



**Diversity in Farmers' Varieties (Landraces) of Common Bean
(*Phaseolus vulgaris* L., Fabaceae) in South Wollo and East
Gojjam Zones of Amhara Region, Ethiopia**

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(*Phaseolus vulgaris* L., Fabaceae) in South Wollo and East
Gojjam Zones of Amhara Region, Ethiopia**

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This is to certify that the Thesis prepared by Menbere Berhane G/Egziabehar, entitled: “Diversity in Farmers’ Varieties (Landraces) of Common Bean (*Phaseolus vulgaris* L., Fabaceae) in South Wollo and East Gojjam Zones of Amhara Region, Ethiopia” and submitted in partial fulfillment of the requirements for the degree of master of science in Plant Biology and Biodiversity Management complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

Diversity in Farmers' Varieties of Common Bean (*Phaseolus vulgaris* L., Fabaceae) in South Wollo and East Gojjam Zones of Amhara Region, Ethiopia

Menbere Berhane G/Egziabehar, MSc. Thesis

Addis Ababa University, June 2017

*This study was conducted on common bean (*Phaseolus vulgaris* L., Fabaceae) varieties identified by farmers of South Wollo and East Gojjam. The field study was conducted in two of the main production areas of the species focusing on 12 kebeles (smallest administrative units) distributed in six districts within the two zones of South Wollo and East Gojjam of Amhara Region. The main objective of the study was to investigate on the diversity of common bean landraces (farmers' varieties) and to know the ethnobotanical values of the crop. The field study was carried out between October 2016 and January 2017. A total of 168 informants comprising 144 general informants and 24 key informants (84 men and 84 women) aged between 19 and 75 years were interviewed. Structured interviews with general informants and semi-structured interviews with key informants, field observations, guided field walk and market surveys were used to collect information at the household level and at market places. Descriptive statistics, informant consensus, preference ranking, ANOVA (analysis of variance), Shannon-Wiener diversity index and t-test were employed for the analysis of the data by using R-software (R-studio) v 3.2.2 and MS Excel 2016 spread sheet. The findings are presented in tables, figures and words. A total of 69 common bean landrace seed samples were collected. The majority of the farmers gave names to their varieties based on morphological traits, seed color, seed taste and maturity time. Interview results indicated that the majority (80%) of the informants asserted that they cultivate local landraces, of which seven distinct farmer-named types of common bean landraces were sorted out. Common bean landraces were mainly cultivated as a sole crop but intercropping was also practiced. The dominant landraces were NECH BOLOQE in the four strata (SM3 of S. Wollo, M2 of S. Wollo, M3 of E. Gojjam and M2 of E. Gojjam) ranging from 70 to 40 % followed by KEYE BOLOQE and DALECHA BOLOQE. TEKUR BOLOQE was found (12 % of occurrence) in M2 of S. Wollo. Informants showed that common bean is an important food item mainly consumed in the form of SHIRO (fine ground grains used in the making of sauces), KIK (split grains for sauce making) and NIFRO (boiled grains). Uses of common bean varieties for human consumption and income generation have statistically significant difference ($p < 0.05$) among varieties. NECH BOLOQE was shown to be extremely important for income generation (98%) whereas KEYE BOLOQE and TEKUR BOLOQE were said to be important for human consumption. The grains of this crop were among the important marketed grains in the local markets at kebele and district levels. Moreover, farmers showed that common bean is an important crop for animal feed, agroecological intensification through intercropping and crop rotation, as medicine and the flowers are foraged by honeybees. Varieties varied significantly ($P < 0.05$) in their resistance to diseases and pests. However, there is no statically significant difference ($P > 0.05$) in resistance to frost among varieties both in S. Wollo and E. Gojjam. The study has confirmed the essential role that traditional farmers play in the development and maintenance of common bean landraces and therefore farmers' practices need to be backed up and enhanced for effective conservation of the genetic resources found in the study area and elsewhere in the country. Education and awareness raising of the local farmers and further research are needed in order to maintain the landrace diversity and the genetic resources of common bean.*

Key words: Common bean, diversity, landrace/farmers' variety, Ethiopia, farmers' knowledge

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Acronyms

AEZ	Agroecological Zone
ANOVA	Analysis of Variance
CIAT	International Center for Tropical Agriculture
COMESA	Common Market for Eastern and Southern Africa
CSA	Central Statistical Agency
EBI	Ethiopia Institute of Biodiversity
E. Gojjam	East Gojjam
FAOSTAT	Food and Agriculture Organisation of the United Nations (FAO)Statistics
GIS	Geographical information System
SSA	Sub Saharan Africa
S. Wollo	South Wollo
SM3	Tepid sub moist mid highland
M2	Warm moist lowland
M3	Tepid moist mid highland
NMSA	National Meteorological Service Agency
ODK	Open Data Kit

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the study

Legume seeds are an important staple foods and sources of dietary minerals that potentially provide all of the 15 essential minerals required by humans. Common bean (*Phaseolus vulgaris*) is the most vital grain legume for direct human consumption. The species has high diversity as seen in its morphological variability, uses and growth habits and patterns (Baeta *et al.*, 2010; Heuze *et al.*, 2013). In the study area, common bean is known as BOLOQE in the local Amharic language. Other names of the crop include dry bean, bean, kidney bean, haricot bean, French bean and field bean. It is a particularly important legume crop grown worldwide. It grows best in warm climates at temperatures of 18 to 24°C (Gebre-egziabher Murut *et al.*, 2014).

This crop is currently estimated to be one of the most important legumes worldwide and it is described as a nearly "perfect" food. Nutritionally rich, it is also a good source of protein, dietary fiber and complex carbohydrates (Pachico, 1993) and it is an important source of nutrients for more than 300 million people in parts of Eastern Africa and Latin America, representing 65% of total protein consumed, 32% of energy and a major source of micronutrients, e.g., iron, zinc, thiamin and folic acid (Petry *et al.*, 2015). It is also important in Nitrogen fixation thus improving the soil fertility as well as increasing crop production and improving the livelihoods of farmers (Gebre-egziabeher Murut *et al.*, 2014). It is described as a non-sensitive crop to soil as long as it is well-drained and fertile (Rahman *et al.*, 2014). It can be grow successfully on most soil types, from light

sands to heavy clays, but friable, deep and well-drained soils are best preferred (Gifole Gidago *et al.*, 2011).

According to Margaret *et al.* (2014), common bean in Sub-Saharan Africa (SSA) is an important crop for food-security and nutrition. It plays a big dietary role, supplying proteins, carbohydrates, essential elements and vitamins to both rural and urban households. It is estimated that the crop meets more than 50% of dietary protein requirements of households in SSA. The annual per capita consumption is higher among low-income people who cannot afford to buy nutritious food stuff, such as meats and fish (Arenas *et al.*, 2013).

Common bean is also a major food and cash crop in Ethiopia as well and it has considerable national economic significance. It is often grown as cash crop by small scale farmers and used as a major food legume in many parts of the country where it is consumed in different types of traditional dishes (Kedir Oshone *et al.*, 2014). For a very long time, it has been cultivated as a field crop. Moreover, for more than 40 years it has been an export crop (Rahmeto Negash, 2007). It is cultivated in a wide range of agro-ecologies and farming systems including well-watered and drought-stressed areas (Asrat Asfaw *et al.*, 2009).

This crop is distributed and grown in different parts of Ethiopia depending on climatic and socio-economic factors and is being part of the diets of the farming households; it serves as a source of protein to supplement the protein deficient main dishes like maize and Enset in the southern parts of the country especially in Wolaita and Sidama areas. Besides, the farmers also grow common bean to use the straw as forage for livestock,

source of fuel, mulching, bedding, and covering material for houses of poor farmers (Kefyalew Dagneu *et al.*, 2014). In Ethiopia, the major common bean producing areas are central, eastern and southern parts of the country (Hirpa Legesse *et al.*, 2013).

Common bean production has been practiced in all Regions of Ethiopia. Oromia (43%), Amhara, SNNPR, Benishangul-Gumuz and Tigray Regions are the major producing Regions that contribute more than 99 percent of the total production. Among the major bean producing zones, which provide more than 50 percent of their produce for market are East Gojjam (63%), East Showa (53%). West Arsi, South Gonder and South Wollo provide more than 40% of their produce for market. These areas are the major surplus producing area of white beans and almost all beans that are used for export purposes are collected from these areas (Frehiwot Mulugeta, 2010).

1.2. Statement of the problem, Research questions, Hypotheses and Research objective

1.2.1. Statement of the problem

Even though common bean is an important food security crop, the production of the crop is inconsistent due to biotic and abiotic stresses. However, integration of *Phaseolus vulgaris* with the current farming system using native farmers' varieties can make a significant contribution to improving soil fertility and productivity, improving dietary quality and reducing susceptibility to the effects of climate change (Zeven, 1998). Reservoirs of useful genetic diversity of landraces need to be conserved for the uncertainties of the future. There are few studies done in Ethiopia on beans and most of them focus on adoption, agronomic aspects, breeding, disease resistance aimed at

increasing yield (Agete Jerena, 2014). However, studies on farmers' varieties diversity and germplasm collection of this potential resource is important to guarantee the improvement of the crop. Such studies can be a source of new genes for combating different threats to agricultural production. Therefore, this study was initiated to assess and document the landrace diversity and the ethnobotanical aspects of common bean (*Phaseolus vulgaris*) in South Wollo and East Gojjam zones of Amhara Region.

1.2.2. Research questions

This research has attempted to answer the following main research questions:

- What are the most preferred uses of common bean in South Wollo and East Gojjam Zone?
- What are the common bean (*Phaseolus vulgaris* L.) landraces found in the study area and which ones are most commonly used by the farmers in the area?
- What are the local names of the landraces of common bean and what are their respective meanings?
- What are the economic values of common bean in the study area?
- How is common bean cultivated (sole cropping, intercropping, crop rotation and border cropping) in the three agroecological zones found in South Wollo and East Gojjam Zones?
- What are the problems associated with the production of common bean in the study areas?
- What conservation and management measures are required to be undertaken for cultivation of common bean?

1.2.3. Research hypotheses

- There is no significant difference in the common bean landrace diversity maintained by farmers in South Wollo and East Gojjam.
- Farmers' varieties of common bean are ethnobotanical used for the same purposes in South Wollo and East Gojjam zones.
- Seed selection criteria and ways of traditional seed storage have no differences in South Wollo and East Gojjam zones of the study area.
- Agroecological variations do not affect the number of common bean farmers' varieties.
- Cropping season, crop rotation pattern, benefits of crop rotation and intercropping practices are not different among the three agroecological zones and in the four strata (SM3-South Wollo, M2-South Wollo, M2-East Gojjam and M3-East Gojjam) in South Wollo and East Gojjam zones.
- The different farmers' varieties of common bean have different percentages of germination under laboratory condition.

1.2.4. Objectives

General objective

The general objective of this study was to identify and document the landrace diversity, distribution and ethnobotanical uses of common bean (*Phaseolus vulgaris*) farmers' varieties in South Wollo and East Gojjam Zones, Ethiopia.

Specific objectives

- To identify and document the landrace diversity of common bean by recording vernacular names reported by farmers.

- To gather, record, analyze and document indigenous knowledge on the traditional uses, management practices including cropping systems, beliefs, stories associated with common bean in general and the individual landraces in particular.
- To investigate the distribution of common bean farmers' varieties in the different agroecological zones found in South Wollo and East Gojjam
- To facilitate germplasm preservation of the landraces following suitable conservation strategies at appropriate institution
- To study the germination status and the agromorphological characters of the landraces on station
- To measure the diversity of common bean landraces for possible contributions to the development and refinement of future management, utilization and conservation strategies

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Botanical description of common bean

The growth forms are of the annual climber type or sub erect herbs, leaflets are ovate or ovate-rhombic, 4.5-15 x 2.5-10 cm, acuminate and pubescent. The inflorescence is 1-several-flowered; bracteoles ovate-lanceolate, 5-6 mm long. Calyx 4-5 mm long. Corolla white, yellowish, purple or pink; standard 1-1.5 cm long; keel spirally incurved. Pod linear-lanceolate, c 10-20 x 1-1.5 cm, compressed, puberulous or glabrous, c 5-10-seeded. Native in America, now cultivated throughout the world; in Ethiopia commonly grown at intermediate altitudes and perhaps locally naturalized (Thulin, 1989).

Seeds variable in size, shape and color, as a rule oblong but also ellipsoid, globular or kidney-shaped, laterally compressed, (6-)8-17(-20) x (4-)5-7(11) mm, white, purple, black, ochre, brown, white, black mosaic, brown, black mosaic, light colored, purple mosaic, light colored, red-purple mosaic, light colored, brown mosaic, light colored, orange mosaic, and grey-brown, very small light spots, usually glossy. Hilum oblong, sometimes elliptic, about 2-3.5 mm long, central, covered by a layer of white detachable tissue, brownish, often surrounded by a darker colored hilum ring, with a darker colored, often conspicuous twin-bump situated near the hilum at the opposite side of the micropyle (Westphal, 1974; Thulin, 1989).

2.2. Origin and domestication of common bean

Common bean originated from the New World; two centers of origin were identified Andean and Mesoamerican (Hornakova *et al.*, 2003; Logozzo *et al.*, 2007).

The domestication occurred independently in South America and Central America/Mexico, leading to two different domesticated gene pools, the Andean and Mesoamerican, respectively (Papa and Gepts, 2003; Petry *et al.*, 2015). This crop is native to Mexico and Guatemala where the greater part of the diversity of varieties is found (Arenas *et al.*, 2013).

Common bean is the most widely distributed of the related species and has the broadest range of genetic resources (Gomez, 2004) and is frequently used as food crop throughout the world, especially in Latin America and Africa. Different races have been described in both gene pools differentiated for morph-agronomical traits. Common bean was introduced to Europe probably from Cuba immediately after Columbus's voyage/ since the first half of the sixteenth century. It was distributed widely in all parts of Europe and the Mediterranean area where many landraces and varieties evolved that were grown to provide dry seed or fresh pods (Logozzo *et al.*, 2007). The species was perhaps introduced to the eastern part of Africa by Portuguese traders in the sixteenth century (Wortmann *et al.*, 2004).

2.3. Taxonomic description of common bean

Common bean is the best-known species of the genus *Phaseolus* in the family Fabaceae of about fifty plant species, all native to America. After the Asteraceae and Orchidaceae, the Fabaceae is the third largest family of flowering plants in the world and the first in

Ethiopia (Arenas *et al.*, 2013). It is a family of great economic importance and very unique in having members that can form associations with symbiotic bacteria to fix atmospheric nitrogen (Karagkiozi *et al.*, 2012)

The wide range of growth habits of common bean varieties has enabled the crop to fit in the many growing situations. Among the different growth habits of common bean, the prostrate and the bushy types achieve rapid ground cover, compete with weeds and avoid competition (Zelalem Zewdu, 2014). Moreover, common bean is an important understory companion crop in various intercropping systems throughout the world (Rahmeto Negash, 2007). It is planted in pure stands of single landrace, as mixed plantings of several farmers' varieties, and intercropped with maize, sorghum, sweet potato, cotton, coffee and other crops. Typically, when planted for use as vegetables, common bean is planted as a monoculture crop (Negash Hailu *et al.*, 2015). Under Ethiopian condition, the crop is normally grown twice a year, the first production is during the short rainy season (April to June) and the second is during the long rain season (July to October) (Kedir Oshone *et al.*, 2014).

2.4. Farmers' varieties (landraces) diversity

Landraces have originated together with agriculture and horticulture during the past 10,000 years or so. Hence, landraces of many crops have probably been grown for several millennia. Though landraces are commonly considered as endemic to a particular region (Zeven, 1998). Landraces have been recognized by farmers for adaptation to specific sets of field conditions as well as particular uses within the food system. They are often highly variable in appearance, but they can be identified and almost always

have different local names. They have, as their particular characteristics, a reputation for adaptation to local climatic conditions and cultural practices, and resistance or tolerance to diseases and pests (Harlan, 1992). Major advantages of landraces are adaptation to their specific agro-systems and low input requirements, and ethnic reasons are also present in traditional agricultural practices. The genetic diversity of landraces is very important for global biodiversity conservation for future world production (Wood & Lenne, 1997). Landraces generally provide high yield stability and intermediate average yields under a low input agricultural system (Zeven, 1998).

2.5. Adaptability of common bean

This crop well adapted to the range of altitude from 1200 to 2000 m above sea level (Wortmann, 1998), and in areas with annual average rainfall of 500-1500 mm. It ideally needs moist soil throughout the growing period. However, rainfall towards the end of the growing periods is unwanted. It can be grown successfully on most soil types, from light sands to heavy clays, but friable, deep and well-drained soils are best preferred (Gifole Gidago *et al.*, 2011). In warm climate that shows greater development in environments with average temperature of 18 to 24 °C during the growing season and a precipitation of 300 to 500 thousand millimeters throughout the crop cycle (Agete Jerena, 2014) and excessive temperatures cause flowers to abscise, and low temperatures delay pod production and can result in empty pods. Common bean prefers well-drained, sandy clay or sandy loam soils, with balanced fertility and moderate acidity pH 5.8-6.5 (Ensor, 2009). In Ethiopia, common beans are concentrated in the dry and warmer parts of the country mainly along the rift valley (IFPRI, 2010).

2.6. Cultivation of common bean

Common bean is cultivated in a broad variety of environments, in terms of altitude, temperature, soil type, and moisture regime, however it is grown mainly in dry land and rain fed conditions. It is well known that local farmers have selected farmers' varieties collections that best adapt to the soil and climate conditions of the region (Aguilar-benítez, 2014). The crop is grown by subsistence farmers either as a sole crop and/or intercropped with either cereal or tree crops. Shade tolerance and early maturity contributes to common bean's prominent position as understory intercrop for sorghum, maize, and coffee in the eastern zones of the country in which 85 % of all sorghum is intercropped with beans. Therefore, these characteristics make it an ideal crop for intensification of existing farming system (Rahmeto Negash, 2007).

2.7. Distribution of common bean in the world and in Ethiopia

Common bean is distributed in different parts of the world, mainly in east Africa, in east Asia, in south Asia, Europe Central America and the Caribbean, southern Africa, Southern and the Andean area. The world major common beans producers are India, Brazil, Myanmar, and China. Ethiopia is the third largest producer of common beans in Eastern and Southern Africa and the leading exporter in Africa. The country exported 40 percent of its common beans out of the total production in 2010 (FAOSTAT, 2015). Common beans are increasingly becoming an important food security commodity particularly among the smallholders. For instance, consumption has increased from 98,065 tons to 242,100 tons between 2004 and 2009. In addition, it is important in the country's balance of payments (Gepts, 1991; Agete Jerena, 2014). The distribution of beans in Africa is extremely dependent on rural population density and mean temperature

during the growing season (Wortmann *et al.*, 2004). Different varieties of common beans grow in different parts of Ethiopia, white beans, grow in the central Ethiopia (Shoa) as cash crop, colored beans grow in the southern part of Ethiopia for local consumption and climbing beans grow in the North West (Metekel) and western Ethiopia (Wollega), climbing type of common bean are planted along fences and on the borders of maize fields (Rahmeto Negash, 2007)

2.8. Agroecological requirements of common bean

Common bean (*P. vulgaris* L.) is widely grown in low land and mid altitude areas. It has a wide range of adaptations and grows well between 1400 to 2000 meters above sea level and also does well in some areas as low as 500 m and as high as 1900 m that receive a well distributed average rainfall of 500 to 1500 mm throughout the growing season (Amare Abebe, 1989).

Having short maturity period of about three months; it is available for family consumption during the period when other crops are immature (Amare Abebe, 1989).

Common beans are adapted to a wide range of soils. They are grow most successfully on drained soils of medium texture (loams). The soil should be at least one meter deep. In humid areas, they are grow on acidic soils. The optimum temperature for their growth is about 16-24°C. This crop grow throughout the cooler tropics, but not in hot semiarid or humid Regions. Common bean requires a minimum frost free period of 105-120 days, as they are killed by frost. In general, high temperature (20-30 °C) during flowering causes the dropping of buds and flowers, which reduces yield (Amare Abebe, 1989). Full maturity for dry bean seed type was attained from 45 to 150 days after emergence, depending on growth habit type and location (Singh, 1982). Maturity of bean increased

with the altitude increase. Due to low temperature prolonging the maturity period of beans and it was more pronounced in indeterminate than determinate types (Amare Abebe, 1987).

2.9. Uses of common bean

Common bean is the most commonly consumed legume worldwide, and it is the most important for direct human consumption, with a commercial value exceeding that of all other legume crops combined (Ssekandi *et al.*, 2016). Extraction of common bean as well as some of its individual components have been reported for their effects in reducing appetite and body weight and blood glucose in rats. Common bean is gaining increasing attention as a functional or nutraceutical food, due to its rich variety of phytochemicals with potential health benefits such as fiber, polyphenolic compounds, lectins, unsaturated fatty acids, trypsin inhibitors, phytic acid, among others (Guzman-Maldonado *et al.*, 2000). This crop is essential in Nitrogen fixation to improve the soil fertility as well as increase crop production and livelihoods of farmers (Gebre-egziabher Murut *et al.*, 2014). In Ethiopia, common bean has been one of the most important crops grown by small scale farmers in different parts of the Region, in the central rift valley of Ethiopia, the crop is used as one of the cheapest source of protein apart from being the major source of cash income. It is usually consumed in the form of boiled grain, which is locally known as *Nifro* farmers also prepare a local stew known as *shiro wot* from some bean cultivars (Zelalem Zewdu, 2014).

2.10. World production of common bean

Common beans are important for direct consumption because they grow all over the world and are consumed as dry and snap beans (Asrat Asfaw & Blair, 2014). The world major common beans producers are India, Brazil, Myanmar, China, Turkey and Ethiopia taking significant steps to encourage grain legume production. Ethiopia is the third largest producer of common beans in Eastern and Southern Africa and the leading exporter in Africa (Blair *et al.*, 2007).

Common beans are mostly consumed in countries where they are produced. Countries with the highest rates of consumption per capita (in Central America, Caribbean, East Africa and some Asian economies) produce beans and also import them at varying levels, depending on the harvest, for meeting the internal demand. Considering the global imports and exports of dry beans between 2008 and 2012, it seems that 15 to 20% of the world annual production (around 4 MT on average) is traded internationally. Myanmar, China and the United States are the main exporters, with India and the European Union being the largest importers (FAOSTAT, 2015). Globally, the annual production of green and dry beans is 17 Million tons (FAO, 2010), which makes the crop the most widely utilized of legumes. It is produced for its green pod and dry seed which are both edible. In 2014/15, total common bean production in Ethiopia was about, 5,137,348.07 quintals (1.9% of the grain production) on approximately 323,327.27 hectares of land (2.58% of the grain crop area) and yield Quintal/Hectare is about 31.83 (CSA, 2015).

2.11. Production constraint

Mostly, production of common bean is highly constrained by environmental stresses such as drought, pests, diseases, and low input farming methods that have resulted into declined soil fertility and productivity (Asrat Asfaw *et al.*, 2013). Socio-economic factors related to farmer adoption of new technologies, seed distribution, and market requirements may also restrict bean production. The small-scale farmer's main cost and biggest problem is often the purchase of high-quality seed, production inputs such as fertilizer, pesticide, etc. and adoption of new technology (Frehiwot Mulugeta, 2010). Soil fertility status, recurrent water stress, insect pests, weeds and diseases are considered as the principal abiotic and biotic constraints of common bean production in Africa (Tesfay Amare and Amin Mohammed, 2014; Yitayal Abebe & Adam Bekele, 2015). There are several serious insect pests that attack the common bean, depending on the geographic location, but predation by a wide range of arthropods aphids, beetles, caterpillars, leafhoppers, whiteflies, mites and thrips is seen worldwide (Beebe *et al.*, 2009; Fikere Mulusew *et al.*, 2010).

CHAPTER THREE

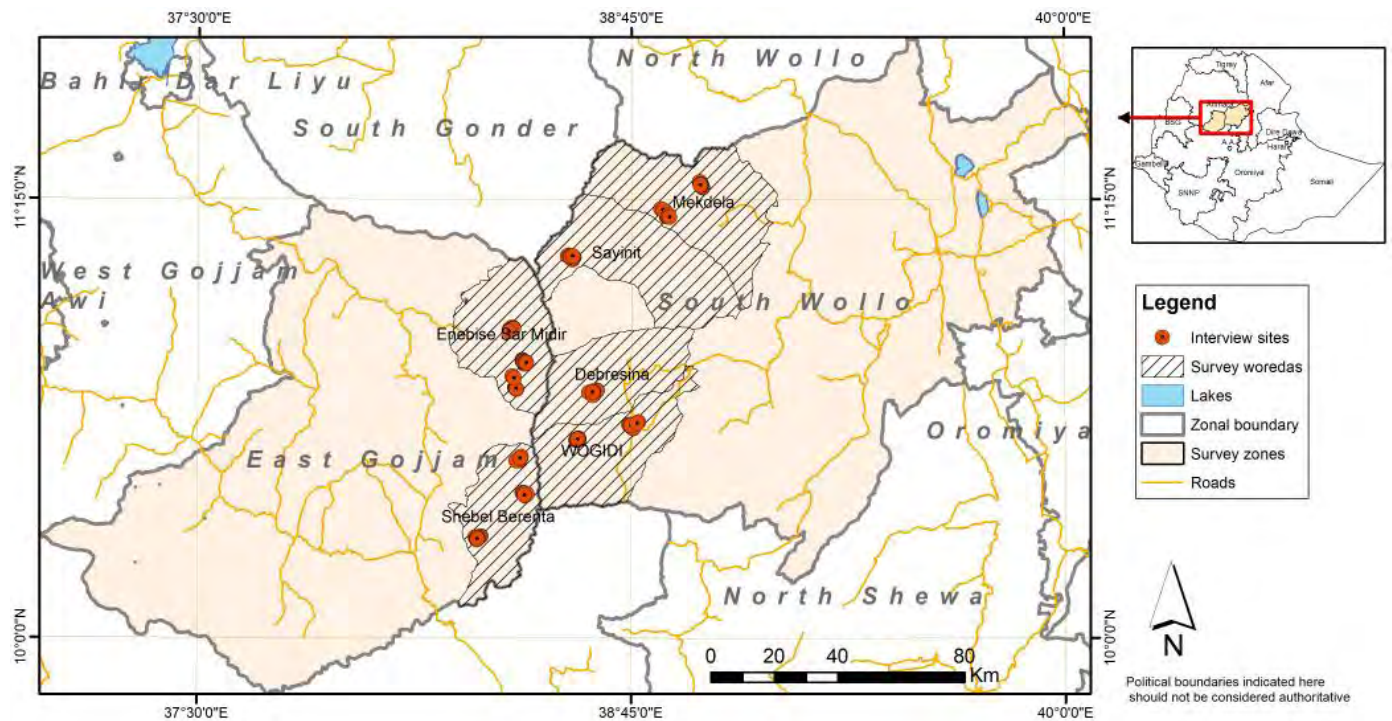
3. MATERIALS AND METHODS

3.1. Description of the study area

The survey was conducted in South Wollo administrative Zone (Debresina, Sayinit, Mekdela and Wogidi districts) and East Gojjam administrative Zone (Shebel berenta and Enebise Sar Midir districts) (Figure 1). Zone were selected purposively based on widespread production of common bean and the presence of multiple agroecological zone, which provide opportunities for comparison. Districts were also selected based on their proximity to facilitate travel between research sites. Within each administrative Zone two agroecological zones were selected, for a total of four distinct strata. In South Wollo, agroecological zones SM3 (tepid sub-moist mid-highlands) and M2 (warm moist mid-highlands) were chosen (Table 1). In East Gojjam, M3 (tepid moist mid-highlands) and M2 (warm moist mid-highlands) were chosen. The survey areas stretch over an altitude ranging from 1820-2447 meters above sea level. This two study Zones were found in Amhara Region; their language was Amharic. In South Wollo there are Christian and Muslim religion followers, however Muslim religion followers was found dominantly where as in East Gojjam almost all people follow Christianity. In the study area farmers cultivate different crops, In South Wollo Grass Pea (*Lathyrus sativus*), Chick Pea (*Cicer aritenum*) and Sorghum (*Sorghum bicolor*) were dominantly cultivated crops while in East Gojjam dominantly cultivated crop was teff (*Eragrostis tef*).

	SM3(Tepid Sub Moist Mid Highlands)	M3(Tepid Moist Mid Highlands)	M2(Warm Moist Lowlands)
Altitude	1600 to 2400 m.a.s.l	1600 to 2400 m.a.s.l	500 to 1600 m.a.s.l
LGP	61 to 120 days	121-180 days	121-180 days
S. Wollo	42 (36 General and 6 Key informant)	Not included	42 (36 General and 6 Key informant)
E. Gojjam	Not included	42 (36 General and 6 Key informant)	42 (36 General and 6 Key informant)

Table 1: Description of the study area

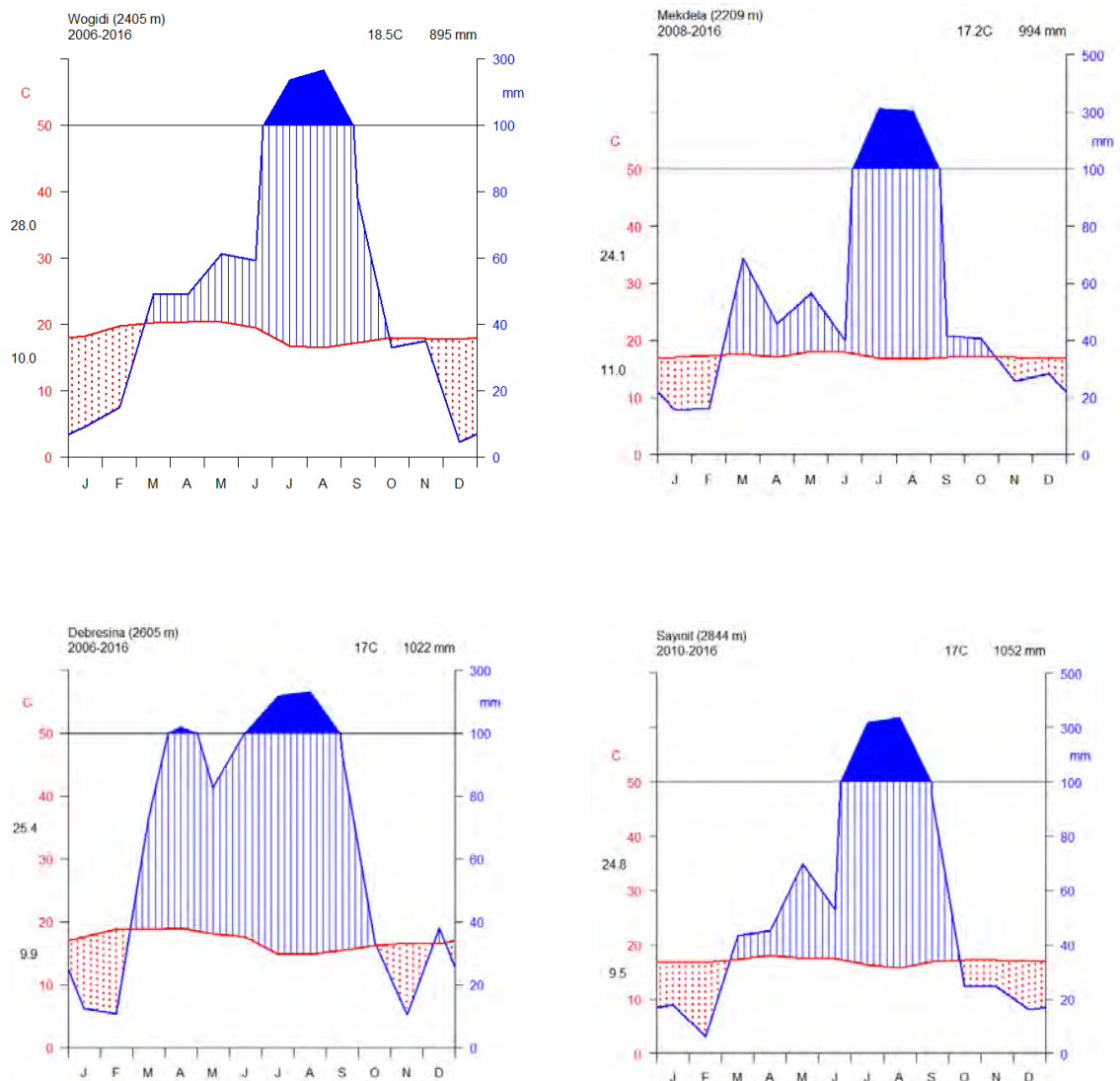


LGP = Length of Growing period, S. Wollo = South Wollo, E. Gojjam = East Gojjam

Figure 1: Map of Ethiopia showing the study area

3.1.1. Climate of the study area

The climate of the study sites has been represented using the rainfall and maximum and minimum temperature based on the data obtained from Ethiopia Meteorological Agency (EMA) for the last three up to ten years. The mean annual maximum temperature of the study areas for the last three up to ten years was ranging between 24.1-28⁰c. The average annual rainfalls of the study areas range between 630-1122mm. The climate conditions of the study districts are shown in climate diagrams (Figure 2).



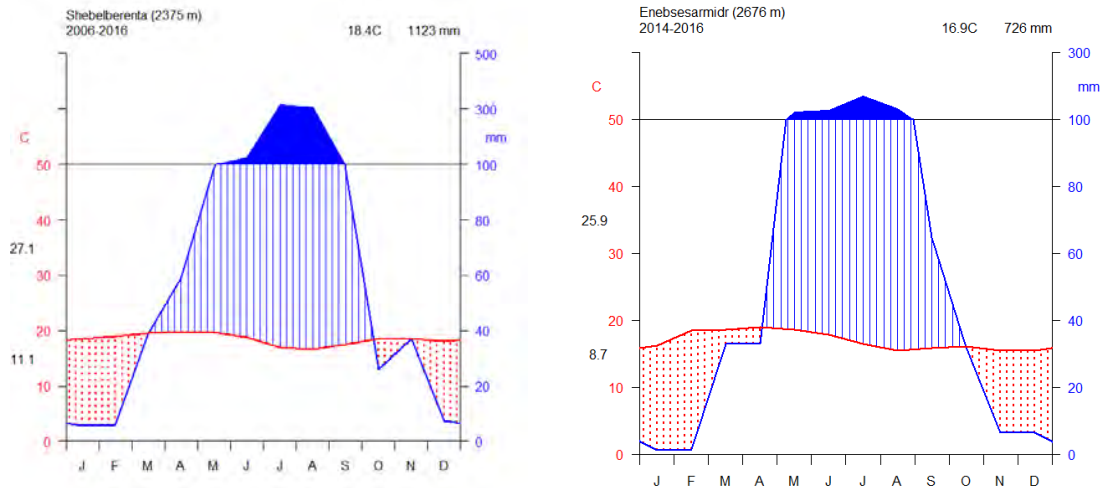


Figure 2: Climate diagram of the study area in South Wollo and East Gojjam Zones of Amhara Region (Data source: EMA)

3.2. Materials

The materials used include

- Global positioning system (GPS) using android phone to collect georeferenced data of interviewee and seed collection sites.
- Digital camera: to document pictures of the farmers' varieties and landscapes.
- Android phone to conduct structured interview. using open data kit (ODK)
- Semi structured interview was conducted using pre-prepared hardcopy
- Petri-dish, filter paper and distilled water were used for germination test.

3.3. Methods

3.3.1. Site selection

The study Regions and Zones were selected by referring to different literature sources, studying their collection areas in herbarium and gene banks and also by referring to the survey made by CSA (2015) on area. Totally, two Zones comprising 6 Weredas with 12

kebeles were included (Table 2), Zones were selected purposively and kebele were selected randomly based on agroecology and administrative zone, i.e. within each stratum (SM3 S. Wollo, M2 S. Wollo, M2 E. Gojjam and M3 E. Gojjam) 3 Kebeles were selected randomly from each agroecological zone. Therefore, from the two study Zones totally twelve Kebeles were selected. Six Kebeles from South Wollo and six Kebeles from East Gojjam Zones were selected (Figure 4).

Table 2: Regions, Zones, Weredas, Kebeles and Agroecological zones used in the study area.

Region	Zones	Districts	Kebeles	AEZ	Number of informants	
					Female and Male General informants	Female and Male key informants
Amhara	S. Wollo	Wogidi	Serto Masaya	SM3	12	2
			Zemod	M2	12	2
			Mendeyo	M2	12	2
			Deja	SM3	12	2
			Doka Debresina	SM3	12	2
			Mess	M2	12	2
Amhara	E. Gojjam	Shebel berenta	Anshebna Zuchir	M2	12	2
			Bonaya Sakala	M3	12	2
			Yeju Bayile	M2	12	2
			Adis Alem	M3	12	2
			Liuil	M2	12	2
			Zihon Wiha	M3	12	2
Total	2	6	2	3	144	24
					Total No of Informants from two Zones = 168	

3.3.2. Informant selection

Lists of farmers who produce common bean in the study area were obtained from Agricultural development agent with considering their wealth status. Accordingly, 144 households (of these 72 women and 72 men) were selected randomly from the membership list of their corresponding Peasant Association for the interview. Agricultural development agents were helpful in accessing relevant records and in each of 4 strata for a total of 144 interviews (12 informants^o x 3 Kebeles x 4 strata = 144). Three women from low-income households, three women from high or medium-income households, three men from low-income households, and three men from high or medium-income households were selected for the interview. Interview two key informants per Kebele, in each Kebele one man and one woman who were knowledgeable about common bean were selected. These key informants were selected among the farmers who have already responded to the structured interview by ODK (open data kite), key informant selection was based on the recommendations made during the interviews, or selected based on information from other village members. The total number of key informant were 24 (4 strata x 3 Kebeles x 2 key informant).

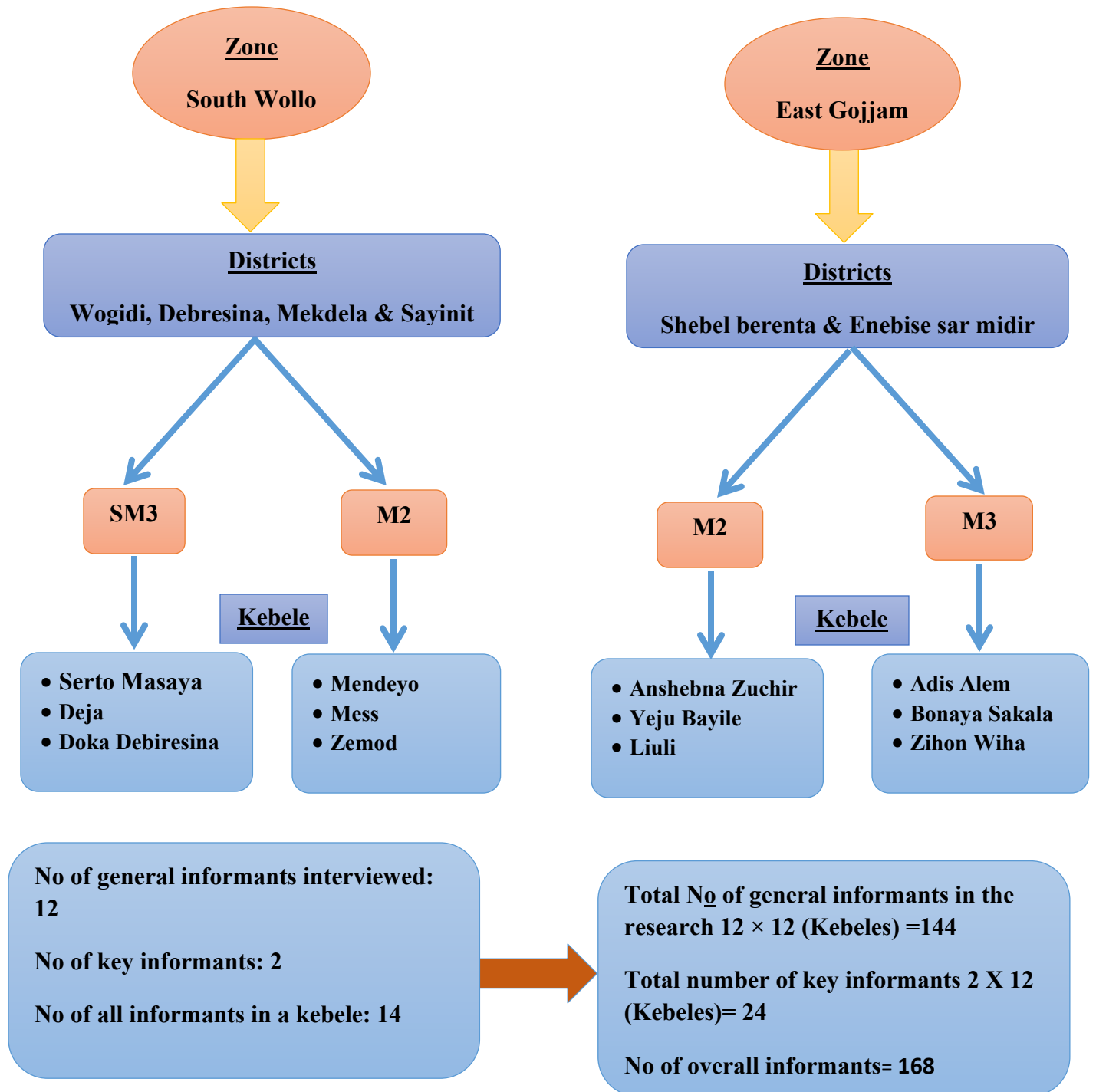


Figure 3: Schematic diagram of sampling Kebeles within districts and different categories of informants

3.3.3. Field data collection

The survey was conducted from October, 2016 up to January, 2017. Germination test was conducted between March/30/2017 up to April 6/2017 and the full research was completed in June 2017. Botanical data and ethnobotanical profiles of common bean and its landrace varieties were acquired using primary and secondary data sources. Primary source of data was obtained from the farmers“ who grow common bean. Secondary data were collected from the Zone administrative centers by gathering information on common bean production status of districts and overall description of the study area. Seed sample collection were undertaken, from each Kebele three up to twelve seed sample were collected from individual common bean varieties.

3.3.4. Ethnobotanical data collection

Ethnobotanical data were collected in order to know the indigenous knowledge of participants or farmers on common bean. Different qualitative and quantitative ethnobotanical data collection methods like structured and semi-structured interview and also market survey was used in order to gather the necessary information from the participants.

3.3.5. Interview

General informants were interviewed by using structured interview method via ODK and informant consent which come first, which is one of the formal interview methods in ethnobotanical (Appendix 1) and the key informants were interviewed using semi-structured questionnaires (Appendix 2). This method was selected because it is largely flexible and it is also the best tool to use when it is not possible to interview the same informant twice (Albuquerque *et al.*, 2014).

The semi-structured interview contains open ended and closed questions. The structure and semi-structure interviews used to collect information on local knowledge on plant parts used, description of preparation of plant parts, management, cropping systems, seed supply, storage of the species, local name of the landrace, time of cultivation and harvesting, market value of the crop, production constraints and the management taken by farmers to control the constraints. Interviews were held at the household level or in farmers' common bean fields. Local extension officers assisted in conducting the interviews. The interview was conducted by using Amharic language and all the landraces name were recorded by Amharic.



Figure 4: Interview with informants (On November, 2016 in S. Wollo and December, 2016 in E. Gojjam)

3.3.6. Market survey

During the study, market survey was undertaken to record the common bean varieties that were available in the market. In addition, information on market values of common bean were recorded. This is especially a good method to identify, use and conserve landrace varieties of common bean that have high economic value. Therefore, 10 local markets in the study areas were visited and a total 24 common bean sellers were interviewed. Semi-structured interview (Appendix 3) was conducted with common bean producers and or sellers at the market to record and determine the value or income generated from such practices.

3.3.7. Field observation

The field observation was conducted with the help of local guides and participant informants to acquire the required information in the study area. The information on how common bean is cultivated, intercropped, used and marketed was then systematically recorded. The local perspectives on dominant crops produced landscapes and soil type of the study area was identified by the researcher through personal observation and discussion with common bean farmers as well as local agricultural experts.

3.3.8. Seed collection methods

The seed samples were collected from farmer's traditional seed storage containers and from local markets. The collection strategy was to collect the maximum number of land race diversity recognized by the farmers seed stores and from local markets. The seed collections were then used for seed morphology description, germination test, morphological diversity study and germplasm preservation using suitable conservation strategies (Appendix 4)

3.3.9. Standard germination test (%)

Germination test was conducted in the laboratory of Ethiopian Biodiversity Institute (EBI) gene bank seed germination laboratory. Twenty-five seeds were taken for every four replications and for every different common bean tested for standard germination. From the collected accessions of common bean farmers' varieties, the representative seed samples from the two Zones based on Agroecology, were subjected to germination percentage evaluation. The experiment was conducted using twenty treatments (from each study Zones and from each agroecology). The test was made by keeping the seeds on the top of filter paper in the Petri dishes with a diameter of 12.5cm at a room temperature (25°C). Then every replication was watered optimum distilled water daily until the end of the test. The first and final counts were made on 5th and 8th days respectively. During the counting days, the seedlings were evaluated and clustered into normal, abnormal, and dead seed.

The normal seedlings were considered as standard germination and their respective percentages were calculated for all the four replications as indicated in (ISTA, 2004).

Germination percentage was calculated by using the formula as given below;

$$\text{Germination \%} = \frac{\text{Number of normal seedlings}}{\text{Number of seeds sown}} \times 100$$

3.3. Data analysis methods

3.3.1. Descriptive statistics

Both qualitative and quantitative analytical tools of ethnobotany were used for data analysis following the relevant approaches of Martin (1995) and Cotton (1996). Ethnobotanical data were analyzed by using R-software version 3.2.2. The data were first entered into the excel spreadsheet version 2016 and summarized using descriptive statistics to identify the most widely used common bean farmers' variety in the study area. To determine proportions of different farmers' varieties, source of collection, cultivation methods, and other calculation such as various ethnobotanical ranking methods, percentage frequency methods and inferential statistics in order to test the consistency of respondents' information and to obtain scientifically more reliable results. Then, the results were presented with graphs, charts and tables as well as in texts.

3.3.2. Shannon-Wiener diversity index

It is used in genetic resource studies as a convenient measure of both richness and evenness using phenotypic data (Shannon and Wiener, 1949). Diversity index was calculated as:

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

Where: H' = Standardized relative diversity index; n = the number of phenotypic class per characters; p_i the proportion of the total number of entries in the class; \ln = natural logarithm

3.3.3. Beta diversity

Whittaker (1960) divided diversity into various components. The best known are diversity in one spot that he called alpha diversity, and the diversity along gradients that he called beta diversity. The basic diversity indices are indices of alpha diversity. Beta diversity should be studied with respect to gradients (Whittaker, 1960), but almost everybody understands that as a measure of general heterogeneity (Tuomisto, 2010): how many more species/variety do you have in a collection of sites compared to an average site.

Gamma diversity - the total number of farmers' varieties within a Region or among farmers of a certain group.

Alpha diversity - the average number of landraces listed by each farmer.

Beta diversity - gamma divided by Alfa. This indicates the degree to which farmers within the same ethnic group or Region share the same landraces.

3.3.4. Preference ranking

In this analysis method, 24 key informants were involved to provide information on five use value of common bean. Thus, five use values were short listed and ranked by the key informants based on their personal preference or perception following the procedure explained by Martin (1995) and Cotton (1996). Ranking value assigned for the least important was 1 and while the ranking value assigned for extremely important was 4.

3.3.5. Analysis of Variance (ANOVA)

One-Way ANOVA was used to the analysis of farmers' varieties diversity and amounts of landraces used for household consumption and market use among Zones of the study area, to compare yield of common bean in different year in the different Zones. Two-way

ANOVA was used to analyze germination percentage among varieties and also among agroecological zones.

Kruskal Wallis test: - was used to rank yield of common bean during different constraint and to calculate price and yield of common bean.

3.3.6. T- test

The student's t-test was used to compare the differences between administrative and agroecological zone in terms of number of varieties and T-test tell statistical difference between the average yield between yield. To compare yield of common bean in different year, between Zones. To compare area of common bean among Zone.

CHAPTER FOUR

4. RESULTS

4.1. Common bean landrace diversity

A total of 69 common bean accessions were collected from two Zones of Amhara Region, Ethiopia. The accessions collected from the two Zones are given in Table 3 and the detailed data of informants and location are presented in Appendix 5. The highest numbers of accessions were collected from S. Wollo, Mess Kebele of the M2 agroecology zone and the least was from E. Gojjam in Yeju Bayile Kebele from M2 agroecological zone.

Table 3: Number of Accessions from two Zone, their local names and relative meanings.

Region	Zone	District (m.a.s.l)	Kebeles	AEZ	No of accessions	No of Farmers' Varieties	Name of landrace	Meaning of landrace name	Identification criteria	
Amhara	S. Wollo	Wogidi (1839-2426)	Serto Masaya	SM3	4	4	NECH BOLOQE	White	color	
							KEYE BOLOQE	Red	Color	
							DALECHA BOLOQE	Grayish	Color	
							TEKUR BOLOQE	Black	Color	
			Zemod	M2	8	4	NECH BOLOQE	White	Color	
							KEYE BOLOQE	Red	Color	
							DALECHA BOLOQE	Grayish	Color	
							TEFTAFA NECH BOLOQE	Grayish	Size and color	
			Debresina (2222-2437)	Mendeyo	M2	6	3	NECH BOLOQE	White	Color
								KEYE BOLOQE	Red	Color
								DALECHA BOLOQE	Grayish	Color
			Mekdela (2116-2376)	Deja	SM3	8	4	NECH BOLOQE	White	Color
								KEYE BOLOQE	Red	Color
								TEKUR BOLOQE	Black	Color
								GUREZA BOLOQE OR BURABURA BOLOQE	Combination of two colors	Color
Doka Debresina	SM3	4		3	NECH BOLOQE	White	Color			
					KEYE BOLOQE	Red	Color			
					TEKUR BOLOQE	Black	Color			
Sayinit (2384-2440)	Mess	M2	13	5	NECH BOLOQE	White	Color			
					KEYE BOLOQE	Red	Color			
					TEKUR BOLOQE	Black	Color			

							DALECHA BOLOQE	Grayish	Color
							YEAREBA KEN BOLOQE	Mature within forty days	Color
Amhara	E.Gojjam	Shebel berenta (1820-2447)	Anshebna Zuchir	M2	4	3	NECH BOLOQE KEYE BOLOQE	White Red	Color Color
							DALECHA BOLOQE OR WALEBELAY BOLOQE	The taste is more than other common beans or less white	Taste and color
			Bonaya Sekela	M3	6	3	NECH BOLOQE KEYE BOLOQE DALECHA BOLOQE	White Red Grayish	Color Color Color
			Yeju Bayile	M2	2	1	NECH BOLOQE	White	Color
		Enebise sar midir (1879-2433)	Adis Alem	M3	5	3	NECH BOLOQE KEYE BOLOQE DALECHA BOLOQE	White Red Grayish	Color Color Color
			Liuil	M2	5	3	NECH BOLOQE KEYE BOLOQE DALECHA BOLOQE OR WALE BOLOQE	White Red The taste is more than other common beans	Color Color Taste and color test
			Zihon Wiha	M3	4	3	NECH BOLOQE KEYE BOLOQE DALECHA BOLOQE	White Red Grayish	Color Color Color
Total	2	6	12		69	7			

Common bean has different name in different parts of South Wollo and East Gojjam Zones. In South Wollo, the local name of common bean is BOLOQE OR ZABUTEA. In this Zone, seven types of common bean were identified NECH BOLOQE, KEYE BOLOQE, TEKUR BOLOQE, DALECHA BOLOQE, GUREZA BOLOQE OR BURABURA BOLOQE, YEAREBA KEN BOLOQE and TEFTAFA NECH BOLOQE. The seven farmers' varieties identified differed with respect to the associated seed color maturity time, yield, uses and shape.

The landrace named YEARBA KEN BOLOQE had the shortest maturity time while DALECHA BOLOQE had the longest maturity time. The farmers' varieties also showed differences

based on drought resistance. Although DALECHA BOLOQE, TEKUR BOLOQE, GUREAZA BOLOQE and YEAREBA KEN BOLOQE varieties were more drought resistant than NECH BOLOQE

In East Gojjam three types of common bean farmers' varieties were identified. Respondent called them NECH BOLOQE, KEYE BOLOQE and DALECHA BOLOQE.

Instead using white common bean as food many farmers used it as cash crop for generating income. As informant mentioned when they eat white common bean it causes stomach pain. TEKUR BOLOQE somewhat important for food but it is not as such important for income generation this is due to black color of the seed and also it has no market value. In this study, the farmers' varieties of DALECHA BOLOQE in South Wollo and KEYE BOLOQE and DALECHA BOLOQE in East Gojjam Zone were preferred more than the other farmers' varieties for consumption. Their preferences were mainly linked with good taste of the variety and has low stomach pain

Table 4: Vernacular names of common bean farmers' varieties in study area and their meanings.

Name	Zone	Meaning	Seed color
NECH BOLOQE	S.Wollo and E.Gojjam	White-seeded common bean	White
KEYE BOLOQE	S.Wollo and E.Gojjam	Grayish type good tasting common bean	Red
DALECHA BOLOQE OR WALE BOLOQE OR KEMO ZEM	S.Wollo and E.Gojjam	Grayish type common bean has good taste	Grayish type
GUREZA BOLOQE OR BURABURA BOLOQE	S.Wollo	Mosaic type common bean	Mosaic type
TEKUR BOLOQE	S.Wollo	Black type of the common bean	Black
YEAREBA KEN BOLOQE	S.Wollo and E.Gojjam	Forty-days (early type) common bean	Light yellow
TEFTAFA NECH BOLOQE	S.Wollo	Flat white type common bean	White

In S. Wollo and E. Gojjam DALECHA BOLOQE have different local names called it WALE BOLOQE OR WALE BELAY BOLOQE, this is because it has very good taste and also called it DUBEA BOLOQE due to the big size of the seed like pumpkin. In the market call it KEMO ZEM, because the boiled grain is soft and easy for chewing as well as swallowing. These varieties have different color but some informants mentioned that this difference came due to differences in environmental factors and soil type, and not because they are different varieties.

The varieties include TEFTAFA NECH BOLOQE, YEAREBA KEN BOLOQE, GUREZA BOLOQE OR BURABURA BOLOQE, and TEKUR BOLOQE. TEFTAFA NECH BOLOQE and GUREZA BOLOQE OR BURABURA BOLOQE were not used by most farmers and only found with few farmers. In addition to the landraces mentioned above, informants were also asked if they know of any variety of common bean that has been lost from the locality over the years. In all the study areas informants mentioned that they are using the varieties that their fathers and mothers were using before and there is no lost variety they are aware of it. However, informants found in Wogidi Wereda in S. Wollo Zone mentioned that there was a variety which is not available currently, a variety with big seed and mosaic color locally called YEFERENG BOLOQE. From the descriptions they gave, this is probably lima bean (*Phaseolus lunatus*) and not common bean even though the generic local name is BOLOQE. The photos of (*Phaseolus vulgaris*) diversity are presented below (Figure 6), which are collected from different parts of the study area.

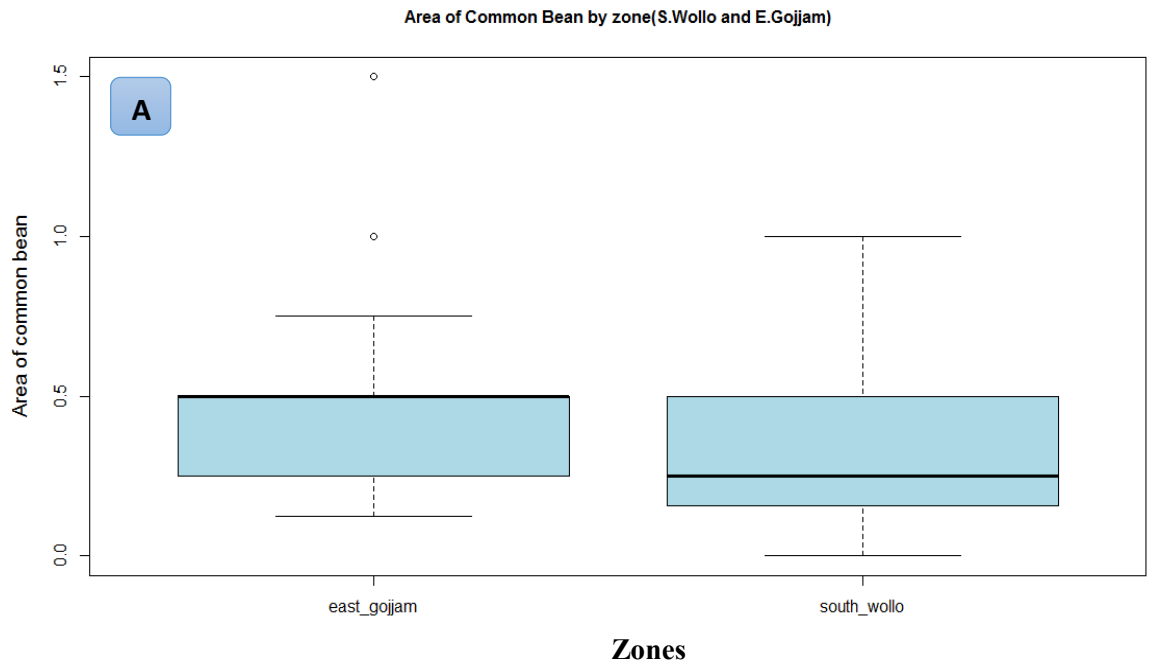


Figure 5: Photos of farmers' varieties of common collected from the study area (A, B, C, D, E, F, G, H, I and J found in S. Wollo and A, D and F found in E. Gojjam) (Photo by Menbere Berhane from the study area ,October,2016 up to January, 2017)

4.2. Total area planted with common bean

The total area that was planted with common bean in the two Zones of the study area (S. Wollo and E. Gojjam) statistically has significance difference as the p value shows 0.0237 ($P < 0.05$). The mean area of common bean planted in S. Wollo and E. Gojjam was 0.36 ha and 0.45 ha respectively. The size of most farms ranged between 0.25 ha and 0.75 ha (Figure 6A). Statistically there was no significant difference among the area of common bean planted in 2014/15 and 2016/17 years. The mean farmer size of common bean in the two years were 0.47 and 0.50 respectively.

Based on wealth statistically there is no significance difference the area planted by common bean the p value shows 0.071 ($P > 0.05$). Low income and medium-high income farmers in the study area plant common bean almost all in equal area (Figure 6 B).



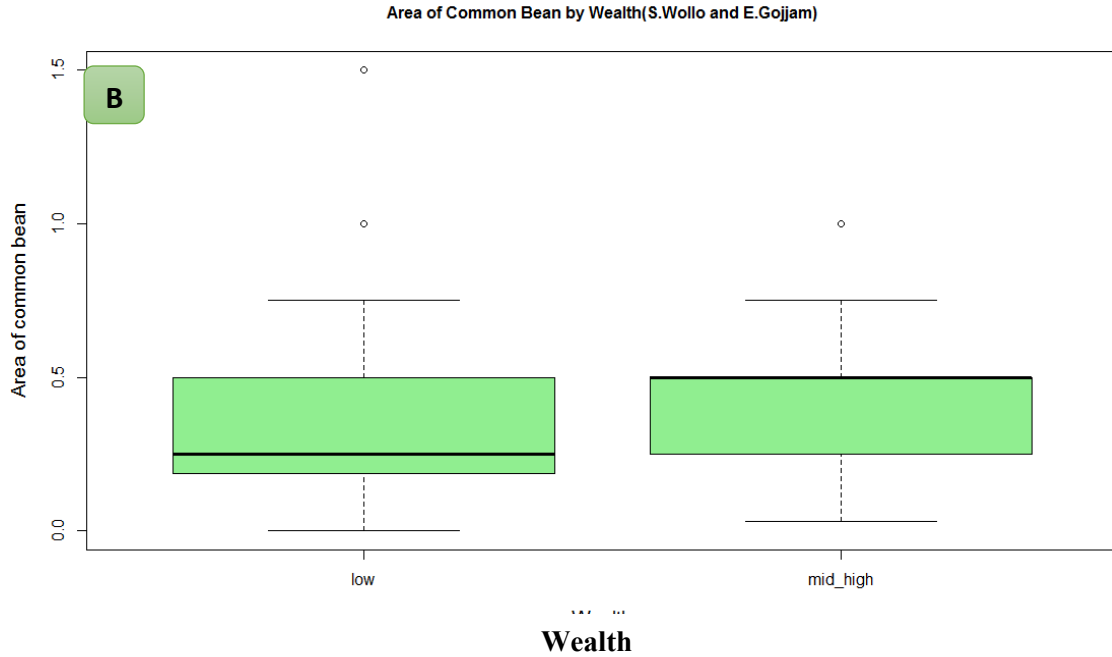


Figure 6: Total area of common bean planted in S. Wollo and E. Gojjam and by wealth

Area of common bean among agroecological zones

The area planted among the three agroecological zones (SM3, M2&M3) have different area coverage

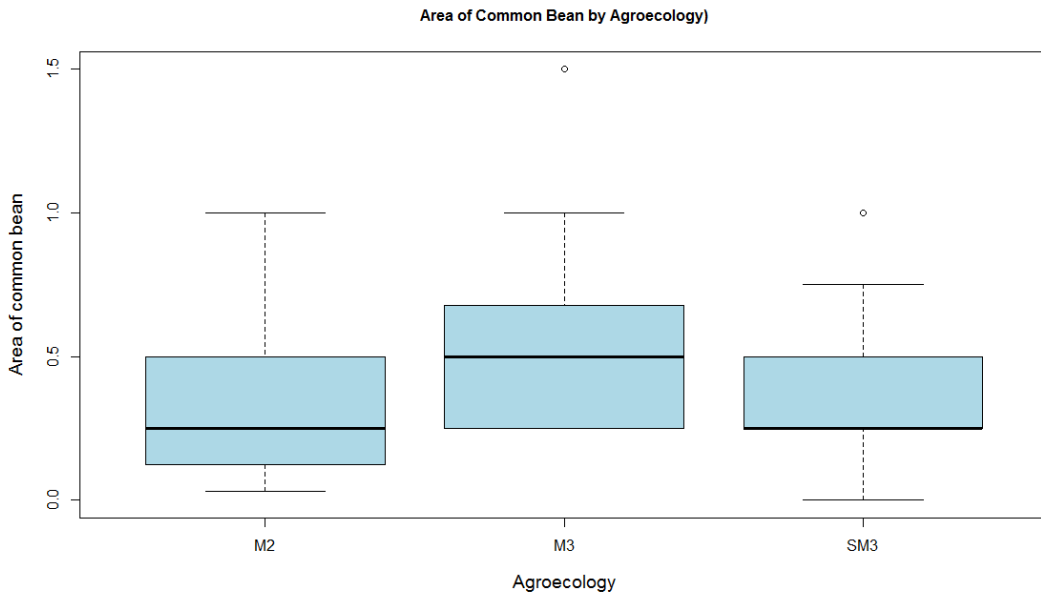


Figure 7: Area planted by common bean in each agroecological zone

Area of common bean among the three agroecological zones has statistically significant difference ($P < 0.05$). In M3, there was high area coverage 0.54 ha. This is because common bean is greatly adapted in this area. In M2 and SM3 common bean area coverage is 0.35 ha and 0.41 ha respectively. Statically, the area of common bean coverage between the two zones (S. Wollo & E. Gojjam) was significant different ($P < 0.05$)

4.3. Diversity and landrace richness

Based on agroecological zone, NECH BOLOQE and KEYE BOLOQE were found in the four strata (SM3 S. Wollo, M2 S. Wollo, M3 E. Gojjam and M2 E. Gojjam). However, DALECHA BOLOQE was found in the three strata (SM3 S. Wollo, M2 S. Wollo, M3 E. Gojjam) except M2 of E. Gojjam. TEKUR BOLOQE was dominantly found in M2 of S. Wollo followed by SM3 of S. Wollo (Figure 8).

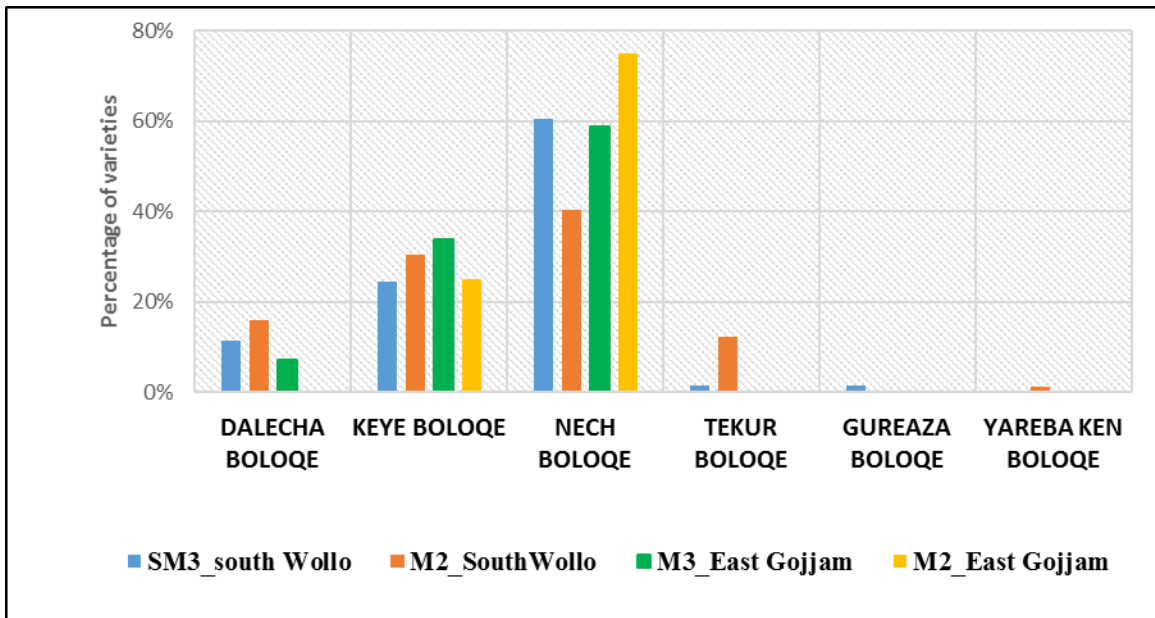


Figure 8: Dominant landrace in each stratum.

The Shannon- Wiener Diversity indices of the land races in the four strata were different. The highest diversity was shown in M2 in South Wollo with the mean value of 1.331 and this was followed by SM3 in South Wollo Zone with the mean value of 1.031. The lowest diversity index was shown in M2, East Gojjam Zone with mean value of 0.562 (Table 5).

Table 5: Shannon diversity index by strata

Strata	Shannon diversity
M2_South Wollo	1.330782
SM3_South Wollo	1.03143
M2_East Gojjam	0.562335
M3_East Gojjam	0.866883

The values calculated for the different diversities are given in Table 6.

Table 6: Gamma, Alpha and Beta diversity of farmers' varieties among in the four strata

AEZ	Zone	Household	Alpha	Gamma	Beta
M2	E.Gojjam	36	1.33	2	1.5
M3	E.Gojjam	36	1.56	3	1.93
M2	S.Wollo	36	2.28	5	2.20
SM3	S.Wollo	36	1.69	5	2.95

In M2 of S. Wollo the highest number of landrace was listed by farmers Whereas the lowest number of farmers' varieties were listed by informants in M3 of E. Gojjam. Beta diversity was highest in SM3 of South Wollo.

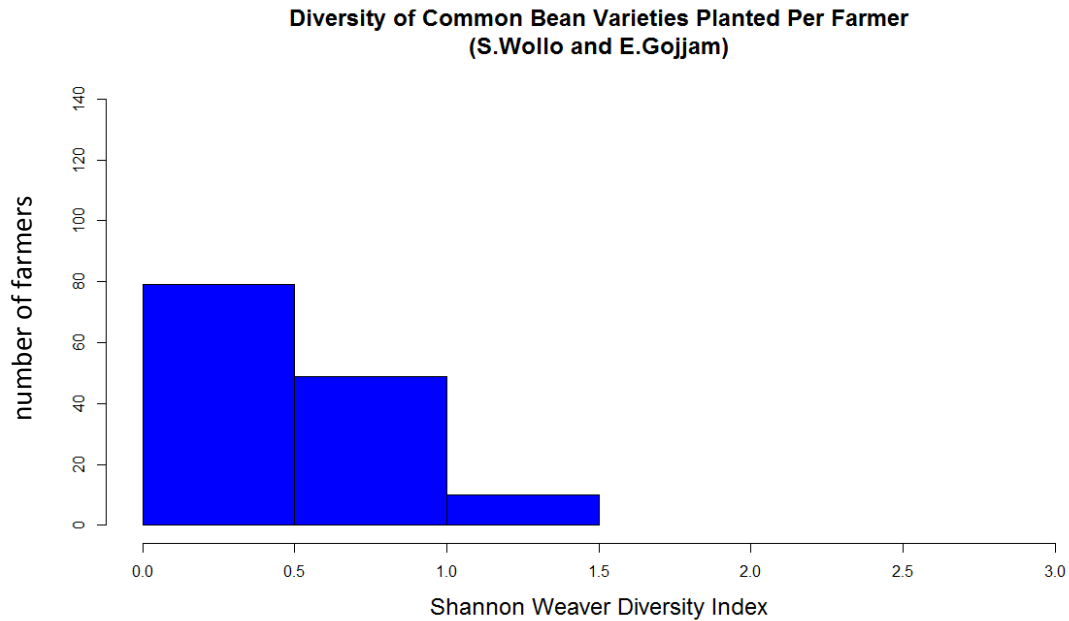


Figure 9: Shannon diversity index based on count of farmers.

Most farmers (80%) grew few landraces ($H'' = 0 - 0.5$), but there were a few farmers (15%) that grew higher number of landraces ($H'' = 1.0 - 1.5$).

4.4. Yield of common bean varieties in South Wollo and East Gojjam in 2014/15 and 2015/16 as reported by farmers who participated in the interview

The average yields of common bean varieties in 2007 and in 2008 S. Wollo and E. Gojjam had differences. The mean values show that in 2007 NECH BOLOQE had the highest yield and it was followed by KEYE BOLOQE whereas in 2008 the result was the reverse of 2007 yield. In 2008 KEYE BOLOQE had the highest average yield, followed by NECH BOLOQE (Figure 10).

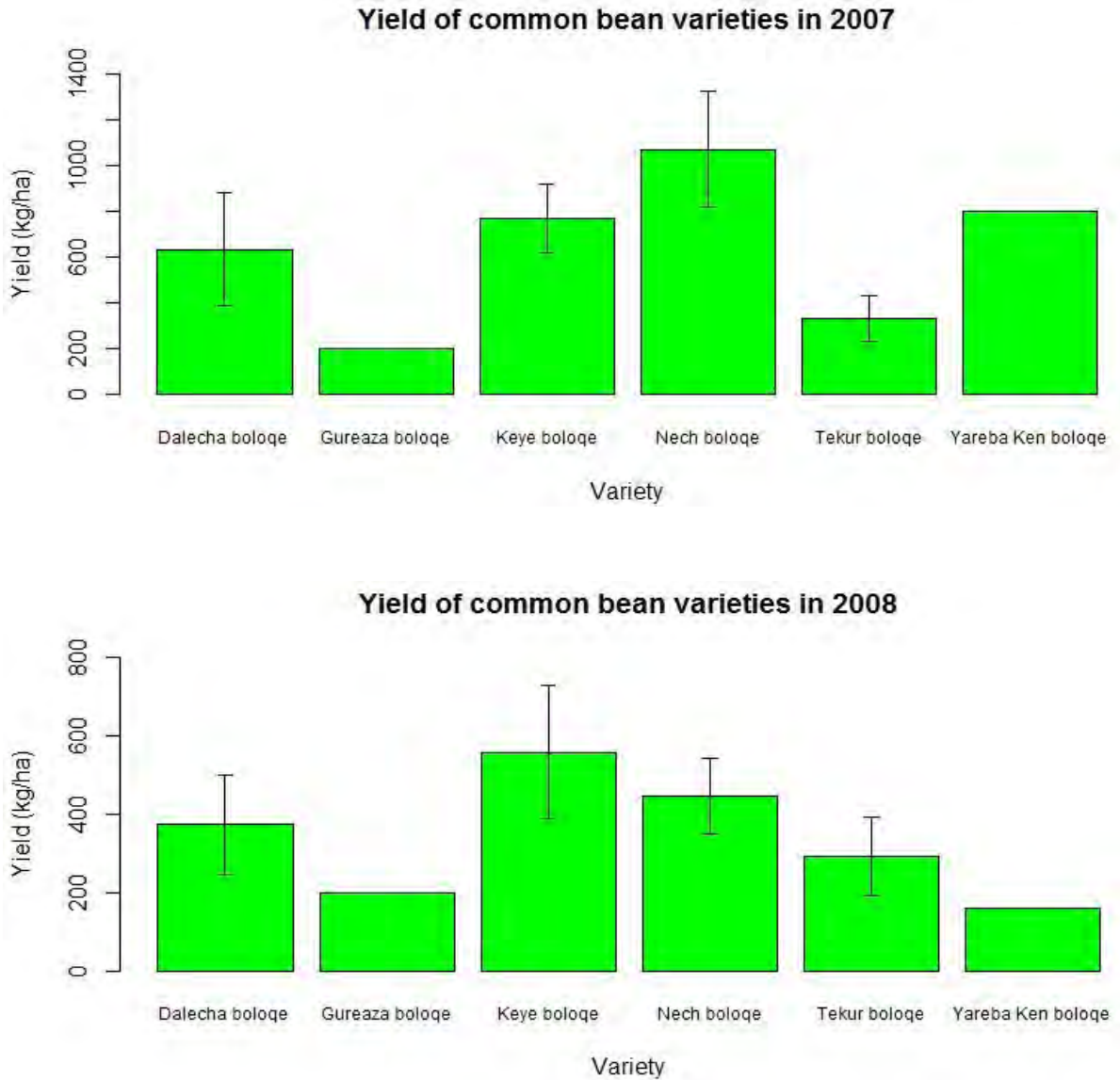


Figure 10: Yield of common bean in 2007 and 2008 E. C in S. Wollo and E. Gojjam Zones

Table 7 and Table 8 show the mean yield of common bean landraces in the study area. The average yield of the different varieties of common bean in 2008 shows some difference. The mean yield of NECH BOLOQE was the highest followed by KEYE BOLOQE. The production of common bean in, 2008 was lower than the production in 2007 because of the drought in that year.

Table 7: Mean yield, standard deviation(SD) and standard error (SE) 2007

Variety	Mean yield	SD	SE
DALECHA BOLOQE	420.5656	501.90	102.45
GUREZA BOLOQE	200.0000	-	-
KEYE BOLOQE	625.5775	597.95	70.96
NECH BOLOQE	1032.921	1465.94	124.34
TEKUR BOLOQE	298.9091	178.97	53.96
YEARBA KEN BOLOQE	800.0000	-	-

Table 8: Mean yield, standard deviation(SD) and standard error (SE) 2008

Farmers' Variety	Mean yield	SD	SE
DALECHA BOLOQE	171.5050	235.88	48.15
GUREZA BOLOQE	200.0000	-	-
KEYE BOLOQE	259.1549	433.60	51.45
NECH BOLOQE	260.8329	399.09	33.85
TEKUR BOLOQE	160.0000	176.18	53.12
YEARBA KEN BOLOQE	160.0000	-	-

4.5. Yield of common bean during drought, waterlogging and shortage of rainfall

As Kruskal-Wallis rank sum test shows there is no significant difference in the yield of common bean during drought, waterlogging and Shortage of rainfall. The p value was 0.32, 0.29 and 0.11 respectively. In general, yield of all common bean varieties was highly affected by drought and shortage of rainfall, however waterlogging is not a problem on the yield of common bean (see Figure 11).

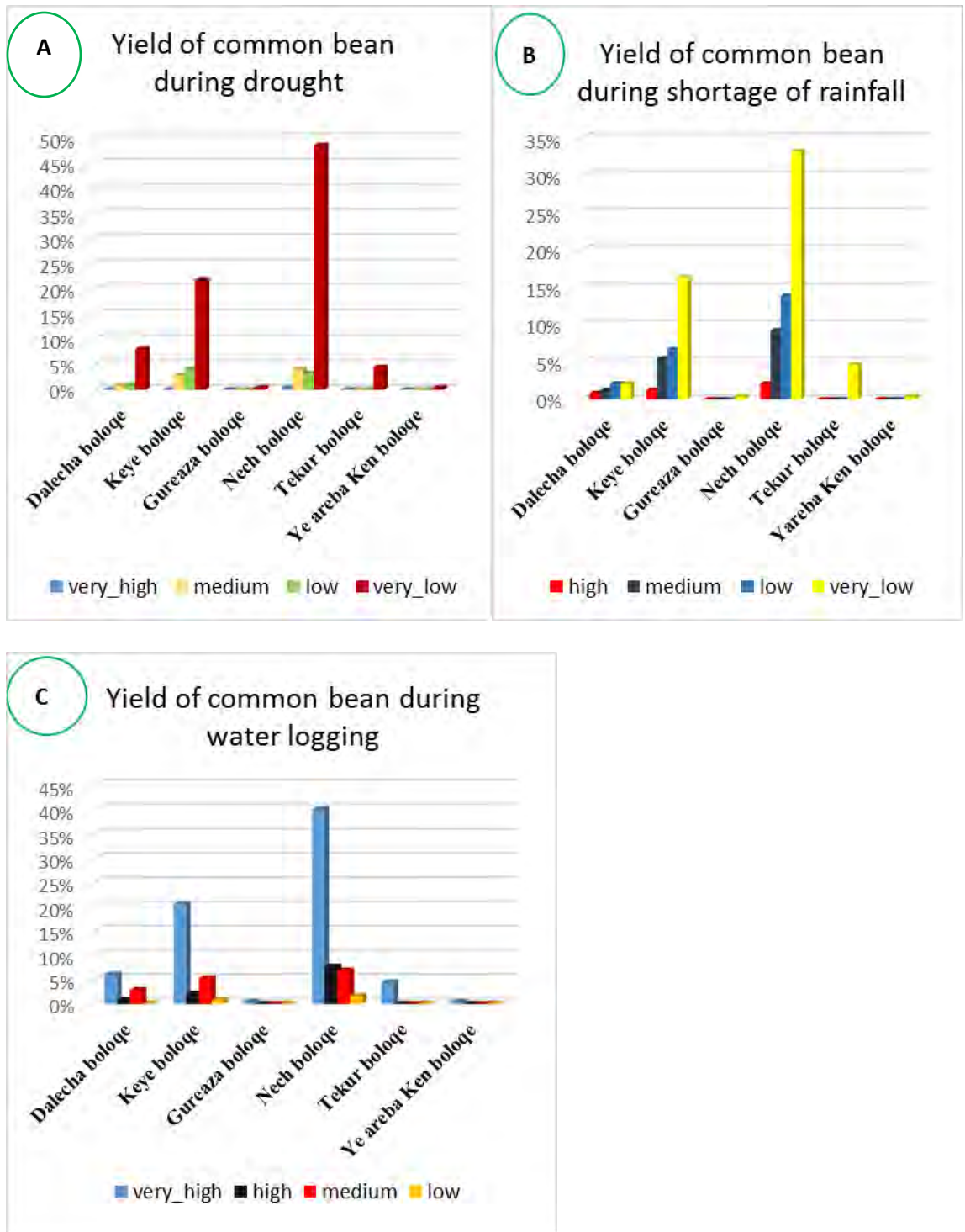


Figure 11: Yield of common bean varieties during drought (A), shortage of rainfall (B) and waterlogging (C)

4.6. Common bean landrace collection in the study area

For the purposes of this study, common bean farmers' varieties were collected between the latitude $10^{\circ} 16' 52''$ - $11^{\circ} 18' 4''$ (N) and the longitude $38^{\circ} 18' 6''$ - $38^{\circ} 57' 23''$ (E). The altitude of the study area was between 1,820–2,447 m.a.s.l with an average value of 2,255 m.a.s.l. the collection site (Figure 12)

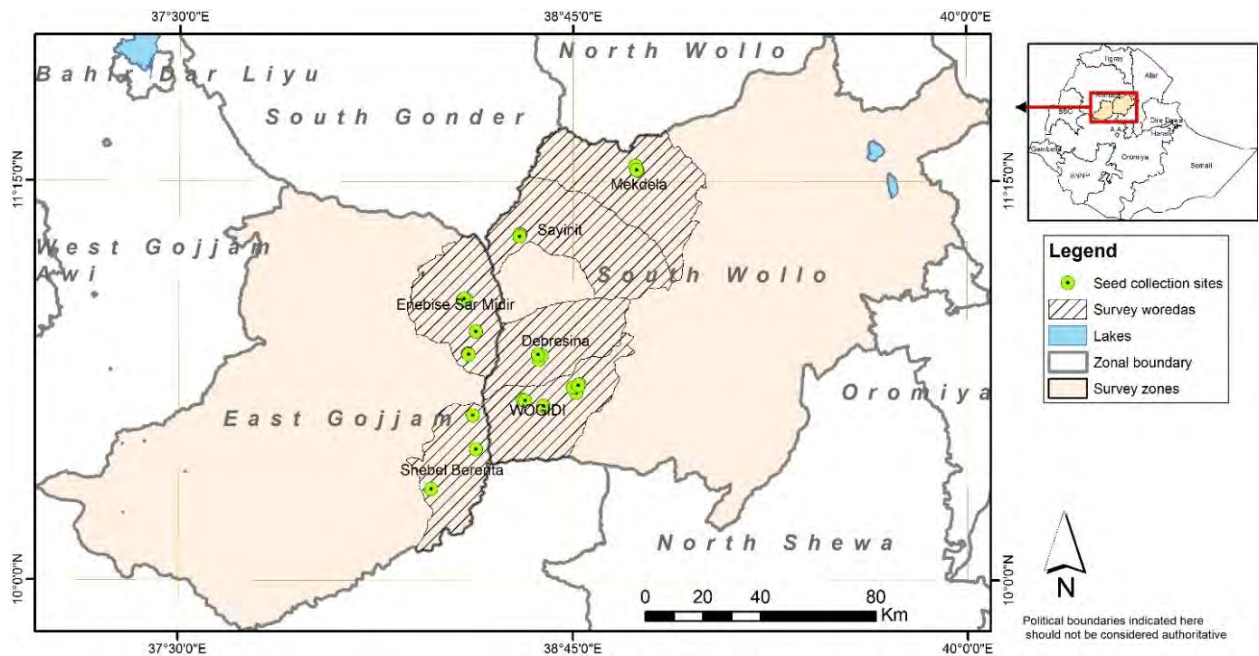


Figure 12: Map of study area showing seed collection site of common bean Farmers' Varieties .

4.7. Common bean cultivation, Cropping systems and Management practices

4.7.1. Common bean cultivation

Most common bean growing farmers (87%) in South Wollo and East Gojjam Zones cultivated common bean only on their main farm fields, while 10% cultivated it both on their main farm fields and home gardens, and the rest 3% cultivated in home gardens only. In East Gojjam 38% and South Wollo 49% of the farmers cultivate common bean in

their main field. The rest 6% in South Wollo and 4% in East Gojjam reported that they cultivate common bean both in their main

farm fields and home gardens, however cultivating common bean on home garden (3%) was practiced only in South Wollo (Figure 13)

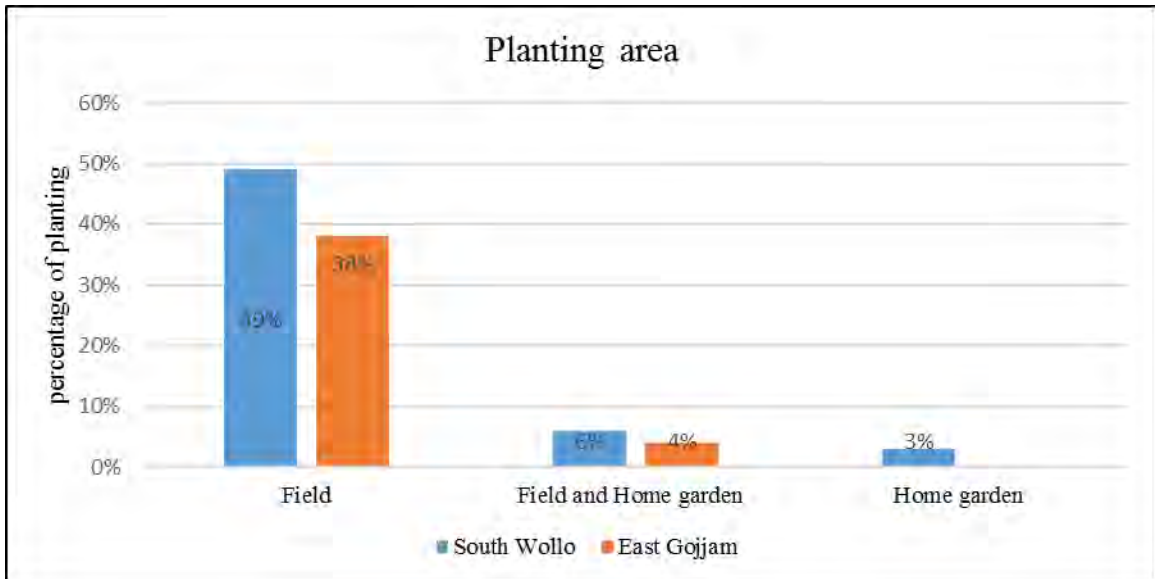


Figure 13: Common bean planting area in S. Wollo and E. Gojjam

The informants reported that they plant common bean varieties on different soil type. Planting of white common bean in their main fields, which is thin or unfertile soil locally called it SHEKEKE OR SESE MERET. In home gardens the soil type is black and fertile locally called WALEKA AFER, as the respondent said this type of soil is not good for yield of common bean. The white common bean growing on black soil was reported to be affected by water logging and found to produce more vegetative part and also make it vulnerable to pests and disease, hence the yield will get very low. However, when grow in well drained main field called SHEKEKE OR SESE MERET it was reported to give better yield.

In the entire study area, common bean was reported to be cultivated at least once a year. In the study areas, common bean was reported to be cultivated two times per year, in the short rainy season (BELG). About 98% of the common bean cultivation being undertaken once per year in the main rainy season (MEHER). In all the study area, common bean farming system was rain fed. In the strata M2 South Wollo most of farmers planting time was between late June (45%) and early July (39%) and in M3 of East Gojjam farmers plant common bean between mid-June to late June. In SM3 of South Wollo, the majority of farmers (77%) reported to plant common bean between early July and Mid-July. In M2 of East Gojjam, common bean is planted in late June (83%).

Harvesting extends between late September to early October for the main cropping season, while it extends between early June to mid-August for the BELG cropping season. In general, common bean takes 3-4 months for harvesting.

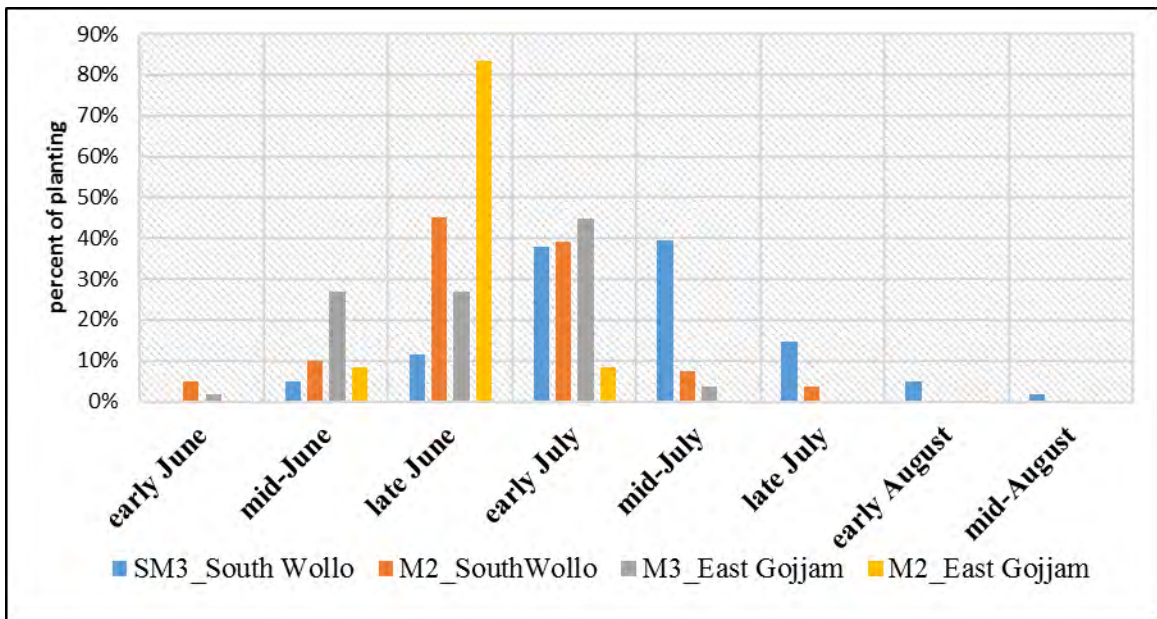


Figure 14: Planting time in the four strata.

In the four strata (SM3 South Wollo, M2 South Wollo, M3 East Gojjam and M2 East Gojjam), common bean planting time was found different, for M2 in E. Gojjam the majority (83%) of farmers plant common bean in the late June, whereas farmers in M2 in S. Wollo plant it from late June to early July (See Figure 14).

Harvesting time of common bean in the four strata had differences, in SM3 and M2 of S. Wollo harvesting of common bean was reported to takes place between late September and early October, which was similar with M3 of E. Gojjam. In M2 of E. Gojjam the harvesting time was between mid-September and late September unlike other strata. However, the harvesting time in M2 of S. Wollo and M2 of E. Gojjam was reported to take place in mid-October (see Figure 15).

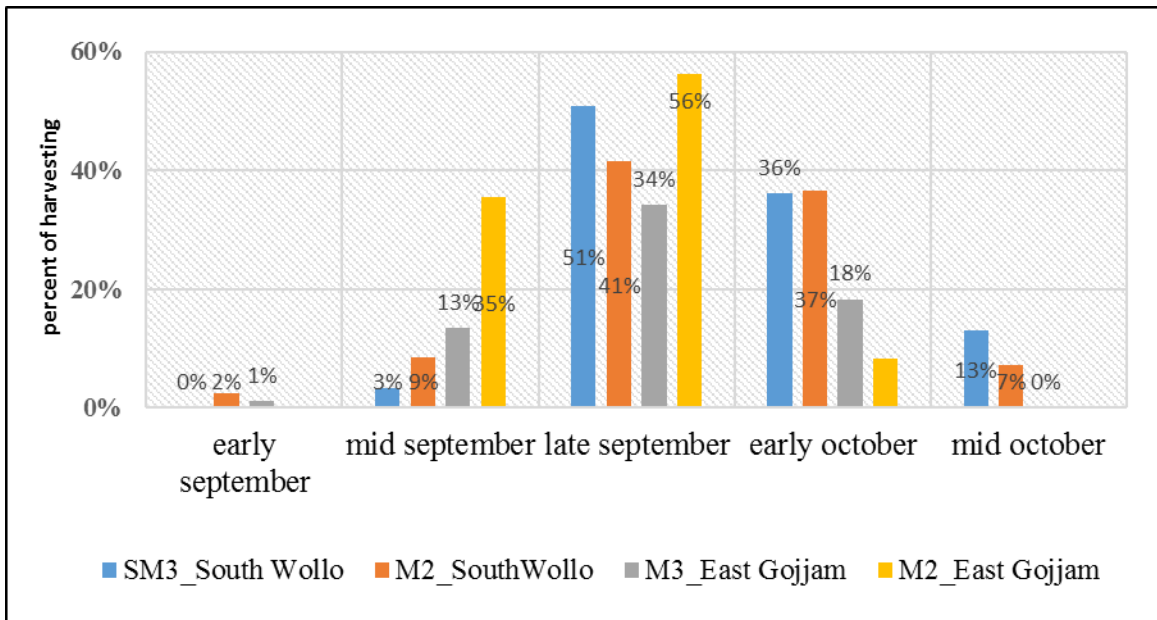


Figure 15: Harvesting time in the four strata.

4.7.2. Cropping system

In the study area, common bean varieties were mainly established as a sole crop and inter-cropping systems. The white common bean was cultivated as a solo crop only. Inter

cropping was practiced in the entire strata (SM3_South Wollo, M2_South_Wollo, M2_East_Gojjam and M3_East_Gojjam) with all varieties (DALECHA BOLOQE, KEYE BOLOQE, GUREAZA BOLOQE, TEKUR BOLOQE and YAREBA KEN BOLOQE) except NECH BOLOQE. Sorghum was mostly used for intercropping with common bean followed by maize. In addition to this, in M2 in East Gojjam farmers practiced intercropping of common bean with sunflower which is not common practice in the other strata (Figure 16).

In the cropping system, farmers grew common bean after harvesting the preceding crops like TEFF, sorghum, barley and wheat or in their home garden they intercrop common bean with sorghum, maize and sunflower. In such systems, the common bean is usually planted when the maize and sorghum are mature enough to support the common bean.

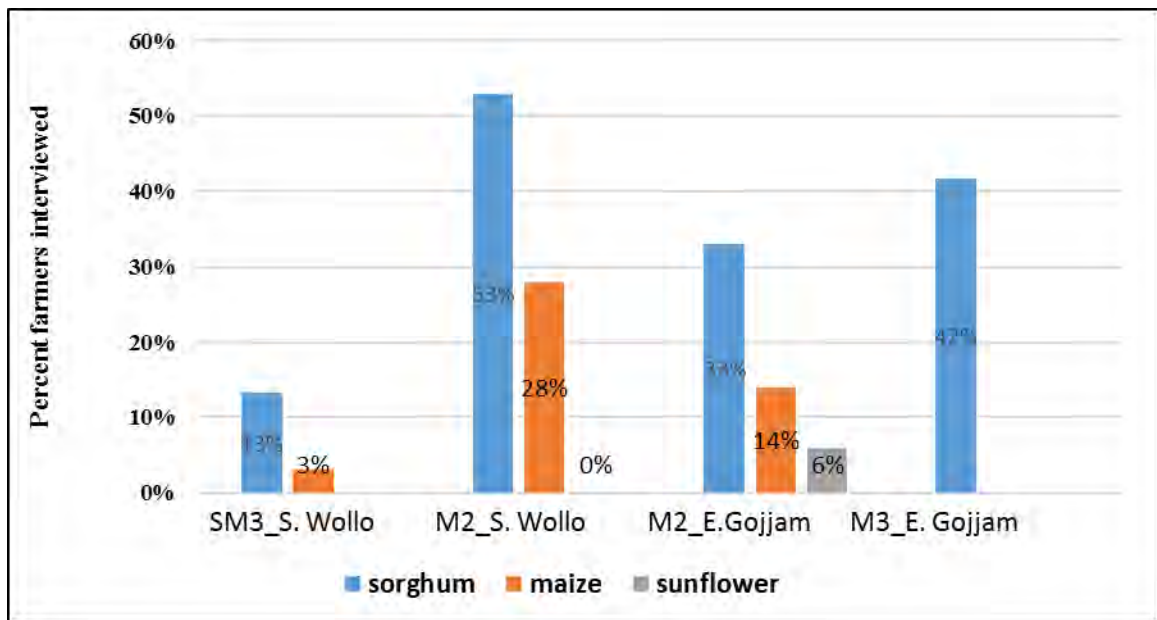


Figure 16: Intercrop common bean with other crop.

4.7.3. Management practices

Traditional management of common bean was practiced in the study area. As reported by key informants in the study area, common bean is a crop that needs minimum agricultural

practices. Sowing of common bean was done by broadcasting method on the farm lands, as informant mentioned to control seed quality and to get good yield, seed selection was undertaken for sowing purpose.

In the study area land ploughing for common bean farm land was carry out by men. Only some farmers (30%) plough their common bean farm land two times before sowing and after sowing to minimize the risk from weed. As the key informants mentioned, there is a difference of yield between ploughed and non-ploughed land, and that the ploughed one has high yield than that of the non-ploughed one. This practice is locally called MEBESHER or MEKEMKEM but many (60%) farmers ploughed their common bean farm land only once before sowing. Those who mentioned that they ploughed their land had a common idea that ploughing of land for common bean was not practiced earlier but started these days, because unlike the earlier time recently there is shortage of land and the soil is not fertile, so as to use the land effectively. Besides this they ploughed the land since they want to make it ready or minimize their work for the next sowing season. The crop is harvested when leaves start to senesce and start shedding, pods turn yellow, plants dry, and seeds feel hard within the pod. The crop was harvested by handpicking as soon as the pod gets dried and changed yellow, before it starts to dehisce and scatter the seeds.

Fertilizer use in common bean was relatively much less than its use in wheat, teff and other cereals. It is used mainly in waterlogged and low fertility areas. As key informants mentioned, 20 out of 24 (83%) didn't use fertilizer. Local communities cultivate and manage common bean farm mainly using the natural fertility of the land itself without application of fertilizers, manure and herbicides. In the study area, fertilizer requirements depend on the nutrient status of the fields, and thus, vary from field to field. Fertilizer

application was common in Shebel berenta district to enhance the fertility of common bean farmland where 17% of the farmers reported to use fertilizer such as “Hiyaw Madaberiya” before sowing, by mixing the seed with fertilizer.

Common bean was reported to be weeded at least once throughout the production season. As the key informants mentioned common bean was not weeded in the rainy time, weeding takes place on a sunny day. In addition to this, after the plant starts growing weeding was not reported to be carried out. Farmers control weeds by manual weeding. No report of herbicides or pesticide use was found from all informants to control weed and pest, a few farmers traditionally use admixtures of ash with animal urine and spread it on the common bean plant to control pest or some farmers sow the crop in mid-July, as they believe that after this time the pest locally known as KISHKISH OR AMUGN does not appear.

4.8. Importance of common bean in the study area

4.8.1. Importance of common bean as a Food, Feed, Source of Income, Medicine and Bee forage.

Traditionally, the local people have their own way of categorizing important value of common bean. Informants were mentioned use of common bean production for their food, fodder, and medicinal uses, in addition to socio-economic and agroecological value. Based strata common bean has different use (Figure 17).

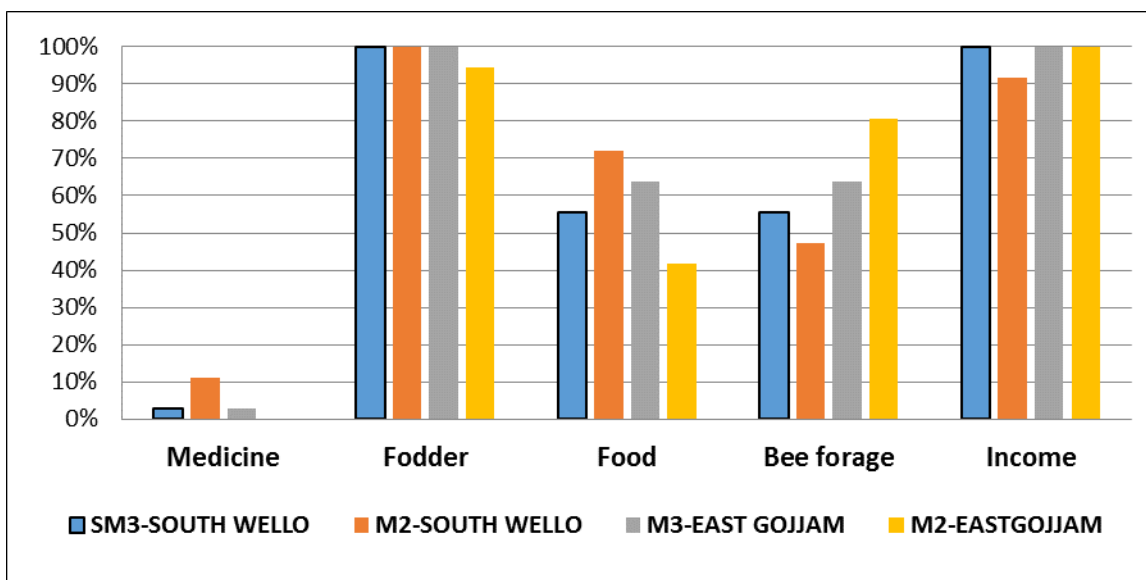


Figure 17: Use of common bean within strata.

In the four strata in SM3 South Wollo (56%), M3 East Gojjam (64%), M2 South Wollo (72%) and M2 East Gojjam (42%) used as source of food. The seed part only was used and it was consumed in the form of sauce either as SHIRO WOT, KIK WOT and NIFRO (TEREA), the most frequently reported recipes were SHIRO WOT, KIK WOT NEXT TO NIFRO.

In the entire study area, common bean was highly used as livestock feed. In SM3 South Wollo (100%), M3 East Gojjam (100%), M2 South Wollo (100%) and M2 East Gojjam (94%) crop residue was used as a fodder for animal such as cattle, sheep and goat. It heals sick and drought attacked cattle. As fodder use the stems, leaves, pods for feed, the seed was not given for animals in its row form. It was given as a boiled grain by soaking or boiling it in a water containing salt. The respondents were explaining the importance by comparing common bean with another crop. As mentioned by respondent grass pea residue is very important for their animals as well as common bean residue too very important that of grass pea.

In the four strata in SM3 South Wollo (100%), M3 East Gojjam (100%), M2 South Wollo (92%) and M2 East Gojjam (100%) of the informant reported to use common bean as a source of income by selling the grain for market.

SM3 South Wollo (3%), M3 East Gojjam (3%), M2 South Wollo (11%) used as medicine, farmer common bean is used as a medicine, mainly used in order to treat gastric pain. In the study area as the informant mentioned, eating the boiled grain of common bean by empty stomach it helps to treat gastric problem however in M2 East Gojjam common bean was not important for medicinal purpose. SM3 South Wollo (56%), M3 East Gojjam (64%), M2 South Wollo (47%) and M2 East Gojjam (81%), farmers mentioned that, common bean flower was used as bee forage bees assimilate common bean flower. Common bean traditional food prepared and its relative common English common name are shown in the table 9

Table 9: Common bean use values

Sources of collection/Wereda	Major recipes prepared (Amharic Language)	Common English name
Wogidi	SHIRO WET, KIK WET(SELASUT) AND NIFRO	fine ground grains used in the making of stew, split grains for sauce making and boiled grain
Debresina	SHIRO WET, KIK WET AND NIFRO	fine ground grains used in the making of stew, split grains for sauce making and boiled grain
Mekdela	SHIRO WET AND NIFRO	fine ground grains used in the making of stew and boiled grain
Sayinit	SHIRO WET AND NIFRO	fine ground grains used in the making of stew and boiled grain
Shebel berenta	SHIRO WET, KIK WET AND NIFRO	fine ground grains used in the making of stew, split grains for sauce making and boiled grain
Enebise sar midir	SHIRO WET, KIK WET AND NIFRO	fine ground grains used in the making of stew, split grains for sauce making and boiled grain

Details of common bean preparation method, regularity of time farmers used this food and the preferred varieties to prepare those traditional foods are given in Table 10.

Table 10: Common bean foods and their preparation

Name	Method of preparation/processing	Frequency of use	Preferred variety
SHIRO WET (raw grain flour)	Roasted and crushed with different spices such as, pepper,	• Prepared daily	KEYE BOLOQE TEKUR BOLOQE DALECHA BOLOQE
KIK WET (SELASUT)	Split grain and crushed with different spice.	• Prepared daily	KEYE BOLOQE DALECHA BOLOQE
NIFRO	Nifro Boiled grain prepared from dry and fresh of common bean. Mix with maize seed and boiled it together.	• Prepared occasionally • Mostly prepared for cultural occasions	Prepared from DALECHA, KEYE and GUREZA BOLOQE from dried and fresh seed.

Use of common bean varieties for human consumption as well as income generation within the study Zone, statistically had significant difference at p-value $2.2e-16$ ($p < 0.05$) among varieties. KEYE BOLOQE and DALECHA BOLOQE very important for human consumption. TEKUR BOLOQE Somewhat important however many farmers are not interested to plant this variety because of the color

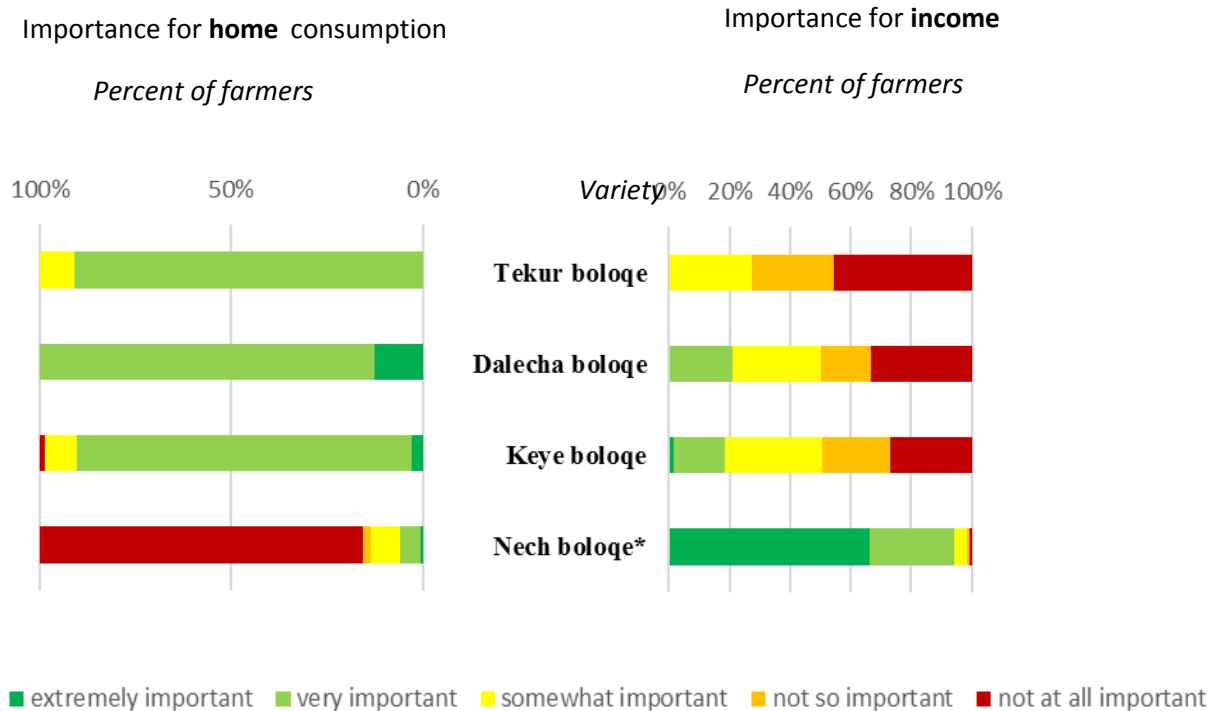


Figure 18: Use of common bean varieties for consumption and income generation.

It was found that the majority (90%) of farmers reported NECH BOLOQE was not used for consumption, However extremely important for income generation (98%). It was found 11% of farmers reported to use KEYE BOLOQE for home consumption it was the most preferred variety for making local-dish and 16% used for both consumption as well as for selling at the market to generation income. DALECHA BOLOQE somewhat important for home consumption and 7% used for both home use as well as 3% selling to the market. DALECHA BOLOQE varieties were preferred for „KIK“ (stew). Farmers use black seeded varieties however, majority of respondent mentioned black seeded varieties were not liked, because of its non-attractiveness (color) for eating and the associated low marketability. Small-white varieties were preferred for income generating.

4.8.2. Importance of common bean in Agroecological Intensification

As key informant mentioned Common bean is very important for their farm land in addition to other usages (Figure 19). They reported that the common bean helped them to increase and restore soil fertility (15 respondents, 63%), control weed (5 respondents, 21%), to increase yield (3 respondents, 13%) for the next crop specially for teff when it is included in their crop rotation time and weed control and restore soil fertility (1 respondent, 4%).

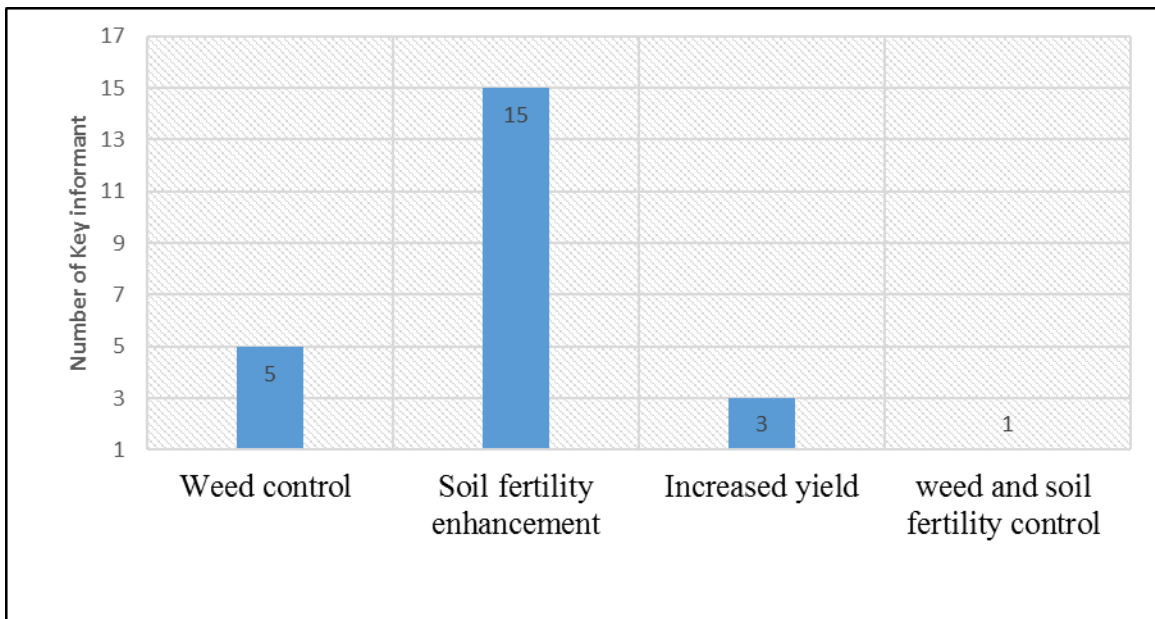


Figure 19: Advantage of crop rotation of common bean with other crops control.

A number of farmers included common bean in their crop rotation sequences for different purpose. The crop rotation sequences most frequently indicated by farmers are summarized and presented in table 11. As shown in the table, cereals and legume crops were included in most of the farmers' crop rotation sequences; teff and sorghum were also mostly grow after common bean.

Table 11: Major Crop Rotation Practices by Farmers in the Study Zones.

Zone	Rotation Sequence	No of respondents
SM3_South Wollo	Common bean-teff	20
	Common bean-teff-sorghum	10
	Common bean-sorghum	2
	Common bean-teff- barley	2
M2_South Wollo	Common bean-teff	19
	Common bean-teff-sorghum	9
	Common bean-teff-wheat	3
	Common bean-barley-teff- wheat	1
	Common bean-barley	1
	Common bean-barley-teff	1
M2_East Gojjam	Common bean-teff	25
	Common bean-teff-sorghum	9
	Common bean-sorghum	2
M3_East Gojjam	Common bean-teff	15
	Common bean-teff-sorghum	6
	Common bean-sorghum	3
	Common bean-teff-faba bean	1
	Common bean-wheat-faba bean	1
	Common bean-wheat	8
	Common bean-barley-wheat	1

In the two study Zones crop rotation systems were practiced as shown in the (Figure 20). Majority of farmers (84%) rotate common bean with teff and 28% rotate with sorghum

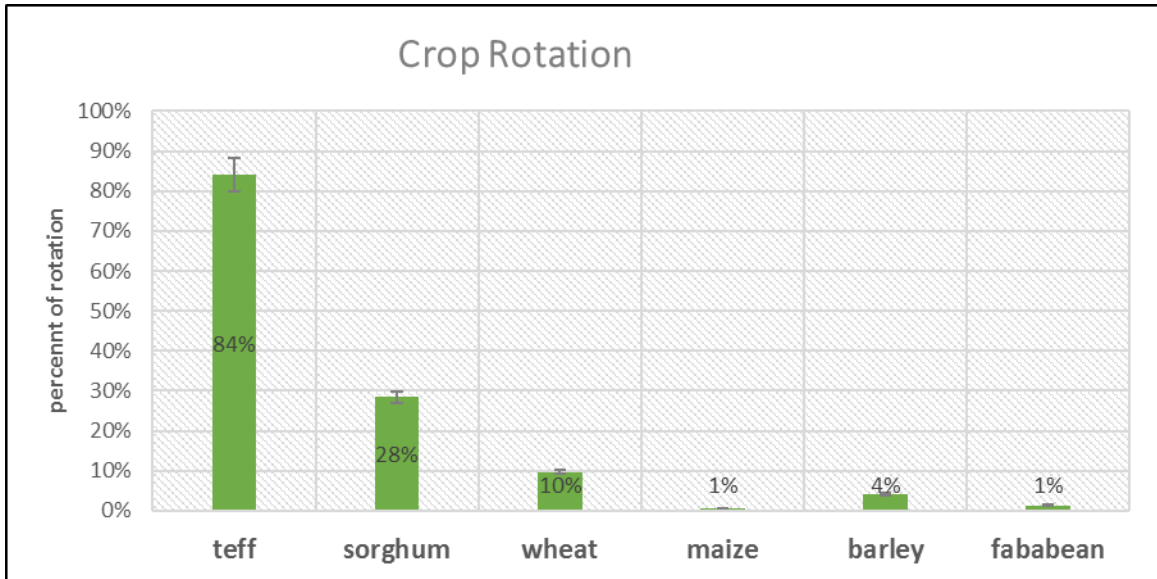


Figure 20: Rotation of common bean with other crop.

4.8.3. Preferences of Farmers'

The preference ranking of importance of common bean by 24 key informants showed that it is more preferred as income generation and followed by fodder. Different ranking was observed among studied Weredas (Table 12).

Table 12: Farmers' preference ranking for use value of common bean 1= Ranking value assigned for the least important ; 2= Ranking value assigned for somewhat important; 3= Ranking value assigned for very important and 4= Ranking value assigned for extremely important

Data collection Weredas	Food	Fodder	Enhance soil fertility	Income generation	Medicinal value
Wogidi	2	3	3	4	1
Debresina	2	3	3	3	0
Mekdela	1	3	3	3	0
Sayinit	2	3	2	3	1
Shebel berenta	2	3	3	3	1
Enebise sar midir	2	4	3	4	1
Total score	11	19	17	20	4
Rank	4th	2nd	3rd	1st	5th

4.8.4. Production constraint of common bean

Farmers in South Wollo and East Gojjam face multiple production constraints of common bean. Out of 24 key informants, (20 respondent) 83% mentioned that drought is a major constraint, (10 respondents, 42%) mention pest as production constraint locally known as KISHKISH or AMEGN and also 8 respondents, 33% mentioned that disease locally known as MAGED, WAGE and YEWEHA MCH as a constrain. Farmers mentioned that Common bean was affected by pests and disease at early stages, it the vegetative and flowering stages. as described by the informants the pest is small living organism living on the air and has metal like black cover. The pest pores the leaf and also at flowering time by making not to flower and the pod will be shrink, due to this the number of seed inside the pod will be less. The disease caused, if someone move inside the plant after growing the tendril, locally they call it MAGED, WAGE and YEWEHA MECH. Less proper care also farmers listed as a production constraint. That mean lack of weeding, lack of ploughing the area of common bean planted again and again and low soil fertility, this tend to decrease common bean production. In East Gojjam farmers mention that, if there

is high amount of rain the common bean affected by disease locally known as YEWIHA
MECH OR MECH.

4.9. Local Farmers Perception about common bean

In this study, key informants were asked what they think about the status of the production of common bean in their area; 22 (92%) of respondents mentioned that production of common bean has decreased, 17 (63%) of them said it has increased and 7(29%) of respondents mentioned no change in its production.

In the study area, farmers listed out different characters that made common bean different from other crops. According to their responses, most of the unique characters mentioned by informants were positive like short lifecycle of common bean was considered the unique property that differentiated it from other legumes. Unlike other crops common bean was a crop which was reported to be used both for animal and human consumption, drought resistant, it used for soil fertility and needs low input but gives high production. However, some negative characters were also mentioned like its being affected by pest and some varieties are only used for selling if the market price decrease the only chance is selling it in the cheapest price because it is not important for household consumption. It was not eaten without processing, if one eats more it causes vomiting and diarrhea, as explained by informants. From the listed unique characters, its being a crop that needs low input but gives high product stood first because this crop does not require intensive management (it does not need that much weeding, ploughing, fertilizer application, easy to grow and collect), it can grow in small area, small amount of seed is needed for sowing but will give high production

4.10. Seed Source, Selection, Storage and Management Practices

In the study area farmers mostly relied on purchases seed from local markets or informal exchanges by another crop with their neighbors or relative's, seeds of one variety with another variety of the same crop species, or a different crop species for the required attributes.

About 54% of the traditional and 12% of the improved varieties of the seed source was reported to be obtained from market whereas 19% of the traditional and 1% of the improved seed source was obtained from their family. About 4% of the seed source from their neighbors which is traditional seed, exchanging with other crop by other farmers" varieties. About 5% of traditional and 4% of improved seed is from development agents (Figure 21).

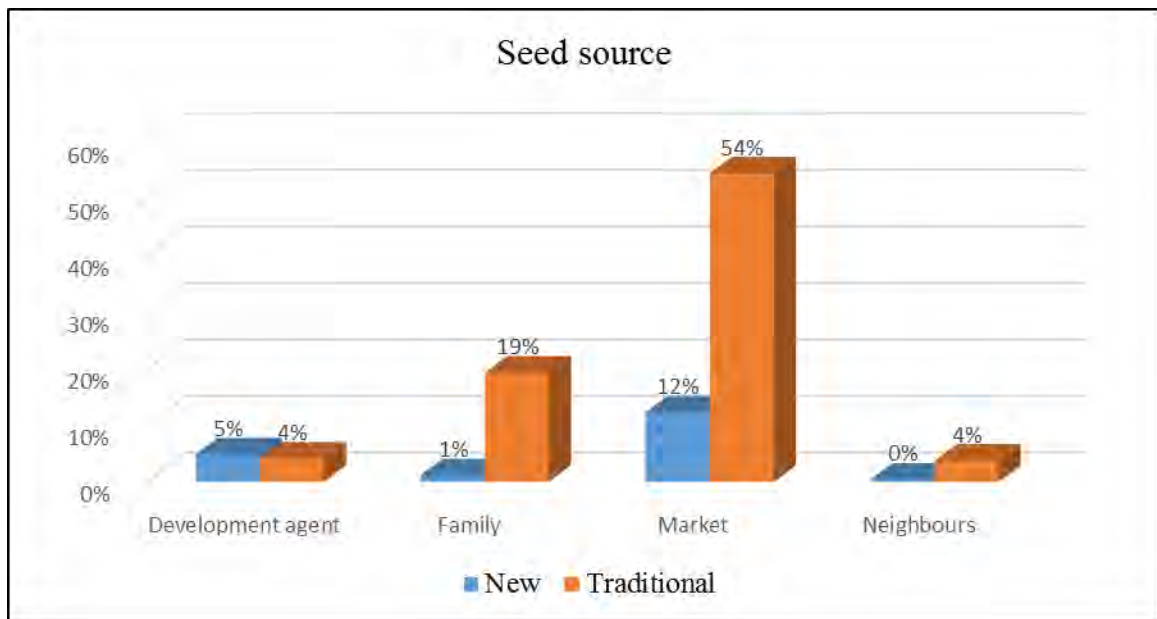


Figure 21: Sources of common bean seeds

The majority of farmers 84% reported to apply seed selection for the next sowing season. 15% reported that they did not make seed selection for the next growing season. Farmers reported to apply selection of seeds at harvesting time or when get closes the planting time for the next cropping season. As mentioned the key informants the use of traditional container for common bean storage, namely *GOTERA* or *GOTA* which is made from animal dung and mud (by 54% of respondents), in addition to this 46% of respondents use modern sack locally called *KESHA* for storage purpose because it is easy to take it to the market. Seed usage based on income level, 36% low and 44% mid-high income farmers used landrace (traditional) varieties, whereas 9% low and 11% mid-high income use new (improved) (traditional). in both mid-high income farmer and low income farmers prefer to use landrace (traditional) seed (see Figure 22).

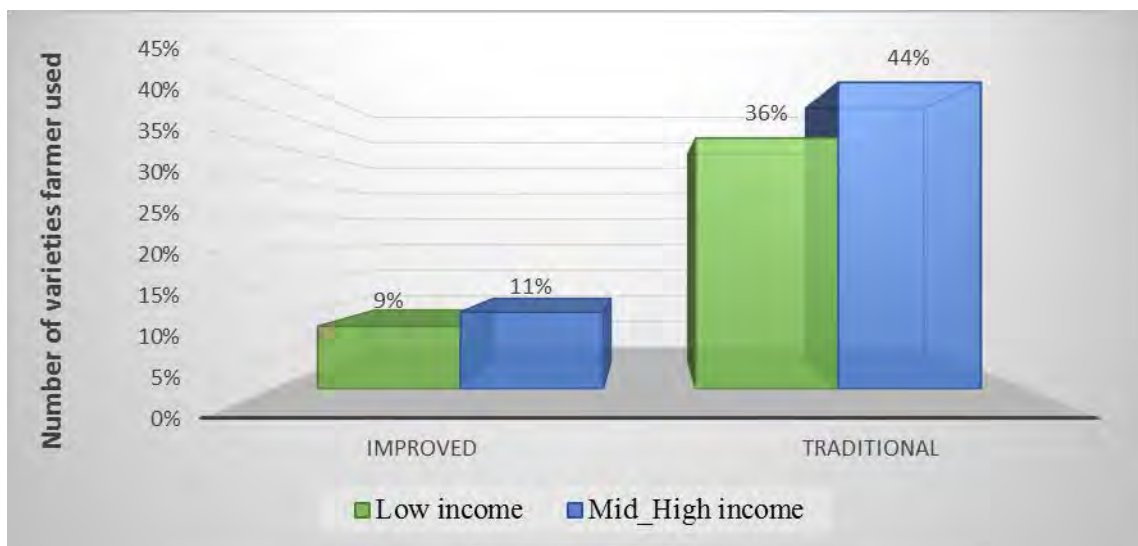


Figure 22: Wealth of farmers in relation to varieties used

Traditional seed storage materials



Figure 23: Photo of traditional Seed storage containers(GOTA OR GOTA) in S. Wollo (A) and E. Gojjam (B) (photo by Menbere Berhane, November and December/2016)

4.11. Gender Roles for Maintaining the Landrace Diversity of common bean

In the study area, most of the management practices/agronomic practices in the cropping of common bean were done by both female and male farmers except plowing and planting, which was only done by male. Both of them participate in hoeing, replanting, weeding, harvesting, threshing, storage, marketing, seed selection, fodder collection and food preparation (Figure 24). In South Wollo and East Gojjam Zones many of the activity done by female adults and male adults. However, the other family members also participate in some activities like seed selection in S. Wollo but in E. Gojjam only male and female adults participate in seeds election for sowing purpose (see Figure 25).

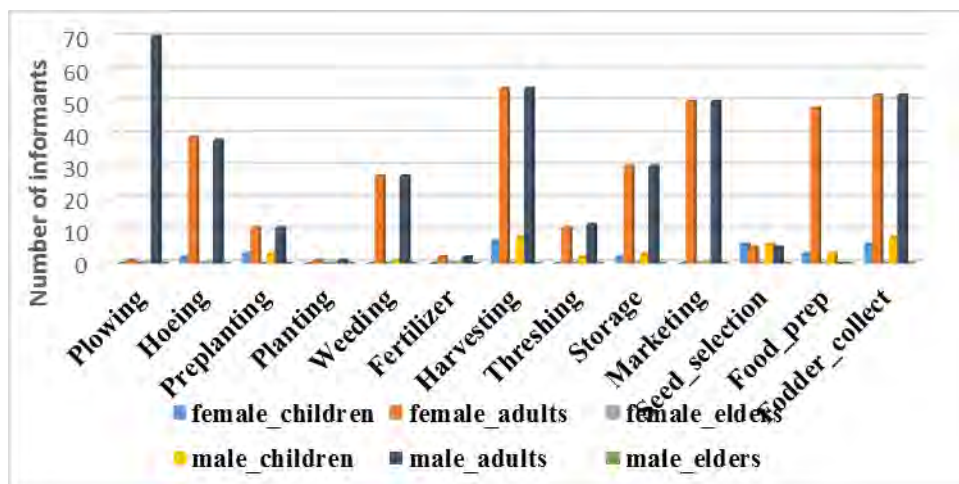


Figure 24: Gender role in common bean process S. Wollo

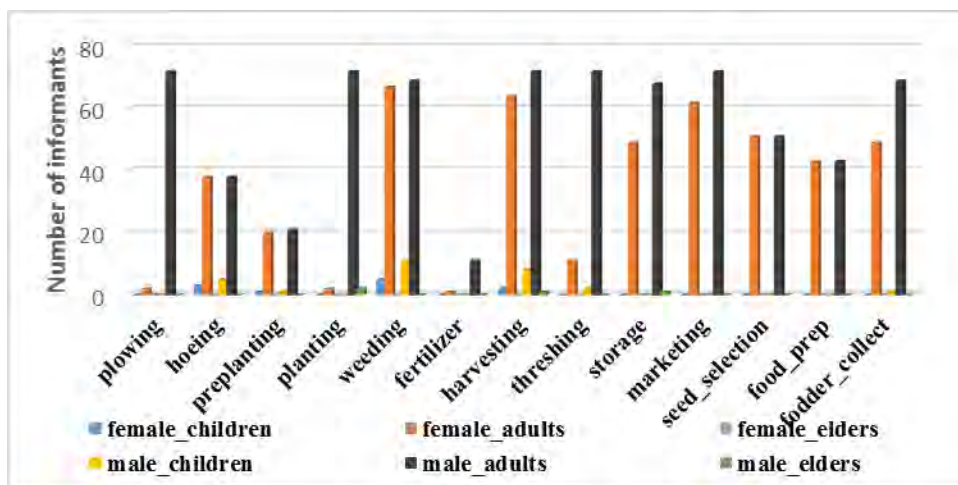


Figure 25: Gender role in common bean process E. Gojjam

4.12. Resistance of common bean varieties to pest, frost and disease

In the study area according to ratings by farmers, there is no significant difference (P -value = 0.18, $P > 0.05$) to resistance of pests among varieties. That means DALECHA BOLOQE, KEYE BOLOQE, NECH BOLOQE, TEKUR BOLOQE they are susceptible or always affected to pest as mentioned by informants, Pest was the major production constraint (Figure 26).

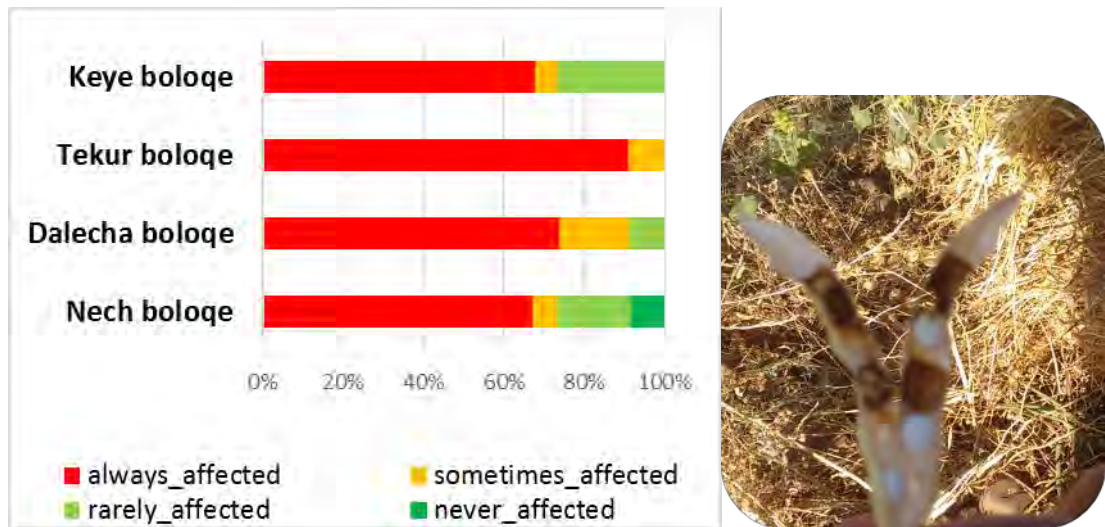


Figure 26: varieties of common bean resistance toward pest and a photo which is the pod of common bean affected by pest

In study area, statically there was no significant difference ($P\text{-value} = 0.10, P > 0.05$) to frost resistance among varieties. that means DALECHA BOLOQE, KEYE BOLOQE, NECH BOLOQE, TEKUR BOLOQE they are never affected by frost as the respondent mentioned (Figure 27). Common bean grows in warm areas therefore frost was not a problem for common bean production.

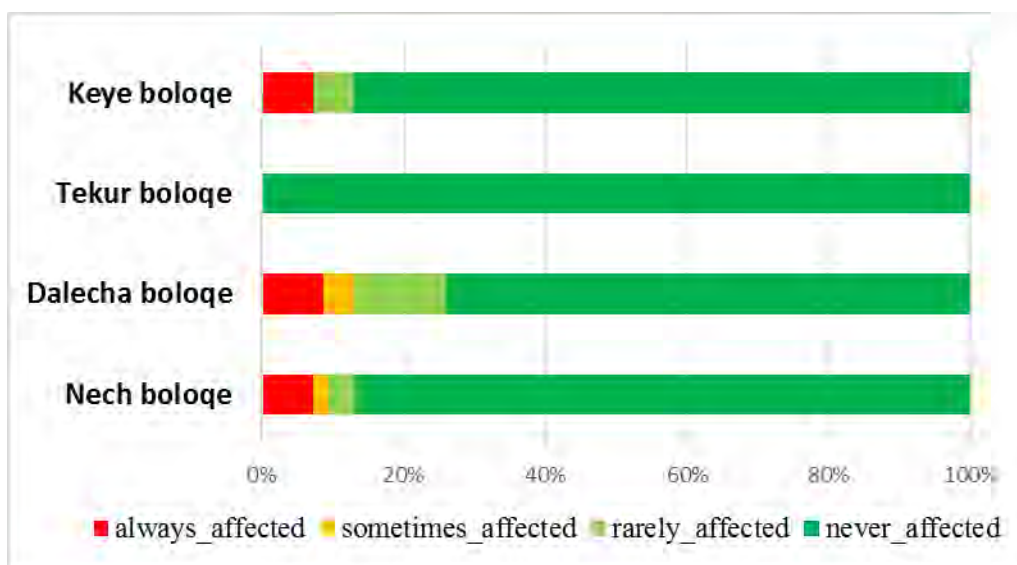


Figure 27: varieties of common bean resistance to frost

Resistance of common bean variety for disease in S. Wollo and E. Gojjam, there was significant difference (P-value = 0.04, $P < 0.05$), as farmers mentioned KEYE BOLOQE always affected by disease whereas NECH BOLOQE rarely affected. However, TEKUR BOLOQE was the least affected by disease (Figure 28).

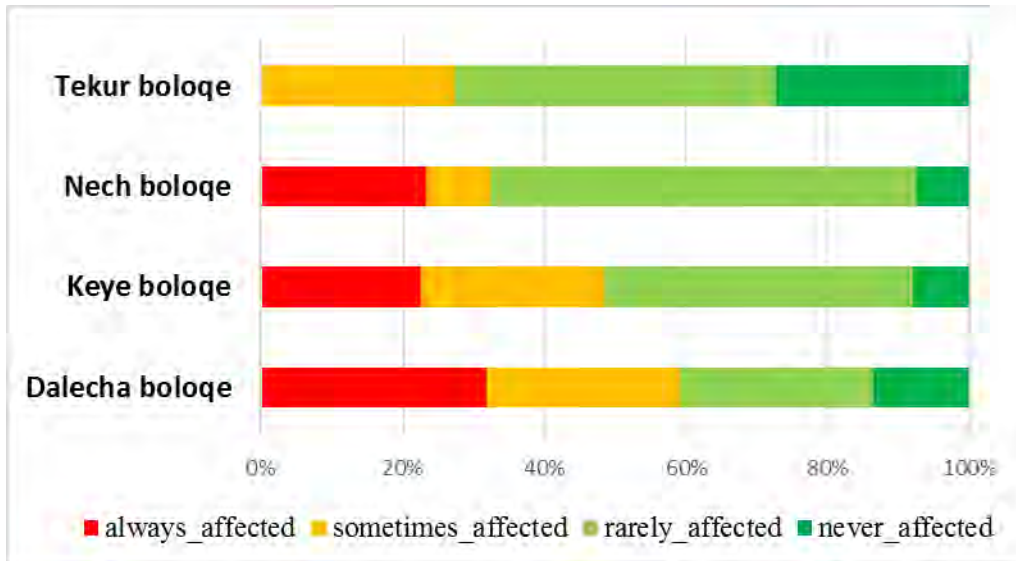


Figure 28: varieties of common bean resistance to disease

4.13. Germination percentage

Mean germination percent of all farmers' varieties were ranged between 91-100%. All the accessions were started germination on the third day and finished germinating on the eighth day. Based on germination testing result, all representatives of seed samples were germinated having an average germination capacity of 96.6% (see Table 13). In the three agroecology, remarkably NECH BOLOQE has the lowest germination percentage. Common bean landrace varieties collected from S. Wollo (WDO22) in SM3 agroecology, S. Wollo (WME024) in M2 agroecology and E. Gojjam (EGB032) in M3 agroecology showed lower germination percentage (92%, 91% and 92%) respectively and the other landrace

varieties that showed the lowest germination percentage (92%) were seed of DALECHA BOLOQE from S. Wollo in M2 agroecology (SWZ007). In addition to this, GUREAZA

No	Accession Code	Name of landrace/Farmer's Variety	Collection Zone	AEZ	Germination Percentage (mean)
1	SWS002	DALECHA BOLOQE.L	S.Wollo	SM3	95
2	SWS003	DALECHA BOLOQE	S.Wollo	SM3	94
3	SWD16	GUREAZA BOLOQE	S.Wollo	SM3	93
4	SWD17	DALECHA BOLOQE	S.Wollo	SM3	100
5	SWD18	TEKUR BOLOQE	S.Wollo	SM3	100
6	SWD19	KEYE BOLOQE	S.Wollo	SM3	100
7	WDO22	NECH BOLOQE	S.Wollo	SM3	92
8	SWZ007	DALECHA BOLOQE	S.Wollo	M2	92
9	SWZ009	DALECHA BOLOQE	S.Wollo	M2	100
10	SWM014	DALECHA BOLOQE.R	S.Wollo	M2	99
11	SWM015	KEYE BOLOQE	S.Wollo	M2	97
12	WME024	NECH BOLOQE	S.Wollo	M2	91
13	SWME026	TEKUR BOLOQE	S.Wollo	M2	97
14	SWME028	YAREBA KEN BOLOQE	S.Wollo	M2	100
15	EGA036	KEYE BOLOQE	E.Gojjam	M2	95
16	EGL040	KEYE BOLOQE	E.Gojjam	M2	100
17	EGB032	NECH BOLOQE	E.Gojjam	M3	92
18	EGB033	WALEBELAY BOLOQE	E.Gojjam	M3	97
19	EGAA038	KEYE BOLOQE	E.Gojjam	M3	100
20	EGZ043	YAREBA KEN BOLOQE	E.Gojjam	M3	98

BOLOQE from S. Wollo in SM2 agroecology germination showed percentage of (93%).

Table 13: Germination percentage of common bean varieties

In the three agroecological zones no significance difference ($P>0.05$), ANOVA value indicated (**P-value=0.957**) Was observed for germination percentage. The mean germination percentage on the three agroecology. M2, M3 and SM3 was 96.77, 96.75 and 96.28 respectively as ($P>0.05$). Statistically there was no significant difference among the tested common bean varieties as well as in the three (SM3, M2 and M3) agroecological zone for germination percentage. Therefore, there was no germination problem of all farmers' varieties under study.



Figure 29: photo of germination trials in EBI (Photo by Menbere Berhane, April/2017)

4.14. Market prices of farmers' varieties

There was significant difference on the price of common bean among varieties P value is $2e-16$ ($p < 0.05$) (Figure 30) and also price of common bean varieties among districts was statistically significant different i.e. p value $1.69e-06$ ($P < 0.05$). The market price of farmers' varieties was varying from variety to variety. NECH BOLOQE had the highest market price followed by KEYE BOLOQE and DALECHA BOLOQE. TEKUR BOLOQE had the lowest market price this is due to many farmers that they don't like black color of the variety. The market price of farmers' varieties was slightly varying from Wereda to Wereda (see Figure 31).

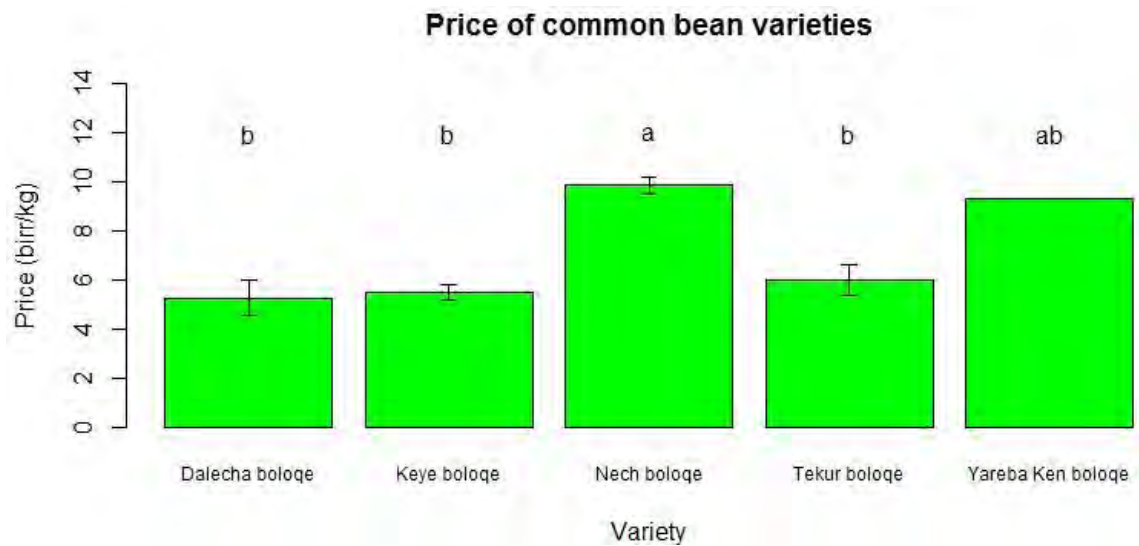


Figure 30: Market price of common bean varieties in the study area

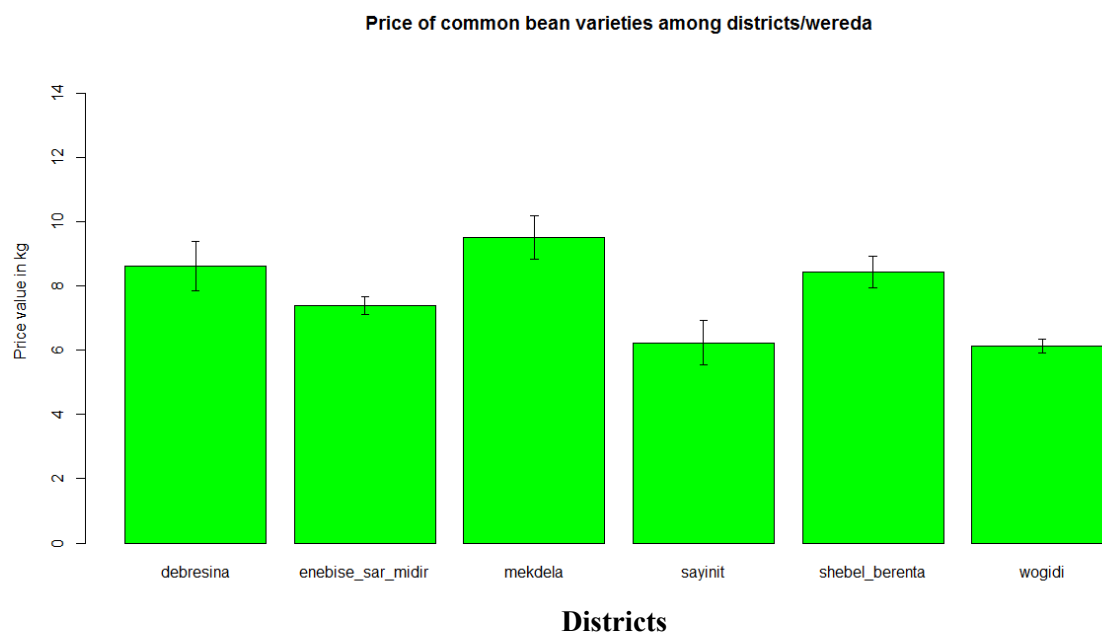


Figure 31: Market price of common bean landrace varieties in the study Weredas

The market survey undertaken in 10 different market places in each Kebele in the study Zones showed that common bean is cash crops that helped farmers and merchants to generate income. Unlike before when it was sold with the price of 10-12 birr per kilo, during the study period common bean was being sold with the price of 7- 9 birr per kilo. The price of common bean showed some differences in the study areas where the highest

price was recorded in Mekdela Wereda and the lowest price was recorded from Wogidi Wereda. The marketing chain is the farmer sells common bean varieties which is important for food like KEYE BOLOQE and DALECHA BOLOQE but in all markets of the study area farmers sell their white common bean (NECH BOLOQE) for legal buyer, who is licensed to buy common bean from farmers by kilogram not by traditional measurement. But farmers can sell other variety of common bean in local market by local measurement. Some farmers who don't produce common bean but involved in selling common bean, buy the seed from wholesalers or from common bean producing farmers to resale. NECH BOLOQE were expensive in all study area as compare to the other varieties.

CHAPTER FIVE

5. DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.3. Discussion

5.3.1. Diversity of farmers' varieties

Landraces have a high „stability of their characteristics“ and great „resistance capacity to tolerate adverse influences. However, it is less than that of cultivars and when grown outside their home Region, their genetic composition will change (Zeven, 1998).

This demonstrates that farmers use morphological characters, food quality, adaptation and so on to name, characterize and identify their landraces. Ethnobotanists have long described this fact. Farmers who live in South Wollo and East Gojjam Zones gave names for each common bean variety and also, they use some collective (generic) names.

Seven common bean farmers' varieties were identified. All common bean varieties were not affected by water logging because, planting of common bean undertake on sandy soil, this type of soil has low water holding capacity even in rainy time it can't hold water, locally called it SHEKEKE OR SESE MERET.

KEYE BOLOQE has a broad leaf which may have resulted for their selection as animal feed, and also have dense and long vegetative part which can cover large area so helps for soil fertility. In addition to this, farmers use dried and fresh seeds of common bean for their consumption, except NECH BOLOQE.

Based on strata, in M2 of S. Wollo has high diversity index, suggests that the area is dominated by five landrace variety. A low value for the index diversity was in East Gojjam of SM3 agroecological zones suggesting only few farmers' varieties, in this strata

farmers plant one or two landrace. Dominantly planted landrace was white common bean which is very important as cash crop. Based on agroecological zone beta diversity was highest in SM3 of S. Wollo and this shows farmer's plant different farmers' varieties. While in M2 of East Gojjam beta diversity was, the lowest this shows farmers plant almost similar landrace. The low Shannon - Wiener indices indicate that many farmers cultivated similar land races. However, few farmers have different landraces of common bean.

5.3.2. Cropping and cultivation systems

In all study area planting of common bean were occurred between late June to early July. Result is in agreement with that of Ali *et al.* (2006), in that planting dates between mid and end of June gave highest grain yields around Hawassa. The harvesting time took 3-4 months and the time was between September to mid-October. Farmers prefer this time because it has long rainy season(MEHER) so as the soil gets enough water. Planting of common bean after the soil gets wet, it leads to good yield. In all study area cultivation of common bean depends on rain fed.

In South Wollo Zone the gray and red soil used for white common bean production, in locally called SHEKEKE MERET (NECHAMETEA) which is thin soil but the other variety like DALECHA BOLOQE, KEYE BOLOQE, GUREAZA BOLOQE, TEKUR BOLOQE and YAREBA KEN BOLOQE plant on black soil (vertisol). While in East Gojjam Zones farmers used black (vertisol) and red soil for KEYE BOLOQE. Farmers were found to use gray sandy and red sandy soil when there is enough rain and black soil is use when there is shortage of rainfall because it is compact and has ability of holding water. Therefore, red and gray soil are very suitable for common bean if there is enough rain while black soil is good if there is less rain fall.

Based on agroecology, intercropping was practiced in the four strata. The crop was intercropped with common bean including sorghum and maize. This finding is similar with the report by EPPA (2004) that common bean is a principal food crop particularly in Southern and Eastern part of Ethiopia, where it is widely intercropped with maize and sorghum, respectively, to supplement farmers' income. The significance level is different for the intercropped crop of common bean among agroecology, for example intercropping common bean with sorghum, there was no significance difference among agroecology, the p value is 0.1131 ($p > 0.05$). While for maize there is significant difference among the three agroecology, the p value is 0.000923 ($p < 0.05$). In S. Wollo of M2 strata many farmers intercrop common bean with maize than the three strata.

In the intercropping practice, first plant sorghum or maize then after some weeks strew the common bean between sorghum or maize. The finding agrees with, with the study conducted by Asrat Asfaw *et al.* (2009), in the practice of a system with different crops, the sequence of sowing dates for each crop and variety decided on the basis of the crops' growing period and labor availability. Maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* L.) are the major cereal crops, which require longer growing seasons than common bean; consequently, farmers prioritize planting maize and sorghum at onset of rain followed later by the sowing of common bean. This helps to use area sufficiently, to have two products and also not faced problem of feed for their animals.

In E. Gojjam intercropping of common bean with sunflower was commonly practiced. Based on variety, DALECHA BOLOQE, KEYE BOLOQE, TEFTAFA NECH BOLOQE, GUREAZA BOLOQE, TEKUR BOLOQE and YAREBA KEN BOLOQE, plant as intercrop with other crops but NECH BOLOQE plant as

a sole crop mainly. Soil selection for NECH BOLOQE is different from the other crop, farmers plant white common (NECH BOLOQE) bean on unfertile soil the reason was when planting white common bean in fertile soil the vegetative part grows more therefore the amount of yield will decrease. As farmers mentioned thin soil (unfertile soil) was preferred for the white common bean plantation. Because, intercropping practice exposed the white common bean to water deficit during critical flowering and grain filling stage when the rains terminate prior to pod development.

As stated by Fernandez-Aparicio *et al.* (2007) intercropping is advantageous for soil conservation; weed control, lodging resistance and yield increment and legume root parasite infection control. Crop rotation was practiced by the majority of farmers in the study area to improve soil fertility of the farmlands and to eradicate problems of weed.

5.3.3. Place of common bean grown

Most of the time farmers plant the white common bean in their main field because in home garden the soil type is black (Vertisol) which is not well-suited for this crop, locally called it WALEKA AFER. When planted the white common bean on black or clay soil the production will decrease. For white common bean sandy soil is suitable, mainly found in their main field. The other varieties except white common bean, can cultivate in all soil types which is found in their home garden as well as in the main field. In the entire study area common bean was grown once a year.

5.3.4. Management Practices

Farmers' variety and seed management practices in traditional farming are often effective in achieving goals of adaptation and genetic gain in terms of yield but also in terms of maintaining formal, culinary and market traits (Cleveland and Soleri, 2007).

This study showed that local farmers played a great role in maintaining the farmers' varieties of common bean by applying traditional farming systems, seed selection and seed storage practices. Farming practices for common bean were easier, weeding and fertilizer application were not applied by most common bean growing farmers. As stated by Asrat Asfaw *et al.* (2013), farmers consider culinary quality and marketability among the most important variety traits.

Farmers' variety and seed management practices are based on farmers' experiences built over a lifetime. They have been the core elements of agricultural development since the domestication of crop plants and continue to be important for the future of agricultural crops (Margaret *et al.*, 2014)

5.3.5. Importance of common bean in the study areas

5.3.5.1. Importance of common bean as a human food

Common bean is widely consumed in Ethiopia as in many other countries in east, central and southern Africa (CIAT, 2003) and it is mostly prepared as *nifro* (boiled grain), mixed with sorghum or maize. This study also confirmed that, common beans are used as a source human food, only the seed part was used, form of green bean or as dry seed, boiled seed (*NIFRO*), fine ground grains used in the making of sauces (*SHIRO WET*) and *split grains for sauce making* (*SELASUT* or *KIK*) but it had different percentage based on agroecology.

Common beans are good sources of mineral nutrients required for normal functioning of the body. Seeds contain about 22% protein, 46% carbohydrate and very small amount of fiber and fat (Broughton *et al.*, 2003), being an important source of dietary protein, the common bean plays a vital role in the provision of food security and as cash income

(Ferris and Kaganzi, 2008). In general, dry bean has high nutrient contents, commercial potential and atmospheric Nitrogen fixing ability. Thus, it holds a great promise for increasing income, improving soil fertility as well as ensuring food security in Sub Saharan Africa (Katungi *et al.*, 2009; Margaret *et al.*, 2014)

The use of common bean for food in Ethiopia seems to vary considerably with other countries, as some uses reported from other countries were not recorded in Ethiopia. For instance, mixed and cooked with a staple food (e.g. whole maize grains), banana, cassava, sweet potatoes etc. and boiled together. When mixed with maize, it is called Githeri in Kenya. Dry common bean can also be soaked, coats removed, boiled and mashed alone like in Malawi to form Chipper or in mixture with other foods like milk in Kenya or sweet potatoes in Eastern in Uganda. Cooked as green immature pods and eaten alone or with other foods particularly in restaurants in Tanzania (Njungunah, *et al.*, 1980). The use of common bean as an important source to enhance food security and nutrition in rural communities looked clear as 56 % of informants in the present study used it for household consumption and 23% of informant for consumption as well as for generating income.

5.3.5.2. Importance of common bean as a source of income and animal feed

As reported by Ferris and Kaganzi (2008) wide range of common beans grow in Ethiopia such as mottled, red, white, and black varieties. Among the four types of common beans, the commercial varieties are pure red and pure white. These two varieties are becoming the most commonly grown types with increasing market demand. Red bean is produced for both sale and home consumptions. The white beans are exported to the European Union (EU) and United States of America (USA). Red bean is exported to Asia, Africa,

and some EU countries (ERCA, 2008). In the last few years, domestic and international demands for red and white beans have increased.

The study showed the potential of common bean as income generating crop for farmers and traders. The price was being fluctuating from time to time for example in 2014/15 and 2015/16, starting from last year 2016 the price of common bean was decreased in all study area. This is due to lack of information by local farmers about market price, in addition to that there were transportation problem so most farmers prefer to sell their common bean for Urban Collectors with a lower price. In the study area, it was being sold with the price of 6-10 birr per kilo. Especially white common bean is typical source of profit making for retail sellers by taking from Kebele market to district.

In the four strata farmers used common bean as a source of income by selling the grain for market, however in M2 East Gojjam, when it compared with other strata it has low value this is because, some farmers rather than white common bean had other common bean varieties which is not marketable. This study shown that white and red common bean sold in all study area, but the other varieties were not found in the market dominantly.

White beans are not widely consumed locally; they are not part of traditional Ethiopian diet. With farm sizes declining and very limited options to increase their income from staple food crops, many smallholders have started to produce white beans in an effort to seize more profitable market opportunities and maximize their income from the limited land available (Agete Jerena, 2014).

Common bean was used as fodder, it heals sick and drought attacked cattle, farmers give the straw, the seed, the fresh forage. As reported by Teshale Assefa *et al.* (2005), the straw is commonly used for fodder. As many respondents mention it is very important for their livestock, it helps to makes very fat the animal, so farmers get more money when sell them.

5.3.5.3. Importance of common bean as a source of medicine

In this study, DALECHA BOLOQE and KEYE BOLOQE varieties were found to be used for medicinal purpose. Farmers use common bean to cure gastrointestinal disorder and the finding agrees, with the study by Aknod *et al.* (2011), who stated that consumption of common beans linked to reduced risk of diabetes and obesity, coronary heart disease, colon cancer and gastrointestinal disorders.

In the three strata common bean was found to be used as a medicine. Nevertheless, M2 East Gojjam farmers were not using common bean for medicinal purpose because not aware of the medicinal use of common bean and also in these strata farmers produce white common bean which is cash crop.

5.3.6. Local farmer's perception about common bean

Those who stated that common bean production has decreased indicated environmental changes (drought), disease, having no new varieties, decrease in soil fertility, shortage of land size and insects (locally called KISHKISHK) were critical problems. In the study area, weed infestation was not considered as a production challenge, rather a problem of less care for the crop was recorded as a problem. Excess rainfall was not considered a common bean production constraint of the study area; however, it was mentioned to occasionally reduce yields in East Gojjam locally called it YEWEHA MECH.

Those who mentioned that common bean production has increased, gave as reason good marketability of some varieties, increased use of the crop for consumption and also short life cycle of the crop for which farmers tended to prefer this crop.

5.3.7. Market prices of farmers' varieties

Most of the farmers produce farmers' varieties that have high market value. For example, in all districts red common bean (KEYE BOLOQE) were expensive but this time decrease marketability, because of this reasons farmers concentrated on production of white common bean rather than other variety. Farmers' varieties have measured by traditional materials, except NECH BOLOQE. White common bean (NECH BOLOQE) vend by kg for licensed trader, all farmers sell white common bean for those legal traders. Only in a few place of study area sells white common bean in traditional measurement. Some varieties like KEYE BOLOQE, TEKUR BOLOQE, DALECHA BOLOQE, YEAREBA KEN BOLOQE, GUREZA BOLOQE were measured by traditional materials called Tasa = 4-5 birr and 1Tasa+1/3tasa= 1 kg, Birchiko=3 birr and 3 Birchiko =1kg this traditional measurement is in South Wollo. In East Gojjam to measure common bean seed used Shane= 9 birr and Shane=1.25kg. But Red common bean and other variety sell by local measurement stated above. In the study area farmers provide their common bean production to Kebele or Wereda/district market place. The price of common bean has difference based on the market place, majority of farmers sell in Kebele market in lower price than district market because of transportation problem to take their common bean production from Kebele to districts there is 1-4 hr. foot walk, this was difficult so they prefer to sell their common bean in Kebele market specially women and elder. As stated by Agete Jerena (2014), Farmers depend on traders' price and there is no room to negotiate with traders. Farmers revealed that traders

and brokers set the price and it is usually unstable. In addition, there is no channel to convey information directly from export markets to farmers since red bean is not among commodities traded. As reported by the informant that returns from common bean was very little and sometimes losses were higher than benefits. Farmers did not benefit much from production but still kept on producing because the crop is important in saving life during the months of commonly known to farmers as bridge.

Channel I: Farmers → Urban Collectors → Wholesalers → Exporters → Consumers

Channel II: Farmers → Wholesalers → Exporters → Consumers

5.3.8. Production constraint of common bean

Common bean could be attributed to various constraints related to low adoption of improved agricultural technologies, drought, and lack of improved varieties, poor cultural practices, disease and environmental degradation (Legese Dadi *et al.*, 2006). In this study it was also shown that different production constraints are found in the study areas, respondents confirmed that there are abiotic and biotic problems that are challenging the diversity and production of common bean. Teshale Adugna *et al.* (2006) also indicated that, lack of high yielding varieties with improved resistance to diseases and other biotic and abiotic constraints has been the major production constraint of common bean in Ethiopia in general. As biotic problems insect pests, disease are major problem in all study area.

According to farmers, the most crucial abiotic factors sensitive for common bean were land shortage, poor management practices for common bean farmland and low rainfall and shortage of rain were the major problems mentioned by many respondents. This

study agrees with the study of (Passioura 2007) as seated drought is a key challenge to the livelihood of vulnerable smallholder farmers in harsh environments causing significant harvest loss during production. Fortunately, drought is seldom a yearly event and its effect shows seasonal and spatial variation. Drought stress can cause flower abortion, pod dropping and reduced seed filling (Masaya and White 1991). Overall biomass and seed yield, harvest index, number of pods and seeds, seed weight, and days to maturity are also affected. Respondents mention that lack of market, The finding agrees with Ferris and Kaganzi, (2008) lack of market was the major problem for common bean sell. The solution given by respondents to the limitation of common bean production was to control pest traditionally they use the mixture of ash and animal urine and spray the mixture to the plant.

5.4. Conclusion

In conclusion a total of sixty-nine accessions were collected and categorized into seven landraces. NECH BOLOQE, KEYE BOLOQE, TEKUR BOLOQE, DALECHA BOLOQE, GUREZA BOLOQE OR BURABURA BOLOQE, YEAREBA KEN BOLOQE AND TEFTAFA NECH BOLOQE. Most of the names of the farmers' varieties are based on morphological traits such as seed color, taste and maturity time which are used as criteria to differentiate between landraces. From the four strata (SM3-S. Wollo, M2-S. Wollo, M3-E. Gojjam and M2-E. Gojjam), M2-South Wollo showed the highest Shannon diversity index. Shebel Berenta has the lowest landrace diversity. However, there was high production of white common bean in this district.

This research has confirmed the essential role that traditional farmers play in the development and maintenance of common bean landraces. Local farmers in the study area have traditional cultivation, cropping, seed storage, seed selection and management practices. Farmers use sol cropping and intercropping for common bean landrace cultivation. Even though the majority of farmers didn't use selection criteria, some informants applied selection criteria based on seed weight, maturity time and seed yield, which revolved around the fulfillment of certain household needs.

This study indicated a decreasing trend in common bean production because of low marketability. Specially TEKUR BOLOQE, GUREZA BOLOQE OR BURABURA BOLOQE, YEAREBA KEN BOLOQE and TEFTAFA NECH BOLOQE are considered endangered varieties because of low marketability, and this is mainly associated with the production of other crops and decrease in management practices. However, NECH BOLOQE production is increasing due

to marketability of this variety. In the study area farmers used common bean as a source of food, feed, income generation and for enhancement of soil fertility and some used it as medicine.

In South Wollo (28%) and East Gojjam (28%) Zone, farmers produce Common bean only for market supply and 17 % and 6% for home use in S. Wollo and E. Gojjam respectively. large amount of Common bean production was used for market. Mean germination percent of all landraces were ranged between 91-100% indicating Common bean has no germination problem.

5.5. Recommendation

- Landraces represent genetic resources of unknown diversity. So, researchers need to focus on further seed collections of common bean landraces, characterization and evaluation of local farmers' varieties must be applied. This will help the available landraces to be conserved which may have a future value.
- The practices of common bean farmers need to be backed up and enhanced for effective conservation of the genetic resources in this crop and its landraces.
- The good practices have to be transferred to common bean farmers elsewhere in the country.
- The indigenous knowledge held by common bean farmers has to be documented and preserved in appropriate formats including in databases.
- Experiences sharing on the ways of landrace seed selection, intercropping & other cropping practices should be done among different ethnic groups, localities and households to optimize conservation and utilization.
- Many farmers were not aware of how to control pests and diseases of common bean. Therefore, researchers in collaboration with farmers must look for solutions and solutions.
- Education and awareness raising of the local farmers and further research are needed in order to maintain the landrace diversity and the genetic resources of common bean.
- High consideration must be given for the pest as it is mentioned as a major limiting factor for common bean production by local farmers and also local agricultural experts should make local farmers aware of integrated pest management technique to prevent its series problem.

- Education, resources and further research is needed in order to help control production constraints of landraces of common bean.
- This study found that common bean is very important as a source of income. Therefore, trade linkage of farmers and merchants is highly needed. A marketing study focused on marketing channels, sales and purchase at different levels of marketing channels and markets needs developing

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APPENDICES

Appendix 1: Interview data collection format for general informant

Hello, my name is Menbere Berhane and I am a student at Addis Ababa University. This is my colleague, who is assisting me as a local guide and translator. We are conducting a study of common bean as part of my education at the university.”

“Do you grow common bean?” Yes No

The purpose of this study is to identify different types of common bean and to understand their use and management by farmers. With your permission, I would like to ask you questions about common bean. Of course, your participation is entirely voluntary. These interviews require less than one hour. I do not anticipate that the interview will pose any risks to you. Because I am a student, I cannot pay you. We hope that our research will benefit farmers in Ethiopia by promoting the diversity of common bean. If you agree to an interview, you do not have to answer all of my questions, and you can tell me at any time if you would like to stop. I would record your answers to my questions using my cell phone and my notebook. I would include this information in my thesis, and it would be shared with other researchers who are interested in common bean. Do you have any questions? In case you have any questions in the future, here is my contact information. Do you agree to participate in this study of common bean? common bean as part of

I. Basic information

Date of interview:	Start time of interview:
Name of interviewer:	
Region:	Zone:
Wereda/District:	Kebele/Sub-District:
Latitude (in decimal degrees):	Longitude (in decimal degrees):
Altitude (in meters):	
Agroecological classification (e.g. H1, SH2):	
Random number of household from farmers’ association list:	
Relative wealth on farmers’ association list: <input type="checkbox"/> Low income <input type="checkbox"/> Middle/High income	

II. General information about informant

Name of informant:
Language spoken by informant during interview: <input type="checkbox"/> Amharic <input type="checkbox"/> Other (specify): _____
Age (observed): <input type="checkbox"/> 18 to 30 <input type="checkbox"/> 30 to 45 <input type="checkbox"/> 45 to 60 <input type="checkbox"/> 60+
Gender (observed): <input type="checkbox"/> Male <input type="checkbox"/> Female
Is the informant the household head? <input type="checkbox"/> Yes <input type="checkbox"/> No
→If no, household-head gender: <input type="checkbox"/> Female-headed <input type="checkbox"/> Male-headed

III. Market Access

How far is the closest market from your home? ___ minutes on foot
Do you go to any other larger market? <input type="checkbox"/> Yes <input type="checkbox"/> No
→If yes, how far is this larger market from your home? ___ minutes (on foot)

How far is the nearest road with vehicle transport from your home? _____ minutes (on foot)

IV. Interspecific diversity of legume crops

Are you growing any legumes this year? Yes No If yes, select on list and ask about hectares.

Which legumes did you plant in 2008 (Meskerem to Pagume)?

For each of the legumes you listed, how many hectares of land did you plant in 2008 (Meskerem to Pagume) including any areas under intercropping? Make sure you convert any local units to hectares (e.g. 1 timad or qert = 0.25 hectare).

V. Use of common bean

How do you use common bean? Food Spice Medicine Fodder/Forage Fuel

Market Bee forage Other (specify): _____

VI. Cropping Practices

Do you rotate common bean with other crops? Yes No

→ If yes, with which crops do you rotate with common bean?

→ If yes, how often do you plant common bean within the crop sequence?

Do you intercrop common bean with other crops? Yes No

→ If yes, with which crops do you plant common bean in the same field?

VII. Intraspecific diversity of common bean

What varieties of common bean have you grown in the past three years (for the 2007, 2008, and 2009 harvests)?

Are there any other varieties that you have grown in the past, prior to 2007?

Are there any other varieties of common bean grown by other farmers in your community, but not by yourself?

Are there any other varieties of common bean that you remember from a long time ago, or have heard about from Elders, that are no longer grown by your community?

If you run out of a particular variety, whom would you ask to replenish your seeds? (*Record name as a potential key informant*).

VIII. Key attributes of varieties

Question	Variety 1	Variety 2	Variety 3	Variety 4
Local vernacular name of variety (copied)				
Is this a traditional or a new variety?				
Where did you first obtain this variety? (e.g. family, neighbors*, DA, market, food aid, research center)				
For how many years have you planted this variety?				
Where do you plant this variety? (e.g. main fields, field margins, home gardens, fence lines, other places)				
Are the places where you grow this variety rained, irrigated, or both?				
Do you plant this variety on soils with low, moderate, and/or high fertility?				
How many times per year do you sow this variety?				
When do you usually sow this variety?				
When do you usually harvest this variety?				
Is this variety grown mainly for home use or mainly for the market?				
How many hectares of these varieties did you harvest in 2008 and 2007, including area under intercropping?	2008: 2007:	2008: 2007:	2008: 2007:	2008: 2007:
How much of this variety did you harvest in 2008 and 2007.	2008: 2007:	2008: 2007:	2008: 2007:	2008: 2007:
Based on your experience, was the yield for this variety in 2008 and 2007 a very high yield, a high yield, a medium yield, a low yield, or a very low yield?	2008: 2007:	2008: 2007:	2008: 2007:	2008: 2007:
What is the current price of this variety at your local market? (use farmer units)				

IX. Rating of attributes for varieties of common bean

Rating criteria and scale	Var. 1	Var. 2	Var. 3	Var. 4
Local name (copied from previous pages)				
Best yield this variety has ever given you (5=very high, 4=high, 3=medium, 2=low, 1=very low)				
Yield under drought conditions (5=very high, 4=high, 3=average, 2=low, 1=very low)				
Yield when excessive rain causing water logging (5=very				

high, 4=high, 3=average, 2=low, 1=very low)

Yield when rainy season begins late (5=very high, 4=high, 3=average, 2=low, 1=very low)

Yield when rainy season ends early (5=very high, 4=high, 3=average, 2=low, 1=very low)

Resistance to frost (5=never affected by frost, 4=rarely affected by frost, 3=sometimes affected by frost, 2=often affected by frost, 1=always affected by frost)

Resistance to common diseases (5=never affected by diseases, 4=rarely affected, 3=sometimes affected, 2=often affected, 1=always affected by diseases)

Tolerance to common insect pests (5=never affected by insect pests, 4=rarely affected, 3=sometimes affected, 2=often affected, 1=always affected)

Tendency for seeds to detach/shatter (5=seeds never detach/shatter 4=rarely detach/shatter, 3=detach/shatter about half the time, 2=often detach/shatter, 1=always detach/shatter)

Importance as food for the household (5=extremely important, 4=very important, 3=somewhat important, 2=not so important, 1=not at all important)

Importance as a source of income (5=extremely important, 4=very important, 3=somewhat important, 2=not so important, 1=not at all important)

Importance as fodder for livestock (5=extremely important, 4=very important, 3=somewhat important, 2=not so important, 1=not at all important)

Effect on soil fertility (5=very positive effect on soil fertility, 4=some positive effect, 3=no effect, 2=some negative effect, 1=very negative effect on soil fertility)

Ease of harvesting (5=Very easy to harvest, 4=easy, 3=neither easy nor difficult, 2=somewhat difficult, 1=very difficult to harvest)

Ease of preparing as food (5=very easy to harvest, 4=easy, 3=neither easy nor difficult, 2=somewhat difficult, 1=very difficult to harvest)

Taste (5=very good taste, 4=good taste, 3=neither good nor bad taste, 2=bad taste, 1=very bad taste)

X. Gender roles in production and management of common bean

Which gender and age groups live in your household (including the respondent)?	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No

Activity	Gender and age groups*			Is this true for all varieties?*
Ploughing with animals (MARES)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Preparing the soil by hand with a hoe (MEKOFER)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Leveling soil and removing uprooted weeds (GULGUALO)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Sowing (ZERMEZERAT)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Weeding (MAREM) and cultivation (KUTKUATO)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Fertilizer application (MADABERIA, FIG, KOMPOST...)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Harvesting (MACHEDENAMESEBSEB)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Threshing (MEWKAT)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Storage (MAKEMACHET)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Marketing (MESHET)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Seed selection (ZERMEMRET)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Food preparation (MEGIBMAZEGAJET)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Collection of fodder for animals (MENOMESEBSEBE)	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No
Other activity (specify):	<input type="checkbox"/> M-children	<input type="checkbox"/> M-adults	<input type="checkbox"/> M-Elders	<input type="checkbox"/> Yes
	<input type="checkbox"/> F-children	<input type="checkbox"/> F-adults	<input type="checkbox"/> F-Elders	<input type="checkbox"/> No

Thank you very much for your cooperation!

Appendix 2: Interview data collection format for key informant

Hello, my name is Menbere Berhane and I am a student at Addis Ababa University. This is my colleague, who is assisting me as a local guide and translator. It is a pleasure to meet you. We are conducting a study about common bean as part of my education at the university. The purpose of this study is to identify different types of common bean and to understand their use and management by farmers. With your permission, I would like to ask you questions about common bean. Of course, your participation is entirely voluntary. These interviews require up to two hours. I do not anticipate that the interview will pose any risks to you. Because I am a student, I cannot pay you. We hope that our research will benefit farmers in Ethiopia by promoting the diversity of common bean. If you agree to an interview, you do not have to answer all of my questions, and you can tell me at any time if you would like to stop. I would record your answers to my questions using my notebook. I would include this information in my thesis, and it would be shared with other researchers who are interested in common bean. Do you have any questions? In case if you have any questions in the future, here is my contact information. Menbere Berhane -Phone Number- 0910627217. Do you agree to participate in this study of common bean?

Before we continue, I need to make sure that I have your permission to carry out the research in your area. Do you consent to your participation in this research?

Basic information about Key Informant

Date of interview:	Start time of interview:
Name of interviewer:	
Region:	Zone:
WEREDA/District:	KEBELE/Sub-District:
Language spoken during interview: <input type="checkbox"/> Amharic <input type="checkbox"/> Other (specify): _____	
Name of informant:	
Age (observed): <input type="checkbox"/> 18 to 30 <input type="checkbox"/> 30 to 45 <input type="checkbox"/> 45 to 60 <input type="checkbox"/> 60+	
Gender (observed): <input type="checkbox"/> Male <input type="checkbox"/> Female	

I. Knowledge of varieties listed within the same kebele

Names of varieties (from ODK survey)	Have you heard of this variety?	Is this variety planted in this KEBELE?	Have you planted this variety yourself?
1.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
2.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
3.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
4.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
5.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
6.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
7.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
8.	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

II. Attributes/characteristics of varieties

Question	V1	V2	V3	V4	V5	V6	V7
<p>What is the meaning of the local name? (e.g. color, shape, nutritional quality, origin, etc.)</p> <p>Are there alternative names for this variety?</p> <p>How do you recognize this variety? How does it differ from similar varieties? (By appearance or other features?)</p> <p>What are the ideal growing conditions for this variety (e.g. amount and timing of rainfall, sunlight, temperature)?</p> <p>Characterize the soil types on which the variety is planted.</p> <p>What fractions of the farmers in your community plant this variety? (e.g. almost all, half, one out of ten)</p> <p>Over the past 5 years, has this variety become more commonly planted or less commonly planted in your community?</p> <p>If applicable... What is the main reason that this variety is becoming more or less common?</p>							

III. Use of common bean as food

Name of food	Which parts are used?	Which variety is preferred?	Why is this variety preferred?*

IV. Nutritional value of foods prepared with common bean

Name of food	Health benefit	Specific group who use it or for whom it is recommended*?	Which variety is preferred?	Why is this variety preferred?

V. Use of common bean as medicine

Name of ailment treated with common bean	Which parts are used?	Which variety is preferred?	Why is this variety preferred?*

VI. Use of common bean as fodder

Which animals consume common bean?	Which part(s) do they consume?	When (in which season) do they consume common bean?

VII. Other specific uses of common bean

Description of use	Which parts do you use?	Which variety do you prefer?	Why do you prefer this variety?

VIII. Crop Management

Do the people in your community apply fertilizers to common bean? Which fertilizers are used (including manure, compost, crop residues)?

Do people in your community use pesticides or herbicides on common bean?

What else do people in your community do to prevent and control pests, weeds, and diseases affecting common bean?

Are there any varieties of common bean that produce more residues (stems, leaves, etc.) than others?

What do people in your community do with the residues from common bean after the harvest?

Does anyone in your community ever use inoculants for common bean?

How do people in your community store common bean?

What are the major production constraints for common bean in your community (e.g. weeds, pests, diseases, drought, and low fertility)?

Thank you for your time!

Appendix 3: Market survey data collection schedule

Location of market place: _____

Name of data collector: _____

Number _____ Date: _____

Name of language translator (if any) _____

I. Information on vendor

Name: _____ Village _____ Age _____ Gender _____

Location: Region _____ Zone _____ Wereda _____ Kebele _____

Market name _____

Altitude _____ Latitude _____ Longitude _____

Information on the collection of *Phaseolus vulgaris*

- Do you grow *Phaseolus vulgaris*? yes/no,
- If yes, what variety do you grow? Lists their name _____
- What is the meaning of variety name? _____
- Where do you get your seed for sowing? _____
- (If multiple sources, why? _____)
- What is number of landraces in collection/sell? A. single B. Mixture of _____ landraces.
- Mention their names _____
- What is the meaning of each variety name? _____
- Which part is used for market? A. fresh pod B. Dried seed C. other (specify)

- What is the price per kg/unit? a. fresh pod ___ b. dried seed ___ c. other(specify)_____
- In which month is the seed of *P. vulgaris* available in market? _____
- How much sold now compared to in the past? a. more b. same c. less
- If less, why? a. less available for harvest b. less demand by buyers c. others (specify)___

Appendix 4: Common bean seed passport descriptor

Accession No. _____

Collection No. -----Crop-----
 Date-----Genus -----
 Country----- Species-----
 Region -----Local/Vernacular Name-----
 Zone----- Ethnic Group -----
 Woreda-----Language -----
 Kebele-----Village /Site -----
 Farmer's Name-----
 Lat. -----
 Lon. -----
 Altitude----- (M)
 Altitude----- (M)

Sample	Genetic Stat	
1. Single line	1.	Wild
2. Pure line/clone	2. d	Wee
3. 2. Pure line/clone	3. tive cultivar/Landrac	Primi
4. Other (specify)	4. ding line	Bree
	5. nced cultivars	Adva
Topography	Source of collection	
1. Swampy	1. Field	
2. Flood plain	2. Backyard	
3. Plain level	3. Farm store/Threshing place	
4. Undulated	4. Agricultural Institute	
5. Hilly	5. Natural vegetation	
6. Hilly dissected	6. Other (specify)	
7. Steeply dissected		
8. Mountaineer	Nature of Samples	
9. Other (specify)	1. Seed	
	2. Spikes	
	3. Pods	

<p>Site</p> <ol style="list-style-type: none"> 1. Level 2. Sloppy 3. Summit 4. Depression <p>Soil texture</p> <ol style="list-style-type: none"> 1. Sand 2. Sandy loam 3. Loam 4. Clay loam 5. Clay 6. Silt 7. Highly organic 8. Other (specify) <p>Stoniness</p> <ol style="list-style-type: none"> 1. None 2. Low 3. Medium 4. Rocky <p>Origin of seed</p> <ol style="list-style-type: none"> 1. Local 2. Elsewhere <p>Shade Yes, No</p> <p>Usage (Specify) ----- -----</p> <p>Disease & Pests ----- -----</p>	<ol style="list-style-type: none"> 4. Cherry 5. Tuber 6. Rhizomes <p>Soil Color</p> <ol style="list-style-type: none"> 1. Black 2. Brown 3. Orange 4. Red 5. Yellow 6. Other (specify) <p>Drainage</p> <ol style="list-style-type: none"> 1. Poor 2. Moderate 3. Well drained <p>Herbarium specimen Yes, No</p> <p>Photographs Yes, No</p> <p>Sowing Month Yes, No 1 2 3 4 5 6 7 8 9 10 11 12 Early/Mid/Late</p> <p>Harvesting month 1 2 3 4 5 6 7 8 9 10 11 12 Early/Mid/Late</p>
--	--

NOTE (Associated wild weedy species, crop, local flora, disturbance factor) -----

Remark-----

Collectors
Nam(s): _____

Appendix 5: Seed collection, interview and market site

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
1	Husean Taye	45to60	Male	Amhara Amhara	S. Wollo	Wogidi	Serto Masaya	2406	SM3	10 ⁰ 36'29"	38 ⁰ 44'58"		✓	
2	Endris Ali	45to60	Male					2412	SM3	10 ⁰ 36'13"	38 ⁰ 45'2"		✓	
3	Musetefa Mekonen	45to60	Male					2399	SM3	10 ⁰ 36'36"	38 ⁰ 44'40"		✓	
4	Zewedeye Ayalew	18to30	female					2411	SM3	10 ⁰ 36'37"	38 ⁰ 44'52"		✓	
5	Bezuyea Mola	18to30	female					2412	SM3	10 ⁰ 36'28"	38 ⁰ 45'2"		✓	✓
6	Zeyneba Gebeyew	30to45	female					2409	SM3	10 ⁰ 36'6"	38 ⁰ 45'8"		✓	
7	Seyed Eshetu	18to30	male					2386	SM3	10 ⁰ 35'54"	38 ⁰ 45'24"	✓	✓	✓
8	Etaye Mengestu	30to45	female					2394	SM3	10 ⁰ 35'57"	38 ⁰ 45'24"		✓	
9	Selma Husean	30to45	female					2426	SM3	10 ⁰ 36'23"	38 ⁰ 45'1"		✓	
10	Ashagre Kebretu	30to45	male					1839	SM3	10 ⁰ 37'0"	38 ⁰ 46'19"		✓	✓
11	Mamar Teshome	30to45	female					1969	SM3	10 ⁰ 36'48"	38 ⁰ 46'5"		✓	✓
12	Habesha Getahun	45to60	Female					2386	SM3	10 ⁰ 33'55"	38 ⁰ 35'29"		✓	
13	Etata getachew	45to60	Female					2375	SM3	10 ⁰ 35'23"	38 ⁰ 45'39"	✓	✓	
14	Bezunesh Tamerat	30to45	Female					2375	SM3	10 ⁰ 35'23"	38 ⁰ 45'39"	✓	✓	

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
15	Temsgen Belay	45to60	Male				Zemod	2396	M2	10 ⁰ 33'56"	38 ⁰ 35'30"		✓	
16	Tesfaw Sebsebe	30to45	Male					2385	M2	10 ⁰ 34'4"	38 ⁰ 35'34"		✓	
17	Abebe Teme	30to45	Male					2376	M2	10 ⁰ 34'16"	38 ⁰ 35'53"		✓	✓
18	Habtam Tameru	30to45	Female					2382	M2	10 ⁰ 34'10"	38 ⁰ 35'52"		✓	
19	Abebe Ayele	30 to 45	Male					2380	M2	10 ⁰ 35'4"	38 ⁰ 36'1"		✓	✓
20	Abebe Ayele	30to45	Male					2391	M2	10 ⁰ 34'5"	38 ⁰ 35'59"		✓	✓
21	Habesha Desal	30to45	Female					2389	M2	10 ⁰ 34'4"	38 ⁰ 36'1"		✓	✓
22	Kasaye Andarege	30to45	Female					2367	M2	10 ⁰ 33'57"	38 ⁰ 35'58"		✓	✓
23	Geremew Amare	45to60	Male					2413	M2	10 ⁰ 24'10"	38 ⁰ 35'55"		✓	
24	Derege Emeru	30to45	Male					2356	M2	10 ⁰ 34'3"	38 ⁰ 35'47"		✓	✓
25	Abezu Gashaw	30to45	Female					2443	M2	10 ⁰ 34'26"	38 ⁰ 35'59"		✓	
26	Yezeshiw Ababe	30to45	Female					2380	M2	10 ⁰ 34'30"	38 ⁰ 35'53"		✓	✓
27	Legese Ayele	45to60	Male					2447	M2	10 ⁰ 32'55"	38 ⁰ 39'25"	✓	✓	✓
28	Negest Berhanu	30to45	Female					2447	M2	10 ⁰ 32'60"	38 ⁰ 38'30"	✓	✓	✓
29	Muleye Desalew	30to45	Female			Debresina	Mendeyo	2398	M2	10 ⁰ 42'22"	38 ⁰ 38'56"		✓	

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
30	Demeku Tesfaw	30to45	Female					2405	M2	10 ⁰ 42'21"	38 ⁰ 39'5"		✓	
31	Adem Ali	45to60	Male					2402	M2	10 ⁰ 42'22"	38 ⁰ 38'35"		✓	
32	Yesuf Yemam	30to45	Male					2222	M2	10 ⁰ 41'35"	38 ⁰ 38'32"	✓	✓	✓
33	Mulate Belet	30to45	Male					2418	M2	10 ⁰ 42'2"	38 ⁰ 37'44"		✓	
34	Bose Mekonen	45to60	Female					2412	M2	10 ⁰ 42'7"	38 ⁰ 38'21"		✓	✓
35	Seyed Moheyea	45to60	Male					2406	M2	10 ⁰ 42'26"	38 ⁰ 39'11"		✓	
36	Getachew baheru	45to60	Male					2408	M2	10 ⁰ 42'25"	38 ⁰ 39'8"		✓	✓
37	Tegwad Negatu	45to60	Female					2421	M2	10 ⁰ 42'21"	38 ⁰ 38'32"		✓	✓
38	Amesalu Meles	45to60	Male					2256	M2	10 ⁰ 41'34"	38 ⁰ 38'25"		✓	
39	Alemsew Belayneh	30to45	Female					2437	M2	10 ⁰ 24'10"	38 ⁰ 38'28"		✓	
40	Yebeltal Belayneh	30to45	Male					2421	M2	11 ⁰ 42'6"	38 ⁰ 38'23"		✓	
41	Boseyale Ali	45to60	Female					2475	M2	10 ⁰ 34'10"	38 ⁰ 48'38"	✓	✓	
42	Etabez Mohamed	30to45	Female					2440	M2	10 ⁰ 35'23"	38 ⁰ 45'39"	✓	✓	
43	Kaseu Alemu	30to45	Female			Mekdela	Deja	2260	SM3	11 ⁰ 18'0"	38 ⁰ 56'52"		✓	✓
44	Endalemaw Asnake	30to45	Female					2244	SM3	11 ⁰ 17'53"	38 ⁰ 56'59"		✓	

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
45	Anebaw Gunchea	30to45	Male					2376	SM3	11 ⁰ 17'3"	38 ⁰ 57'23"		✓	
46	Shegea Chanea	30to45	Male					2229	SM3	11 ⁰ 17'31"	38 ⁰ 57'14"			
47	Webu Berhane	30to45	Male					2324	SM3	11 ⁰ 17'9"	38 ⁰ 57'20"			✓
48	Merkebu Hayelu	30to45	Male					2246	SM3	11 ⁰ 18'4"	38 ⁰ 56'56"		✓	✓
49	Teshome Tekaw	45to60	Male					2253	SM3	11 ⁰ 17'17"	38 ⁰ 57'10"		✓	✓
50	Danyea Geremew	30to45	Male					2223	SM3	11 ⁰ 17'40"	38 ⁰ 57'5"		✓	
51	Bertukan Getea	18to30	Female					2237	SM3	11 ⁰ 17'31"	38 ⁰ 57'8"		✓	✓
52	Webale Abeyea	18to30	Male					2226	SM3	11 ⁰ 17'40"	38 ⁰ 57'3"		✓	
53	Meten Fenta	30to45	Female					2241	SM3	11 ⁰ 17'39"	38 ⁰ 57'3"		✓	✓
54	Yibeltal Ali	30to45	Male					2324	SM3	11 ⁰ 17'9"	38 ⁰ 57'20"	✓	✓	
55	Seada Kedir	30to45	Female					2376	SM3	11 ⁰ 17'3"	38 ⁰ 57'23"	✓	✓	
56	Abeyot Abebe	30to45	Female				Doka Debersina	2236	SM3	11 ⁰ 17'31"	38 ⁰ 57'1"			✓
57	Asdesa Dawed	30to45	Male					2143	SM3	11 ⁰ 12'7"	38 ⁰ 51'15"		✓	
59	Asame Gezaw	45to60	Male					2116	SM3	11 ⁰ 12'7"	38 ⁰ 51'9"		✓	✓
60	Solomon Temesgen	45to60	Male					2137	SM3	11 ⁰ 12'14"	38 ⁰ 51'10"		✓	

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
61	Debre Degenu	30to45	Male					2137	SM3	10 ⁰ 12'14"	38 ⁰ 51'74"			
62	Aleganesh Asefa	30to45	Female					2138	SM3	11 ⁰ 12'16"	38 ⁰ 51'20"			
63	Kendu Nuru	30to45	Male					2137	SM3	11 ⁰ 12'15"	38 ⁰ 51'24"		✓	
64	Feleku Yasin	30to45	Female					2222	SM3	11 ⁰ 13'5"	38 ⁰ 50'52"		✓	
65	Etewa Mohamed	30to45	Female					2222	SM3	11 ⁰ 13'26"	38 ⁰ 50'12"		✓	
66	Betazaz Teshome	30to45	Male					2191	SM3	11 ⁰ 13'15"	38 ⁰ 50'32"		✓	
67	Asmamaw Aychelea	45to60	Male					2146	SM3	11 ⁰ 12'25"	38 ⁰ 51'30"		✓	
68	Tobyas Ejegu	45to60	Male					2156	SM3	10 ⁰ 12'7"	38 ⁰ 51'28"		✓	✓
69	Agegnaw Tegegn	30to45	Female					2179	SM3	10 ⁰ 12'3"	38 ⁰ 51'39"		✓	✓
70	Tegwad negate	30to45	Female					2193	SM3	11 ⁰ 13'6"	38 ⁰ 50'52"	✓	✓	✓
71	Zuryash Kebede	30to45	Female					2176	SM3	11 ⁰ 25'15"	38 ⁰ 51'30"	✓	✓	✓
72	Tagu Awel	30to45	Male			Sayinit	Mess	2440	M2	11 ⁰ 5'12"	38 ⁰ 35'1"		✓	✓
73	Deblek Zeleke	45to60	Male					2401	M2	11 ⁰ 5'20"	38 ⁰ 44'58"			
74	Hagernesh Adem	45to60	Female					2428	M2	11 ⁰ 5'22"	38 ⁰ 34'48"		✓	✓
75	Tsehaynesh	45to60	Female					2428	M2	11 ⁰ 5'12"	38 ⁰ 35'7"		✓	

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
	Tarekegn													
76	Mesa Belayneh	30to45	Female					2428	M2	11 ⁰ 4'44"	38 ⁰ 34'51"		✓	
77	Melkam Eshetu	45to60	Female					2402	M2	11 ⁰ 5'11"	38 ⁰ 34'56"		✓	
78	Shimastes Yesuf	45to60	Female					2400	M2	11 ⁰ 5'7"	38 ⁰ 34'52"		✓	✓
79	Tetay Abate	45to60	Female					2406	M2	11 ⁰ 5'28"	38 ⁰ 34'42"		✓	
80	Banchi Mekonnen	18to30	Female					2397	M2	11 ⁰ 5'31"	38 ⁰ 34'8'15"		✓	✓
81	Askebeb Mersha	30to45	Female					2431	M2	11 ⁰ 5'24"	38 ⁰ 34'3"		✓	
82	Feleku Abere	18to30	Female					2408	M2	11 ⁰ 5'22"	38 ⁰ 34'24"		✓	
84	Tsfaye Abate	30to45	Female					2410	M2	11 ⁰ 5'18"	38 ⁰ 34'30"		✓	
85	Belaynesh Melese	30to45	Female					2389	M2	11 ⁰ 5'22"	38 ⁰ 34'47"	✓	✓	
86	Gtteye Gared	30to45	Male					2389	M2	11 ⁰ 5'22"	38 ⁰ 34'47"	✓	✓	
87	Gezea Leul	30to45	Male		E. Gojjam	Shebel Berenta	Bonaya Sekela	2384	M3	10 ⁰ 5'23"	38 ⁰ 34'53"		✓	
88	Ytemgne Damte	30to45	Female					1838	M3	10 ⁰ 24'45"	38 ⁰ 26'37"		✓	✓
89	Sefinew Hayelu	30to45	Male					1820	M3	10 ⁰ 24'52"	38 ⁰ 26'36"		✓	
90	Etalema Necha	30to45	Male					1892	M3	10 ⁰ 24'56"	38 ⁰ 26'12"		✓	

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
91	Degual Sewnet	30to45	Male					1889	M3	10 ⁰ 24'50"	38 ⁰ 26'22"		✓	✓
92	Getachew Mesefen	30to45	Male					1871	M3	10 ⁰ 24'32"	38 ⁰ 26'44"		✓	
93	Buzayaew Fekadu	45to60	Male					1835	M3	10 ⁰ 24'31"	38 ⁰ 26'41"		✓	
94	Etataw Walelegn	30to45	Female					1877	M3	10 ⁰ 24'41"	38 ⁰ 26'32"		✓	
95	Trengo Asye	30to45	Female					1842	M3	10 ⁰ 24'26"	38 ⁰ 26'40'		✓	
96	Aregash Abebe	18to30	Female					1836	M3	10 ⁰ 24'25"	38 ⁰ 26'45"		✓	
97	Etenesh Walelegn	30to45	Female					1831	M3	10 ⁰ 24'35"	38 ⁰ 26'50"		✓	
98	Sewnet Ayalew	30to45	Female					1858	M3	10 ⁰ 24'39"	38 ⁰ 27'3"		✓	✓
99	Alemayew Mamo	45 to 60	Male					1867	M3	10 ⁰ 18'52"	38 ⁰ 27'3"		✓	✓
100	Terngo Asayew	30to45	Female					2130	M2	10 ⁰ 30'55"	38 ⁰ 26'0"	✓	✓	
101	Wale Werke	45 to 60	Male					2130	M2	10 ⁰ 30'55"	38 ⁰ 26'0"	✓	✓	
102	Werkea Adera	30to45	Female				Anshebna Zuhir	1869	M2	10 ⁰ 24'31"	38 ⁰ 26'39"		✓	
103	Gashew Abi	45to60	Male					2137	M2	10 ⁰ 30'44"	38 ⁰ 25'50"		✓	✓
104	Yeleftu Terusew	30to45	Female					2136	M2	10 ⁰ 30'55"	38 ⁰ 26'0"		✓	✓
105	Abege Gedamu	30to45	Male					2136	M2	10 ⁰ 31'8"	38 ⁰ 26'1"		✓	

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
106	Baharu Zewedea	30to45	Male					2103	M2	10 ⁰ 30'37"	38 ⁰ 25'46"		✓	
107	Chekole Tsehau	30to45	Female					2097	M2	10 ⁰ 30'24"	38 ⁰ 25'39"		✓	
108	Yalew Melkamu	30to45	Male					2112	M2	10 ⁰ 30'23"	38 ⁰ 25'28"		✓	
109	Abebe Amar	30to45	Male					2114	M2	10 ⁰ 30'29"	38 ⁰ 25'35"		✓	
110	Chekolech Eshete	45to60	Female					2138	M2	10 ⁰ 30'25"	38 ⁰ 25'28"		✓	
111	Teru Wedu	30to45	Female					2109	M2	10 ⁰ 30'24"	38 ⁰ 25'30"		✓	✓
112	Byea Basazew	30to45	Male					2094	M2	10 ⁰ 30'24"	38 ⁰ 25'40"		✓	
113	Telksew Andarge	30to45	Male					2206	M2	10 ⁰ 30'23"	38 ⁰ 25'10"		✓	✓
114	Skebeb Tadele	30to45	Female					2190	M2	10 ⁰ 35'31"	38 ⁰ 27'28"	✓	✓	✓
115	Tadele Sisay	45 to 60	Male					2190	M2	10 ⁰ 35'31"	38 ⁰ 27'28"	✓	✓	✓
116	Leweyehu Ademasu	30to45	Female				Yeju Bayile Adis Alem	2136	M2	10 ⁰ 30'47"	38 ⁰ 25'53"		✓	
117	Endalew Abebe	30to45	Male					2447	M2	10 ⁰ 17'9"	38 ⁰ 18'18"		✓	
118	Wendemy Molu	30to45	Male					2432	M2	10 ⁰ 17'15"	38 ⁰ 18'14"		✓	
119	Etataw Mengistu	18to30	Female					2412	M2	10 ⁰ 17'18"	38 ⁰ 18'6"		✓	✓
120	Aregash Dagne	18to30	Female					2441	M2	10 ⁰ 17'9"	38 ⁰ 18'23"		✓	

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions	
121	Mulu Gebeyew	30 to 45	Female	Amhara				2415	M2	10 ⁰ 17'28"	38 ⁰ 19'6"		✓		
122	Zenash Ayalew	18to30	Female					2400	M2	10 ⁰ 17'27"	38 ⁰ 19'22"		✓		
123	Beyazen Mesganaw	18to30	Male					2418	M2	10 ⁰ 17'21"	38 ⁰ 18'43"		✓		
124	Melaku Kasa	45to60	Male					2433	M2	10 ⁰ 17'16"	38 ⁰ 18'31"		✓		
125	Tetay Dagnachew	30to45	Female					2437	M2	10 ⁰ 17'10"	38 ⁰ 18'25"	✓		✓	
126	Ayenew Debalek	30to45	Male					2441	M2	10 ⁰ 16'56"	38 ⁰ 18'24"		✓	✓	
127	Buzayaew Bale	30to45	Male					2439	M2	10 ⁰ 16'52"	38 ⁰ 18'26"		✓		
128	Madtewal Bedelu	30to45	Female					2410	M2	10 ⁰ 16'52"	38 ⁰ 18'26"		✓		
129	Yibeltal Tameru	45to60	Male					2410	M2	10 ⁰ 16'52"	38 ⁰ 18'26"		✓		
130	Abate Adegu	18to30	Male					Enebise sar midir	2430	M3	10 ⁰ 17'2"	38 ⁰ 18'26"		✓	
131	Yeshialem Damete	18to30	Female					2356	M3	10 ⁰ 47'1"	38 ⁰ 26'54"		✓		
132	Tsfaye Geze	18to30	Female					2355	M3	10 ⁰ 46'52"	38 ⁰ 26'34"	✓		✓	
133	Malefya Antneh	18to30	Female					2373	M3	10 ⁰ 47'10"	38 ⁰ 26'27"	✓		✓	
134	Emamseat Gebrea	18to30	Female					2365	M3	10 ⁰ 47'29"	38 ⁰ 26'13"				
135	Degual Ayenu	30to45	Male					2363	M3	10 ⁰ 47'37"	38 ⁰ 26'13"				

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
136	Aneley Yebeleta	30to45	Male					2378	M3	10 ⁰ 47'33"	38 ⁰ 26'78"			
137	Eyau Wedu	18to30	Male					2317	M3	10 ⁰ 47'27"	38 ⁰ 26'22"			
138	Menberu Yebeletal	30to45	Male					2357	M3	10 ⁰ 47'20"	38 ⁰ 26'18"			
139	Galo Asheber	30to45	Male					2444	M3	10 ⁰ 47'18"	38 ⁰ 26'24"			✓
140	Asmamaw Taye	over60	Male					2356	M3	10 ⁰ 47'10"	38 ⁰ 26'39"			
141	Azebebe Moges	18to30	Female					2441	M3	10 ⁰ 16'56"	38 ⁰ 18'28"			
142	Belaynesh Getu	30to45	Female					2370	M3	10 ⁰ 48'5"	38 ⁰ 24'34"	✓		
143	Terengo Asayew	45to60	Female					2370	M3	10 ⁰ 48'5"	38 ⁰ 24'34"			
144	Habetam Dagnachew	30to45	Female				Liuil	2359	M2	10 ⁰ 47'8"	38 ⁰ 26'54"			✓
145	Abezuya Goshu	30to45	Female					1889	M2	10 ⁰ 42'54"	38 ⁰ 24'54"			✓
146	Tatu Shemeles	30to45	Female					1906	M2	10 ⁰ 42'54"	38 ⁰ 24'54"			
147	Ydeneku Babu	18to30	Female					1904	M2	10 ⁰ 42'48"	38 ⁰ 52'2"			
148	Ayale Dereb	30to45	Female					1900	M2	10 ⁰ 42'45"	38 ⁰ 25'3"			✓
149	Getenet Werkeneh	30to45	Male					1889	M2	10 ⁰ 42'42"	38 ⁰ 25'4"			
150	Abeyu Hayele	45to60	Male					1912	M2	10 ⁰ 42'38"	38 ⁰ 25'8"			

No	Name of informants	Age	Gender	Region	Zone	Wereda	Kebele	Altitude (m.a.s.l.)	AEZ	Latitude (N) (dd mm ss)	Longitude (E) (dd mm ss)	Market	Interview	Accessions
151	Alemnew Asefa	30to45	Male					1879	M2	10 ⁰ 42'35"	38 ⁰ 25'11"			✓
152	Teru Sentea	18to30	Female					1903	M2	10 ⁰ 42'36"	38 ⁰ 25'11"			
153	Fenti Ali	30to45	Female					1908	M2	10 ⁰ 42'44"	38 ⁰ 25'9"			
154	Muleye Mohamed	30to45	Female					2393	M2	10 ⁰ 44'51"	38 ⁰ 24'27"			✓
155	Mengestu Werku	30to45	Male					2351	M2	10 ⁰ 44'32"	38 ⁰ 24'50"			
156	Alem Telahun	30to45	Female				Zihon Wiha	2419	M3	10 ⁰ 52'50"	38 ⁰ 24'6"			✓
157	Teshome Mohamed	45to60	Male					2417	M3	10 ⁰ 52'51"	38 ⁰ 24'7"			
158	Shewaga Amedi	30to45	Female					2387	M3	10 ⁰ 53'1"	38 ⁰ 24'20"			✓
159	Merem Alemu	30to45	Female					2379	M3	10 ⁰ 53'4"	38 ⁰ 24'25"			
160	Alebachew Adal	45to60	Male					2378	M3	10 ⁰ 53'9"	38 ⁰ 24'25"			
161	Abebe Gebeyew	45to60	Male					2376	M3	10 ⁰ 52'56"	38 ⁰ 24'26"			
162	Yedeneku Tameru	30to45	Female					2357	M3	10 ⁰ 53'2"	38 ⁰ 24'39"			
163	Yetateku Kasa	18to30	Female					2349	M3	10 ⁰ 53'4"	38 ⁰ 24'40"			✓
164	Teruwerk Tebebu	45to60	Female					2332	M3	10 ⁰ 53'5"	38 ⁰ 24'40"			
165	Abebe Dametew	over60	Male					2349	M3	10 ⁰ 52'59"	38 ⁰ 24'41"			
166	Astatek Hayele	30to45	Male					2360	M3	10 ⁰ 52'57"	38 ⁰ 24'40"			
167	Welela Tefera	30to45	Female					2433	M3	10 ⁰ 52'28"	38 ⁰ 23'57"			

Declaration

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

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Name: _____ Signature: _____ Date: _____