations (crop plants) in your area

Vegetation _____, _____, _____

6. List the soil types of your locality.

7. What management practices you have been doing in your farm site in order to maintain soil

Fertility and sustain production?

a) By adding manure c) by commercial fertilizers

b) By adding compost d) other methods (please specify)_____

8. List useful crop plant species grown in the farming site including their vernacular name.

9. Do you know the importance of adding fruit and vegetables into your everyday family diet? Yes/No_____

10. How often you add fruits and vegetables into your family diet?

a) Everyday meal b) very rare c) not adding

11. If your answer is not adding or very rare, what do you think is the reason?

12. Are there any cultivated crop plants you can sell? If there are, what are the products of income generating plants you take to the market?

13. From where do you bring the planting material (seed) for all crops cultivated in your farm site? A. From government nursery C. From market

B. From friend and relatives D. Other (specify) _____

14. If you select seed from product of this year for next sowing season what are the criteria's for seed selection?

15. How do you store (put) selected seed until the next sowing season?

16. for how long does seeds can be stored in that situation?

17. What methods do you often use for pest (weeds, diseases, and insects) management in your farm land?

a) Use of pesticides/chemicals b) cultural methods c) both methods

18. Is there task division based on gender? Yes / no

19. If your answer for question no-18 is yes, who is involved in the management practice to

cultivate plants in home garden in a prolonged time?

20. Are there any challenges or threats in the farm land cultivation as well as diversity of crop?

plants in your farm site? List them.

21. What do you think the possible solutions for the above threat to scale up productions in farm land?

22. Do you notice any change (reduction or increase) in the diversity and production of crop plants in your garden? Why?

23. What do you think the major causes for the above challenges?

24. Which cultivated plant do you think is more resistant to drought among the plants grown in your garden?

25. List down use full plants used

Question for market survey

26. Where did you get these plants?

27. Are these plant products cultivated/wild?

27. If they are cultivated from where did you collect them?

28. How many quintals, bundles of vegetables do you produce per year?

Appendix 2 Complete list of crop plants cultivated in the study area

No	Scientific Name	Family	Local name (Amharic)	Crop category	Place of cultivation	Plant habit
1	*Allium cepa* L.	Alliaceae	Key shinkurt	Vegetable	Hg & Fie	Herb
2	*Allium sativum* L.	Alliaceae	Nech shinkurt	Vegetable	Hg & Fie	Herb
3	*Arachis hypogea* L.	Fabaceace	Lewiz	Oil	Fie	Herb
4	*Beta vulgaris* L.	Chenopodiaceae	Key sir	Vegetable	Hg	Herb
5	*Brassica carinata* A.Br	Brassicaceae	Gommen	Vegetable	Hg & Fie	Herb
6	*Brassica oleracea* L.	Brassicaceae	Tiquel gomen	Vegetable	Hg & Fie	Herb
7	*Brassica rapa* L.	Brassicaceae	Qusta	Vegetable	Hg	Herb

8	*Capsieum annuum* L.	Solanaceae	Karia	Vegetable	Hg	Herb
9	*Carica papaya* L.	Caricaceae	Papaya	Fruit	Hg	shrub
10	*Chata endulis* (Vahl)Forssk.ex. Endl	Celasteracae	Chat	Stimulant	Hg	Shrub
11	*Cicer arietinum* L.	Fabaceace	Shimbra	Pulses	Fie	Herb
12	*Citrus aurantifolia* (Chrism) Swing	Rutaceae	Lomi	Fruit	Hg	Shrub
13	*Citrus aurantium L.*	Rutaceae	Komtate	Fruit	Hg	Shrub
14	*Citrus medica* L.	Rutaceae	Tringo	Fruit	Hg	Shrub
15	*Citrus sinensis* (L.) Osbeck	Rutaceae	Birtukan	Fruit	Hg	Shrub
16	*Coffea arabica* L.	Rubiaceae	Buna	Stimulant	Hg	Shrub
17	*Coriandrum sativum* L.	Apiaceae	Dinblal	Spice	Hg	Herb
18	*Cucurbita pepo* L.	Cucurbitaceae	Duba	Fruit	Hg	Climber
19	*Curcuma domestica* Valeton	Zingiberaceae	Erd	Spice	Hg	Herb
20	*Daucus carota* L.	Appiaceae	Carot	Vegetable	Hg	Herb
21	*Elusine coracana* (L.) Gaertn	Poaceae	Dagussa	Cereals	Fie	Herb
22	*Eragrostis tef* (Zucc.) Trotter	Poaceae	Teff	Cereals	Fie	Herb
23	*Glycine max* (L.) Merr	Fabaceace	Akuriater	Pulses	Fie	Herb
24	*Gossypium herbacium* L.	Malvaceae	Tit	Fiber	Fie	Herb

25	*Guizotia abyssinica(*L.) Cass.	Asteraceae	Noug	Oils	Fie	Herb
26	*Helianthus annus* L	Asteraceae	Yeferegesuf	Oils	Fie	Herb
27	*Hordeum vulgare* L.	Poaceae	Gebs	Cereals	Fie	Herb
28	*Ipomoea batatas* (L.) Lam.	Convolvulaceae	Sikuar dinch	Vegetable	Hg	Herb
29	*Lactuca sativa* L.	Asteraceae	Selata	Vegetable	Hg	Herb
30	*Lepidium sativum* L.	Brasscaceae	Feto	Spice	Fie	Herb
31	*Linum usitatissimum* L.	Linaceae	Telba	Oils	Fie	Herb
32	*Lupinus albus* L.	Fabaceace	Gibito	Pulses	Fie	Herb
33	*Lycopersicon esculentum* Mill.	Solanaceae	Timatim	Vegetable	Hg & Fie	Herb
34	*Mangifera indica* L.	Anacardaceae	Mango	Fruit	Hg & Fie	Tree
35	*Musa x-paradisiaca* L.	Musaceae	Muz	Fruit	Hg	Shrub
36	*Nicotiana tabacum* L.	Solanaceae	Timbaho	Stimulant	Hg	Herb
37	*Ocimum basilicum* L.	Lamiaceae	Besobla	Spice	Hg	Herb
38	*Oryza sativa* L.	Poaceae	Ruz	Cerials	Fie	Herb
39	*Phaseolus coccineus* L.	Fabaceace	Boleke	Pulses	Fie	Herb
40	*Phaseolus lanatus* L.	Fabaceace	Adenguare	Pulses	Fie	Herb
41	*Pisdium guajava* L.	Myrtaceae	Zeitun	Fruit	Hg	Shrub
42	*Pisum sativum* L.	Fabaceace	Ater	Pulses	Fie	Herb
43	*Ricinus communis* L.	Euphorbiacae	Gulo	Oil	Hg	Herb

44	*Rhamnus prinoides* L' Herit	Rhamnaceae	Gesho	Spice	Hg	Shrub
45	*Rumex abyssinicas* Jacq	Polygonaceae	Mekmeko	Spice	Hg	Herb
46	*Ruta chalepensis* L.	Rutaceae	Tenadam	Spice	Hg	Herb
47	*Saccharum officinarum* L.	Poaceae	Shenkore ageda	Sugar	Hg	Herb
48	*Sesamum indicum* L.	Pedaliaceae	Selit	Oil	Fie	Herb
49	*Solanum tuberosum* L.	Solanaceae	Dinch	Vegetable	Hg & Fie	Herb
50	*Sorghum bicolor* (L.) Moench	Poaceae	Mashila	Cereals	Fie	Herb
51	*Triticum aestivum* L.	Poaceae	Sinde	Cereals	Fie	Herb
52	*Triticum dicoccon* Schrank	Poaceae	Aja	Cereals	Fie	Herb
54	*Vicia fava* L.	Fabaceace	Bakela	Pulses	Fie	Herb
54	*Zea mays* L.	Poaceae	Bekolo	Cereals	Hg &Fie	Herb
55	*Zingiber officinale* Roscoe	Zingiberaceae	Zingible	Spice	Hg	Herb

Where: Hg= Home garden Fie= Field

Appendix 3 List of cereals, pulses and oil crops cultivated in the study area.

No	Scientific Name	Family Name	English Name	Local name	Crop category	Place of cultivation
1	*Arachis hypogea* L.	Fabaceae	Ground nut	Lewiz	Oils	Field
2	*Cicer arietinum* L.	Fabaceace	Chick pea	Shimbra	Pulses	Field
3	*Elusine coracana* L.	Poaceae	Finger millet	Dagussa	Cereals	Field
4	*Eragrostis tef* (Zucc.)Trotter	Poaceae	Tef	Tef	cereals	Field
5	*Glycine max* L.	Fabaceace	Soy bean	Akuriater	Pulses	Field
6	*Guizotia abyssinica*(L.)Cass	Asteraceae	Niger seed	Nuog	Oils	Field
7	*Helianthus annus* L.	Asteraceae	Sun flower	Yefereng suf	Oils	Field
8	*Hordeum vulgare* L.	Poaceae	Barley	Gebs	Cereals	Field
9	*Linum usitatissimum* L.	Linaceae	Lin seed	Telba	Oils	Field
10	*Lupinum albus* L.	Fabaceae	White lubin	Gibto	Pulses	Field
11	*Oryza satava* L.	Poaceae	Rice	Ruz	Cereals	Field
12	*Phaseolus coccineus* L.	Fabaceae		Boleke	Pulses	Field

13	*Phaseolus lanatus* L.	Fabaceae	Lima bean	Adenguare	Pulses	Field
14	*Pisum sativum* L.	Fabaceae	Pea	Ater	Pulses	Field
15	*Ricinus communis* L.	Euphorbiaceae		Gulo	Oils	Home garden
16	*Sesanum indicum* L.	Pedaliaceae	Sesame	Selit	Oils	Field
17	*Sorghum bicolor* L.	Poceae	Sorghum	Mashila	Cereals	Field
18	*Triticum aestivum* L.	Poceae	Wheat	Sinde	Cereals	Field
19	*Triticum dicocoon* Schran*k*	Poceae	Polish wheat	Aja	Cereals	Field
20	*Vicia fava* L.	Fabaceae	Fava bean	Bakela	Pulses	Field
21	*Zea mays* L.	Poaceae	Maize	Bekolo	Cereals	Field and Home garden

Appendix 4 List of Fruit and vegetables cultivated in the study area.

No	Scientific Name	Family Name	Local Name	Crop type	Habit	Parts consumed
1	*Allium cepa* L.	Alliaceae	Key shinkurt	Vegetable	Herb	Bulb
2	*Allium sativum* L.	Alliaceae	Nech shinkurt	Vegetable	Herb	Bulb
3	*Beta vulgaris* L.	Chenopodiaceae	Key sir	Vegetable	Herb	Root
4	*Brassica carinata* A. Br	Brassicaceae	Gomen	Vegetable	Herb	Leaves
5	*Brassica oleraceae* L.	Brassicaceae	Tiquel	Vegetable	Herb	Leaf

			gomen			
6	*Brassica rapa* L.	Brassicaceae	Qusta	Vegetable	Herb	Leaves
7	*Capsium annum* L.	Solanaceae	Keria	Vegetable	Herb	Fruit raw
8	*Carica papaya* L.	Caricaceae	Papaya	Fruit	Shrub	Fruit raw
9	*Citrus aurantifolia*(Chrism)Swingle	Rutaceae	Lomi	Fruit	Shrub	Fruit raw
10	*Citrus aurantium* L.	Rutaceae	Komtate	Fruit	Shrub	Fruit raw
11	*Citrus medica* L.	Rutaceae	Tringo	Fruit	Shrub	Fruit raw
12	*Citrussinensis* (L.) Osbeck	Rutaceae	Birtukan	Fruit	Shrub	Fruit raw
13	*Cucurbita pepo* L.	Cucurbitaceae	Duba	Vegetable	Herb	Fruit
14	*Daucus carota* L.	Appiaceae	Carrot	Vegetable	Herb	Root
15	*Ipomea batatas*(L.) Lam	Convolvulaceae	Sikuar dinch	Vegetable	Herb	Root
16	*Lactuca serulata* L	Asteraceae	Selata	Vegetable	Herb	Leaves
17	*Lycopersicon esculentum* Mill.	Solanaceae	Timatim	Vegetable	Herb	Fruit
18	*Mangifera indica* L.	Anacardaceae	Mango	Fruit	Tree	Fruit raw
19	*Musa x- paradisiaca* L.	Musaceae	Muz	fruit	Herb	Fruit raw
20	*Psidium guajava* L.	Myrtaceae	Zeitun	Fruit	Shrub	Fruit raw
21	*Solanum tuberosum* L.	Solanaceae	Dinch	Vegetable	Herb	Root

Appendix 5 List of spices and method of preparation in the study area

No	Scientific Name	Family Name	Local Name	Parts consumed	Method of preparation
1	*Coriandrum sativum* L.	Apiaceae	Dinblal	Fruit	The fruit can be mixed with tef flour to flavor 'injera.'
2	*Curcuma domestica* Valeton	Zingiberaceae	Erd	Rhizome	The rhizome dried and powdered. Eventually add to 'wot' to give color.
3	*Lepidium sativum* L.	Brasscaceae	Feto	Seed	The seed powdered and used as preparation of hot pepper sauce(mitmita)
4	*Ocimum basilicum* L.	Lamiaceae	Besobla	Seed	The seed served as a spice in 'Berbere'and 'Shiro' preparation and used for distillation of butter
5	*Rhamnus prinoides* L'Herit	Rhamnaceae	Gesho	Leaves	The leaf is mixed in fermented malt and used for flavoring the drinks 'Tela' and 'Tej'
6	*Rumex abyssinicas* Jacq	Polygonaceae	Mekmeko	Root	The root can be used to spice butter
7	*Ruta chalapensis* L.	Rutaceae	Tenadam	Fruit	The fruit crushed and mixed with others and ground for preparation of 'Berbere' and 'Shiro'
8	*Zingiber officinale* Roscoe	Zingibraceae	Zingible	Rhizome	The rhizome dried, powdered and mixed with other ingredients for 'Berbere' or 'shiro' preparation

Declaration

I, the undersigned declare that this thesis is my original work and has never been submitted in any other university for the same purpose. All sources of materials for this work have duly been acknowledged.

Name Birhanu Mazengia Yalew

Signature_____ Date _____

This work has been done under my supervision

Name: Dr. Kitessa Hundera

Signature_____ Date_____