ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES
COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES
DEPARTMENT OF BIOLOGY

A TRADITIONAL FARMERS KNOWLEDGE ASSESSMENT ON LANDRACES AND TECHNOLOGICAL ADOPTION ON IMPROVED BARLEY VARIETIES IN WELMERA AND EJERE WOREDAS


By Thomas Tsega Sirna

MSc Thesis

September, 2017

Addis Ababa, Ethiopia

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THOMAS TSEGA SIRNA

A Thesis Submitted to the School of Graduate Studies of the Addis Ababa University in Partial Fulfillment of the Degree of Master of Science in Biology

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Approved by the Examining Board:

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This is to certify that the thesis prepared by Thomas Tsega, entitled: A Traditional Farmers Knowledge Assessment on Landraces and Technological Adoption on Improved Barley Varieties in Welmera and Ejere Woreda and submitted to Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Science in Biology complies with the regulations of the University and meets the standard with respect to originality and quality.

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DEDICATION

This thesis is dedicated to my parents: Tsega Sirna and Shitaye Hordofa, to my own family with gratitude for your unfailing love, passion and great support and for believing in me throughout my study period. This work is also dedicated to the farming community in Ethiopia.

DECLARATION

First, I undersigned, declare that this MSc thesis is my own original work and has not been presented for a degree, in any other University, College or Institution and that all sources of materials used for the thesis have been duly acknowledged.

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LIST OF ACRONYMS/ABBREVIATIONS

Abbreviations	Explanation
2, 4-D	2, 4-Dichlorophenoxy acetic acid
ASL	Above Sea Level
CBD	Crop Biological Diversity
CSA	Central Statistical Authority
DAOs	District Agricultural Offices
DAP	Di Ammonium Phosphate
DARD	Department of Agriculture and Rural Development
DAs	District Agents
ESSP	Ethiopia Strategy Support Program
FAO	Food and Agricultural Organization
FGDs	Focused Group Discussions
GE and GI	Genetic Erosion and Genetic Integrity
GIS	Geographic Information System
HARC	Holeta Agricultural Research Center
HCF & DCF	Habesha Cement Factory and Dangote Cement Factory
HHH	Household head
HYVs	High Yielding Varieties
IFPRI	International Food Policy Research Institute
LAB	Lactic Acid Bacteria
MoA	Ministry of Agriculture
NGOs	Non Governmental Organizations
NPSBb	Nitrogen Phosphorus Sulphur Boron blended
PAs	Peasant Associations
PGD	Plant Genetic Diversity
PGR	Plant Genetic Resources
PRA	Participatory Rural Appraisal
SPSS	Statistical Packaging for Social Sciences
USSR	Union of Soviet Socialist Republics

ABSTRACT

The study was conducted in Welmera and Ejere woreda of West Shewa Zone in Ethiopia. The woreda is known for barley production. The study used both primary and secondary data. Multistage sampling techniques were used to select 100 barley producing farmers. Descriptive statistics was used to describe variables under consideration and governing the adoption of improved barley. The main objectives of the study were to generate information on a traditional farmer's knowledge on landraces and technological adoption on improved barley varieties and to understand the socio-cultural significance of barley among local farmers. To achieve these objectives, two PAs were selected from each woreda. Both women and men discussed the comparison of local and improved barley, production systems and utilization in Ethiopia, variety changes, socio-cultural importance (medicinal, ritual significance, myths) and beliefs of each variety along with some other relevant use values of barley. A questionnaire on barley knowledge, its production systems and socio-cultural life style of people related to barley cultivation were developed. SPSS was used for data entry and management as well as descriptive analysis. FGD were made at village level among groups of farmers on specific points led by the principal researcher. Emphasis was given to women since the utilization of crops in the households are their responsibilities. In addition, a few farmers were interviewed following the questionnaire developed. Farmers reported that a number of different homemade dishes and beverages can be made from barley landraces. These include difo-dabo, budena, kita, kinche, marqa, akayi, qori, chuko and beverages like farso and arake. These different dishes and beverages are prepared at regular times or on special occasions (e.g. New Year, religious and non-religious social gatherings). Some of the dishes and beverages are used as sources of income by suburban women who sell their products at markets or home. Farmers use folksongs and proverbs to express the end use qualities of barley varieties. A survey was mainly carried out to collect the indigenous knowledge of the local farmers on the use of barley, genetic erosion of the local landraces and its maintenance. Here, using an interdisciplinary approach combining ethno-botany and technology adoption to document a traditional farmer`s knowledge on barley varieties in relation to their practices to identify their contribution to barley utilization. The ethno-botany approach allowed us to determine the indigenous knowledge of local farmers on barley. This knowledge is useful for participation in plant improvement or breeding program. This knowledge also will help to conserve barley varieties and enable sustainable use of barley.

KEYWORDS

Hordeum vulgare, Landraces, Farmers, Barley, Indigenous knowledge, Technology adoption, Ethnobotany, Ethiopia Folksong, Genetic erosion and on-farm diversity.

CHAPTER ONE
1. INTRODUCTION

1.1. Background of the study

The barley of Ethiopia attracted the attention of the international community at very early date in the history of barley research. Barley (*Hordeum vulgare L.)* is one of the earliest domesticated crop plants (Zohary and Hopf 1993). It is a crop grown widely all over the world but a major cereal grains grown in temperate climates. World-wide, in developed countries, barley is primarily used for animal feed, malting i.e. beer and whisky production with little designated for food, while it is considered as main food crop in developing world. Its worldwide acreage is over 76 million ha which is 5.6% of the world area of arable land and 10.6% of the area occupied by cereals (FAO, 1991). In ranking of cereal crops in the world, barley was fourth among most important cereal crops both in terms of quantity produced and in area of cultivation following wheat, corn and rice (Zohary and Hopf, 1988). Barley is very important cereal in terms of 132 million tons production, 55 million ha acreage and 2.4 t/ha yields in the world. The major barley production areas of the world include most of Europe, Mediterranean, fringe of North Africa, Ethiopia, the Near East, USSR, China, India, Canada and USA (Harlan, 1976). The top barley producer countries in the world are German, France, Ukraine, Russia, Spain, Canada, Australia, Turkey, UK and US, (Zemede, 1996). Barley demonstrates wide ecological plasticity and physiological amplitude throughout the country (Asfaw, 1988). Cold and frost that occur seasonally are the limiting factors of barley production in major parts of the world (Malhotra and Satena, 1993).

Barley is one of the oldest cultivated plants that have been grown and in use in Ethiopia for more than 5000 years (Harlan, 1968). According to Gamst (1969), the first Ethiopians to cultivate barley were the ancestral Agaw, cushitic-speaking people in the northwest, and their first contact with the crop had been estimated to 300BC. As for the Oromo ethnic group of southern Ethiopia (the biggest ethnic group in Ethiopia), barley cultivation is said to be as old as the plough culture itself, and that it is looked up on as a special and sacred crop (Haberland, 1963; Westphal, 1975). Barley is a significant crop plant globally and characteristically for a grain crop, barley cultivated today has long heads and large grains in comparison to its wild ancestors. These features support high grain yield and quality.

Barley production is generally and drastically affected by environmental and seasonal conditions. Ethiopia is very important center for barley resources because of its large number of varieties (Ciferri undated, Orlov 1929). In Ethiopia and many developing countries, barley is produced mainly as a food crop. In highlands of Ethiopia, it is the major stable food grain utilized in various forms of foodstuffs, which accounts for about 60% of the populations total plant food (Zemede Asfaw, 1990).

Barley is very important cereal in terms of 132 million tons production, 55 million ha acreage and 2.4 t/ha yields in the world. Ethiopia is recognized as a centre of diversity for barley; most of the country's farmers still obtain very low yields due to a combination of genetic, environmental and socioeconomic constraints. In Ethiopia, barley is adapted to a broad range of agro-ecological environments and it is tolerant to soil salinity, drought and frost to a considerable level. Field observation in different highlands of Ethiopia showed that frost effect is one of the major constraints of barley production in long rainy season. Research has been on-going since 1955 to address these constraints and improve the livelihoods of farmers by increasing the production and productivity of barley. Despite the suitability of production for barley in general and food barley varieties in particular it has not been widely cultivated/produced out as expected. There are various factors influence the development of barley. Barley development is influenced mainly by quality, quantity and duration of light. In Ethiopia unreliable rainfall (water logging, pests such as field rats, cut worm, shoot fly, aphids and ball worm are the main constraints of barley production (Berhane Lakew et.al 1995). Barley is supplying the basic necessities of life (food, feed, beverages and roof thatching) in highlands areas of Ethiopia. It is consumed in the form of bread, roasted grains, porridge, alcoholic and non-alcoholic beverages. It is the fifth most important cereal crop in Ethiopia after tef, maize, sorghum and wheat. Currently, it ranks only third in terms of land coverage after tef and Sorghum (Engels and Hawkes, 1991).

Eventhough barley is cultivated all over the country, some agro-ecologies are the most important barley producing regions of the country. These agro-ecologies are accommodated in Bale, Arsi, Shewa, Wello, Gojam, Gonder and Tigray, thus account for more than 85% of the total production (Yirga et al., 1998). Currently, the major barley producing regions in Ethiopia are Oromia, Amhara and Tigray regional states, which account for about 87% of the national production. Therefore, barley holds an important position in the food security of Ethiopia as ensuring food security is the basic right of people to the food they need.

Oromia regional state in central part of Ethiopia is a major barley producing area known for a long history of crop cultivation due to diverse geographic, climatic, and socio-cultural conditions. Barley despite its adaptability to a wide range of ecological situations is known to be susceptible to extremes stresses (Stanca et al, 1996). Environmental stresses such as water, salt, temperature, stresses affects the productivities of the crop (Weltzien and Stivastaia, 1981). Barley can withstand frost and salinity. Barley is a crop grown widely all over the Ethiopia because of its various importance and cultivated by traditional farmers. The major evaluation criterion for barley varieties has been biological yield such as improving grain yield, nutritional quality, and resistance to lodging and foliar disease (Berhane Lakew et al 1996). Barley prefers well-drained, loamy soils and will not tolerate waterlogged conditions. Both yields and grain quality are reduced on poorly drained sites.

1.2. Research Questions

The main research questions that were posed in this study include (1) what are the aspects of the indigenous knowledge of the local farmers on the barley varieties?; (2) what are the different cultural significance of local landraces and improved barley varieties?; (3) why the farmers prefer the improved barley varieties over the local barley landraces?; (4) what are the different homemade products prepared from barley (local and improved) varieties?; (5) why some farmers prefer barley than other cereal crops?; (6) how farmers adopt improved varieties of barley in the study areas?; (7) what are the tasks, labor division, and decision making roles in barley production and management by the farmers?; (8) do farmers have their own selection criteria and methods to improve and maintain their barley varieties?

1.3. Significance of the study

The result of this study may be used to determine on farm diversity of barley varieties, different barley production systems and to document a traditional farmers indigenous knowledge with the local farmers regarding the ethno-botany of landraces and technological adoption on the improved barley varieties covering various morphological characters in Welmera and Ejere districts (woredas) of Western Central Oromia. The study also helps to obtain information easily and communicates with the informants regularly to understand the indigenous knowledge of the traditional farmers on barley production knowledge.

1.4. Objectives of the study

1.4.1. General objective

The broad objective of the study was to determine on-farm diversity of barley varieties and to generate information on a traditional farmers knowledge on landraces and technological adoption on the improved barley varieties covering various morphological characters in Welmera and Ejere districts (= woreda or the lowest administrative hierarchy).

1.4.2. Specific objectives

The specific objectives of this study were:-

- To collect the indigenous knowledge of local farmers on the different barley varieties;
- To specify the cultural significance of barley among local farmers;
- To document the different types of barley varieties from farmers point of view;
- To describe the utilization of barley varieties in the diets of the local people;
- To document local processing techniques of barley landraces;
- To study the adoption proportion of local landraces with improved barley varieties;
- To identify cultural and economic importance of barley for sustainable development;
- To document the homemade products of barley and the socio-cultural life style of people related to barley production.

1.5. Statement of the Problem

Farmers in Welmera and Ejere woreda of West Shoa Zone in Ethiopia are practicing their traditional knowledge of farming to grow different barley varieties. Eventhough the district is known for its barley production was the challenge not to yield quality products. Ethiopia is recognized as a center of diversity for barley, most of the country's farmers still obtain very low yields due to a combination of genetic, environmental and socioeconomic constrains. These constrains initiates the researcher to study a traditional farmers knowledge on landraces and technological adoption on the improved barley varieties. The researcher also tried to study the various factors that influence the development of barley production. This study tried to answer the research question designed before the study and the researcher believe that the result fitted the different objectives that are expected.

1.6. Delimitation of the study

This study was delimited to Welmera and Ejere woredas barley producer farmers in Oromia National Regional State particularly in Holeta administrative zone. This is due to resource limitation, the study emphasized at only the two mentioned woredas.

CHAPTER TWO

2. REVIEW OF THE LITERATURE

2.1. The Barley History

Barley is an ancient cereal grain that offers versatility and a high nutritional profile. It was an important cereal grain in ancient civilizations. The health benefits and medical aspects of barley foods are also referred to in ancient Arabic, Chinese, Egyptian, Ethiopian and Greek literature, and have been reported by more recent civilizations from Asia to Europe. It was believed that barley bread gave the people greater strength and stamina compared with other foods. As other grains became more abundant, barley became less important as a food grain and were relegated to the status of a "poor man's bread". In Ethiopia, the long history of cultivation and the diverse agro-ecological and cultural practices have resulted in a wide range of barley diversity. Vavilov (1951) declared that nowhere else in nature he has observed such a diversity of forms and genes. Therefore, he proposed Abyssinia (the former Ethiopian Empire) as a center of origin of cultivated food barley. The diverse series of endemic botanical varieties may be the result of either an independent domestication or development after an introduction from southwest Asia at an early date (Harlan 1969, Negassa 1985, Orabi et al. 2007).

2.2. The Barley Taxonomy

Barley belongs to the genus *Hordeum L.* in the tribe *Triceae* in the family *Poaceae (Gramineae).* The genus *Hordeum* is a distinct genus in the tribe, well distinguished by its three one-flowered spikilets at each rachis node. It is relatively small genus distributed over wide geographical areas and diverse geographical habitats. The single progenitor of the barley is *Hordeum vulgare ssp. spontaneum*, which is still abundant in nature and it was discovered and described by C. Koch. Barley, a member of the grass family, is a major grain and it is evolutionarily closely related to two other small-grain cereal species, wheat and rye. It comprises over 32 species, including diploid and polyploidy, perennial and annual types monocotyledonous herb, which are spread throughout the world and belonging to tribe Triticeae (Von Bothmer et al. 1995). Barley is a diploid species with two sets of chromosomes (2n=14) (Purseglove, 1972).

2.3. Center of Origin and Domestication of Barley

The center of origin may be defined as regions where a crop was initially domesticated and where the wild progenitor and the derived cultivated species exist (Molina-Cano et al., 2005). Locating the origin of cultivated barley has not been without controversy and not exactly known but presumed to be originated either in Egypt, Ethiopia, or the Near East or Tibet. According to Purse glove (1972), barley together with wheat, was the first cereal to be domesticated in the Middle East before 9000 years. He described it to be the most important early cereals.

There is compelling evidence of the possibilities of multi-centers of origin of barley, initiating in the Iberian Peninsula, extending across North Africa but it can be surely said that it was one of the earliest cultivated grains. Orlov (1928) described the Ethiopia highland as an important geographical center for the origin of many important forms of now called *Hordeum vulgare L.* Moreover, Vavilov (1951) after his expedition to Ethiopia in the 1920s established that Ethiopian is the center of origin of barley although later he revised Ethiopia to be secondary center of diversity for the existence of the wild type. It appeared that the question of the center of origin of barley had been settled somehow (Zohary, 1964; Harlan, 1971), based on the simultaneous occurrence of the progenitor or rather, wild relative of barley with the cultivated barley and archeological evidence of antiquity in the Fertile Crescent. Bothmer and Jacobson (1985) assumed the Fertile Crescent in Near East to be the original area of cultivation of barley. Barley was grown on the Korean Peninsula by 1500-850 BC along with millet, wheat, and legumes. In ancient Egypt (3200BC to 30BC) barley bread and beer constituted a complete diet. Its use in the religious ritual of ancient Hindus and Greeks furnishes strong argument in favour of the great antiquity of its cultivation. Remains of barley grains found at archeological sites in the Middle East indicated that about 10,000 years ago the crop was domesticated and allowed researchers to conclude that the Fertile Crescent (fig 1) is the place of origin of barley (Azhaguvel & Komatsuda, 2007; Blattner & Badani Mendez, 2001; Badr et al., 2000). This is the most prominent and accepted theory regarding origin of barley. However, recently, Orabi et al. (2007) claimed that there might be another independent domestication site of barley in Ethiopia and Eritrea and they consider that this geographical region is at least a center of diversification of barley.

Figure 1-The Fertile Crescent, the area early for domestication of barley (Feuillet et al., 2008).

2.4. Geographic Distribution of Barley in Ethiopia

Ethiopia, with its diverse agro-ecological and climatic features, is well known for being one of the 12 Vavilovian centers of diversity (Harlan 1969; Vavilov 1951). Since the country is characterized by a wide range of agro-climatic conditions, barley is one the major cereals grown in wide agro-ecology with significant economic and social importance. In Ethiopia, the total area under crops was estimated to be 12,486,270.87 total area in hectares, of which 9,974, 316.28 total area in hectares are under cereal crops, among these, barley occupies an area of about 944, 401.34 total area in hectares (CSA, 2015/2016 (2008 E.C.). This makes Ethiopia the second largest barley producer in Africa, next to Morocco, accounting for about 25% of the total production in the continent (FAO, 2014).

Barley is widely grown in many different climates and cultivated in wide altitudinal range that ranges from (1450-4000m asl) with higher diversity in the highlands between (2500-3000m asl) (Abebe Demissie and Bjornosted, 1997). It is cultivated in all regions but most barley production concentrated in Shewa, Arsi, Gojam, Gondar, Welo, Bale and Tigrai area (Zemede Asfaw, 1988 and Berhane Lakew, 1996). The soil and rainfall variation, ecological diversity, substantial temperature and diverse social and cultural conditions are some of the possible explanations for the existence of large genetic variation of crop varieties in Ethiopia.

2.5. Genetic Diversity of Barley

Ethiopia is considered as a center of diversity of barley, but not of origin, because of the absence of the wild relatives of barley. Ethiopia based on the diverse variation and concentrations of some characters including genes for disease resistance, a particular restricted area can be defined as a center of diversity and origin of barley in southern Ethiopia in accordance with the current concept of the center of origin and in the sense of the word 'Center' itself. This is the Arsi-Bale highland, where barley grows from an altitude of 1600m asl to above the timber line.

For the genetic variation of cultivated barley, the wild progenitor has significant contributions that are economically important. Barley possesses different important traits. Some of the traits include high yield, biomass, resistant genes for abundant genetic variation against physiological stress such as drought and salinity (Nevo et al, 1984). Ethiopian barley genetic diversity is not evenly distributed within the geographical range of the species gene pool. The genetic diversity of this crop exists in many environments but, its continuity is particularly observed in marginal areas (mountains) due to the well marked environmental change over small distance, seasonally and in isolation between the production zones. In fact, the large genetic diversity of Ethiopian barley landraces could be due to the diversity in soils, climate, altitude and topography together with geographical isolation for longer periods (Harlan, 1968). These environmental stresses play significant role for the diversification through evolutionary process (Harlan, 1968).

The country's heterogeneous environment with the high altitude and its low latitude tropical position are the main reasons for barley diversification in Ethiopia (Simoons 1965 cited in Asfaw, 1989b). Accordingly, Asfaw (1989c) categorized the main factors that are responsible for diversification of barley into three: (a) Conducive environment: - heterogeneous, favorable for mutations (b) Biological process: - selfing and out-crossing, disruptive selection, predominant and combined selfing. (c) Anthropogenic factors such as domestication process (primitive agricultural system, agglomeration of types in a field and deliberate selection) and social factor (social values as criteria for selection, ethnic diversification, diversified uses and association between barley types and uses). The Ethiopian barley has been important worldwide as a source of useful genes for traits such as disease and pest resistance. Genetic diversity also allows farmers to exploit the full range of the countries highly varied microenvironments differing in characteristics such as soil, water, temperature, altitude, slope, and fertility.

Plant Genetic Resources (PGR) defined as the total genetic diversity of cultivated species and their wild relatives. PGRs constitute the building blocks of all modern plant breeding and highly prized for their potential value as sources of important variations for crop improvement programs. Populations of these various forms of plant species also represent sources having the greatest potential for genetic diversity and serve as invaluable means to fill the gaps exist in the available base of genetic diversity in the world collection of many major crop species. The barley genetic diversity provides vital features. Among these, the most important traits are disease and pest resistance, nutritional quality, resistance to drought and other stress conditions and characteristics especially useful in low input agriculture.

2.6. Genetic Erosion in Barley

Genetic erosion has been defined as the loss of genetic variation like so many tangible and intangible assets that make up the framework of our life on the earth. Also it is defined as the loss of variability from barley populations in diversity centers at areas of domestication and diversification (Brush, 1999). Hammer et al. (1996) also defined it as the loss of particular local landraces expressed as the ratio of the number of landraces available to their former number. However, the genetic erosion in a narrow sense refers to the loss of genes or alleles and in broad sense refers to the loss of varieties (FAO, 1998). It is a process acting both on wild and domesticated barley species and it is both natural and man-made process. Genetic variation is the foundation of evolution and the basis for continuation of all life forms. Variation is being narrowed as a result of various agents of genetic erosion.

Reasons for genetic erosion includes displacement of indigenous landraces by new genetically uniform varieties; change and displacement in agriculture or land use, problems like drought, displacement or loss of wild gene pool, habitat disappearance, genetic vulnerability and various factors related to the national breeding program and other related activity also directly or indirectly attributed to persistent loss of genetic resources and, narrowing down of genetic base or genetic wipe out (Worede, 1988). Generally, genetic erosion is caused due to diffusion of exotic seed varieties that has been displacing local varieties. The main consequences of genetic erosion are that genetic uniformity leaves a species vulnerable to new environmental and biotic challenges and causes heavy damage to the society. Rates of displacement vary depending on regions and crops.

In many cases, farmers plant both native and exotic types interchangeably or alongside each other, at times in mixtures, depending on their particular needs, market demand, or other prevailing factors (Worede et al., 2000). In general, native barley are among the crops most threatened by new varieties and/or by other crop species such as tef and wheat, which are expanding with the cereal growing highlands of the Shewa, Arsi, and Bale regions, largely because of greater market demand (Worede et al.2000). Similarly, Tsegaye and Berg (2007) reported that the causes of genetic erosion are multifaceted, emanating from responses to changing natural, socio-economic and policy environments. The impact of the threat has also been extended to the traditional management systems of varieties of crops developed and used by the local people through generations. In Ethiopia, local barley varieties are suffering serious genetic erosion due to displacement by improved varieties (Friis-Hansen, 1999). Genetic erosion can occur at many stages in the preparation, sub-sampling, exchange, storage and regeneration of seed. This shrunk the genetic pool that is available for selection by farmers and has increased the vulnerability of agricultural crops to sudden changes in climate and to the appearance of new pests and diseases. The loss of genetic diversity may lead to increasing crop susceptibility to diseases, pests and environmental stresses.

2.6.1. The Major Factors Causes of the Barley Genetic Erosion

Broadly speaking factors that causes genetic erosion can be grouped into two categories.

2.6.1.1. Natural Factors

This is the natural processes that causes the losses of varieties and contribute to the genetic erosion of both cultivated and wild species of barley. These include natural disasters and droughts which led to complete crop failure and displacement of local cultivars. Insect pests (locusts and armyworm) can cause considerable crop losses. In general, the major constraints to barley varieties loss and production are barley shoot fly, frost moisture stress, net blotch, smuts and scald (Caro and Laurenson, 1999).

2.6.1.2. Man-made Factors

Genetic erosion of improved barley and their wild relatives is accelerating at a high rate because of human activities in Ethiopia (Mekonen, 1997). Human activity is the most important factor threatening biological diversity. These includes land clearing, over-exploitation of species, population growth pressure, environmental degradation, overgrazing, change in cropping pattern and other agricultural systems, reduced fallow land, high-quality and homogenous new varieties with the development of scientific plant breeding, the transformation of agriculture from traditional farming systems to modern types. The large state farms that utilized highly uniform varieties have directly or indirectly contributed to genetic losses (Demissie, 1996a). Barley growing areas gradually diminish due to the expansion of wheat cultivation and oats in some places. Presently the crop is pushed to marginal areas (high altitudes and where frost prevails) and threatened by genetic erosion. Other factors contributing to destruction of the barley varieties and other crops and their wild relatives includes urbanization, developmental pressures on the land resources, social disruptions and the introduction of invasive alien species (FAO, 1996a).

2.7. Maintenance of Barley Genetic Diversity

It is a process of collection, characterization, improvement and conservation of varieties of barley. The objective of conservation is to conserve maximum diversity within each species to ensure that its genetic potential will be available in the future. Gene banks have been established to provide plant breeders with the genetic resources for developing more resistant and tolerant crops that will maintain stable and high yield (Plucknett et al., 1987; Brown et al., 1989). To overcome such erosion, collection, characterization and conservation of varieties are highly important. More genes for better agronomic characteristics, disease resistance, good quality and higher biological yield are necessary for further progress in barley improvement.

However, on-farm genetic resource conservation receives less attention. Therefore, attention should be given to conservation of local landraces.

2.8. Some Features of Ethiopian Barley Landraces

The Ethiopian barley has many distinctive features. They are mostly two rowed (including the deficient type) with two intermediate spike with mainly white to brown and black colour kernel although the six-row type is predominant type mainly in the highland areas.

The Ethiopian barley landraces is distinctive in the short rachila hair and long awn. Some landraces have shown useful traits, especially for resistance to powdery mildew (Negassa, 1985b), barley yellow dwarf virus, leaf rust, septoria, scald, spot blotch, loose smut, barley septoria mosaic virus (Qualset, 1975) and quality traits such as high protein content and high lysine (Munck et al., 1971). Useful characters of Ethiopian barley, includes high tillering capacity, tolerance to marginal soil conditions and resistance to barley shoot fly, aphids and frost. Barley has a lot of varieties which can be clubbed to form different types of classification. A classification criterion includes number of rows of grains on the head. These are two row barley which produces 25-30 grains, four row barley that actually loose six-row and six row barley that produce 25-60 grains. The wild barley is two-rows and the six-row type barley is the most cultivated. Spikelets are arranged in triplets, which alternate along the rachis. Two-row barley has a lower protein content than six-row barley and more fermentable sugar content. High protein barley is best suited for animal feed and food barley is usually lower protein. Barley is increasing in popularity as a food grain and is used in flours for bread making or other specialties such as baby foods, health foods and thickeners (Akar et al. 2012). Six rows barley have three fertile spikelets at each rachis node. There are two sides to the rachis and there are two rows of three giving six rows whereas two rows barley have only one. There is no such thing as four rows barley. Six rows barley have central kernels that are larger than laterals, thus more variability in size and on average smaller kernels. Tradition, higher enzymes and protein suited to high brewing**,** taste factor. Six rows barley have a slight astringency which is related to drinkability. The nutrient content of barley compares favorably with that of corn, oats, wheat and field peas.

2.9. Ethnobotanical Study

The urgent need for greater emphasis in ethnobotanical investigations of important crop plants has been underlined by Xolocotzi (1987). The term “ethnobotany” was first coined in 1896 by the American botanist J. Harshberger as the study of plants used by primitive and aboriginal people and defined as the traditional knowledge of indigenous communities of the surrounding plant diversity and the study of how the people of a particular culture and region make use of indigenous plants. It is the most important approach to study the natural resource management of indigenous people.

The issues of economic compensation and protected areas raise the problem of the divergence between conservation managers and communities in their perception, mode of presentation and system of resource appropriation and allocation. Conservation managers recognition of the knowledge and practices of indigenous people would help reduce tension and conflict between these two parties. Ethnobotany includes all types of relationships between people and plants. The definition of ethno-botany can be summed up in four words: people, plants, interactions and uses. Botanists, explorers and other people who traveled the globe would see a plant and then identify, classify, and name it for the purposes of science. They would ask a local resident to give the name of the plant in the local language or to specify the local uses. This resulted in monographs on the cultural group uses of plants. The particular focus of such monographs would vary depending upon the specific interest of the person undertaking the study. These early attempts of ethnobotany are considered the articulation of colonial economies, imaginations, and projects. They can also be seen as the basic data gathering stage of the ethnobotanical discipline. At present, ethnobotany has shifted its focus from people's use of plants to the relationship between people and plants, which includes; use, cognition, and ecology.

Recent definitions of ethno-botany demonstrate a consensus on the move to include more than just use by focusing on the relationship between people and plants. It is evident that people who have lived in one locality for a long time have particularly rich sets of knowledge about cognition of plants and local ecology. A more fundamental issue relative to knowledge is found within the discussion of the relationship between knowledge as practice and heritage. Ethno-botany has its roots in botany which in turn originated in part from an interest in finding plants to help fight illness. In fact, medicine and botany have always had close ties.

2.10. The Uses and Adoption of Improved Barley Varieties

The first studies on technology adoption were carried out during the decade following the introduction of high yielding varieties (HYVs) in the mid-1960s (e.g., Ruttan, 1977; Feder et al., 1985). Ruttan (1977) based on a large body of literature on HYVs indicated that the new HYVs were adopted at exceptionally rapid rates. Among the many factors that contribute to growth in agricultural productivity, technology is the most important.

The proportion of adoption is subject to its profitability and the degree of risk and uncertainty associated with it and is highly influenced by the capital requirement, agricultural policies, and the socio-economic characteristics of farmers. The question of adoption or non-adoption is also important. Proportion of adoption is actually the most critical criterion in the process. Producers benefit from the adoption of new technology through opportunities to lower production costs, either by increasing outputs from the same inputs or by maintaining the same output from reduced inputs. New technology, such as new crop varieties, may change the optimal levels of inputs used. An understanding of the effect of new varieties on input demand and productivity is crucial for better understanding of potential influence of the technology among farmers. Adoption of new production technology might also be expected to have important market effects. Market level impact can then be estimated by aggregating the farm responses, based on an assumed national adoption level.

The improved technology adoption according to agricultural sector consisted of the following elements; shift traditional barley to higher valued improved barley varieties, promote niche high value export food barley landraces, a focus on selected high-potential food barley landraces, facilitate the commercialization of improved food barley landraces, support the development of large-scale commercial of improved food barley landraces and better integrating farmers with markets – both locally and globally. Adoption could be understood as a decision to make full use of a new idea as the best course of action available (Shoemaker, 1971). Similarly, Feder et al. (1985) defined final adoption at the level of the individual farmer as the degree of use of a new technology in long run equilibrium when the farmer has full information about the new technology and its potential Jha et al. (1990) and Smale et al. (1991) indicated that adoption is a process involving three interrelated decisions. The first adoption decision is the choice of whether to adopt the components of the recommended technology such as seed, fertilizer and herbicide and in which sequence or combination (seed only, fertilizer only, herbicide only or a combination of the three). The second decision is the extent of adoption, the choice of how much land to allocate to new and old technologies. The third decision is the intensity of adoption, the choice of the level per hectare or rate of application, if fertilizer and/or herbicide is adopted. The combination of these three decisions composes the technology adoption decision and aggregated over farms to the national area is the diffusion of the technology.

Separating the components of the technology adoption decision helps to illustrate how farmers choose a variety of technological options in an attempt to satisfy their multiple objectives.

2.11. Trends of Barley Production in Ethiopia

In Ethiopia, barley production has passed through intricate processes. The study showed that there was a brief period when barley was replaced by wheat. In this condition, improved wheat varieties which were introduced into the system pushed to wider areas and became the main cereal crop. Later on, wheat cultivation declined to its prior acreage due to declining soil fertility, frost damage and diseases. In return, barley production rose to its previous status. The transitional period implicated losses in the diversity of food barley varieties. Since then the acreage of food barley fields steadily increased while the number of cultivated landraces and the yield per unit area decreased (Mauricio et al, 2015).

2.12. Barley Production Seasons and Systems in Ethiopia

Unlike in industrialized countries where barley is mainly used for animal feed and malting, it is one of the staple food crops in Ethiopia, accounting for over 6% of the per capita calorie consumption. Barley is one of the oldest cultivated plants that grown, in Ethiopia for at least 5000 years (Harlan, 1968). It is cultivated in every region of Ethiopia and demonstrates a wide ecological plasticity and physiological amplitude throughout the country (Asfaw, 1988; 1989b; Lakew et al., 1996). The most important barley producing regions are Shewa, Arsi, Gojam, Gonder, Wollo, Bale and Tigrai thus account for more than 85% of the total production (Yirga et al., 1998). Barley is a fast maturing crop that ripens earlier than other cereals which indicates that it requires a fewer heat units to reach physiological maturity (Poehlman, 1985). As a result, farmers are able to harvest twice a year in seasons locally called kiremt and belg which extend from June to September and from February to April, respectively.

Barley is the predominant cereal in the high altitudes (>2000m asl) and cultivated in some regions in two distinct seasons. Kiremt and belg account for 85% and 15% of the total barley production, respectively (Fekadu Alemayehu and Hailu Gebre, 1987). Welo, Shewa and Bale are the main belg barley producing regions. Belg which relies on the short rainfall period from March to May and kiremt which relies on the long rainfall period from June to September (Bekele et al. 2005, Lakew et al. 1997).

The kiremt season is through May to December with July and August being the main rainfall months while the belg season is through January to July, with mid January to end of February/early March considered as the best belg planting time for late type to harvest before the kiremt season rain starts. Otherwise, early maturing types can be planted as late as April and harvesting may go into July where there is a risk of damage by the main season rainfall. Oromia regional state is one of the major barley producing regional state in Ethiopia which account over 85% of the national production with Amhara and Tigray regional state. Barley can be cultivated at altitudes between 2000 and 3000m asl (Lakew et al 1996). It is also cultivated from 1400 to over 4000m asl and its importance increases in drought prone areas and at higher elevations (>2800m). Therefore, barley holds an important position in the food security of Ethiopia which recognized as a center of diversity, as its food barley have global significance because of improved traits, including disease resistance (Vavilov, 1951, Qualset, 1975, and Bonman et al., 2005).

Five traditional barley production systems are recognized within the major barley growing agro-ecologies (Chilot Yirga, Fekadu Alemayehu and Woldeyesus Sinebo, 1998). The different barley production systems in Ethiopia were late barley production system which is the dominant system and important in the high altitude areas of Ethiopia and is practiced during kiremt season, the main rainy season from June to August. This system is characterized by two distinct planting dates. The different cultivars are sown in two separate planting seasons. The first cultivar is planted in May, and the second cultivar is planted between mid-June and early July. These cultivars require 5–6 months to mature. Grain yields from this system vary from 0.6 to 2.0t/ha. Guie Barley Production System also practiced during the kiremt season. It is important in the highlands of Shewa, where water logging is a major hindrance to barley production. To alleviate this problem, farmers use soil burning and ploughing 3–5 times of fields that have been left fallow for at least five years. Early maturing cultivars are used in this system and the grain yield in the first year is about 2.0t/ha, but declines in subsequent years. Other cultural practices are similar to the late barley production system. Again, early barley production system also a system practiced during the kiremt season and it is important in both the mid- and high altitude areas in some parts of Shewa. Early cultivars are grown that require 3.5–4 months to mature, such as ‘Semereta’ in Shewa. The cultivars are planted from mid-May to June and harvested in early September to early October.

Cultivars such as 'Ehilzer' (two-row types) are grown in this system. The yield of early barley in a normal year varies from 0.7 to 1.5t/ha. Another production system (Belg) is also practiced in some parts of West Shewa. It is planted in February to early March and harvested in early July. In this system, farmers do not apply fertilizer and moisture stress is the major threats.

The yield of Belg barley in a normal year varies from 0.8 to 1.2 t/ha. Residual barley production system also important in some parts of West Shewa. Early maturing cultivar like 'Semereta' is common in this system. Planting is carried out between September and October, immediately after harvest of the main season barley crop. The seed of the main season barley is re-sown in the same field, in the main-season fallow field, or in any other field where the main-season crop has failed. Fertilizer is not generally applied in this system. Harvesting is carried out from December to February. Grain yield from this system is generally low, less than 1.0t/ha, and mainly used as seed for the next season.

2.13. The Nutritional Profile Barley

Barley is a nutrition powerhouse. The main nutritional contents include different nutrients, vitamins and the minerals are shown in table 1.

Table 1- The nutritional profile of barley. Daily value per gram, for e.g 100g of barley provides 66% of daily requirement of Manganese

Nutrients	Vitamins	Minerals
Calories (18%)	Niacin (23%)	Manganese (66%)
Protein (20%)	Vitamin B6 (13%)	Selenium (54%)
Carbohydrates (26%)	Thiamin (13%)	Phosphorus (22%)
Dietary fiber (62%)	Riboflavin (7%)	Copper (21%)

2.14. The Barley Utilization in Ethiopia

The importance of barley for the Ethiopian society is visualized only after a thorough analysis of its role in the economic and social life of the various regions in which it has been abundantly cultivated since time immemorial. Some of the reasons why farmers prefer barley other than the other crops were discussed as follows.

- Suitable for high altitude and performs better than other crops;
- Can be produced both in belg and kiremt seasons unlike the other crops;
- Tolerant to weather and agronomic stresses like frost, water logging, weeds and diseases;

- Suitable for preparation of many kinds of dishes with a better taste;
- Good source of energy and consuming barley foods gives body strength;
- Medicinal purposes for gastritis, headache and can heal broken bones and fractures;
- The best choice for local beverages that produced traditionally within communities;
- Relatively high yielding with low management system and low fertilizer application;
- Quality straws for roofing (thatching) houses and bedding;
- Grain, flour and food products of barley store better than other crops;
- Good cash crop as it is highly demanded for local beverages prepared in towns for sale.
- Produces high quantity and quality straw for feed, which is preferred by animals in dry season; **(**Hailemichael Shewayrga and Peter A Sopade, 2011)

Barley is grown primarily for local food and beverage consumption. For small-scale highland farmers, barley is the predominant subsistence crop (Asfaw, 2000). As for the type of total food preparations, it is shown that different kinds of bread, dough balls, porridges, soup and gruel are made in every household from any barley type, but there are preferred types for different food categories. Concerning drinks, there are many alcoholic and non-alcoholic local beverages are brewed in the household from barley grains for daily consumption or for holidays and celebrations. Barley is also used for cultural purpose. The Oromo people, for instance, consider it the holiest of all crops; their songs and sayings often feature this "King of grains". It has magnificent relationship with the culture, such as the gada system, Atete and marriage traditions.
The barley crop residue is used as fodder mainly for bovine cattle and equine. The small grain that fail to fill up and those crushed in the process of threshing and consequently mixes with the chaff are kept aside for chicken feed (and small ruminants and riding horses or mules) by some families.

2.15. Vernacular Names of Barley Landraces

Vernacular names of landraces signify the properties such as response to environmental conditions, physiological characteristics, productivity and vigour and indicate their social and biological basis. Improved material of barley is given a specific cultivar name. For landraces vernacular names are given by local farmers and vary according to the local languages.
According to Zemede Asfaw, a list of barley vernacular names used in many Ethiopian languages is given in Cufodonts (1968 P. 1217).

Another advantage of vernacular names is communication with local farmers and the consumer public sector. Vernacular names may not always correspond to botanical distinctness but they are quite descriptive of the cultivar they symbolize. Good examples are the vernacular names lukaa or senef both of which refer to easy dehulling and gealemie which refers to easy to maturation within two months only; balekaport which refers to the possession of broad outer glumes that appear like an over coat of the grain. Thus the name lukaa adi balekaport signifies a cultivar with partial naked white grains and having broad outer glumes. These vernacular names are not always meaningful as some have gone through a series of transformations with time and space and derived from several languages. Baum (1986) underlined the fact that names of cultivars are important in crops like barley where number of cultivars is quite high. Vernacular names are different in localities outside the study area. Those lacking consistency can be rendered consistent by selecting appropriate names from among the several used in different localities (Zemede Asfaw, 1989).

2.16. Barley Processing Techniques and Food Types

The food processing of hulled barley starts with the removal of the tightly adhered, inedible hull by techniques based on pearling. The grains of hull-less barley cultivars or the grains already dehulled may also be pearled further, if the removal of bran layers is desired. For the maximization of the hull removal and the minimization of the pearling loss, grains with uniform size and shape, shallow crease and thin hull are favoured for pearling. Pearled barley is utilized as a substitute for rice, or it may be processed further by flaking, dry roasting, puffing or milling. In milling, the use of barley poses certain problems compared to wheat. The bran of the barley grain is easily shattered during roller milling, which causes darker color and a higher ash content in barley flour in comparison to typical wheat flour. Another typical processing feature of barley is flake formation during roller milling, which further challenges the separation of bran and reduces the flour yield. Barley with increased bran resilience would probably help in reducing both the shattering and flaking during milling. With respect to grain hardness, pearling and milling set different requirements for barley. In pearling, the hardness of the barley grain correlates linearly with the pearling time.

A hulled, waxy-type barley cultivar with a hard-textured endosperm has been shown to produce less broken kernels during pearling compared to barley with regular starch composition. In milling, more mechanical energy and changes in the milling process are required to produce flour of similar coarseness from harder barley grains.

Barley consumption starts from the milky stage with row grains and goes on through various levels of treatments. The foods and drinks may be made for daily consumption or for special occasions. According to farmers, barley is the "king of crops" ("gebs ye ehil nigus"='' Garbuu mootii midhani') and it is preferred to other crops and it is put for diverse uses with more different types of dishes and beverages reportedly prepared in the study area. The various barley traditional foods have perceived qualities and health benefits by the farmers. Diverse food barley landraces were reported by farmers, and the ethnobotany as well as technology adoption of the improved food barley varieties reflects key quantitative and qualitative traits (Shambel Kumbi 2001). Some improved barley varieties that are preferred for their culinary qualities are being marginalized due to moisture shortage and soil degradation. Different traditional barley dishes and beverages were described by the local farmers prepared from barley using various processing techniques. The food and beverage products are prepared from different forms of barley for main, side, ceremonial and recuperating dishes. The food value of local landraces and improved barley as sources of energy is highly acknowledged by the farmers. Some dishes are served to breast-feeding mothers with the belief that they enhance breast milk production. Besides, some dishes are claimed to be a remedy for gastritis while some others are reported to be a good substitute for breast milk; good to heal broken bones and fractures. For foods prepared from flour, the milling of barley is done either by special stone mill (traditional hand-grind grains using a stone grinder) or motorised mill. The flour can be stored for long time depending on the temperature of the area with high temperature storage places increasing the rate of deterioration. Containers made of clay (pots) or mud and/or animal skin are used for storing flour.

2.17. Barley Foods from Raw-grain

The main food products prepared from raw barley grain are injera, kinche and genfo. Injera, an unleavened thin pan cake, is the main dish and daily diet of the people in the study area. Shege**,** Gelane and Beka are the preferred improved food barley varieties for the production of the mentioned products in the study area.

The grain is well dried, cleaned, dehulled using mortar and pestle, heated lightly and milled into moderate fine flour, sieved and dough is prepared. The dough preparation and other procedures for making injera are well-documented with the reports from the farmers in the study area with some variations. Fermentation can be for 2-4 days, but, if time is limited, the dough can be fermented for only one or two days. The injera from well fermented dough makes a better sourer taste and has good storability. The higher is the altitude, the longer is the fermentation time required as temperature would be lower. LAB and yeasts are the main fermentation organisms in injera, and their products coupled with a drop in pH would stabilize injera during storage (Firdissa Eticha et al, 2010).

2.18. Traditions Linked to Barley Landraces

Ethnobotanical conditions have contributed much for the continued cultivation of local food barley landraces. The diversity of foods and drinks prepared from particular barley variety has motivated farmers to cultivate some barley despite low yields realized under unfavorable edaphic and climatic factors. It was observed that farmers beliefs, social and cultural situations have strong linkages with foods and drinks made from barley. The wealth of traditional sayings, poems and songs gives a picture of the importance of barley in society's daily life (Firdissa Eticha et al, 2010).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. The Study Methodology and Approach

The detail information on the structure of data and the methods used is presented in the next section. Data was collected through questionnaires, FGDs, interviews and field observations. The study woredas were visited in June and July 2017. The two woredas within Holeta zonal administration were selected. Holeta is located at a distance of 29km West of Addis Ababa between $9^0$30'N and $38^0$30'30'E in Oromia Special Zone Surrounding Finfine in the central plateau of Ethiopia. It has a total area of 5,550ha with an extensive chain of highland system (2214-2498m) which is very suitable for barley culture.

The study was carried out at Welmera and Ejere woredas from Holeta town administration which is one of 14 districts found in a central Oromia Regional National state in Special Zone Surrounding Finfine. Two PAs; Burkusemi Rob Gebiya and Telecho Gebriel and Elu Aga and Basoo from Welmera and Ejere districts respectively were purposively selected for the study to address the objectives of the study from December to November 2017. These sites were selected based on their agro-ecological suitability for food barley production. All localities were surveyed together with elderly experienced barley producer farmers who supplied vernacular names and other information related to the significance and barley production in the area. Welmera woreda is located 35km from capital city of Ethiopia on the old road to Ascho, then the new road to Ambo and Wollega, while Ejere woreda located at 40km from Finfine to West Shewa on main road to Ambo. The study kebeles; Rob Gebiya located at 6km, Telecho Gebriel at 20km, Elu Aga at 18km and Basoo at 22km from Holeta town, respectively. The location of the study sites is shown in Fig 2.

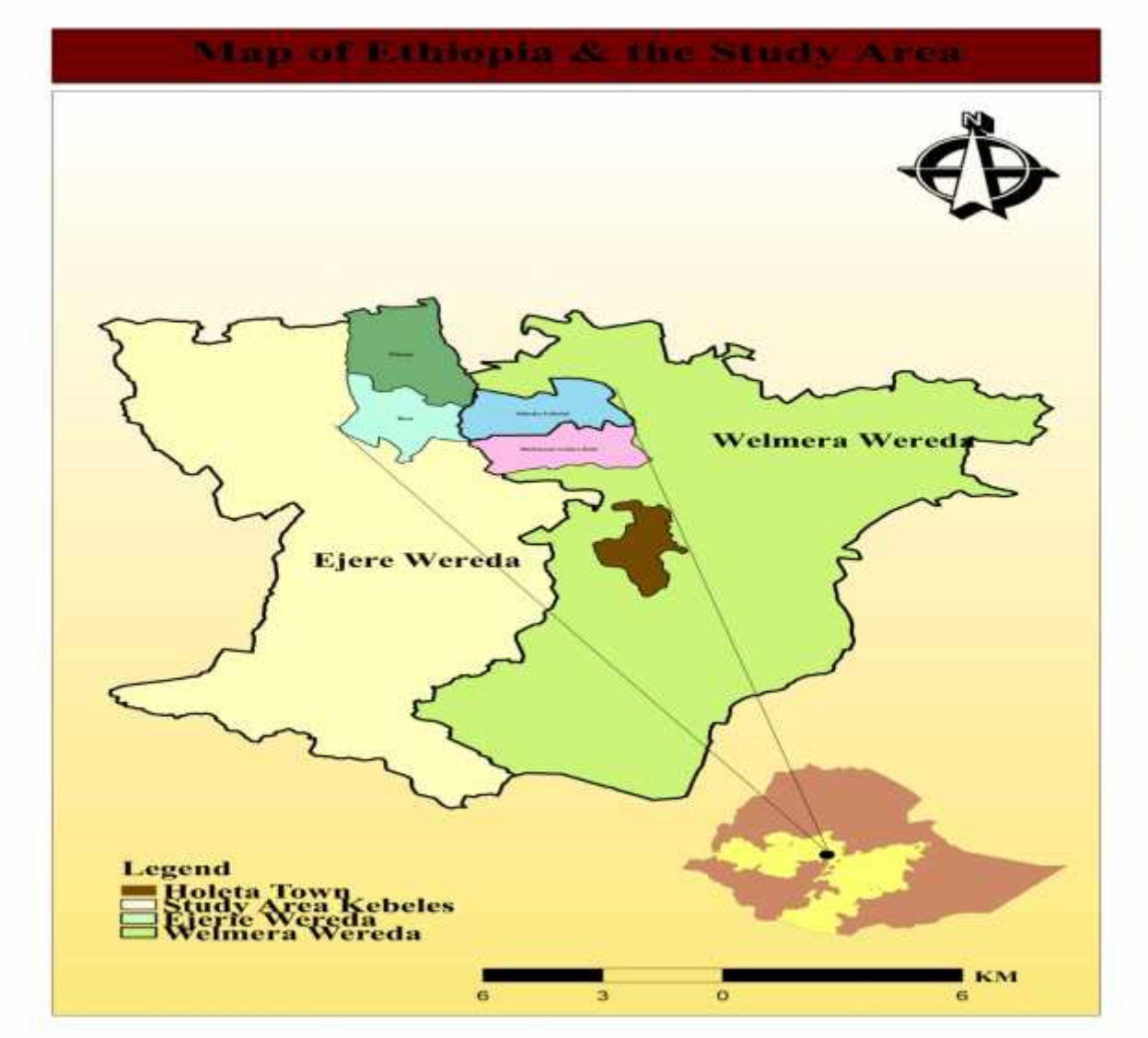


Figure 2- Sketch map of Ethiopia, Oromia, Welmera and Ejere weredas showing the study area

The district agro-climatic zone is weynadega with altitude of 2214-2498m asl and with the annual rainfall of 1037mm with average temperature of 21^0C. It is located at $9^0$30'N latitude, $38^0$30'30'E longitude. The administration of the district consists of 5 peasant associations and 3 urban dwellers associations.

Table 2- The population size of the study areas

S/N	Name of woredas	Population size		
		Male	Female	Total
1	Holeta	28233	29388	57,621
2	Welmera	51832	52311	104,143
3	Ejere	59238	49103	98,341
4	Rob gebiya	488	105	543
5	Telecho	520	88	608
6	Elu Aga	412	193	605
7	Baso	317	114	461

The rural based population engaged in traditional rain fed agriculture, irrigation and off-season farm income generating activities. Moreover, the study area connects the cash crop producers with food crop producers. According to the information from Welmera and Ejere District Agricultural Offices (DAOs), the dominant crops are cereal and pulse crops. Wheat, teff and barley are main cereal crops and the pulse crops are bean and field pea. There is also livestock production such as cattle's, equines, poultry, sheep and goat. Generally, the area is suitable for crops and livestock production with high market accessibility.

3.2. Physical and Spatial Aspects of the Study Area

According to the information from both District of Agricultural Offices (DAOs); there are three soil types that characterize the area. The predominant soil types in the study area were Mellisols (reddish heavy clay), Vertosols **(**dark to very dark, gray to grayish brown heavy clays) and Nitosols (reddish brown salty clay). The vegetations is characterized by bush lands, numerous herbaceous floras, scattered trees and cultivated eucalyptus and oil crops, horticultural crops and others are also common in the area according to the information gathered from Welmera and Ejere District Agricultural Offices. The average temperature of the town is 21^{o}C; the annual rain fall is 1037mm but usually range between 2250-2500m. The monthly average relative humidity at Holeta and the surrounding area varies between 50% (December) and 80% (August) with the mean value of wind speed 2.9-5.7km/hr and the wind direction is from North to South. The study area has a vast plain area with lowest altitudinal value of 2214 meters above mean.

The highest altitudinal value, 2498 meters above mean see level, is found at Welmera Michael Orthodox church and also the site classified 52.3% plain land 31.58% gentle slope, 9.09% marshy area, 2.9% Rivers and 4.31%ther landscapes.

3.3. Study Design

3.3.1. Study Types

The survey includes the individual farmers home or farm to gather the information using different data collection methods. The data collection involving the men and the women at times to get information on the indigenous knowledge of local farmers that require specific knowledge and skills of either member of the households. Emphasis was given to the woman since they are traditionally responsible for preparing foods and more knowledgeable about food preparation techniques and cooking qualities. The farmers are asked to describe their indigenous knowledge, the types, the names, the special characters and the quality attributes of local landraces and improved varieties, preparations methods of the homemade products and different barley production systems. Farmers in the study woredas purposely maintain barley varieties to address various needs. These needs included suitability for planting, yield potential in relation to the type of environment, conditions of the soils and intended dishes and beverage products. The survey design consisted of two stages. In the first stage, two study districts were selected using secondary data from HARC and the Ejere Woreda Agricultural Office. In the second stages, farmers producing barley for different purposes were selected from each kebeles. The study sites were purposely selected in terms of area coverage for barley production and barley foods consumption preferences. The research design was non-experimental and cross-sectional based on multi-stage sampling procedures. In the sampling procedures, household surveys were conducted covering 100 households to understand farmers' views on the values, constraints and opportunities of growing local and improved varieties of barley. This was supported by focused-group and informal discussions with elders, key informants, and women's groups.

3.3.2. Sampling Procedures

Selection of kebeles and peasant households constituted the sampling frame. This study employed multiple stage of sampling method (Source: Own study). In first stage, two woredas from Holeta area administration was randomly selected to provide sample farmers.

The selection of districts was purposively among the different barley producer kebeles of Special Zone Surrounding Finfine due to the fact that the potential of barley production**.** In second stage, two PAs from each woreda; Burkusami Rob gebiya, Telecho Gebriel from Welmera woreda, Elu Aga and Basoo from Ejere woreda, respectively were selected purposively owing to production potential of the barley based on information from Department of Agriculture and Rural Development (DARD). These sites were selected based on their agro-ecological suitability for barley production. In the third stage, the farmers in the selected peasant associations are listed and stratified according to their activities role. In the last stage, an adequate size of sample observation for a traditional farmer`s knowledge assessment on barley varieties and technology adoption study taken and determination of barley production system. Hence, different sample farmers are selected in systematic random sampling proportionality to size using the list of sampling frame from each categories of stratified unit in order to determine sample respondents. Finally, different data collection systems were used to gather the information of local farmers indigenous knowledge on ethnobotany of landraces and technology adoption on the improved barley varieties.

3.3.3. Sample Size

Two districts from one zone, two kebeles from each district and 25 farmers from each kebeles with a total of 100 households was identified and visited to collect information of local farmers indigenous knowledge on the ethnobotany of landraces, the technology adoption, production and utilization of local and improved barley varieties as well as how barley end-uses influence the maintenance of landraces diversity in the study area and to determine the homemade products of barley.

3.4. Study Methods and Sampling Approaches

The approach used in the studies involved interviews with different main categories of farmers depending on the type of participation in activities. They are selected at random from the population of farmers in the areas where the demonstrations and field days took place. This study was supported by focused-group and informal discussions with elders, key informants, and women’s groups.

A questionnaire on barley variety knowledge, production systems (ploughing, weeding, harvesting, crop rotation and herbicide, pesticide and fertilizer application, processing, time and method of land preparation), crop residue utilization and socio-cultural life style of communities (medicinal, ritual significance, myths, legend and songs attached to use and cultural practices) related to barley landrace and improved varieties of the barley was developed by the researcher. During the group discussion, specific points were raised by the principal researcher following the questionnaire. In addition, a few farmers among 100 households were interviewed following the questionnaire developed.

3.5. Data Types and Sources

This study was used non experimental cross sectional data collected in 2016. The study used data generated from both primary and secondary sources. Both the primary and the secondary data was considered, collected and used for this study. Primary data were collected from smallholder farmers growing barley during the 2016/2017 production season. This contains both quantitative and qualitative data collected from selected households with structured questionnaire. This questionnaire of the primary data was collected from sampled respondent farmers and pre-tested to verify the social, bio-physical characteristics, barley production system and utilization, socioeconomic importance and cultural significance of barley production in which farmers operate and variables hypothesized to influence the ethnobotany of landraces and technology adoption on improved barley varieties. Secondary data were collected from different sources and offices who are supposed to have adequate information for this study. Structured interview schedule was pre-tested with 100 households and set to conduct the formal survey. Whenever possible, secondary data were surveyed from published sources. Collection of primary qualitative data was managed through different focused group discussions, several key informants interviews and direct observation. Generally, the secondary data were used for this study was collected through checklists and review of district reports, central statistical authority, proceeding and journals.

3.6. Methods of Data Collection and Interpretation

Different methods were employed to address the stated objectives. The study was mainly focused on a traditional farmer`s knowledge assessment on landraces and technological adoption on improved barley varieties. A study involving field visits, farmers interviews, group discussion and questionnaires were conducted in one administrative zone. FGD was organized to approach barley growing farmers in Ejere woreda by development agents of the District Agricultural Offices (DAO) and in Welmera woreda by HARC that coordinating national barley research. Every farmer from the group was allowed to give his/her ideas freely. In addition, a total of 100 households were allowed to answer the questionnaire developed following the interview and focus group discussion.

At the household level, information was collected on household composition, age of household head, level of education, variety identification criteria, variety selection procedures, farmers reasons for their choices of varieties, areas allocated to different varieties of barley and grain yield obtained from the different barley varieties. A question was also posed about intra-household decision making related the utilization of food barley varieties and other resource utilization. The farmers were asked to classify and evaluate their varieties based on their uses, including those planted in the current season and those planted in the preceding years. In addition, the farmers were asked to list all varieties they knew and the distribution of each one. The issue of women's role on ethnobotany of landraces and technology adoption was addressed during the household survey and in the group discussions. This was supplemented with personal observations of farmer practices. They observed local differences in farmers practices and asked local people about individuals or groups who had developed new ideas and experimented with innovations without support from formal extension services. Finally, consolidated ideas were noted.

3.6.1. Selection of Respondents

At the beginning, 100 households were randomly sample from the list of many farmers. An initial survey was made to the households in order to identify barley growing farmers. During the survey, leaders of the peasant associations and development agents working in each peasant association assisted in providing the list of farmers in each PAs.

From the list, informant was selected randomly, and this random sampling permitted all class, sex and age categories to be represented.

Hundred randomly selected households, that is, 44 males and 56 females were involved in a household questionnaire survey from the four peasant associations of the Welmera and Ejere woredas. Hundred smallholder farmers, rich and poor (farmers in each group), and women and men were selected and interviewed. The key informants were selected in order to conduct in-depth interview and discussion. They were selected from household heads of both sexes and different age groups based on their availability, willingness and practical knowledge on barley landraces and technology adoption on the improved food barley varieties. The local administrators and DAs helped in identifying the names of the focus group. The households were interviewed using a semi-structured questionnaire (Appendix 2). The questionnaire covered different topics such as varieties of barley commonly grown;, introduced improved varieties and name of lost varieties in past year with reasons for loss and acquisition of new varieties and specific information on the use of food barley, varieties in production and varieties rarely in production as well as factors affecting the genetic diversity of barley in the study areas. The detailed information focused on cultural practices, the effect of new varieties on local genetic erosion, seed quality of barley varieties and types of food prepared and traditional values of barley. These farmers explained food barley variety cultivation practices, barley production and utilization, cause of genetic erosion, specific features of the cultivars, their growth requirements and for what purpose each type best suited barley fields were sampled at random in the area. The respondents were also asked about their perception of the production of food barley and the possible advantages of growing the barley as compared to other cereal crops known in the area.

3.6.2. Focused Groups Discussions and Key Informant Interviews

In addition to personal interviews, focus group discussions and key informant interviews were carried out to complement the information obtained from individual farmers. For FGD, 4-6 farmers from each PA were identified to conduct in-depth interview and follow-up on interesting issues that had surfaced during individual interviews. Two approaches were used to quantify the loss of local varieties. The first approach was a comparison of the number of local varieties and improved varieties found in an area. A second approach was interviewing farmers about local varieties formerly grown in the area.

In both methods, evidence for genetic erosion was reflected in a decrease in the number of local varieties. Using the calculation scheme: GE = 100% - GI, that is, the still extant local varieties, a genetic erosion was calculated for two weredas (Girma Megersa, 2014). A digital camera was used to document all the necessary information about different local barley interaction with improved barley varieties that had been identified by farmers. Participatory varietal evaluation, description and characterization of barley diversity, agronomic and socio-cultural preferences (medicinal and socio cultural value, yield potential) were used. Local varieties that were once cultivated by farmers were also recorded during the study. This evaluation was one of the methods employed for assessing genetic erosion. Furthermore, wealth of traditional sayings, poems and songs were interviewed to obtain a picture of the importance of barley in society's daily life and expressions linked with barley production. Participatory variety selection was conducted with farmers to compare the overall performance of the enhanced local varieties using farmers own selection criteria such as high yield potential, disease and drought resistance, demands on markets etc. Key informants and focus groups were asked about the meaning of local names with special attributes associated with the names. Finally, they were asked about their production status of barley. A gender-specific question within individual households was raised to see whether there were differences in the participation of the household in management and household in preference use of barley and if a particular management functions, such as seed selection, as related to gender.

3.7. Methods of Data Management

The multivariate analysis was preceded by Participatory Rural Appraisal (PRA) tools to understand the status of barley diversity in the villages. Direct field observations were made on barley fields, farming systems, management practices and soil and water conservation methods. Key informant interviews and Focus Group Discussions (FGDs) were conducted to document the knowledge and preference ranking of farmers. The qualitative data obtained from the focused group discussions, model farmers interviews, questionnaire survey from different respondents was organized based on the theme of the questionnaire: food barley production systems and activities, end uses qualities, and socio-cultural values of communities with food barley production.

3.8. Techniques of Data Analysis

Non experimental data analysis for open ended questionnaire, interviews and focused group discussions was used for analysis of data to meet the objectives of the study within a given time frame. All the collected data were subjected to descriptive statistics and analyzed using SPSS20 (Statistical Packaging for Social Sciences) statistical software version 20. Accordingly, descriptive statistics in a form of percentage and frequency were used to analysis socioeconomic profile of the respondents. Geographic Information System (GIS) was also used to demonstrate the spatial patterns and sketch map of the Ethiopia, Oromia regional state, Welmera and Ejere woredas showing the study area.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

4.1. Socio-demographic background of respondents

Data on age and family structure of the households was collected from a total of 100 respondents, 25% of each from the Rob gebiya kebele, Telecho gebriel kebele, Elu Aga kebele and Baso kebele. Among the respondents, 56% were females and 44% were males. Proportionally, women and men participated in group discussions, questionnaire, interviews and other data collection methods. Emphasis were given more to women since the utilization of crops in the households are usually their responsibilities. Women in rural Ethiopia are responsible for indoor activities like preparation of foods, gathering fuel wood, looking after children, etc. whereas men are responsible for ploughing the land, for raising crops, keeping cattle, etc. Weeding, harvesting and threshing of crops are done both by men and women. Most of the respondents were in the age ranges from 31-40 years (37%) followed by the age group ranges from 41-50 years (28%), 51-60 years(18%) and above 60 years (17%), respectively. It shows that the younger the rural dwellers more involved in agricultural activities and less the experienced farmers participated in the agricultural activities that may lead to genetic erosion of different barley varieties. The farmers participated in the questionnaire survey were of mature age, thus having an experience in practicing agriculture and all its underlying challenges, crop raiding inclusive.

Majority of the respondents which is about 78% were married, 13% were single or unmarried and 9% were separated. From the respondents, the larger number that accounts about 86% were Oromo ethnic group and others were small in number which accounts about 6% Amhara, 4% Tigre, 3% Gurage, 1% others (Wolayta) peoples were participated in different activities of the field survey. The Oromo ethnic group takes parts more in the barley production than the other ethnic groups in the study area. With respect to the religion of the respondents, 76% Orthodox followed by the 21% Protestant and 3% Muslim. Orthodox religion followers are the dominant in the study area with the great tolerance with the others. Regarding the educational level of the respondents 9% were illiterate, 73% were both grade 1-4 and 5-8, 15% were grade 9-10 completed and 3% were others such as religious education, adult education or one year of education.

The educational status of the respondent is another vital issue concerning the sustainable development of the agricultural practices and educated people easily familiarized with the activities of the agriculture. Many of the respondents were stayed in the study area for more than 25 years, 4% were stayed in the area in range of 16-25 years, and 2% were lived in the area for years in range of 6-15 years whereas only 1% stayed there below six years, respectively. These indicated that there are more experienced farmers in the agricultural activities in the study area and they provide well documented information on the necessary data.

Table 3-The socio-demographic characteristics information of the respondents

Socio-demographic characteristics	Description	Respondents	(%)
Sex	Males	44	44
	Females	56	56
Age of the respondents	30-40 years	37	37
	41-50 years	28	28
	51-60 years	18	18
	>60 years	17	17
How long the respondents lived in the study area	<6 years	1	1
	6-15 years	2	2
	16-25 years	4	4
	>25 years	93	93
Educational level of the respondents	Unable to read and write	9	9
	Primary school (1-4)	27	27
	Primary school (5-8)	46	46
	Secondary school	15	15
	Others	3	3
Marital status of the respondents	Married	78	78
	Single	13	13
	Separated	9	9
Ethnic group of the respondents	Oromo	86	86
	Amhara	6	6
	Tigre	4	4
	Gurage	3	3

Socio-demographic characteristics	Description	Respondents	(%)
	Others	1	1
Position of the households	Household head	96	96
	Members of household	3	3
	Others	1	1
Origin of the respondents	Indigenous	97	97
	Settler and moved in	3	3
Religion	Orthodox	76	76
	Protestant	21	21
	Muslim	3	3

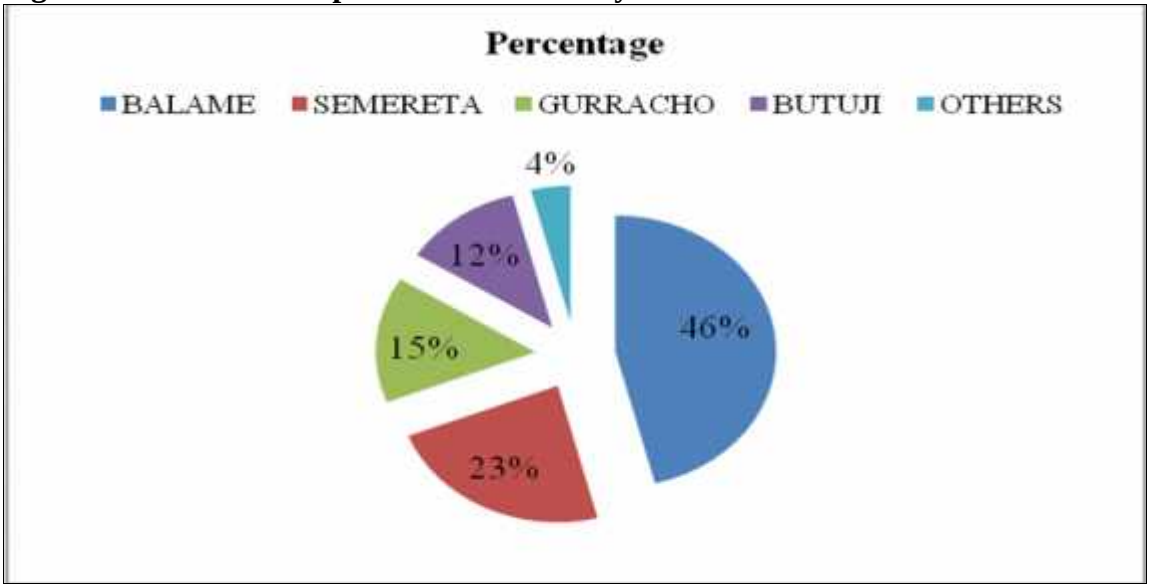
Relatively equal males and females with little difference in females' respondents participated in the questionnaire survey. This indicated that both sexes involved in the barley production activities. Most of the households are in the age ranges from 30-40 years. The respondents varies in the educational level with very large number completed the junior elementary school, large number attained the primary school, some learnt the secondary school where as the others unable to write and read. The marital status matter the agricultural activities in addition to the educational level and the position of the households. All respondents in the study area cultivated local barley landraces except one farmer.

4.2. Barley Production Practices in the Study Districts

According to the respondents, 99% of the farmers grown local (non-improved seeds) varieties of barley in Welmera and Ejere woredas while 1% not cultivate the local varieties of barley. Very few farmers couldn't cultivate local and improved food barley varieties in past 10 years mainly due to unavailability of seeds, high seeds price, absence of credit access, susceptibility of seeds to disease/pest, low yielding and/or unacceptable test for consumption. In order to address these problems local farmers establish farmer groups/coops in their kebeles to provide barley seeds and create credit access. The gradual decline in barley cultivation in these highlands over several years could lead to disappearance of important landraces and genotypes of barley as part of ongoing phenomena of crop genetic erosion in the central highland.

The main reason why farmers not interested to produce and/or cultivate the local landraces in past years was that admixture among local landraces in the fields and the acquisition of the more productive varieties from extension agents. This brings about genetic erosion in local landraces in the country in general and the study area in particular.

Figure 3- Name of most preferred local barely landraces



According to the respondents, 46% of the farmers preferred Balame local barely landraces to cultivate, 23% preferred Semereta, 15% produced Black barley, 12% of them preferred Butuji and 4% of the study area farmers preferred other types of local landraces to cultivate and produce for both home consumptions, markets demands and to meets their other different needs. In the two woredas more than five different barley landraces were identified, indicating the presence of modest diversity at village level. Among the most preferred local food barely varieties cultivated in the study area included Balame, Semereta, Garbu Gurracha, Butuji and few others. The basic reason why farmers preferred these varieties was that they are pure in the farmland and more productive. According to key informant interviews and other data sources the preferred local barley landraces with their special features were discussed as follows. The Balame barley its tolerant to low soil fertility and drought, good flour quality and with different preferred end uses such as injera, kinche, chuko, beso, porridge and beverage. The Semereta barley characterized by large seed size, requires fertile soil, tall plant height, lodging tendency, high 'vitamin' content with different preferred end uses beso, injera, shameta and kolo.

The Gurracho barley needs fertile soils, high yielders, tall plant height, and tendency to lodging with preferred end uses malt and beverage whereas the Butuji barley is short plant height, lodging tolerant, requires fertile soils, large grain size, requires soil fertility, high yields and its preferred end uses are malt (bikil), homemade beer and liquor.

About 92% of the study area farmers grown improved varieties of food barley and 8% not grow these varieties, instead they grow the local cultivars. This indicates that the farmers of both districts are willing to adopt new technology. On the other hand, there is a replacement of the local landraces with improved and new improved food barley varieties. As a result, the farmers of both Welmera and Ejere woredas improve their livelihoods by improving the productivity of their barley. Consequently, such a barley production system led to genetic erosion through the replacement of local landrace with improved cultivars, which in turn brings the loss of variability. The basic reason why the farmers preferred improved barley varieties than the local landraces are high yield varieties, some with early maturity, provide more preferred end use and nutritional profile, better agronomic remarks. (Annex1p. 107)

The 65% of the households concluded that local landraces are very susceptible to different diseases and that variety become low in its yield and then consequently results in the genetic erosion of that particular variety. About 22% of the farmers reported that the local landraces they grow are intermediate to disease reaction while the 13% of them reported their local landraces were tolerant and provides high yields in quintals per a year. Instead of growing disease tolerant varieties some farmers focused on introduction of the new varieties that provide high yields and resist diseases. Finally, the introduction of the improved varieties out compete the traditional one and causes the genetic erosion on them as well as the farmers compares the two in terms of the yield potential, the maturity period, the market demand etc and preferred the new varieties with different end uses quality. (Annex2p. 107)

Among other factors contributing for the low productivity of the crop, the low yielding ability of farmers' cultivars and soil acidity problems are the major bottlenecks. The disease and other environmental factors tolerant barley varieties are very important to enhance life status of the farmers communities and to improve the food security of the country in general and the study area in particular. Cultivation is mostly by traditional varieties that are chosen by farmers for their suitability for end-use or their adaptation to specific farming systems. A farmer cultivates several plots of different types of barley in study area.

Some of the grains are to be marketed, some for special purposes and the greater part for general purposes. About the 94% of the respondents cultivated the native barley, but about only 6% of the study area farmers they don't produce this variety. This indicated that most of the farmers directly or indirectly involved in on-farm conservation of barley landraces. In addition, the respondents made the indigenous varieties available for the future generations as well as barley improvement. (Annex3.107)

About 52% of the respondents cultivate Shege as their most preferred improved barely variety, 33% cultivate Gelane, 9% cultivate Beka while 6% cultivate other improved barley varieties such as HB-42, Miscal, Olker etc to meet their needs. (Annex4.p-107) .The farmers were asked to list all varieties they knew and determine the distribution of each one. Accordingly, the varieties the farmers they grow includes Garbu Guracha (long and short head) which is equivalent to Tikur Gebse, Mouga, white Baleme, black Balami, Senef gebs, Werkineh (Barseded), Butuji, Semereta, Bilal, Shasho (Acient white barley), Adi suloo, Kate, Bokoni, Kasale and Derebe Neche Gebse among the local landraces and Beka, Shege, HB-42 (Bareeddu), Gelane, Holker, Miscal, Ahor, Ardu-12, Dimtu (Red barley), HB-1307, X-4198 and EH-1493 among an improved barley varieties. These show the great diversity that exists in the two districts at on-farm level. Before the recommendation of improved varieties to a certain area, participatory evaluation of improved varieties by breeder against the local variety is essential to select the best fit variety among the improved varieties. According to the interviewed farmers, only four types of food barley varieties are grown at present, two of them – Shege and Gelane– are grown on a larger acreage. Recently, the production of potato has increased around homesteads where it competes with barley for space.

The Welmera and Ejere farmers use potato as a major food crop providing food security and cash. Particularly rich and elite farmers are specialized in seed potato production for sale to other farmers/organizations from different parts of the study area. The expansion of potato at the expense of barley is a result of research intervention by the introduction of improved, high yielding and disease resistant varieties such as Jalane and Gudane along with agronomic practices. Respondents classified their varieties as popular, rare, and endangered on the basis of area shared yields of varieties. They defined ‘‘popular’’ as those varieties grown by many households over large areas plot. ‘‘Rare’’ types are those grown by few households on very small (sub plot) plots and ‘‘endangered’’ types are grown by only a few households.

This shows that Shege barley variety is popular and dominant, Gelane is rare in contrast to the first one and Beka is endangered food barley varieties among the improved barley varieties. Balami is dominant and popular, Semereta is rare type, Guracho and Butuji endangered among local varieties.

About 2% of households reported that a few improved varieties are susceptible to a disease for example Beka, 59% of them concluded that some are intermediate for instance Gelane and 39% of this varieties are tolerant for example Shege among the most preferred introduced barley varieties. (Annex5,p-107) Accordingly, these varieties are more tolerant and productive than the traditional landraces. The improved barley varieties with high yield potential are vital in the sustainable economic development and poverty reduction of the developing country such as Ethiopia. The diseases (rust, viruses, smuts etc) tolerance is one of the major criteria in the varieties identification for production in addition to the adaptability to poor soils, tolerance to drought, stress and frost resistance. The improved varieties are highly tolerant to the different diseases and other environmental factors in comparison of the local landraces. This made the modern varieties more productive than the traditional varieties; in turn they become important in pertaining food security of the urban and rural communities of the Ethiopia. Barley is very susceptible to water logging. It is less tolerant than wheat or oats to water logging. Barley should not be grown on soils where water logging is likely to occur for periods of more than 2 weeks, or on irrigation layouts with poor drainage.

Ethiopia displays different cultivation of barley practices. The cultivation of food barley was also by introduced (improved) varieties that are chosen by farmers for their suitability for end-use or their adaptation to specific farming systems. About 99% of the respondents cultivated the new cultivars of barley, but about only 1% of the study area farmers they don't produce this variety. (Annex6,p-108) This indicated that very few farmers directly or indirectly involved in on-farm conservation. In addition, the respondents made the improved varieties with the indigenous available for the future generations. A study on the current status of barley diversity is useful as input for policy decisions concerning improvement of farmer livelihoods. In the study area the use of external inputs is maximal and there is "improved" (i.e. introduced) variety of barley adopted by farmers. This has led farmers to rely on both varieties for seed management and production.

The popularity of barley can be associated with the consumption habits of the farmers. Compact types and hull-less type become more frequent towards the upper altitudinal limits of cultivation.

Table 4-Barley production duration in season

Proportion of local and improved barley varieties	Frequency	%
Local varieties	92	92
Improved varieties	99	99
Both varieties	96	96
Dominant local barley landraces grown		
Balame	46	46
Semereta	23	23
Black barley	15	15
Butuji	12	12
Dominant improved barley varieties grown		
Shege	52	52
Gelane	33	33
Beka	9	9

The proportion of local and improved barley varieties, as 96% of the respondent indicated, Similarly, Balcha and Tanto (2008) reported that agricultural development in developed and developing countries alike has been accompanied by the replacement of local with modern varieties threatening genetic diversity. The main reason for the reduction of cultivation of local varieties was displacement of local varieties by introduction of improved varieties and followed by other crops. The replacement of local varieties with modern cultivars is a gradual process, and the length of the transition period will vary much between varieties and areas. In developing countries, the replacement of local varieties is currently in progress, while in some areas, local varieties have become absent, and farmers grow only modern cultivars. The first improved varieties introduced in an area will not immediately displace local varieties and it is likely that the total diversity will initially show an increase. In the early stages, the contribution of the modern cultivars to the total diversity will be minor while in the latter stages the local varieties contribution will become small. For studying trends in diversity during the process of replacement of local with cultivars, the total diversity at a certain time should be taken into

account. A possible modernization due to the replacement of local varieties by cultivars would be reflected in a higher diversity of the local varieties before the introduction of cultivars as compared to the diversity of the cultivars after the replacement with the local varieties is completed. The above table highlights the ethnobotany of some of the varieties grown by farmers, which gives some idea about the richness of varieties types and their management as described by the farmers. The presence of different barley varieties in the area was the basis of our food supply and good nutrition, providing humans with various and nutritious foods and other products and services. Comparison of collections, survey methods such as on farm monitoring, semi-structured interviews and focused group discussion were used in assessing farm genetic erosion. Accordingly, the proportion of both the local and improved varieties barley was 92% native varieties while 99% introduced varieties, respectively. This indicates that the local landraces are being lost due to the introduction of the improved varieties. About 96% of both the local and improved varieties of barley were cultivated in the study area. The barley is the third crop in the study area next to the teff and wheat. According to the respondents, the distribution of each variety was 46% Balami, 23% Butuji, 15% Semereta, 12% black barley among the dominant local barley varieties grown whereas the 52% Shege, 33% Gelane and 9% Beka, respectively among the dominant improved barley varieties grown in the study area. Such the barley genetic diversity in the study area provides security for the farmers against diseases, pests, drought and other environmental stresses. They form the raw material from which new, more disease and drought resistant and high yielding varieties have been systematically selected and cultivated to meet the growing need for more food and other needs. Comparison of the potential productivity and current productivity, most of the farmers in the study areas obtained low yield that could have been enhanced from the use of improved technologies.

Table 5-Trends of barley production at Welmera and Ejere woredas

Varieties in production	Varieties rarely in production	Varieties lost	Reasons for loss of the varieties
HB-1307	Baleme	Mouga	Incompetent variety in terms of income
Shege	Semereta	Derebe Netche Gebse	Low market demand in the area due to low price
HB-42	Gurracho	Workineh	Displacement by new and improved varieties
Beka	Shasho	Butuji	Provide very low grain yields

There are different major causes for the loss of local barley varieties in the study areas means that there is no single factor that is solely responsible for local barley variety genetic erosion in the study area. At present, increasing crop yield through improved technology led to the loss of genetic diversity. The major causes of genetic erosion are agricultural modernization such as introduction of improved varieties, replacement of specific crop by other crops, weather variability, change in size of land use and lack of policy support were factors reported for barley genetic erosion at both woredas. The displacement of native seeds by the improved one and its proportion of the displacement depending on the uses of crops, market demand of the varieties and the agricultural practices. The loss of food barley landraces in Ejere and Welmera reported according to the farmers who participated in the present study have listed many factors that have contributed to the loss of barley landraces.

The major factors were diseases (leaves and stem wag), water logging, frost, the more frequent occurrence of cold temperature and soil acidity. All these factors led to low yield grain of food barley. Currently, Shege and Gelane are dominant and widely cultivated improved varieties, Beka and HB-42 are cultivated to less extent, while the cultivation of other landraces including Semereta, Mouga, Garbuu adii was given up in recent times.

Table 6-The main factors affecting genetic erosion of barley varieties

Factors	Frequency	Percentage (%)
Introduction of improved varieties	57	57
Weather variability	18	18
Lack of policy support	11	11
Replacement by other crops	6	6
Change in land size	5	5
Change in land use pattern	3	3

4.3. Factors Causes Genetic Erosion of Barley Varieties in the Study Districts

4.3.1. Introduction of Improved Barley Varieties

Agricultural extension in the woredas has focused on the introduction of improved varieties which is the main causes of genetic erosion of local barley varieties.

Improved barley varieties along with improved production packages were promoted through the formal agricultural extension system.

In addition, access to agricultural inputs (improved seeds, inorganic fertilizers, herbicides), and information on improved production practices were made available along with the new varieties. Many farmers (99%) adopted the new varieties; as a result, the local varieties were gradually left out of the production. The main reason for genetic erosion was introduction of improved varieties, followed by weather condition variability. The study indicated that, a high yielding improved barley variety (HB-1307) is currently expanding and accelerating the loss of local barley landraces diversity. Changes in land use and land size are also problems that limit local barley production and leads to genetic erosion. Seed diffusion became linear and top-down from the plant breeder to the seed company and then to the farmer, and farmers purchased seed either each year or in different years, gradually stopping the adaptation process that occurs when farmers save and replant seeds of genetically diverse population-varieties.

4.3.2. Lack of Policy Support for Local Varieties

Policy makers and some local expert have considered local varieties as low yielding and susceptible to different diseases. All of the respondents reported that training and other awareness had been given on improved barley varieties production to increase productivity and to attain food self-sufficiency. Socio-cultural values for local varieties, indigenous knowledge of the local farmers and local barley genetic resources have been given little or no attention by policy makers and development agents.

4.3.3. Weather Conditions Variability

The unstable rainfall with the longer growing period of local varieties forced farmers to adopt early maturing barley types and improved barley varieties or other crops that tolerate droughts and other stresses. The respondents reported that barley planting time has been changed due to lack and shift of rainfall. Variability of rainfall is a major cause of fluctuations in production of barley in the central highlands of Shewa.

4.3.4. Socio-economic Factors

The three categorized independent variables: sex, level of education and class had positive association with trend on local varieties of food barley genetic erosion.

Male farmers were socially powerful on the discussion of farming activities, had access to adopt new technologies than female farmers.

Rural women in Ethiopia represent a tremendous productive resource in the agricultural sector. They are major contributors to the agricultural workforce, either as family members or in their own right as women heading households. There have been recent policy initiatives to strengthen the position of women in the agricultural sector. Gender roles and relationships influence the division of work, the use of resources, and the sharing of the benefits of production between women and men. In particular, the introduction of new technologies and practices, underpinned by improved service provision, often disregards the gendered-consequences of market-oriented growth and many benefits bypass women. However, despite these recent initiatives, a mixture of economic constraints, cultural norms and practices continue to limit women's contribution to household food security. Level of education also influenced access to extension on adoption of new technologies. Moreover, rich farmers owned more plots of farmland and maintained local varieties than poor farmers.

However, in order to obtain better yield and sustain their families poor farmers used improved varieties, most of the time through seed exchange from their neighbor/relatives, which on the other hand positively correlated to genetic erosion. On the other hand, age of the respondent showed positive association with local varieties conservation. An increase in one year of the respondent's age contributed to maintain local varieties. The other factors that also contributed to the loss of the varieties in the study area include change in land use pattern, change in land size and so on. Simply, according to the respondents, the introduction of improved varieties which account about 57% was the major factor which cause the genetic erosion of the barley in the study due to enforce from the HARC, about 6% was the replacement with the other crops such mainly potato, wheat and others, 18% weather variability, 3%change in land use pattern, 5%change in land size and 11% lack of policy support, respectively.

4.3.5. Land tenure and farm size

In Ethiopia, the land belongs to the government and local farmers have use right. A plot is a piece of land physically separated from others for cultivation of the specific crop; while a sub-plot is a sub-unit of a plot in a cropping area. According to the data collected, 82% of the farmers cultivate barley on their owned farmland, 17% were rented in the plot and only 1% was shared in the land for barley production (Annex7,p-108).

A unique method related to the barley sub-plot tenure in the study area was called 'siso' in which farmer involved in ploughing of the farmland gives one third of the product for land owner rented out the land for the barley production.

However, there are different barley sub plot tenure including shared in/shared out and borrowed in/borrowed out, but no farmers involved in the later land tenure system in the study area. The rich farmers with very large land size ploughed barley in small amount for specific purpose such as tella production since they considered barley as poor humans' bread whereas poor farmers produce barley on large land size for different purposes.

The total sizes of land owned in hectares in the study area were 54% of farmers have below 2 hectare, 26% has 2.1-4 hectares, 14% has 4.1-6 hectares and 6% has above 6 hectares (Annex8,p-108). The study area famers classify their lands to different crop varieties. Farmer's total size of the owned land greatly varies and the land allocated for food barley production also related to the individual land size. The farmers having the greater land size provide the larger size for barley production and the vice versa. In some cases, the total land size provided for the barley production was indirectly related with the total land sizes in relation to rich farmers. Generally, a few farmers have large total land size in hectares and many farmers have small total land size. The rich farmers provide less land size for barley production from total land size while the poor farmers allocated the more land for barley cultivation than other crops since it is early matured. Better-off farmers maintained more local varieties than poor did. Although it is just, this study is in agreement with Tsegaye and Berg (2007), the larger the size of total land holding, the larger is the barley area of a household. However, this situation was not always true.

The study conducted indicated performance evaluation of local and improved varieties that there were high yielders local varieties in yield and yield related parameters. Inadequate attention has been given to improvement of local varieties, as they regarded as low yielding. The policy makers were interested in increasing grain yield and total food production in the short run. The total land sizes allocated for the barley production were discussed as follows.

The total land allocated for food barley production depends on the total sizes of land owned in hectares because the farmers categorized their farmland to cultivate different crops to meets their certain needs. About 79% of the respondents allocated below two hectare land for barley production, 16% allocated 2.1-4 hectares, and 4% allocated 4.1-6 hectares land and only 1% allocated above 6 hectares land for production of the barley (Annex9,p-108).

Relatively the land the farmers allocated for production of this crop were less next to teff and wheat but high followed by potato and bean with other crops rare in the study area. Barley is less important than wheat or teff for both home consumption and market demand in the study area.

The farmland allocated for production of each variety based on soil fertility and nutrient demand of the variety. The farmers having the large size owned land proportionally allocated smal size for barley production and the vice versa. Plot size showed negative association for genetic erosion, that is, with decrease in one hectare of farmland there was increase genetic erosion. Individual farmers allocated farm size to each local varieties based on soil fertility and nutrient demand of the varieties. Farmer with limited plots of farmland would be forced to give up cultivation of local varieties in favor of improved varieties. Hence, in another year no seeds of that local variety will be available within the informal seed system. Introduction of other crop seeds were also factors for the loss of local varieties. Introduction of other crop seeds such as potato causes the loss of local barley varieties.

4.4. Soil condition, crop rotation and intercropping

Poor soil fertility is the major constraint affecting the productivity of barley in the highlands of Ethiopia. The fertility of the soil of the barley plot is one of the main factors influence the productivity of the crops. As 39% of the respondent indicated, the fertility of their barley farmland was good, 55% medium and 6% poor which results from the soil erosion (Annex10,p-108). This finding was indicated that the soil of the study area was less fertile for other crops production. According to both district farmers, the soil of the environment was very good for barley production; means their barley plots needs less application of the fertilizer. Moreover, they reported that barley adapts better to lower soil fertility than wheat and other crops. However, food barley varieties also vary in their nutrient demand and it was reported that many varieties which demand good soil properties are presently out of production.

According to the respondents the soil fertility of the farmland allocated for barley production in the study area, it could be classified as good, medium and poor. About the 39% of the soil fertility is good, 55% medium whereas 6% poor in the soil fertility. These indicated that the study area were suitable for barley production. Therefore, barley is more dominant cereal crops in the Welmera and Ejere woredas. The farmers used barley as a rescue crop and cash crop with potato and other vegetables in the study area.

The fertility of the soil was another important factor in limiting the output of the crops including the barley. If the farmland is poor in the soil fertility, it needs more fertilizer application and results in the low yields which bring the food insecurity.

Overall 60% the respondents reported that the soil slope of their farmland is gently slopes, 20% is medium slope and 12% is steep slope (Annex11,p-109). About 8% of the farmers give the negative response because they don't know the slope of the soil of their barley sub plot. As more of the study area farmers used the oxen plow for their barley plots preparation and sub plot ploughing, the gently slope farmland was very suitable for the barley cultivation. According to the farmers the Oxen is a valuable asset for ploughing the land. Generally, the gently slope land were more suitable for barley and other crops production with the aid of hand hoe, animal traction and tractor land preparation methods. Both medium slope and steep slope was less appropriate for traditional and modern land preparation methods for the crop production.

The soil types of the study area were 31% black, 9% gray, 40% brown, 12% red and 8% type of soil which is the mixture of black and red (Annex12,p-109). These are the soil type of barley sub-plot in the study area in which the black was the dominant next to brown and red, gray and other types arranged in the descending orders. The soil types and texture were specific and the major yield limiting factor of the barley grain. According to the reports from the farmers of both the Welmera and Ejere woredas 1% of the farmers practice inter cropping of barley with other crops whereas 99% do not practice the inter cropping of barley with other crops (Annex13,p-109). If the barley plants grow with other crops, the farmers believe that pest infestation would be enhanced. The farmer reports that as he/she practice the intercropping do not determined that crops mean that it a negative response in terms of practicing the intercropped with barley. Generally, there is very scanty intercrop practice of barley varieties with other at both districts.

Figure 4-Previous crops grown on barley plot before one season

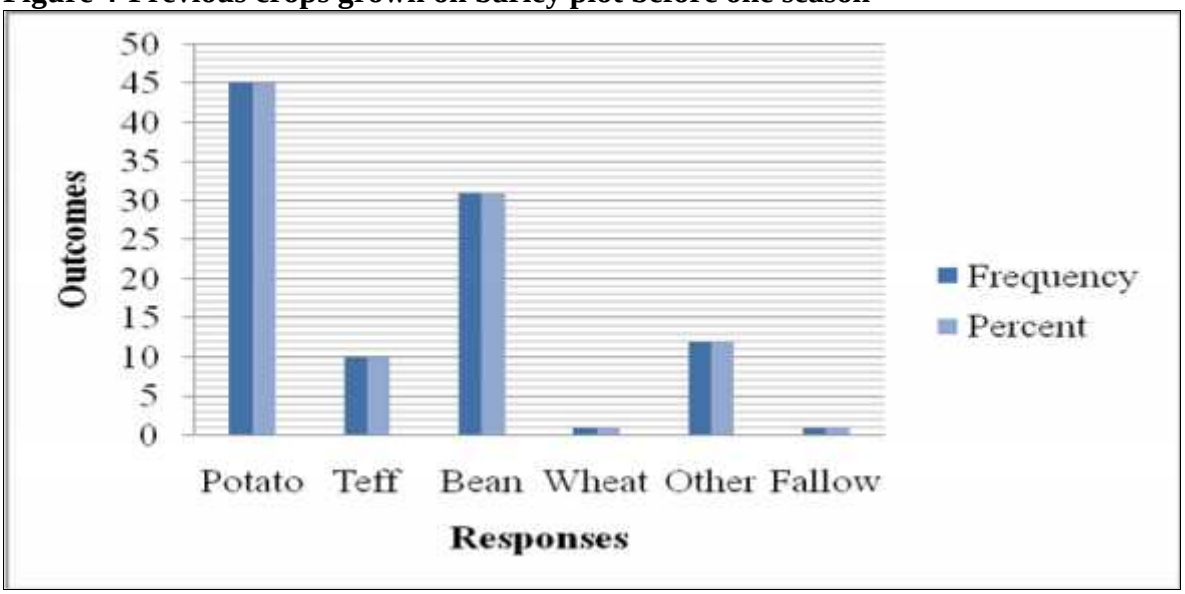
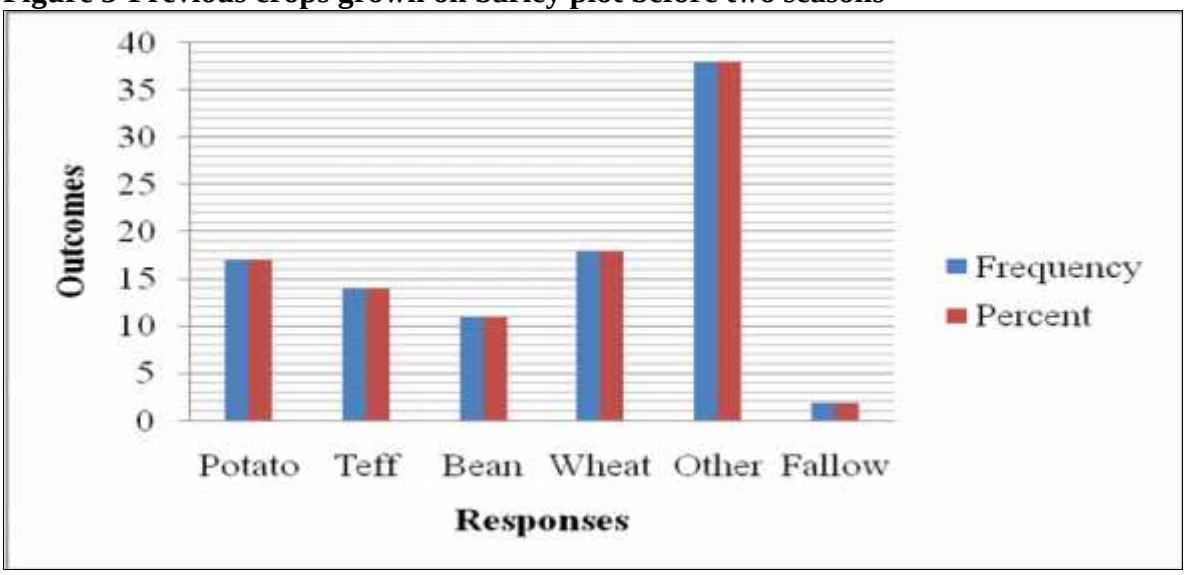


Figure 4 gives the basic information on the crops rotation. About the 45% of Ejere and Welmera district farmers grow potato on the barley plot before one season, 10% cultivate teff, 31% bean, 1% wheat, 12% grow other crops such as barley itself, peas, lentil and linseed, and 1% fallows the land for the next season barley production. Farmers indicated that planting barley after barley or any other cereal crops results in very low yields. Crop rotations with grain legumes failed since the latter ones did not adapt to the prevailing environmental conditions. Recently, research and extension promoted improved barley varieties as a strategy to maximize land use for crop production in the face of growing human population and declining farm size.

Barley is suitable to the growing conditions of the study area and it is expanding as a rotation crop to barley instead of the usual barley fallow systems. The different crops for rotation in the study area from different sites are listed below in two different successive seasons.

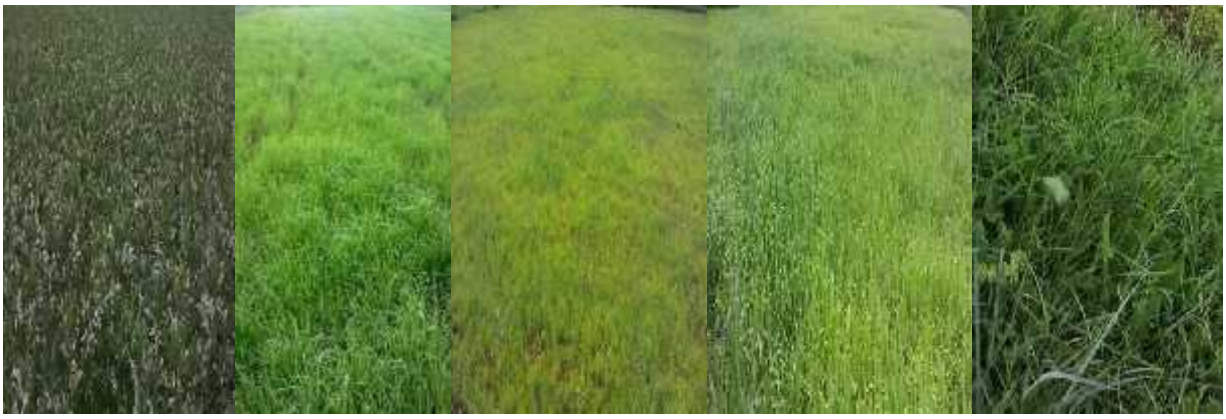
Figure 5-Previous crops grown on barley plot before two seasons



The crops rotation may used in different seasons by different farmers with different varieties. A few farmers used the same varieties on different cropping seasons and others used the different varieties on different seasons. The barley plots on the current cropping season grow various crops before two seasons. The distribution of varieties for crop rotation in Welmera and Ejere woredas on barley sub plot determined as follows. Accordingly, 17% potato, 14% teff, 11% bean, 18% wheat, 38% other crops including barley with very high percentage, linseed, lentil and peas before two cropping seasons.

About 2% of households fallow their land for the next barley production. Other changes in agricultural practices have also had major effects on barley diversity. Traditionally, crops were rotated so that in a field one year a cereal would be grown, another perhaps a root crop such as carrots and potato, then in another year a legumes such as beans and perhaps one year 'fallow' (just grass, no crops). The rotation would be carried out with different timing in different fields, so that all varieties were always available. This meant different people could find different foodstuffs. However, the intensive farming of just one crop year after year, keeping pests at bay with herbicides and pesticides, reduces the diversity available. Such practices have been blamed for the decline and, in some cases, the extinction of the local and improved barley varieties in the production. The crop rotation in the field increases its yields and then ensures the availability of many food sources in the area that used by the urban and rural communities directly as insurance and coping mechanism to increase flexibility and reduce risk in the face of increasing uncertainty in food supply.

The different crops used for rotation in the study area before two seasons in different percentage with first season are the following. These includes potato, teff, bean wheat, peas other cereals, legumes and barley itself.



Beans Barley Teff Wheat Fallow

Figure 6-Different crops for rotation in different seasons in the study areas

The term crops rotation broadly defined as the production or/and cultivation of crops year after year on a particular farmland. The activities of crop rotation have direct and indirect positive or negative effects on the agricultural practices. The different nitrogen fixing bacteria and other decomposer organisms found in various plants are very important in trends of increasing the product and productivity.

The different crops rotated on a specific farmland, the different organisms involved in decomposition of the detritus and results in the improvement of the soil fertility and then the productivity. This shows that the farmers in the study area know about the role of nitrogen fixing bacteria and fallowing systems to increase the agricultural products. The previous cropping is likely to affect levels of trash, slug activity, and autotoxicity as well as the amount of water available in the soil. The impact of previous cropping may also be confounded by indirect effects, for example late harvested crops such as potatoes and beans may delay subsequent sowing, and crop suitability to specific soil types may mean differences in establishment are not directly due to the previous crop.

According to the study area district farmers 94% apply the compost on barley plot during 2017 cropping season to increase their productivity whereas about 6% do not apply compost; instead they used the inorganic fertilizer (Annex14,p-109). The respondents concluded that the application of both compost and fertilizer was very important in increasing barley products and other agricultural productivity.

No farmers in the study area cultivate the barley without application of fertilizers in different application rate and systems. Some farmers use the fertilizers in a row application system and others random application system. Because of the increased product of barley in study site, no households exposed to the food shortage in the past years and they describe the barley as a recue crop. The farmers not apply the compost to their barley farmland and as a result they gain relatively the low products from the agriculture. There are different modes of manure application. Among these methods broadcasting was widely used with 92%, ring with 5% and 3% of the farmers of both woredas were not well oriented about manure preparation methods and application modes (Annex15,p-109). Side/heaping manure application mode not applicable for barley production but it is good for other crops including maize, teff and others. The farmers those knew the manure application modes obtained high yields According to the 91% farmers knew the fertilizer application rate on barley sub plot while 9% not have any idea about the fertilizer application rate (Annex16,p-110). Only knowing fertilizer application is nothing to do in increasing agricultural productivity unless the farmers are well oriented to the application rate. The fertilizer application with its recommendation rate was crucial to enhance the outputs from low inputs and then to improve the livelihoods of the smallholder farmers. As a result, it is important to promote the food security of the area and then of our country. According to the 84% of the respondent reported that they apply the fertilizer as per the recommendation from agricultural extension services while 16% does not apply as per the recommendation (Annex17,p-110). Fertilization application as per the recommendation was another major factor in determining the outputs of the agricultural productivity. If fertilizer not applied, it has the direct negative effects on the barley production because it reduces the products obtained from agricultural activities but fertilizer application increases the productivity. Information or training must be necessary for the farmers not applied fertilizer as per the recommendation otherwise their number increase. The fertilizer application has both direct and indirect effect on barley products.

4.5. Barley Seed System

According to the 29% of the study area farmers bought the improved seeds barley varieties on the current cropping season, 9% recycled the improved food barley varieties for two years, 4% recycled for three years whereas many of the respondents which accounts about 58% used the

improved barley varieties for more than three years. The farmers used the seeds more than two years reported that its quantity was decreased in the next years due to the presence of admixture seeds varieties. According to the reports of some farmers those used the barley seeds varieties only for each cropping season had a negative effects on their livelihoods because seed cost increase year after year.

Figure 7-Barley improved seeds recycle in a year

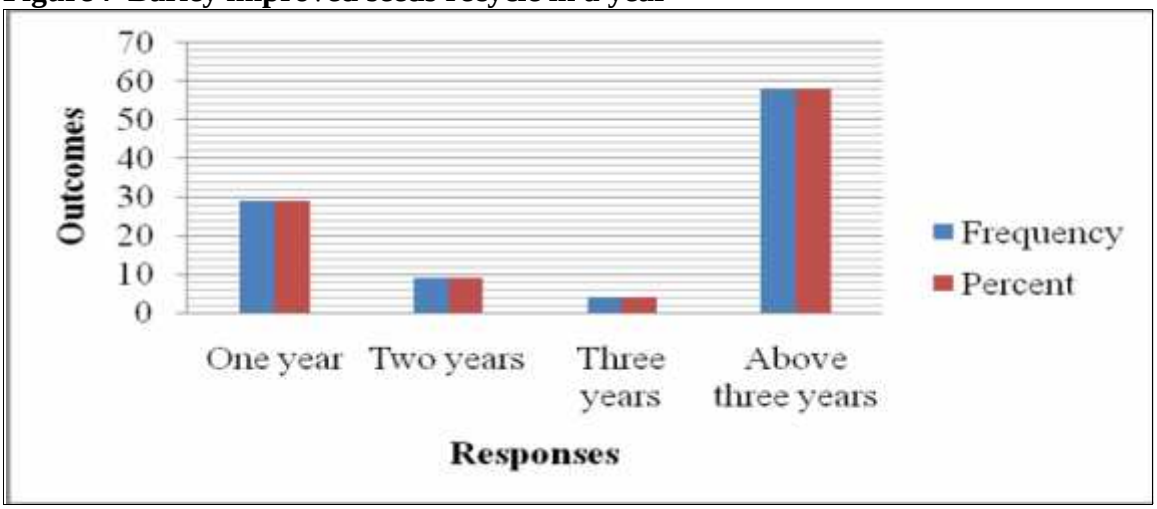
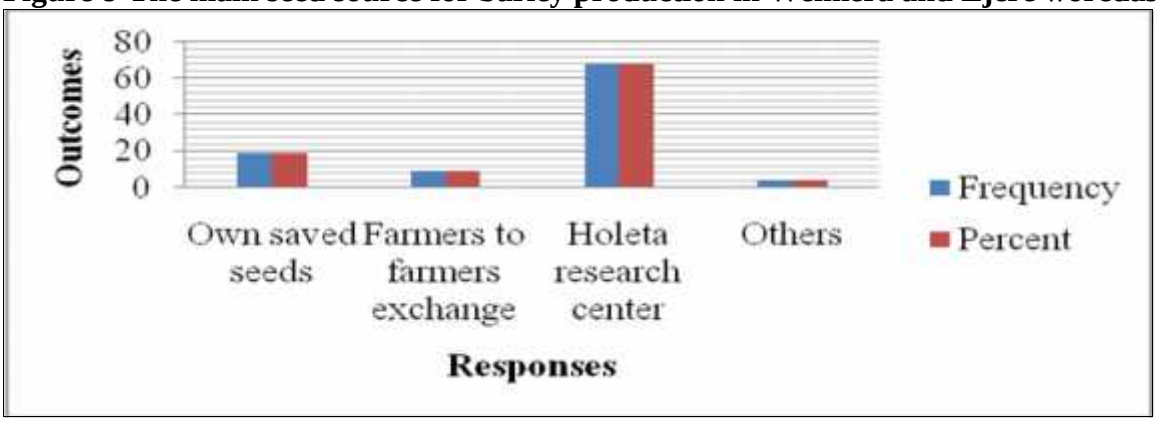


Figure 8-The main seed source for barley production in Welmera and Ejere woredas



The seed sources for barley landraces and improved varieties in the study area are discussed as follows. The respondents reported that they have different source of barley seeds.

About 19% of the households obtained improved seed barley varieties from their own saved, about 9% got from farmers to farmers exchanges, 68% from Holeta Agriculture Research Center (HARC), 4% from other sources such as government extension, gift from relative/neighbors, local market and farmers groups/cooperative.

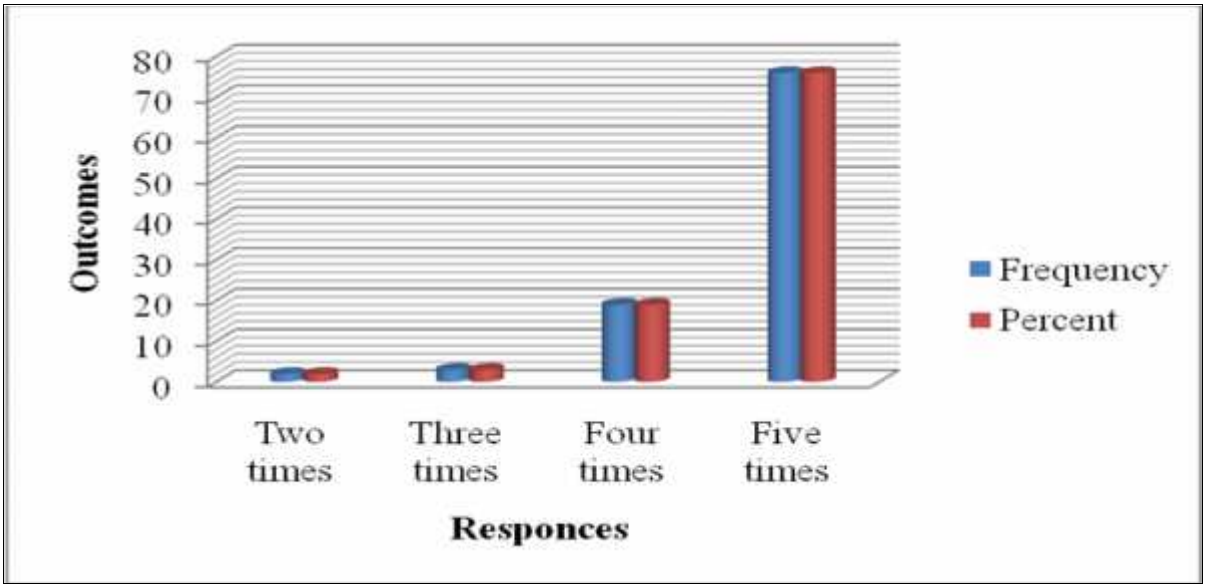
According to the interviewed farmers asked to determine the other source of seeds, they reported that there are few seed traders, private seed supplier, on farm trials, extension demo plots, local seed producers and provided free by NGOs/govt. Also the farmers of four kebeles identified for the study was described the seeds from HARC are good in providing high yield, resistant to disease and drought as well as other environmental conditions. Those from their own saved seeds reporting saving seeds was more advantageous because there are two advantages of having seeds locally: First, it conserves the indigenous knowledge of the local farmers together with the landraces. The second, it is a low cost production processes and is being accessible to all community members. Many farmers obtain barley landrace seeds mainly through government extension services (HARC) and through farmers to farmer seed exchange and exchange with other commodities among neighbors. Besides, farm saved seeds are also a practice among farmers of the two districts. Overall, the major seed source of improved barley varieties for the farmers of the study areas is the MoA through the Holeta Agricultural Research Centre. Seeds of improved varieties are also obtained through purchasing from the market and/or seed exchanges with other commodities among neighbors. The presence of good road networks in these areas provided opportunities to have access to high local and regional market except basoo kebele to get the seeds.

4.6. Barley Land Preparation Methods

About the 98% of the study sites farmers used animal traction (Oxen plow), 1% tractor and 1% used hand hoe to prepare the land for barley production (Annex18,p-110). Therefore, method of land preparation it varies depending on the household wealth status, economic reason and land slope to use. This indicated that the poor farmers used hand hoe to prepare land for barley production and the rich farmers used either the animal traction or tractor. The traditional farming systems that is ploughing the land using the oxen is the more it takes the agricultural practices and less than using the tractor whereas the hand hoe land preparation method is more and more overload the agricultural practices. Using the tractor for ploughing the plot, results in the better agricultural practices than the two traditional methods. Since fewer farmers used the mentioned modern land preparation method for the barley production, animal traction was the dominant land preparation method in the study area. The reason most of the farmers used the ancient method was related with their land slope and other agriculture related activities.

Figure 9-Land preparation methods in Ethiopia for barley production

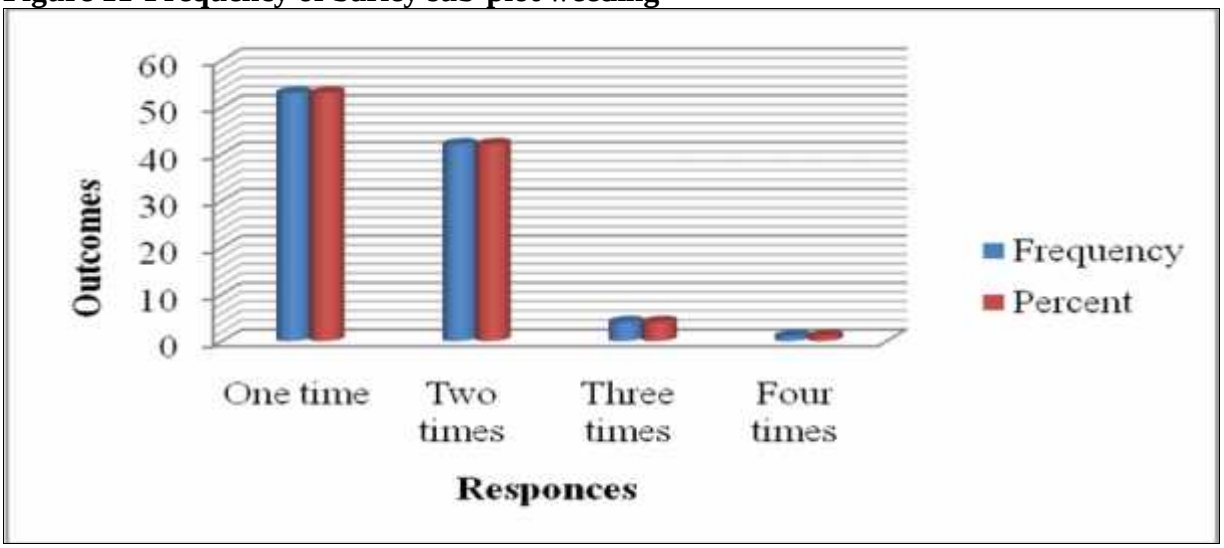
Figure 10-Frequency of barley sub-plot ploughing



According to the information obtained from the two districts farmers barley sub-plot ploughed in different frequency. The 2% of the households ploughed their plot two times for barley production, 3% ploughed barley plot three times, 19% ploughed four times and many of them which accounts about 76% ploughed five times. As the respondents reported, ploughing more than three times has its own benefit in improvement of life of livelihoods because it promotes increased crops products. Also reduce weeds varieties that demote yield potential of the produced barley variety. Again, it is vital to save the cost released to buy the herbicides as well as the number and types of labor involved in weeding. These descriptions were only for the households used oxen plow to prepare land for barley production. Generally, the land ploughed by oxen more than three times was well prepared to cultivate both local and improved food barley varieties. The hand hoe land preparation methods were more difficult, but the uses of tractors were easy and costly with little time consumption than the two traditional methods.

Generally, the ploughing the land with the help of oxen was the dominant and suitable for the barley production.

Figure 11-Frequency of barley sub-plot weeding



The frequency of barley sub-plot weeding depends up on the frequency of ploughing. As the sub plot ploughed more, less the frequency of weeding or no weeding at all. About 53% of the respondents weeded their barley sub plot only one time, 42% weeded two times, 4% three times and only 1% weeded four times. Both the frequency of barley sub-plot ploughing and weeding has direct proportional effects to each other. Simply, this indicated that barley varieties require low seed management and production system in comparison of other crops as a result farmers choose to cultivate barley. In addition to hand weeding, farmer used herbicides in order to enhance their productivity from small plot with low inputs. Farmers usually not willing to use herbicides rather weeded more times through traditional methods with several labors including family members, in addition hired permanent and causal workers. In few cases, some households used both traditional weeding method and herbicides applications with recommended rates to obtain more yield than the individual used either of the two. The main advantage related to the traditional weeding method, it reduces or avoid the cost released to buy herbicides and also hand weeding supports the crop rotation in the aeration process for barley production.

4.7. Barley Planting Methods and Preferred Seasons

There are two major barley planting methods that the farmers of our country practiced. About 9% of the respondents plant the barley using the random method and also about 9% cultivate this crop with the help of row method. According to the respondents in the study area, most of the farmers which account about 82% produce barley on the basis of both random and row methods (Annex19,p-110). They reported that planting barley using row method is better than the random method because it is good for proper management during fertilizer application and harvesting activities.

Barley is produced twice annually, i.e. during the main season 'kiremt' and the short rainy season 'belg'. The 'kiremt' barley is important in Welmera and Ejere woreda and other highland parts of Ethiopia. Belg is a crop harvested between March and August whereas Kiremt is a crop harvested between June and September in any production season. In the study area, barley is mainly produced in kiremt season and it is the dominant crop. All the farmers in the study sites (100%) reported that the barley production duration in season takes place during the main rain season. Therefore, kiremt barley production is the only system in both Welmera and Ejere woredas, on the other hand, there is no Belg season barley production. Generally, the season used for barley cultivations in the study area only long rainy seasons.

4.8. Planting, Genotype Selection and Agronomic Practices by Local Farmers

According to the 3% of the respondents used the space below 10cm between barley plants rows, 59% of the households reported that as they used 10-20cm between the rows while the 38% of the farmers used 20-30cm Annex20,p-110).The smaller and larger the space between the rows has a negative effect on the product because the larger space between rows provides low grain yield from large size land with many inputs and needs high management and production systems. On the other hand, smaller space between rows led the variety to for high nutrient completion and other growth requirements and then the variety provides very low yields per year.

About the 97% of respondents apply the fertilizer for barley production while 3% of the study area farmers do not apply the fertilizer on their barley farmland but they used the manure in order to increase soil fertility and then productivity (Annex21,p-110). Generally, there is no farmers produce barley in the study area without application of either fertilizer or manure.

According to the respondents, the fertilizer, “calla guddistuu” in local language, is the vital in enabling the crops to provide high yields. About the 57% of the respondents apply the fertilizer only once on barley sub plot in a year, 34% apply twice and 9% apply three times per a year (Annex22,p-111). Fertilizer application method, frequency of application and rate of application, all have the direct or indirect effects on barley production systems and its products.

If the fertilizer applied using the broad casting method, once in a year at two weeks after cultivation, the barley results in high yields while using the other method of application applied more than once and before or after two weeks give the variety with too low yields. Weeds compete with barley for water, light, mineral nutrients, and other requirements for its growth. They increase the cost of labor and equipment; reduce the yield and quality of the grain, and harbor insects and certain diseases. Weeds interfere with combine harvesting and increase storage costs. The seeds of some weeds are difficult to separate from the threshed grain, some reduce the quality of grain and grain byproducts, and other weed seeds are unpalatable to certain classes of livestock. Weeds effectively controlled by 2, 4-D and becoming increasingly dominant in the weed population spectrum in barley and other small grain crops.

Most of the respondents that account about 89% used 2, 4-D herbicides for barley production, 6% used other herbicides such as Comando, 2% not used herbicides (Annex23,p-111). According to the reports from many farmers, they utilized the herbicides first and then next weeded the weeds that resist the chemicals with the help of the traditional methods by farmers groups/cooperative locally called ‘Dabo’. Such groups of farmers also involved in the threshing, harvesting and processing of the barley and other crops. In the coops of farmers both gender involved specially in the weeding.

Harvesting barley plants infected by Ergot fungus disease for consumption, cash and other purposes has negative side effects. According to the respondents 27% harvest barley plants infected by disease for different purpose while 73% of the study area farmers does not harvest barley plants infected by diseases (Annex24,p-111). Harvesting barley plants infected by disease may cause disease on farmer population and later results in death. Also, reduces yield quality and quantity and lower its demand in local and regional markets. About the 12% of the farmers harvest barley plants with disease take special measures to prevent its transmission whereas 88% of the respondents do not take any measures (Annex25,p-111). The special measures they take include washing, grinding, milling and drying.

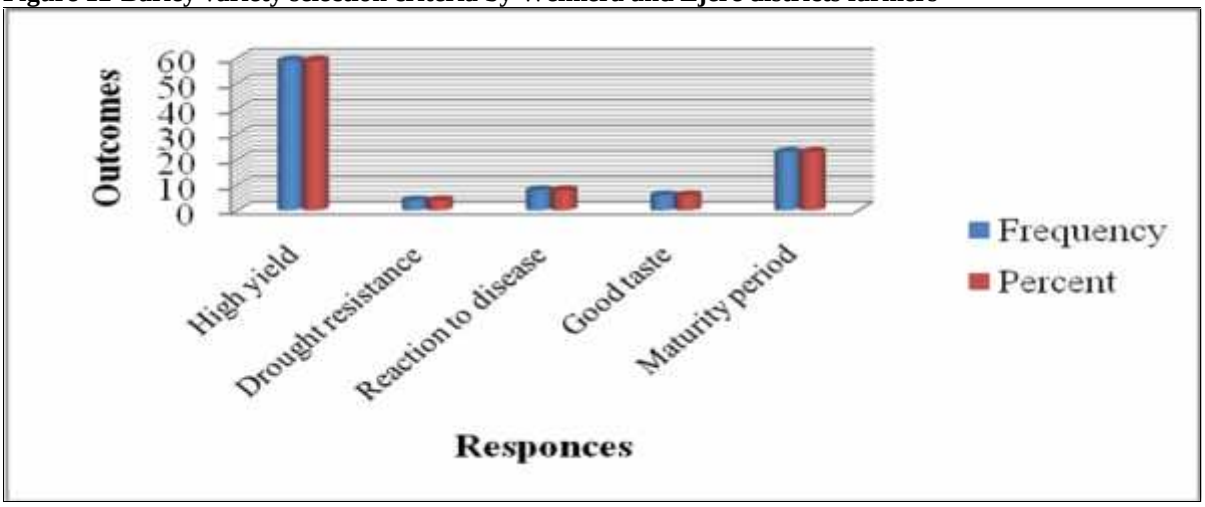
These all the special measures may prevent disease transmission from the infected plants to the individual farmers or from one farmer to another if it is communicable diseases.

4.9. Barley Maturity and Varietal Selection Criteria

There are various variety selection criteria. The traditional criteria for selection of landraces involves their apparent and applied values including adaptability, yield reliability, nutritional quality, color, grain size and texture, and delight of various sorts.

Farmers decisions to grow improved food barley varieties, the land type and area allocated to each seem to be associated with the role of each food barley landraces in each households consumption pattern. Recommendation packages from different agricultural research centers indicated the presence of a number of improved varieties released with the potential productivity of about 5 tons ha-1 and 3 tons ha-1 at research station and at farmers field, respectively. Yield potential which is the characteristics of most modern varieties and the most important criterion for the choice of a variety by a farmer followed by social values.

Figure 12-Barley variety selection criteria by Welmera and Ejere districts farmers



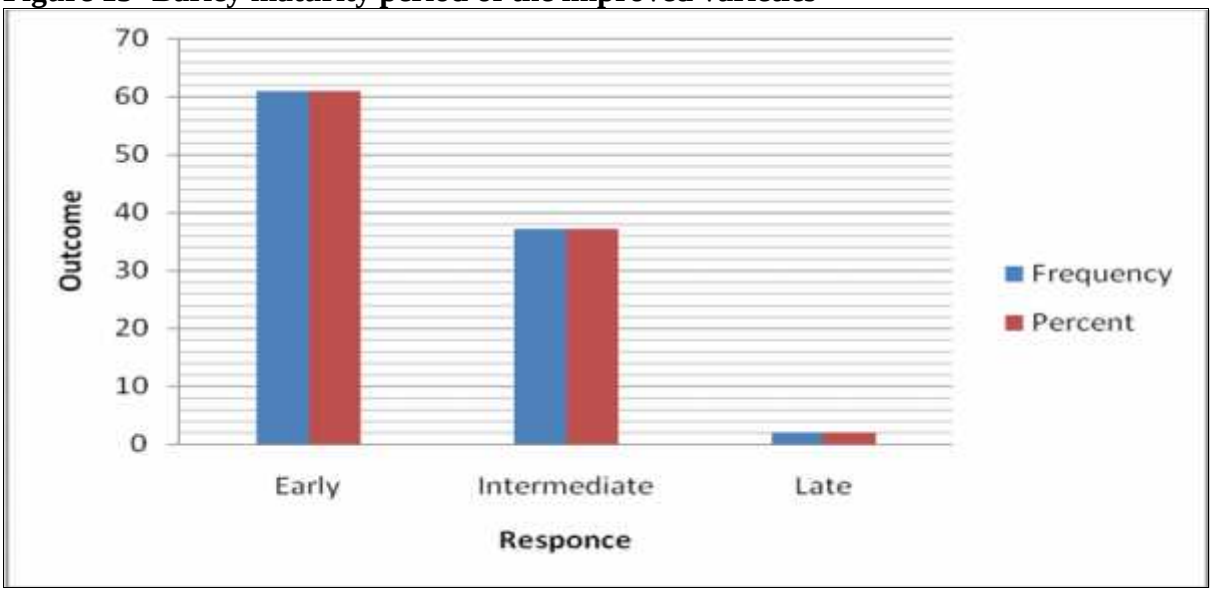
The other selection criteria of barley varieties are early maturity period and good taste/quality during consumption.

Depending on this 59% of the respondents choose the barley variety on the basis of high yield potential which is HB-1307, 8% depending on disease resistance which are Shege and Gelane, 4% ability to resists drought, 6% good taste/quality and 23% of farmers select variety depending on early maturity period. This indicates that the major variety selection criteria in the study area are both the yield potential and early maturity period.

About 42% of the respondents reported that the local landraces are early matured, about 51% of them reported the intermediate maturity period whereas about 7% of the respondents identified the late maturity period of the local landraces (Annex26,p-111). According to the respondents, the early maturity period rescues the food shortage in the area and escape from drought and other environmental conditions. The late maturity period was one of the causes of food shortage and simply damaged by short rainfall and other weather variability. If there are no early maturity local landraces, the farmers select the variety with intermediate maturity period because of all the relativity.

To overcome the problems, the farmers preferred the varieties with the early maturity period. The late barley landraces requires high moisture an cultivated in higher altitudes during long rainy season and when there is early and sufficient rainfall. The fast maturing ones come to the rescue of inhabitants during periods of food shortages.

Figure 13- Barley maturity period of the improved varieties



Some forms are sown early in the season, others later and a few can be sown any time during the sowing season. Some are fast maturing while other are slow. About the 61% of the respondents described that the improved barley varieties with early maturity period, 37% with intermediate maturity period and 2% with late one. According to many respondents, the improved food barley varieties have a lower maturity period in comparison with traditional varieties. Because of this reason, nowadays, cultivation of modern varieties was dominant over the local one. These in turn

brings the genetic erosion of the local barley varieties in study area. This will have long term negative consequence on food security of country in general and the study area in particular.

Table 7-Utilization of morphological characters of barley for variety identification

Responses	Frequency	Percent
YES	78	78
NO	22	22
Total	100	100

According to the data collected from the study area, about 78% of farmers of both districts used parts of barley for the variety characterization while 22% not used. Parts of barley the farmers used for the variety identification includes leaves (broad or narrow), thick/thin stem, long roots, flowers, single/double head, long/short height, number of rows, large/small varieties. According to the respondent, these all barley parts used for barley identification one from the others.

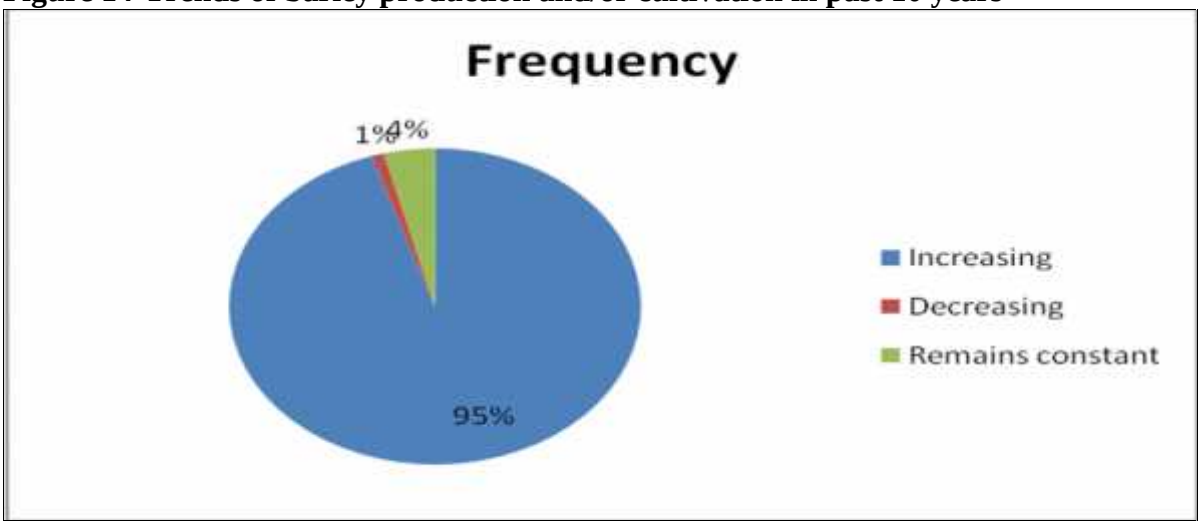
4.10. Barley Cultivation Trends

Among the given alternatives, about 95% of the study area farmers reported and data gathered from DAOs of both districts, food barley production in past 10 years showed increasing. According to both woredas farmers, the reasons for the trends in increasing the barley production includes introduction and utilization of new technologies, good agricultural practices of ploughing the plot, introduction of the new varieties, land preparation and production on time in planting season, utilization of fertilizer as per the recommended from agricultural extension expertise, the use of the improved seeds, the presence of different barley varieties with high yield potential, good access to seeds in local area, follow up of the expertise, experience exchange with different farmers, the increase interest to utilize barley as a main food, barley variety tolerance to disease with low output, barley as a multipurpose crop, expanding results of agricultural research centers and planting in row rather than random.

Only one percent of interviewed farmer reported that production of local barleylandraces in past 10 years decreases. The reason for the decreasing barley production trends includes introduction of new varieties, weather condition variability such as off-time rain, variety susceptibility to disease (eg. wagi), soil erosion and infertility, low yield potential of that specific variety and the decrease in varieties on markets demand.

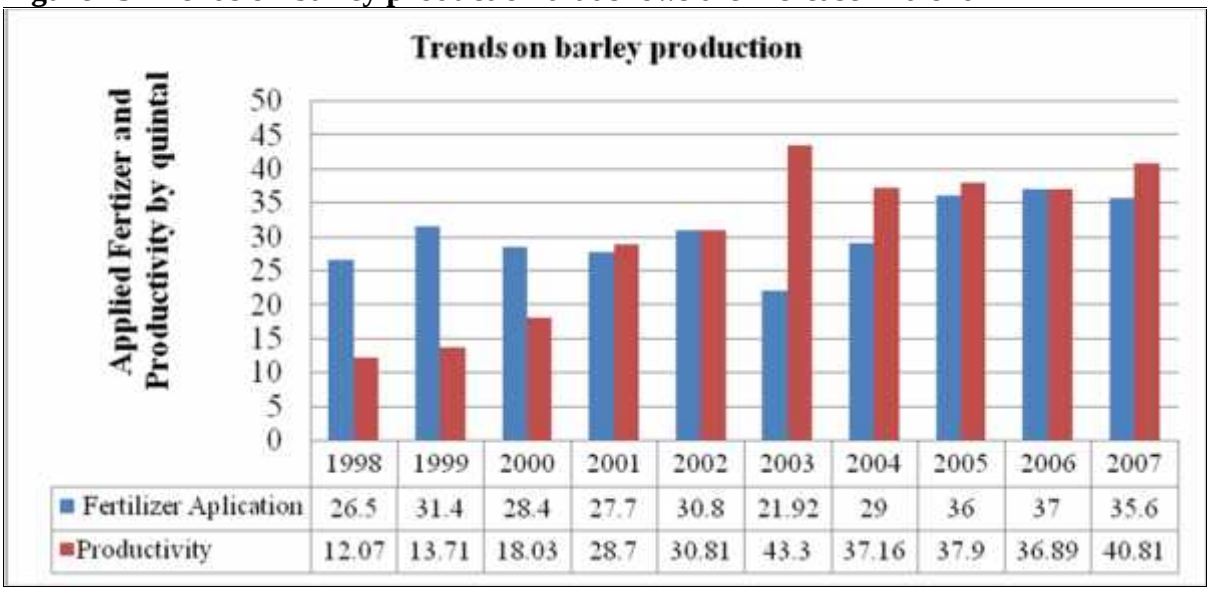
About 4% of the farmers of both districts reported that barley production for last 10 years remains constant, because the wheat and teff are considered as the dominant food and cash crops. The other reasons for declining barley production in order of decreases severity include, low rainfall, poor soil fertility, frost and aphids. The table showing increase in barley production trends were discussed as follows.

Figure 14-Trends of barley production and/or cultivation in past 10 years



According to data obtained from the District Agricultural Offices (DAOs) since 1998 up to 2007 EC, the barley production was shows the dynamic increase as determined below.

Figure 15-Trends on barley production that shows the increase in trend

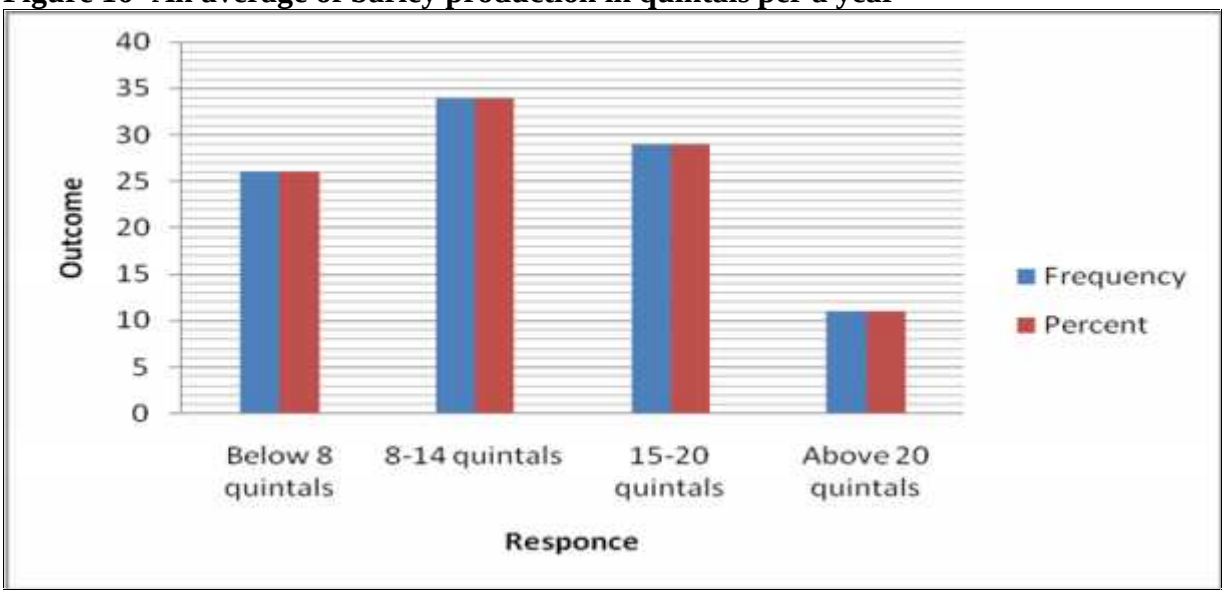


	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Fertilizer Aplication	26.5	31.4	28.4	27.7	30.8	21.92	29	36	37	35.6
Productivity	12.07	13.71	18.03	28.7	30.81	43.3	37.16	37.9	36.89	40.81

In Ethiopia, the total barley productivity per hectare estimated to be 19.66 yield (Qt/Ha) (CSA, 2015/2016 (2008 E.C.).

According to the information obtained from the key informant interview, the main reasons for the in the trend to increase the food barley production or/and cultivation in the past years includes the presence of several competent and productive variety in terms of the income, farmers utilization of the new technologies, good technology packages managements such as fertilizer application, introduction of the modern agricultural practices, high fertilizer application and the existence of the different varieties with high yields, disease and drought resistant varieties, high adaptation to environmental factors, various varieties has high market demand in terms of colour, size and product services.

Figure 16- An average of barley production in quintals per a year



According to the farmers of the districts, about the 26% of the households harvest an average of below eight quintals barley per a year, 34% produce eight to fourteen quintals, 29% of them produce 15 to 20 quintals whereas the remaining 11% of the respondents produce above 20 quintals barley in a year. This indicated that rich farmers having large size of owned land produce little barley per year as they consider barley as a poor man's food. Instead such farmers produced other crops such as teff, wheat etc for consumption, cash and other purposes.

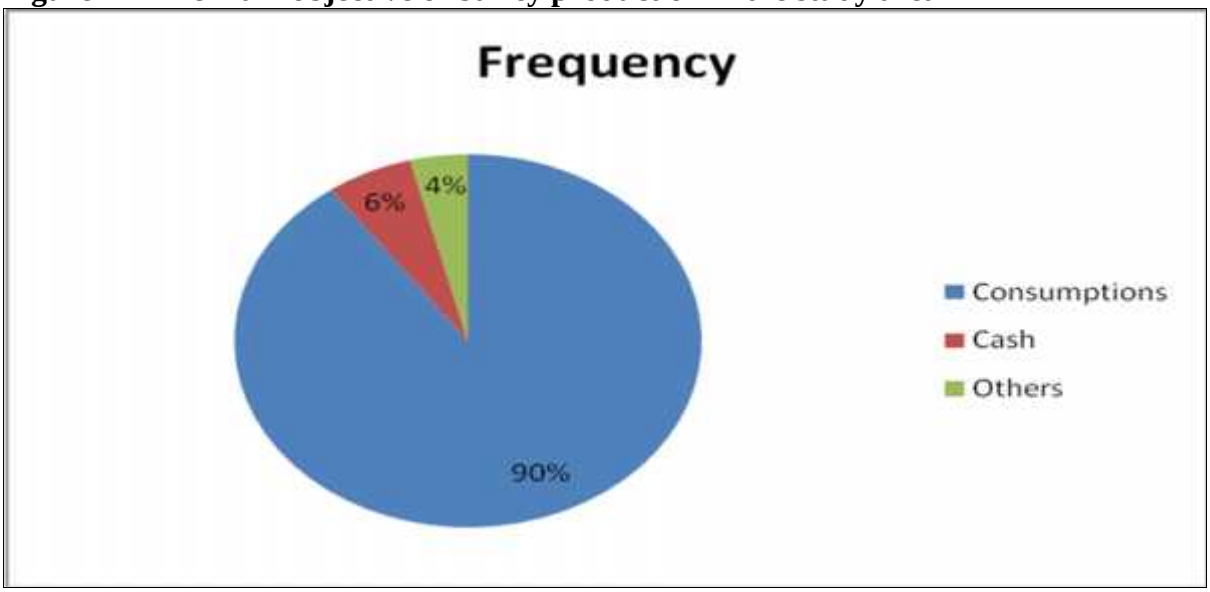
4.11. Barley Utilization and Local Food Types

Barley is a crop with the diverse uses for dishes and beverages. Barley is supplying the basic necessities of life (food, feed, beverages and roof thatching) in highlands areas of Ethiopia. It is consumed in the form of bread, roasted grains, porridge, alcoholic and non-alcoholic beverages.

It is the fifth most important cereal crop in Ethiopia after teff, maize, sorghum and wheat. Currently, it ranks only third in terms of land coverage after teff and potato in the study area. According to the farmers, there is no other crop they know or are aware of that is as suitable as barley to prepare numerous dishes and beverages known in the study areas. The expression "barley is the king of crops'' emphasizes its suitability for diverse use.

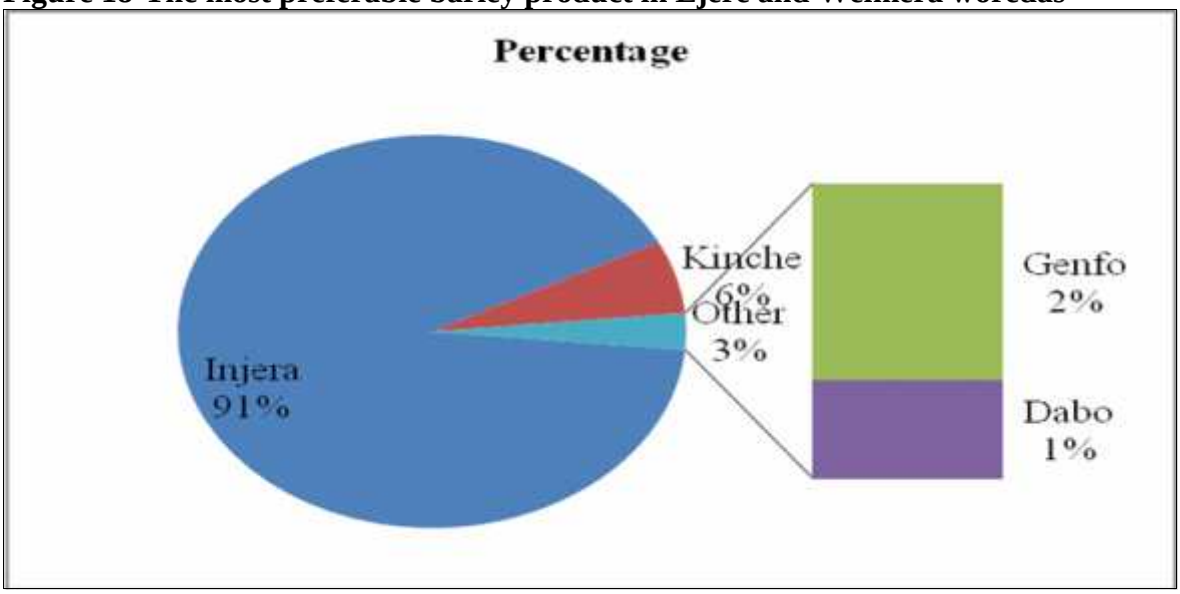
Some of dishes and beverages like genfo, besso and shameta are only prepared from barley. Some dishes and beverages may be prepared from other crops. For example, tela and bukre may be prepared from sorghum or maize, and kolo can be prepared from wheat or pulses, but the quality and taste would not be as good as that from barley. As it was reported from farmers in Welmera and Ejere woredas, the various improved barley foods and drinks also play an important role in the socio-economic and cultural life of farmers and urban dwellers of the study area. Special events like wedding, annual festivals and ceremonies are celebrated with foods and drinks of barley. Traditionally, it is a custom in many parts of Ethiopia (both rural and urban areas) to prepare barley flour for genfo or an expectant mother and barley is the crop of choice. A postnatal mother eats genfo with spiced butter for breakfast and her guests are also served genfo, neighbors and close relatives also served barley genfo. Besides, tella is sold in small towns and cities as a source of income for many families. Barley can be served as a component of various health foods and certain distilled beverages.

Figure 17- The main objective of barley production in the study area



About 90% of the respondents produce barley mainly for consumption, 6% produce for cash main objective and others accounting about 4% produce barley for different purposes such as barley for malting, to produce local alcoholic and non alcoholic drinks. Consumer preferences have been shifted towards other cereal grains such as wheat. Therefore, according to most of the respondents barley becomes third important cereal next to teff and wheat in the study area. However, barley now found to have the desirable nutritional composition and medicinal values.

Figure 18-The most preferable barley product in Ejere and Welmera woredas



The different foods and beverages prepared from barley at Welmera and Ejere woredas are Injera, Tella, Genfo, Kolo, Basso, Shameta, Areke, Kinche, Shorba, Dabo, and Dobdobo. The

study shows, 91% of the study area farmers used Injera as their most preferred barley product, 6% used kinche, and about 2% and 1% used Genfo and Dabo as their most important barley food respectively. About 72% of the study area farmers produce Areke barley products mainly for cash requirement whereas 19% produce Tella barley products mainly for cash requirement and 9% with negative response.

On the other hand, there is no specific purpose production of barley products. About 94% farmers produce mainly Injera for consumption and 4% and 2% produce Genfo and Kinche respectively for the same purpose. The barley plants still used by Oromo society in Welmera and Ejere in different ways. Different types of solid, semi liquid and dried food items as well as the diverse drinks of both alcoholic and non alcoholic types are made from the barley grains while additional uses are made of the crop residue as fodder for animals, especially horses and others in dry seasons. Other dishes and local beverages prepared from barley are Dabo kolo**,** Chuko**,** Keneto**,** Atmit and Qori (Dhobdhobbo). Its grain is used for the preparation of different foodstuffs, such as Injera, *Kolo*, and local alcoholic drinks, such as Tela and Areke. According to the respondents barley was the major staple food grain utilized in the study area. The major foodstuffs prepared in all the sites are Injera (thin leavened bread) which is most favorite foodstuffs of Ethiopians, Besso (roasted barley flour), Kolo (roasted barley grain) as well as both alcoholic and non alcoholic drinks. Detailed description, kinds of materials, preferential grain quality, utilization rate and site specificity local name of food items made of barley were discussed in the following table.

Table 8-A brief description of the types and preparation methods of barley dishes and beverages in Ethiopia

Name	Method of preparation	Frequency of use
Injera	A leaven bread made from raw grain flour with the dough fermented for 2-4 days and baked on clay pan	• It is the main daily dish
Kita	Instant bread baked from unfermented dough of raw grain flour	• Occasionally when no injera or kolo is available and prepared for children
Dabo	Thick bread baked from fermented dough of	•Not common • Wheat is preferred

Name	Method of preparation	Frequency of use
	raw grain flour	
Kolo	Roasted grain prepared from dehulled barley	• Prepared daily as additional food to the main meal and also used as travelling food
Nifro	Boiled grain prepared from dehulled barley	• Prepared occasionally and mostly prepared for cultural occasions
Beso	Solid food prepared from roasted barley flour and water	• Prepared occasionally, Relieves gastritis and used as travelling food
Shameta	Semi fluid drink made from roasted barley flour	• Prepared occasionally by farmers, Daily for sale in towns & relieves gastritis
Genfo	Thick porridge prepared from raw or lightly roasted grain flour	• Commonly as a substitute and prepared for postnatal mothers
Kinche	A dish prepared from cracked raw barley grains Somewhat equivalent to oat meal	• Occasionally as a substitute to other dishes and breakfast
Muk	Gruel made from raw barley grain fine flour	• Occasionally for a change • Prepared for children and sick person
Shorba	Semi fluid drink prepared from cracked grain	•Occasionally and commonly in Ramadan
Tihlo	Prepared from roasted barley flour and water, served with sauce	• Occasionally and it is only known in Tigray(Wag Hamra), Amahara region
Tela	Alcoholic beverage prepared from gesho, malt, roasted grain (asharo) and kita	• Prepared mainly during holidays or traditional ceremonies

Name	Method of preparation	Frequency of use
Bukre	Non-alcoholic beverage prepared from malt, roasted grain and kita	• Prepared occasionally, usually for holidays • Prepared by Muslims
Korefe	Alcoholic beverage prepared from gesho, malt and lightly roasted barley grain and kita	• Occasionally for holidays • Usually prepared and sold in towns
Filtered Tella	An alcoholic beverage similar to tela with slightly different preparation and higher alcoholic content	• Occasionally during holidays • Sold in towns
Eshet	Barley seeds consumed green at milky stage	• Consumed in the field during grain filling stage mainly by children minding livestock
Enkuto	Flame roasted dry spikes consumed in the field	• Occasionally during harvest time and wheat is preferred
Arequie	Alcoholic spirit (the most intoxicating spirituous liquor)	• Occasionally and wheat is preferred
Tea/ Coffee	Drink from dark roasted	• In very limited cases and when proper tea/coffee has run out in Hotel

Source: http://nutritionfortheworld.wetpaint.com/ page/.

Table 9-The main types of foodstuffs and drinks made from barley in study area

Local Name	Description	Kinds of material	Preferential grain quality	Utilization Rate	Site specificity
Budeena/Injera	Thin, leavened bread (loaf)	Fine flour, thin dough	Large grain (late barley)	Most of the time	In all sites

Local Name	Description	Kinds of material	Preferential grain quality	Utilization Rate	Site specificity
Besso	Utilized as moistened powder	Grainroasted and ground to fine or course flour	Any type	Most of the time	In all sites
Akayii/Kolo	Roasted grains	Grain roasted and pounded	Large grains	Some times	In all sites
Ambasha/Kita	Pisa like un spliced	Fine flour, thick dough	Any type	Some times	In all sites
DifoDabo	Thickbread	Fine flour	Whitekernel	Holidays	In all sites
Merqa/Genfo	Soft porridge	Fine flour	Any type	Preparedfor postnatalmothers	In all sites
Kinche	Hard porridge	Course flour	Hull less	Breakfast	In all sites
Farso/Tella	Fermented,undistilled	Course rousted flour and malt	Black barley	Some times	In all sites
Arake	Fermented, distilled	Course rousted flour and malt	Black barley	Rare in villages	In all sites

Figure 19-Some dishes and local beverages prepared from barley

Source: National Nutrient Database for Standard Reference

Figure 20-The researcher interviewing farmers in Welmera and Ejere woredas

4.12. Economic Importance of the Barley

In Holeta, barley grain used as a major food item and the straw as fodder for domestic animals such as Horse and cattle. In most of the upper highlands (>2500m), barley accounts more than 6% of the total food. It is made into finely ground flour such as bread, porridge and soup and other foods and drinks.

Barley can be consumed in the form of kolo, genfo, besso, qorii, wateli, eshet, coarsely ground flour (kinche), and as alcoholic (areke, tella etc) and non –alcoholic drinks (mewuded, shameta etc). Raw barley is a favorite food of children. Spikes at the right stage of ripening are picked and rubbed between the palms with the hands in order to remove the fragment of the rachis and glumes. The dried heads can also be roasted by holding a handful of spikes over the flame which is called Wateli. This is a common practice of the youth and makes supplementary field meals.

The Oromos believe that barley food is both strengthening and nourishing. Children are encouraged to consume barley meals in this society, a view with universal acceptance all over the highlands of Ethiopia. The highlanders claim that barley makes the child brave and courageous. Barley porridge and soup is given to mothers up to 40 days after delivery and at regular intervals during the remaining lactation period. It is a food for lactating mothers and children. In Ethiopia food and variously named non-alcoholic beverages made of water-infusions of roasted and ground grains are highly valued nutritionally. A considerable proportion of the yield is consumed by “local liquor industry “which does not require type specification.

4.13. Implications of the study on Barley Diversity, Technology Adoption and cultural significance

4.13.1. Types of barley Varieties

Today, Ethiopia is considered as centers of food barley diversification. In Ethiopia, the long history of cultivation & the diverse agro-ecological and cultural practices resulted in wide range of barley diversity The high variation in barley types from the high heterogeneous Ethiopian landscape has shown biological principles under operation. The results presented above show that the different Ethiopian barley types have significantly contributed to the understanding and improvement of the worldwide status of crop (Hoyt, 1988; Munck 1988). The study area has a large number of different forms of cultivated barley *(Hordeum vulgare)* varieties.

The barley (local and improved) diversity and uses of this crops are typically studied at different scales ranging from the village level, which allows the maintenance and characterization of diversity maintained by local community to larger regional distributions, which allow end use about the varieties. Both farming communities and the scientific literature usually identify different varieties for a given cultivated species.

The specific varieties within a species have been selected and used for a particular purpose and are distinct from other varieties of the same species by morphological traits and their particular use characteristics. A report (Fekadu and Hailu, 1987) has shown that over 80% of barley currently produced uses farmers landraces. The farmers can distinguish more distinct types of barley using their criteria than could be achieved using the available barley variety identification. The dominating types vary between fields and localities depending on the environmental factors, farmers preferences, other crops grown in the area and the uses of the grains. Most of the cultivated barley was obtained from the farmers fields while the others from seed samples from the local markets.

4.13.1.1. Diversity of Local Landraces

The inherent potentialities of the varied landraces are poorly studied and underutilized at the local level and improvement works have not been undertaken on an adequate scale.

Table 10-Vernacular name of local landraces diversity and its meaning

Vernacular Name	Meaning of Name
Garbu guracha duda	Black barley compact type
Garbu guracha hado	Black barley original type
Garbu adi duda	White barley compact type
Garbu adi hado	White barley original type
Garbu wolloye	Barley from Wollo region
Firezebegna dima	Horse guard red type
Firezebegna gare	Horse guard grey type
Chuchiye adi	“Baby” barley white type
Kukurfe adi	Stout white type
Garbu kerfe	……..
Garbu mouga	Dizzy (sleepy) barley

Vernacular Name	Meaning of Name
Garbu butuji adi	……..
Garbu duda Sidamo	Compact form of Sidamo
Workineh	Golden type
Garbu mage	…….
Temeja adi	Hull-less white type
Temeja adi duda	Hull-less white dense type
Lukaa adi balekaport	Lazy white jacketed type
Lukaa guracha balekaport	Lazy black jacketed type
Gealemie	Of two months
Semereta dima	“Semereta” red type
Semereta bora	“Semereta” grey type
Weketena	……
Kete adi	Kete white type
Kete guracha	Kete white type
Balami adi	Two-parted white type
Balami bora	Two-parted grey type
Lukaa bora	Lazy grey type
Lukaa adi	Lazy white type
Lukaa guracha	Lazy black type

Table 11- Description of barley landraces cultivated in Dandi and Jeldu districts, West Shewa zone, Ethiopia.

Vernacular Names	Seed Color	Head,Caryopsis type	Maturity (months)	Preferred end-use	Agronomic remarks
Ababadhas	White	6-row, hulled	5	kinche,chuko and injera	long spikes, drought tolerant, lodging, light & chaffy seeds
Abashewaye	white, purple	6-row, hulled		injera, beverage	tall plant height
Balame	white,	2-row, hulled	5-5½	injera,kinche,	tolerant to low soil

Vernacular Names	Seed Color	Head,Caryopsis type	Maturity (months)	Preferred end-use	Agronomic remarks
Balame-adi Balame-guracha	black			chuko, beso, porridge, beverage	fertility and drought, good flour quality
Butuji Butuji-adi Butujigurach	white, black	6-row, hulled	early	malt (bikil), homemade beer, liquor	short plant height, lodging tolerant, requires fertile soils, large grain size, high yields
Garbu guracha	Black	6-row, hulled	6	malt, beverage	needs fertile soils, high yields, tall plant height, tendency to lodging
Hadho (Garbu hadhoadi)	White	6-row, hulled	6	injera, kinche, chuko	large seeds, good flour quality, tall plant height, lodging tendency, susceptible to drought and cold, straw for livestock feeding
Kate	white, black	2-row, hull-less	3-3½	malt (bikil), beverage, roasting	short plant height, lodging tolerant, seed shape similar to wheat grains
Kitankite	White	6-row, partially Hulled	4	kolo, beverage	small seed size, short plant height, loses easily the hulls after heating, needs fertile soils
Luka'a (Senefgebs)	white, black	2-row,half Hulled	4-5	roasted, kinche, beso	prefers fertile soils, low yield
Muga	Purple	6-row, hulled	7	injera, beverage, liquor, porridge	large seeds, house construction, needs long rainy seasons and fertile soils, high grain yields, good flour yield, straw for thatched roofs
Samareta	white,	2-row, hulled	4-5	beso, injera,	large seed size, requires

Vernacular Names	Seed Color	Head,Caryopsis type	Maturity (months)	Preferred end-use	Agronomic remarks
Samareta-adi Dimicho	purple			shameta, kolo	fertile soil, tall plant height, lodging tendency, high 'vitamin' content
Shamari	Black	2-row, hulled	6	beverage, liquor, roasted	
Sidamo	white, purple, black	6-row			probably named after the Sidamo region, located in the southern parts of Ethiopia
Warkina	White	6-row, hulled	3-3½	beso, porridge, beverage	short plant height, tolerant to lodging, prefers fertile soils, residual moisture production system

Source: www.ethnobotanyjournal.org/vol8/i1547-3465-08-025.pdf

4.13.1.2. Diversity of Improved Barley Varieties

The natural processes and traditional practices still play a bigger role in the "improvement" of barley varieties. The name of improved barley varieties and their unique characteristics discussed as follows.

HB1307: High yielding, lodging resistant, resistant to leaf diseases with good biomass yield and white seeded

Dimtu: Good yield under low input conditions with good biomass yield

Cross 41/98: High yielding, late maturing

Balame: Tolerant to low soil fertility and drought, good flour quality

Shege: Good yield under low input conditions and tolerant to major leaf diseases.

EH1493: High yielding, late maturing

HB42: Resistant to scald and good biomass yield

Miscal: High yielding with good malting quality; resistance to lodging with multiple disease resistance

Dribie: Tolerant to drought

4.13.2. Barley Technological Adoption Study

This section determines the level and extent of barley technological adoption. The agriculture and rural development policy direction of Ethiopia is to enable farmers use modern agricultural technologies and new agricultural practices efficiently and effectively to increasing production and productivity.

Adoption of improved technologies offers potential advantages for increasing productivity and income for smallholder farmers. The level of awareness of technologies was generally good. Adoption was the highest for the cases of improved wheat in contrast to improved barley varieties with intermediate level of adoption. The level and distribution of adoption was significantly influenced by HARC extension input and by household food self-sufficiency. Landraces are generally to be used in production as a source of foods, beverages and other uses. As a results, characterization and sorting of indigenous and improved barley varieties receive little appreciation from barley producers. The indigenous barley and farmers knowledge has never been seriously considered by the modern sector of Ethiopian agriculture. Increased emphasis is being made to incorporate traditional landraces, indigenous knowledge and technological adoption in barley improvements efforts. The efforts to improve the status of barley in Ethiopia can be channeled along different lines.

These includes, the better local types can be selected for agro-ecological zones considering performance, yield, adaptability, and community acceptance as well as mixture of the several landraces can be formulated considering their co-adaptive relations. Both the local and the improved food barley varieties with high yielding could be accommodated side by side by cultivating the former in less favourable areas and seasons while the later can be used to improve the production under favourable and high management practices. It must be possible to combine the native landraces, traditional farmers knowledge, modern varieties and modern management practices in the agricultural system of the country.

In traditional farming, human and natural processes still strongly interact to determine the proportion of change in barley varieties. Two levels of human processes should be taken into account: first, the seed diffusion between farmers; second, cultural practices such as artificial selection and seed storage conditions. Because farmers use their own saved seed for different years, seed diffusions are not very frequent. There are different factors affecting technology adoption that encourage or discourage households to use improved technologies. These include

access, food self-sufficiency, ethnicity and gender. Age, farm experience, oxen, membership of cooperative, distance to all weather roads and annual income were found to be significant variables affecting the proportion of improved barley varieties technology adoption.

4.13.3. Cultural Significance of Barley

The economic importance, the cultural role and the local naming system for different forms of barley determines its speciality in both districts in terms of utilization. A review of some of the important practice of the Oromo community an ethnic group (nationality) making the overwhelming majority of the inhabitants in Holeta was bring to light the cultural significance of food barley. Moreover, the important roles played by barley local cultivars in the cultural and religious aspects of the Oromo people have been discussed by several authors (Gugsa, 1975; Hassan 1983 both cited in Negassa, (1985a).

4.13.3.1. The Gadaa system

Gadaa is the name given to very old traditional organization of the Oromo society of Ethiopia. Asmarom (1973) states that gadaa is unique institution of temporal differentiation of the Oromo community of Ethiopia. The Oromos living within a certain boundary have a complex organization in which five age groups are recognized. Each age has defined rank and responsibilities. After period of eight years a gallant ceremonials occasion held, those aged forty retire from the system and younger are promoted to the next higher rank. The elders handle the responsibilities of councilors, planning and resolution of disputes, while the younger defense and other affairs. The system is said to have operated at least for 400 years (Asmarom 1973).

The farmers of Holeta affirmed that among the important cultural dishes and drinks served for gadaa ceremonies barley porridge (merqa) and fermented barley beverage (tella) take a central place, indicating how this crop is tied up with their cultural life. The porridge is made of white barley that is completely dehulled and ground into fine flour. The beverage is made of some barley malt roasted and coarsely ground grains to which ground stems and leaves of a flavoring plant hopes (*Rhamnus prinoides*) and water will be added. The infusion is sealed in a jar and left for a week to ferment and clear. In some cases the barley is malted into dough which is partly eaten and partly made into a special beverage called Buquri. However, the gadaa system is no longer as important as formerly.

4.13.3.2. The Atetee

This is another widely celebrated Oromo practice in which rituals wishing healthy life and promulgation of prosperity for the family members. A special barley porridge (kinche) and partially fermented barley beverage (gush tella) obligatory for this ceremony in areas where barley hardly cultivated. It is commonly practiced by Christians but completely disapproved by the church. It is not a religious ceremony as such but considered a sort of archaic religion.

4.13.3.3. The Ghinie

This is celebrated at the family level for wishing healthy life and high productivity to domestic animals. Barley porridge (merqa) is prepared inside cattle shed and eaten there by the members of the family together with neighbors. A similar practice for wishing healthy harvest and high yield is also performed by families and the food served is besso, barley flour of roasted grains moistened with water. Some families make porridge and fermented beverage from barley and sprinkle it on the back of their cattle with the firm belief that it would save them from any kind of epidemic disease.

4.13.3.4. The marriage traditions

In the old days, Oromo parents were asked to permit marriage of their daughters to suitors. They required some time before the decision was made. During this time, they prepared malt, observed the manner of germination and based their acquiescence or rejection on that. It is said that the manner of grain germination was used to predict if the requested marriage was going to be a fruitful or not. If they accepted the request the malt would be kept on the smoke in the house for a year or two in order to improve the quality of the tella that will be prepared from it for the wedding. The malt is always prepared from barley; the carbohydrate source is also preferentially barley but other crops like maize, sorghum etc can be substituted.

4.13.3.5. The Songs and Sayings on Barley

Table 12-Traditional songs, phrases and sayings linked to barley varieties cultivated in Ethiopia

Traditional saying	Meaning	Description	Notes

Traditional saying	Meaning	Description	Notes
Ya abalu garbuu nuu ta'i	Please be barley for us	Expression to another person to be as kind as barley	Refers to the tolerance of barley
Abalu garbu dha	He/she is barley	A person who bears any kind of burden or stress	Refers to the wide adaptation of barley
Manyaan rakasee, garbuun kiiloo kore	Barley became more expensive than tef	Increasing the price of barley	Refers increasing importance of barley for farmers
Dadhiin bishanuma, itti buusi farsoo gaariin midhaanuma	Well prepared farso is more a food than tej	Farso (local barley beer) is believed to be more nutritious than dadhi (local drink made from honey) from balame barley	Refers to end-use quality of barley
Akkana sanyiin mootii, Balame xajjii gooti	The woman deserves respect	Females makes tej from balame barley	Refers to the excellent brewing quality of balame
Itti hammaari garbuu, itti hammaaran malee fardi daarii hin darbu, dhiirris roorroo hin sarmuu	Feed the horse with barley Otherwise it cannot cross the border	Horses fed with barley will become strong and powerful	Refers to the food and feed quality of different barley varieties

Traditional saying	Meaning	Description	Notes
Mangaagaa raasaan bulee, garuu garaanhagabuu na bulee	I was eating all through the night, but still I feel hungry	Used for comparison of barley with other cereals e.g., sorghum, wheat, maize	Refers to the food quality of barley
Garbuu jedhi garbichi, balaa danada'a	Barley and servants tolerate hardship	Expression of the tolerance of barley and slaves	Refers to the tolerance of barley to stress
Lolii qoti farsoon kooticha, buddeen furdicha	Now you can plough strongly	You drank farso and ate food made from barley grown on black soil	Refers to the nutritional quality of barley foods and beverages
Yaa Oromiya biyya koo, yaa midhaan dhirsa koo, daddagaagii margi balaan si hin argiin	Oromia my living place and barley my husband grow and flourish well	I wish you the best season	Refers to the specific adaptation and its importance of barley
Baallammi haammannee, Edsii balleessina waliin mar'anne	Let us be busy by producing more balame	Being busy in the production of balame to protect ourselves from AIDS	Prevents idleness infidelity and death by AIDS
Ballammii yaa asheeta garbu,gurba hin agartu Qerransa qaxaamuree	Balame at milk stage,guy don't you see the leopard passingby	Balame food gives strength to the grower so that there is no reason to fear the leopard	Refers to the popularity and food quality of balame barley

Traditional saying	Meaning	Description	Notes
darbuu			
Aannan bassotti dhangala'e	The milk added into beso	Praise of a food which is as tasty as beso (barley food) with milk	Refers to the food quality of barley
Garbu hangafa midhani	Barley'elder' of crops	Strong linkage between barley and Ethiopian community	Refers to the long history of barley cultivation
Garbicha garbuu nyaatu, goftaa qamadii nyaatu	The servants consume barley, the lords eat wheat	Barley is more nutritious than wheat. Therefore, hard working people should eat barley to become strong and persistent	Refers to the food quality of barley
Garbu hangafa midhani	Barley as elder of crops	Describe the long history of barley cultivation	The existence of the barley before the other crops
Biyya ormaa yaa gaaddisa mukaa aduun nama gubaa ,biyya ofii yaa gaaddisa garbuu aduun nama hin arguu	Barley as the rescue crops than the others	Signifies the importance of barley for household food security	

Source: www.ethnobotanyjournal.org/vo18/i1547-3465-08-025.pdf

During some years reduction in crop harvests are encountered due to weather conditions or other reasons as result of which food items get depleted before the next harvest is ready for consumption. The major diet of the people during such period becomes cabbages, sweet potato and other unconventional foods such as Amaranthus, portulaca.

Table 13-Traditional songs, phrases and sayings linked to barley varieties cultivated in Ethiopia

Traditional Oromo Sayings	Descriptions
Kutii kutiin inddaqqoo lafa garbutti yatee Na hin daddarbin garaa koo na daddarbutti katee	Groups of hens at barley field to find their food, my stomach don't disturb me

Traditional Oromo Sayings	Descriptions
Aka'iin qaciii koo bishaaanin gabii koo	Refers to end-use quality of barley kolo with water
Shagee koo yaa shaggitu, ijji koo sii hin dagatu Garaan koo sii hin irranfatu, belaa ballessitetu maqaan kee dagatame sii hin dagadhu ormii yoo si dagate	The end use quality and importance of Shege barley for farmers
Galoo koo ya galitti, galaa fudhetan sitti gala masatti Aduudha jedhe hin gabbu, qorra jedhe hin dubbadhu Waqaatti darii hin darbuu, cubbu keetuu natti darba Afan koo qabadhettan, meshaa koo fudhadhetan Shara koo dirirfadhettan, masatti gala galoo koo	Refers to the more productivity of Gelane barley. Farmer stay at farm field to harvest
Biyya orma aduun nama gubaa, biyya ofii yaa gaddisa garbuu, duun nama hin argu	Barley as a rescue crop because it's of early maturity of period
Garbuu yaa midhan nyata, nama qubsita maltu si himata	Refers to the excellent nutritional quality of barley
Dhibee garracha namatti fura, hir'ina dhiga bakka busa	Refers to the medicinal value barley
Garbuun nyaata (boranticha), fardaa fi garbbicha	Barley as food of devil, horse & slaves.
Garbichi fi garbuun miya'e	Increasing the importance of servant & price barley for farmers
Bilee garbun, belli si hin argu taphadhu gurba	No more famine because of barley ripening
Shaggen shagga tatee shaggar bate	Refers to the wide adaptation of Shege barley and its escape from local market
Galaneen gala nu jala fixxe	Refers to the productivity of Gelane

Traditional Oromo Sayings	Descriptions
	barley
Nami garbu nyaatu dafee hin bela'u, hin dullomus, hin du'us	A person fed on the barley never famine, aged and died soon
Humna nama kenna, dugda ni jabbessa	A person fed with barley will become strong and powerful
Shaggen belaa ballessite	Shage barley becomes dominant over famine
Anati si dha'e miti barsadaaditi si dha'e	Refers to the high alcoholic content of beer or liquor made of barley variety barsadadi.
Holataa yaa biyya koo, mee dadagaagii margi garbuu ya dhirsa koo, iji amtuun si hinargiin	Holataa is the place where high production of barley in west Shewa.
Ayyaana waggaatti dufoo –daabboo baatanii waaqa kadhatu jedhama	Refers to the tradition of bread serving and worshiping during holidays

Barley cereal reverses leaf-based famine diet into grain-based normal diet due to its early ripening compared to other grain crops. This is well reflected in some of the traditional songs and sayings of the different Ethiopian nationalities. The traditional Oromos song that begins "balli garbu darare" brings the good news that the barley has flowered and nothing to worry about any more. The Amhara people, one of the big nationalities of Ethiopia song that includes the line "ayzosh nefsie dereselish gebse" is meaning take it easy my soul, my barley has ripened to rescue you. This is sung jointly by family members during an evening camp-fire shortly before the first harvest of season, on the eve of the Ethiopian New Year.

The Amharic saying "minim biarsu inde gebs ayafsu" means "no matter how much one ploughs, one cannot reap as much from any other crop as that of barley". Such songs and sayings show that this crop is so important that it has become completely integrated in every day affairs.

4.13.4. Common practices

Very frequently grains are inside the house or under the shade of a big tree at the village. On this occasion a couple of handfuls of barley roasted grains are scattered in all directions for the bad spirits that are said to become harmless after eating it. The rest of the roasted grains is shared among those present and eaten while coffee is being taken.

4.13.5. Traditions belief about origin

Pointing to the antique of barley in Ethiopia Haberland (1963) has explicitly stated that in the primeval Oromo agriculture only one crop was grown and that was barley. The Oromo name for barley, garbu, is an original Oromo word. Haberland (1963) according to Oromo belief, barley was created by God to be used for sacrificial purposes. Among the Oromos, barley was considered as the holiest of all crops, also by tribes in whose area barley can hardly be grown (Haberland, 1963). Parallel to this the ancient Greeks thought that barley was the primary food given by the Gods (Briggs 1978). Besides the economic importance, a special significance of symbolic and occult nature is attached to this crop by the Oromos. Such an attitude is declining today because other crops like wheat have become intruded in most of the highland; considerably reducing the dependency on barley. Historical evidences (Mohammed 1983), suggests that the crop had immensely contributed to transform the originally nomadic Oromos to a settled genteel society through making their life more tell secure.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Barley is the fourth most important cereal crop, in production, next to wheat, maize and rice on the world (Zohary and Hopf, 1988). Barley is the third crop next to wheat and teff both in terms of acreage and production in the surveyed area. It is the most dependable and desirable crop for the resource poor farmers where poor soil fertility, frost, water logging, soil acidity and degradation are the major yield limiting factors, and where other cereals fail to grow. In such areas, barley is the major source of food, cash, home-made drinks and animal feeds. Barley grain is used in a diversity of traditional recipes and its preparation deeply rooted in the culture and tradition of rural people's diets.

The major seed sources of barley (landraces and improved) varieties are HARC, neighbors through exchange, farm saved seeds, extension services (government or seed enterprises) and local markets. Farmers store barley grains and seeds in plastic bags to protect from weevils, molds damage and other physiological changes that cause loss of viability.

Barley grains produced from different varieties are stored separately unless they are grown in mixtures. Barley grains can be stored for 2-3 years depending on the storage conditions, with dry and cold places being ideal for long storage. Farmers hardly produce any surplus that can be stored for more than a year. The farmers justifications for planting time match with the agronomic principles for production of barley. Very small amount of barley grain is sold to generate cash.

The Kiremt barley production is the only system in both Welmera and Ejere woredas, i'e there is no Belg season and other production barley production systems in the study area. The improved food barley varieties grown by farmers in the study districts purposely maintain different varieties to address various needs.

These needs included suitability for early or late maturity, yield potential in relation to the type of environmental conditions, conditions of the soils (i.e. water-logged, fertility or frost effects), and intended dishes and beverages (includes quantitative and qualitative aspects such as product volume, taste, color, storability etc).

Local and improved barley varieties vary in maturity, yield potential, stress tolerance, end-use qualities and other agronomic traits. Information concerning the impacts of socio-cultural conditions of local farmers on the maintenance of barley varieties and other crop genetic resources are rare in study area and other parts of Ethiopia.

The straw is used as animal feed, especially during the dry season. Further studies on improving indigenous knowledge of local farmers, developing suitable improved food barley varieties and improving the food utilization of barley including processing techniques could contribute to food security of our country. There are many nutritional and impressive health benefits of food barley varieties. Farmers use folksongs and proverbs to express the end use qualities and their agronomic characteristics of different barley (local and improved) varieties.

Some value specific variations were observed in the way barley foods were processed. The main limitation consistently mentioned by the farmers interviewed in the study area with regards to food preparation from barley was that the manual processing of the varieties (i.e. dehulling, grinding, sieving, and roasting) is very time consuming. The manual processing and removal of the hull also have wastage of some grains and it is also likely to have a negative effect on the nutritive value. Hence, it is important to investigate how to adapt for Ethiopia the various studies conducted on barley as a food with a view to mechanizing many labor-intensive manual operations with simple utensils to maximize the benefits of barley as a food.

In Holeta, barley is multipurpose crop. It is botanically diverse and the farmers who used it for centuries knew very well the names diagnostic features and the growth requirements of the cultivated in their vicinity. It is the single cereals intricately tied up with the socioeconomic life of the people, even to the data this area qualifies as of the best pockets for any kind of work towards an *in situ* development of promising landraces.

The indigenous knowledge of landraces and technology adoption on food barley varieties reflects key quantitative and qualitative traits. Further studies on improving maintenance and utilization of improved food barley varieties, developing suitable varieties and improving the food utilization of barley including processing techniques could contribute to food security of the area and then of country.

Both physical and compositional properties of barley grain are important with respect to food use as the food value of barley as sources of energy is highly acknowledged by the farmers.

5.2. RECOMMENDATIONS

The following conclusions form the basis of recommendations for the future assessment of indigenous knowledge of the local farmers in the study area of Ethiopia. Recommendation domains are defined as a group of farmers whose circumstances are similar enough that the same recommendation can be given. In other words, places and sets of conditions for which a particular target technology is considered feasible and good to promote. The recommended domains for barley production are areas with altitude ranging from 2000 to 3500m asl, 15-20^{o}c temperature, with an annual rainfall of 500 to 1200mm and well drained fertile soil. The farmer should have access to capital or credit to purchase inputs, such as improved seed, fertilizers, other inputs and transportation means by his/her own or by payment. The following recommendations are being proposed for further studies on local landraces and improved food barley by the researcher: (i) Identification of more barley landraces with high nutritional value using indigenous knowledge of local farmers: (ii) Isolation of more popular local landraces and improved barley varieties with its specific end uses, (iii) Improvement of the indigenous knowledge of the local farmers on both the local landraces and the improved barley varieties, (iv) Selection of barley (local and improved) varieties in terms of cultural and economic importance for sustainable development and poverty reduction, (vi) Improve the maintenance and utilization of barley varieties, (vii) Attention should be given to conservation of local landraces and improved barley varieties in order to avoid the genetic erosion and on the suitability for improved barley foods, (viii) there is a need for research on the barley quality traits required for the different dishes under different processing conditions including why some varieties are suitable for a specific food product.

The results obtained in this study provide a better understanding on traditional farmers indigenous knowledge of local farmers on local landraces and technological adoption on food barley varieties at Welmera and Ejere woredas. Based on the results of this thesis indigenous knowledge of the two districts farmers can be evaluated how to prepare and process different barley foods and alcoholic and non alcoholic drinks. The proportion of technology adoption used in this study can lead to improve the food barley end uses that play a vital role in poverty reduction of our country.

REFERENCES

Abbasi, A.M., Khan, M.A., Ahmad,M., Zafar, M. 2012.Medicinal Plant Biodiversity of Lesser Himalayas-Pakistan. P: 1-3.

Adrian Clive Newton & Andrew J. Flavell & Timothy S. George & Philip Leat & Barry Mullholland & Luke Ramsay & Cesar Revoredo-Giha & Joanne Russell & Brian J. Steffenson & J. Stuart Swanston & William T. B. Thomas & Robbie Waugh & Philip J. White & Ian J. Bingham. 2011. Crops that feed the world 4. Barley: a resilient crop? Strengths and weaknesses in the context of food security. P: 141-143.

Alka Vasan+, Manisha Mani, and Pinky Boora. 2014.Barley Foods and Health: Opportunities Ahead. P: 1-3.

Alnarp. 2013. Barley cultivation fields, barley spikes, seed collecting and field trials. P: 3-15.

Amanda Boxes. 2008. The Biology of the Hordeum vulgare L. (Barley). P: 4-5

Asresie Hassen, Molla Tafere, Mekonen Tolla, Seferew Dagnew, Abel Ahmed, Yihenew G.Selassie, Desallegn Molla and Alemu Worku. 2015. Best fit practice manual for food barley production. P: 5-8.

Bayeh Mulatu and Stefania Grando. 2006. Barley Research and Development in Ethiopia. Proceedings of the 2nd National Barley Research and Development Review Workshop Holetta Agricultural Research Centre, Ethiopia, 28–30 November 2006. P: 23-24.

Bedada Begna, Mesay Yami and Eshetu Lemma. 2014. Characterization of a barley based farming system in the Arsi Highlands, Ethiopia. P: 1 and 2.

Bingxin Yu, Alejandro Nin-Pratt, José Funes, and Sinafikeh Asrat Gemessa. 2011.Cereal Production and Technology Adoption in Ethiopia. Development Strategy and Governance Division. International Food Policy Research Institute, Ethiopia Strategy Support Program II (ESSP II) ESSP II Working Paper 31.P:7-17

Fassil Kebebew, Yemane Tsehaye and Tom McNeilly. 2001. Morphological and farmers cognitive diversity of barley (Hordeum vulgare L. (Poaceae) at Bale and North Shewa of Ethiopia. P: 1-3.

Fetien Abay, Ann Waters-Bayer, Åsmund Bjørnstad. 2008. Farmers' Seed Management and Innovation in Varietal Selection: Implications for Barley Breeding in Tigray, Northern Ethiopia. P: 2.

Fetien Abay, Asmund Bjørnstad and Melinda Smale. 2009. Measuring on Farm Diversity and Determinants of Barley Diversity in Tigray: Northern Ethiopia. P: 1-5

Fetien Abay, Asmund Bjørnstad and Melinda Smale. 2009. Measuring on Farm Diversity and Determinants of Barley Diversity in Tigray: Northern Ethiopia. P: 1-5

Firdissa Eticha, Woldeyesus Sinebo and Heinrich Grausgruber. 2010.On-farm Diversity and Characterization of Barley (Hordeum vulgare L.) Landraces in the Highlands of West Shewa, Ethiopia. P: 26-30.

Gina Egbert. 2008. Entry prepared in College Seminar 235 Food for Thought: The Science, Culture, & Politics of Food Spring. P: 1- 9.

Girma Megersa, Firew Mekibib and Berhane Lakew. 2015. Performance of the farmers and improved barley for yield components and seed quality. P: 1 and 2.

Girma Megersa. 2014. Genetic erosion of barley in North Shewa Zone of Oromiya Region, Ethiopia. P: 1 and 2.

Hailemichael Shewayrga and Peter A. Sopade. 2011. Ethnobotany, diverse food uses, claimed health benefits and implications on conservation of barley landraces in North Eastern Ethiopia highlands. P: 5-12

J.A.G. van Leur1, and Hailu Gebre. 2002. Diversity between some Ethiopian farmer's varieties of barley and within these varieties among seed sources. P: 1

J.A.G. van Leur1, and Hailu Gebre. 2003. Diversity between some Ethiopian farmer's varieties of barley and within these varieties among seed sources. P: 1

K. Sato et al. 2014. Genetic Diversity and Germplasm Management: Wild Barley, Landraces, Breeding Materials. P: 21-23.

Kassahun Tesfaye. (Unpublished). Morphological and Molecular Diversity Study of Ethiopian Barley Landraces from Central and Southeastern Highlands. P: 1-4.

Kemelew Muhe and Alemayehu Assefa.2011. Diversity and Agronomic Potential of Barley (Hordeum vulgare L.) Landraces in Variable Production System, Ethiopia. P: 1 and 2.

Lakew B, Gebre H, Alemayehu F. 1996. Barley Production and research. In: van Leur J, Gebre H (eds.). Barley Research in Ethiopia: Past work and future prospects. Proceeding of the first Barley Research Review Workshop, IAR/ICARDA, Addis Ababa, Ethiopia.1-9

Mauricio R. Bellon, Elisabetta Goter and Francesco Caracciolo. 2014. International journal of Agricultural Sustainability.Conserving landraces and improving livrlihoods: how to access the success of on farm conservation project? P: 2.

Nahusenay A1 and Tesfaye Tafesse. 2015. Rural women participation in agricultural activities and household managements in Ethiopia. P: 1-3

Negash Geleta and Heinrich Grausgruber. 2013. Homemade Products and Socio-Cultural Values of Wheat Seed Production in Ambo and Dandi Districts of West Central Ethiopia. P: 1 and 2

Phillip Bowden and Neil Fettell. Barley Growth and Development. P: 10-11

Sarfaraz Khan Marwat et al. 2012. Barley (Hordeum vulgare L.) A Prophetic Food Mentioned in Ahadith and its Ethnobotanical Importance. P: 1-7.

Shahidur Rashid, Gashaw T. Abate, Solomon Lemma, James Warner, Leulsegged Kasa, and Nicholas Minot. March 2015. The Barley Value Chain in Ethiopia. International Food Policy Research Institute (IFPRI)

Shambel Kumbi. 2001. Morphological and Biochemical Diversity in Recent collection of Barley (Hordeum vulgare L.) From Variuos Regions of Ethiopia. P 1-24.

Taner Akar, Muzaffer Avci and Fazil Dusunceli. 2004. Barley Post-Harvest Operations. P: 4-26.

Tesema Tanto Hadado, Domenico Rau, Elena Bitocchi and Roberto Papa. 2009. Genetic diversity of barley (Hordeum vulgare L.) landraces from the central highlands of Ethiopia: comparison between the Belg and Meher growing seasons using morphological traits. P: 1-3.

Tiegist Dejene Abebe. 2010. Genetic Diversity and Population Differentiation Analysis of Ethiopian Barley (Hordeum vulgare L.) Landraces using Morphological Traits and SSR Markers. P: 15-23.

Ulla Holopainen-Mantila. 2015. Composition and structure of barley (*Hordeum vulgare* L.) grain in relation to end uses. P: 10 and 11.

Wondimu Fekadu, Habtamu Zeleke and Amsalu Ayana. 2011. Genetic improvement in grain yield potential and associated traits of food barley (Hordeum vulgare L.) in Ethiopia. P: 2-4.

Xinshen Diao, IFPRI. 2010. Economic Importance of Agriculture for Sustainable Development and Poverty Reduction: The Case Study of Ethiopia. P: 7.

Yemane G/Egziabher. 2001. Frost resistance in indigenous Barley (Hordeum vulgare L.) Landraces cultivated at Different Altitudinal Ranges in Ethiopia. P: 1-23.

Yetsedaw Aynewa, Tadesse Dessalegn and Wondimu Bayu. 2013. Participatory evaluation of malt barley (Hordeum vulgare L.) genotypes for yield and other agronomic traits at North-West Ethiopia. P: 1 and 2.

Yigezu A. Yigezu, Chilot Y. Tizale, and Aden Aw-Hassan. 2014. Modeling Farmers' Adoption Decisions of Multiple Crop Technologies: The Case of Barley and Potatoes in Ethiopia.P: 2-11.

Zemede Asfaw. 1989. The Barley of Ethiopia: A focus on the Infraspecific taxa. An ethnobotanical Study of Barley in the Central Highlands of Ethiopia. P: 3-13.

Zemede Asfaw.1980. An eco-physiological study of cultivated barley in Welmera P: 8-23

APPENDICES

Appendices

Appendix 1-Format for the socio-demographic characteristics information of respondents

Part one: General Information for family members

Instruction: Tick (✔) the appropriate answer to your level best

1. Gender Male [ ] Female [ ]
2. Age [ ]
3. For how long have you been living in the area?

   < 6 years [ ] 6-15 years [ ] 16-25 years [ ] >25 years [ ]
4. Marital status Married [ ] Single [ ] Separated [ ] Divorced [ ]
5. Ethnic group Oromo [ ] Amhara [ ] Tigre [ ] Gurage [ ] Other [ ]
6. Educational back ground Unable to read and write [ ] Elementary school [ ] Primary second cycle (5-8) [ ] High school (9-10) [ ] Others [ ]
7. Position in householdHead of household [ ] Member of household [ ] Other [ ]
8. What is your origin Indigenous [ ] Settler [ ] Moved in [ ]
9. Religion 1. Orthodox 2. Protestant 3. Muslim 4. Others

Appendix 2-questionnaire for farmer's communities on food barley varieties

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF MICROBIAL, CELLULAR AND MOLECULAR BIOLOGY

A QUESTIONNAIRE ON AN ETHNOBOTANICAL STUDY AND TECHNOLOGICAL ADOPTION ON THE IMPROVED FOOD BARLEY VARIETIES IN WELMERA AND EJERE WOREDAS

QUESTIONNAIRE FOR FARMERS COMMUNITIES ON FOOD BARLEY VARIETIES

SECTION 1: BARLEY VARIETY KNOWLEDGE

1.1. Have you grown local varieties of food barley in the last 10 years? _____ 1. Yes 0. No

1.2. Have you grown improved food barley varieties in the last 10 years? _____ 1. Yes 0.No

1.3. How do you verify the origin and purity of food barley seeds? _____

1.4. What is the name of your most preferred improved food barley variety in your area?

1. Shege 2. Gelane 3.Beka 4.Other

1.5. Disease vulnerability? 1. Susceptible 2.Intermediate 3.Tolerant

1.6. Do you cultivate that variety? _____ 1. Yes 0. No

1. 7. What do you think the most important problem related to food barley varietal acquisition?

_____

SECTION 2: BARLEY PRODUCTION SYSTEMS AND UTILIZATION KNOWLEDGE

2.1. Food barleysub-plot tenure? 1. Owned 2. Rented in 3. Other _____

2.2. How fertile is the soil of this sub-plot? 1. Good 2.Medium 3.Poor

2.3. What is the soil slope of this sub-plot? 1. Gently slope (flat) 2.Medium slope 3.Steep slope

2.4. What is the soil type of this sub-plot? 1. Black 2. Gray 3. Brown 4. Red 5. Other_____

2.5. Do you practice intercropping food barley with other crops? 1. Yes 2. No

2.6. If yes, please mention the name of possible intercrops? _____

2.7. Name of previous crop grown before one season? _____

1. Potato 2. Teff 3. Bean 4. Wheat 5. Others _____

2.8. Name of previous crop grown before two seasons? _____

1. Potato 2. Teff 3. Bean 4. Wheat 5. Others _____

2.9. Herbicides used?1. Round up 2. 2, 4-D 3. Other. _____ 4. None

2.10. Name of pesticide used? _____

2.11. Was compost applied to this plot? 1=Yes 0=No

2.12. Do you know the recommended fertilizer application rate for food barley? 1= Yes; 0= No

2.13. If yes, do you apply as per recommendation? _____1= Yes; 0= No

2. 14. How many seasons improved barley seed was recycled?

1) One year 2) Two years 3) Three years 4) More than three years

2.15. Main source of seed? 1. Saved 2. Farmer to farmer exchange 3. Research centres 4. Others

2.16. What did you use for ploughing? 1. Oxen plow 2.Tractor 3.Hand hoe

2. 17. How many times was this sub-plot ploughed including planting?

1. Two times 2. Three times 3. Four times 4. Five times

2.18. How many times was this sub-plot weeded?

1. One times 2. Two times 3. Three times 4. Four times

2.19. Identify the major stress? 1. Insects/pests 2. Disease 3.Water logging 4. Frost 5. Others ___

SECTION 3: BARLEY PRODUCTION SYSTEMS

3.1. Total size of land owned in hectare? 1. Below 2ha 2. 2.1-4ha 3. 4.1- 6ha 4. Above 6ha

3.2. How much hectare land is allocated for food barley production in hectare?

1. Below 2ha 2. 2.1-4ha 3. 4.1- 6ha 3. Above 6ha

3.3. Food barley planting method? 1. Row 2. Random 3. Both

3.4. System duration in season 1. Belg 2. Kiremt 3. Other (specify) _____

3.5. Time of land preparation for barley production in month? _____

3. 6. Space between rows of food barley plants?

1. Below 10cm 2.10-20cm 3.21-30cm 4. Above 30cm

3.7. Would you use fertilizer for food barley production? 1. Yes 0. No

3.8. Fertilizer type you used for your barley production? 1. Manure 2.DAP 3.Urea

4. NPSB blended5. Not used _____

3.9. Frequency of application? 1. Once 2. Twice 3. Three times 4. More than three times

3.10. Method of application? 1. Broad cast 2. Ring 3. Side/Heaping 4. Other (specify) _____

3.11. Time of weeding (months) _____

3.12. What is your selection criterion of barley varieties? RANK

l. High yield 3. Disease resistance 5. Early maturity period

2. Tolerant to drought 4. Good taste/quality 6. Others_____

3.13. Mention the type of food barley varieties grown on your farmland? _____

3.14. Maturity period? 1. Early 2.Intermediate 3.Late

3. 15. Do you use any food barley part for variety identification? 1. Yes 2. No

3.16. If yes, what parts of the food barley are used for identification purpose? _____

3.17. What is the trends of production in the past 15 years?1. Increasing 2. Decreasing 3. Constant

3.18. Reason for the trend: _____

3.19. List of food barley varieties lost in the past years in your area? _____

3.20. Reason for the loss? _____

3.21. List of food barley varieties newly acquired in your area? _____

3.22. Reason for acquisition? _____

3.23. How much quintal food barley on average do you harvest per hectare in a year?

1. Below 8 quintal 2. 8-14 quintal 3. 15-20 quintal 4. Above 20 quintal

3.24. List major barley foods and beverages products harvested? _____

3.25. Main objective of food barley harvesting?

1. Consumption 2. Cash 3. Food security 4. Medicinal 5.Other _____

3.26. Which one is the most preferable barley product for food in your locality?

1. Injera 2. Kinche 3. Genfo 4. Dabo 5. Others (specify)_____

3.27. Do you harvest food barley plants infected by disease for consumption or other purpose?

1. Yes 0. No

3.28. If **yes**, do you take special measures to prevent disease transmission? 1. Yes 2. No

3. 29. What is that? _____

3.30. What food barley products did you produce mainly for cash requirement? _____

3.31. What food barley products did you produce mainly for consumption? _____

3.32. Which of the following factors affecting genetic erosion of food barley varieties?

1. Introduction of improved varieties 2. Replacement by other crops 3. Weather variability
4. Change in land use pattern 5. Change in land size 6. Lack of policy support

THANK YOU FOR YOUR COLLABORATION!

Lists of Annexes

Annex 1- Improved barley grown in Welmera and Ejere woredas in 2017cropping season

Responses	Frequency	Percent
YES	92	92
NO	8	8
Total	100	100

Annex 2-Disease vulnerability of preferred local barely varieties

Responses	Frequency	Percent
Susceptible	65	65
Intermediate	22	22
Tolerant	13	13
Total	100	100

Annex 3-Cultivation of local barley landrace at Welmera and Ejere woredas in past 10 years

Responses	**Frequency**	**Percent**
YES	94	94
NO	6	6
Total	100	100

Annex 4-Name of most preferred improved food barely varieties

Responses	Frequency	Percent
SHEGE	52	52
GELANE	33	33
BEKA	9	9
OTHERS	6	6
Total	100	100

Annex 5-Disease vulnerability of preferred improved barely varieties

Responses	Frequency	Percent
Susceptible	2	2
Intermediate	59	59
Tolerant	39	39
Total	100	100

Annex 6-Cultivation of improved barley at Welmera and Ejere woredas in past 10 years

Responses	Frequency	Percent
YES	99	99
NO	1	1
Total	100	100

Annex 7- Barley sub-plot tenure

Responses	Frequency	Percent
Owned	82	82
Rented	17	17
Others	1	1
Total	100	100

Annex 8-Total sizes of land owned in hectares

Responses	Frequency	Percent
Below 2 hectare	54	54
2.1-4 hectares	26	26
4.1-6 hectares	14	14
Above 6 hectares	6	6
Total	100	100

Annex 9-Total land allocated for barley production

Responses	Frequency	Percent
Below 2 hectare	79	79
2.1-4 hectare	16	16
4.1-6 hectare	4	4
Above 6 hectare	1	1
Total	100	100

Annex 10-The soil fertility of the farmland allocated for barley production

Responses	Frequency	Percent
Good	39	39
Medium	55	55
Poor	6	6
Total	100	100

Annex 11-The soil fertility of the farmland allocated for barley production

Responses	Frequency	Percent
Gently slope	60	60
Medium slope	20	20
Steep slope	12	12
Total	92	92

Annex 12-The study area soil type of barley sub-plot

Responses	Frequency	Percent
Black	31	31
Gray	9	9
Brown	40	40
Red	12	12
Other	8	8
Total	100	100

Annex 13-Practices of inter cropping of barley with other crops

Responses	Frequency	Percent
YE	1	1
NO	99	99
Total	100	100

Annex 14-Different crops for rotation in different seasons in the study areas

Responses	Frequency	Percent
YES	94	94
NO	6	6
Total	100	100

Annex 15-Modes of manure application on barley plot

Responses	Frequency	Percent
Broad casting	92	92
Ring	5	5
Other	3	3
Total	100	100

Annex 16-Fertilizer application rate on barley sub plot

Responses	Frequency	Percent
YES	91	91
NO	9	9
Total	100	100

Annex 17-Fertilizer application recommendation for barley production

Responses	Frequency	Percent
YES	84	84
NO	16	16
Total	100	100

Annex 18-Method of land preparation for barley production

Responses	Frequency	Percent
Oxen plow	98	98
Tractor	1	1
Hand hoe	1	1
Total	100	100

Annex 19-Barley planting methods in Ejere and Welmera woredas

Responses	Frequency	Percent
Row	9	9
Broadcasting	9	9
Both	82	82
Total	100	100

Annex 20-Space between rows of barley plants

Responses	Frequency	Percent
Below 10cm	3	3
10-20cm	59	59
21-30cm	38	38
Total	100	100

Annex 21-Fertilizer application for barley production in study area

Responses	Frequency	Percent
YES	97	97
NO	3	3

Total	100	100

Annex 22-Fertilizer application frequency on food barley sub plot in a year

Responses	Frequency	Percent
Once	57	57
Twice	34	34
Three times	9	9
Total	100	100

Annex 23-Name of herbicides used for barley production

Responses	Frequency	Percent
Round up	3	3
2,4-D	89	89
Others	6	6
None	2	2
Total	100	100

Annex 24-Harvesting barley plants infected by Ergot fungus for different purpose

Responses	Frequency	Percent
YES	27	27
NO	73	73
Total	100	100

Annex 25-Special measures the farmers taken to prevent barley plant disease transmission

Responses	Frequency	Percent
YES	12	12
NO	88	88
Total	100	100

Annex 26-Barley maturity period of the local landraces

Responses	Frequency	Percent
Early	42	42
Intermediate	51	51
Late	7	7
Total	100	100