ETHIOPIA: THIRD COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Institute of Biodiversity Conservation (IBC)

Addis Ababa, October 2012
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<tr>
<td>ABS</td>
<td>Access and Benefit Sharing</td>
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<tr>
<td>ADLI</td>
<td>Agricultural Development Led Industrialization</td>
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<td>BYDV</td>
<td>Barely Yellow Dwarf Virus</td>
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<td>CBD</td>
<td>Convention on Biological Diversity</td>
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<td>CGB</td>
<td>Community Gene bank</td>
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<td>CRGE</td>
<td>Climate-Resilient Green Economy</td>
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<td>CSA</td>
<td>Central Statistical Agency</td>
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<td>EAPGREN</td>
<td>East Africa Plant Genetic Resources Network</td>
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<td>EHNRI</td>
<td>Ethiopian Health and Nutrition Institute</td>
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<td>EIAR</td>
<td>Ethiopian Institute of Agricultural Research</td>
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<td>EOSA</td>
<td>Ethio-Organic Seed Action</td>
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<td>ESE</td>
<td>Ethiopian Seed Enterprise</td>
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<td>EWP</td>
<td>Edible Wild Plants</td>
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<td>FAO</td>
<td>Food and Agricultural Organization</td>
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<td>FDRE</td>
<td>Federal Democratic Republic of Ethiopia</td>
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<td>GEF</td>
<td>Global Environmental Facility</td>
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<td>GTP</td>
<td>Growth and Transformation Plan</td>
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<td>HLI</td>
<td>Higher Learning Institutions</td>
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<td>IBC</td>
<td>Institute of Biodiversity Conservation (Ethiopia)</td>
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<td>IBCR</td>
<td>Institute of Biodiversity Conservation and Research (Ethiopia)</td>
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<tr>
<td>ILRI</td>
<td>International Livestock Research Institute</td>
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<td>ITPGRFA</td>
<td>International Treaty on Plant Genetic Resources for Food and Agriculture</td>
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<td>JICA</td>
<td>Japan International Cooperation Agency</td>
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<td>MoA</td>
<td>Ministry of Agriculture</td>
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<td>MoARD</td>
<td>Ministry of Agriculture and Rural Development</td>
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<td>MTA</td>
<td>Material Transfer Agreement</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>NARS</td>
<td>National Agricultural Research System</td>
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<tr>
<td>NGO</td>
<td>Non-Governmental Organizations</td>
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<tr>
<td>ODAP</td>
<td>β-N-oxalyl-L-a, β-diaminopropionoc acid</td>
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<tr>
<td>OPV</td>
<td>Open Pollinated Varieties</td>
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<tr>
<td>PASDEP</td>
<td>Plan for Accelerated and Sustainable Development to End Poverty</td>
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<tr>
<td>PPB</td>
<td>Participatory Plant Breeding</td>
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<td>PVS</td>
<td>Participatory Variety Selection</td>
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<td>RARI</td>
<td>Regional Agricultural Research Institute</td>
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<tr>
<td>SLMP</td>
<td>Sustainable Land Management Program</td>
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<td>SNNPR</td>
<td>Southern Nations, Nationalities and People Regional State</td>
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<td>TSW</td>
<td>Thousand Seed Weight</td>
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<td>UNDP</td>
<td>United Nation Development Program</td>
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<td>WFP</td>
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EXECUTIVE SUMMARY

This country report has been prepared in line with the agreement made between the Institute of Biodiversity Conservation (IBC) of Ethiopia and the Food and Agricultural Organization (FAO) of the United Nation. The Institute of Biodiversity Conservation (IBC), together with other stakeholders has prepared the Third National Report on the State of Plant Genetic Resources for Food and Agriculture (PGRFA). The report has been prepared in accordance with the FAO guidelines for the 3rd national/country report, and contains nine parts.

The existence of diverse farming systems, cultures and agro-ecologies have endowed Ethiopia with highly diverse PGRFA. As a result, the country is regarded as a center of origin and/or diversity for many crops plants. Crops such as coffee (*Coffea arabica*), safflower (*Carthamus tinctorius*), tef (*Eragrostis tef*), noug or niger seed (*Guizotia abyssinica*), ANCHOTE (*Coccinia abyssinica*), Ethiopian potato (*Plectranthus edulis*), GESHO (*Rhamnus prinoides*), Ethiopian mustard or Gomenzer (*Brassica carinata*) and ENSET (*Ensete ventricosum*) have originated in Ethiopia. The country is also considered as a center of diversity for field crops such as barley (*Hordeum vulgare*), sorghum, tetraploid wheats (*Triticum* spp.), finger millet (*Eleusine coracana*), faba bean (*Vicia faba*), tef (*Eragrostis tef*), linseed (*Linum usitatissimum*), niger seed (*Guizotia abyssinica*), sesame (*Sesamum indicum*), safflower (*Carthamus tinctorius*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), cowpea (*Vigna unguiculata*), grass pea (*Lathyrus sativus*) and fenugreek (*Trigonella foporum-graceum*).

The diverse agricultural production systems in Ethiopia depend largely on native PGRFA that are adapted to the local conditions. In Ethiopia, more than 95% of the arable land is cropped with farmers' varieties. The locally adapted PGRFA are highly valued by farmers for their useful agronomic traits and sustainable yields in the various agro-ecologies where improved crop varieties cannot perform satisfactorily. Despite these facts, the trend in the conservation status of the rich PGRFA of the country is declining from time to time. The major contributing factors include: displacement of the local farmers’ varieties by improved varieties, market-oriented crop production, pests and diseases, population pressure, breeding ventures focusing on
genetic uniformity in improved varieties, invasive alien species, drought, and environmental degradation. Un-wise market-oriented and cash crop production systems have resulted in the loss of farmers' varieties. Ethiopia is the sole gene pool for globally important crops such as Coffea arabica and Eragrostis tef. Therefore, the loss of these crops will have negative implications not only for Ethiopia but also for the world at large.

Ethiopia has ratified the convention on Biological Diversity (CBD) and International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). After entering into these commitments, Ethiopia has issued proclamation on Access to Genetic Resources and Traditional Knowledge and Community Rights and Regulation. The Institute of Biodiversity Conservation (IBC) is the focal institute for implementation of CBD and ITPGRFA. The country has also signed the Nagoya Protocol which is believed to enhance the implementation of the National ABS laws.

Several exploration missions have been carried out by IBC to collect and conserve the diversity of plant genetic resources of the country. Collection planning is mainly based on the degree of threat, economic importance and research priorities of the country. To date, the Institute has conserved 68,014 accessions and 6,700 accessions of different crops in cold rooms and field gene banks, respectively. The size of the collections has been increased by 13% over the period 2007 to 2012. The lion shares of the conserved germplasm in the gene bank are farmers' varieties, and grain crops alone make up more than 97 percent of the total holdings. Absence of safety duplication and shortage of space in the gene bank have hindered further collection activities, while this problem has also even more so considerably hampered the collection and conservation of clonally propagated species. The viability of the conserved seeds is monitored every 5 to 10 years depending on the crop types, and rejuvenation is done if the germination test result becomes less than 85%. To date, 5606 accessions have been regenerated and 3089 accessions need immediate regeneration. About 109,257 seed samples have been distributed from the gene bank to different users. Each year, the national gene bank dispatches about 6000 seed samples on average for local research activities.
Characterization is essential to enhance the utilization of conserved germplasm, and to solve the challenges of agricultural production in the face of climate change. So far, morphological and bio-chemical characterizations have been conducted on some major crop species. Molecular characterization works have not yet been initiated mainly due to lack of facilities and skilled manpower. Thus, extensive study on Ethiopia’s diverse germplasm should be a priority area of IBC to complement the morphological characterization and identify genes that possess traits of agricultural and economic importance.

Practical measures have been taken in on-farm conservation of farmers' varieties mainly to support the farming communities in their efforts to maintain crop diversity and ensure food security at the local scale. "Conservation through use" is the guiding principle in the implementation of on-farm conservation in Ethiopia. The on-farm maintained farmers' varieties are used as a source of germplasm with a wide range of adaptation and other useful traits. Currently, six on-farm conservations sites actively managed by farmers are found in Ethiopia. The community seed banks are used to restore farmers' varieties displaced due to various factors. Recently, additional five community seed banks are already established in the SNNP Regional State of the country. Displaced farmers' varieties of different crops have also been restored from the national gene bank. In general, the community seed banks are intended to increase farmers’ access to diverse crop types, and to decrease seed shortage at planting. Conservation of PGRFA is also effected in Ethiopia within and outside the protected area. For instance, Yayu and Keffa biosphere reserves found in south western parts of the country help in the preservation of the wild gene pool of Coffea arabica and various wild edible plants. Considering the huge genetic diversity that the country possesses, however, the present efforts are quite limited. The implementation of on-farm conservation of PGRFA has been constrained mainly because of lack of financial resources.
CHAPTER 1: INTRODUCTION TO THE COUNTRY AND AGRICULTURAL SECTOR

1.1. Physiography

Ethiopia, with a total surface area of 1,127,127 km², is located within the tropics in the Horn of Africa between 3º and 15º N latitude and 33º and 48º E longitude. The country is currently divided into nine regional states and two city administrations. The country has got enormous topographic and climatic diversity, which has given rise to many and varied ecological systems. Besides, there is huge variation of altitude from 110 meters below sea level to 4620 meters above sea level. The Great Rift Valley runs from northeast to southwest of the country and separates the western and south-eastern highlands. The highlands on each side of the rift valley give way to extensive semi-arid lowlands to the east, south and west of the country.

![Map of Ethiopia](image)

Fig. 1 Map of Ethiopia

1.2. Climatic features

Ethiopia is a tropical country with varied macro- and micro-climatic conditions. The influence of high altitudes modifies mean temperatures and leads to a more moderate Mediterranean type
climate in the highlands. These varied climatic conditions have contributed to the formation of diverse ecosystems inhabited with a great diversity of life forms. The rainfall varies widely in amount and distribution. The mean annual rainfall patterns range from below 200 mm to above 2800 mm, the south western parts of the country receiving the heaviest annual rainfall that goes to above 2800 mm. The relative humidity regimes closely follow the rainfall pattern. The rainfall pattern itself and the high variation in temperature (>30 °C and <10 °C) greatly influence the types and diversity of vegetation and their distribution over the country.

1.3. Vegetation

Ethiopia because of its geographical positions, range of altitudes, rainfall patterns and soil variability has an immense ecological diversity and a huge wealth of biological resources. This complex topography coupled with environmental heterogeneity offer suitable conditions for various vegetation types. A recent study indicated that the number of higher plants in Ethiopia is estimated to be 6000 species, of which 12 percent are considered to be endemic. According to Friis et al. (2010) the present vegetation of the country is classified into the following twelve vegetation types:

1) Desert and semi-desert scrubland
2) *Acacia* - *Commiphora* woodland and bushland
3) Wooded grassland of Western Gambela region
4) Moist evergreen Afromontane forest
5) Lowland (Semi-) evergreen forest
6) *Combretum-Terminalia* Woodland and wooded grassland
7) Dry evergreen Afro-montane forest and grassland complex
8) Afro-alpine and Sub-afro-alpine vegetation
9) Transitional rainforest
10) Riparian and swamp vegetation
11) Fresh-water lakes, lake shores, marsh and floodplain vegetation
12) Salt-water lakes, salt-lakes shores, marsh and pan vegetation
1.4. Human Population

Ethiopia’s population is estimated at 84.3 million with a density of 114 persons per square kilometer. About 83% of the people live in rural areas, and are mainly engaged in agriculture. The settlement pattern of the population is influenced by environmental factors and economic activities which have skewed the population distribution towards the highlands. The Ethiopian highlands are (> 2000 m.a.s.l.), which cover 37 percent of the total area are inhabited by about 77 percent of the population. Hence, the highlands of the country are densely populated, resulting in over-grazing and severe degradation of the natural resources, while the lowlands are sparsely populated. This uneven human population distribution throughout the country is one of the factors that have led to the reduction of the productivity of agricultural lands.

1.5. Agricultural sector

Agriculture is a key driver of Ethiopia’s economic growth and food security. Eighty four percent of the population depends directly on agriculture for livelihood. The sector accounts for more than 42% of national GDP and the lion’s share of its foreign currency earnings from the export of agricultural commodities. Private peasant farming activities is the main contributor of the gross agricultural output, whereas the few commercial farms found in the country contribute only 5% of the gross agricultural output (CSA 2011).

Ethiopia is dependent on rainfall for agricultural production, and irrigation covers only very limited percentage of agricultural crop areas. A considerable proportion of seed inputs are derived from local planting materials, and the country’s seed resources are critical to the performance of agriculture. Seed production and multiplication activities are being carried out by federal and regional research Institutes and seed enterprises. These days, however, some cooperatives and model farmers are also involved in seed multiplication activities. Despite these efforts, the existing national breeding and seed multiplication capacity is not sufficient to address the seed demand at the national level. The CSA’s (2011) agricultural survey estimated that the total private peasant holding was about 13 million hectares and most of the
agricultural land (more than 76%) was under annual crops. The average land holding per household was 1.18 hectares.

Sustainable land use is the key to long lasting development. In light of this fact, the government of Ethiopia has launched large-scale soil and water conservation activities throughout the country to restore degraded areas. This program has increased the total area of agricultural lands, and enabled the initiation of rehabilitation of the original vegetations. The water holding capacity of the soil has also improved, thereby, creating conducive environments for crop production. Similarly, in an effort to reduce the challenges the agricultural sector is facing and to achieve faster agricultural growth and food security, the Government of Ethiopia has launched different development strategies such as Agricultural Development led Industrialization (ADLI), Plan for Accelerated and Sustained Development to End Poverty (PASDEP) and Growth and Transformation Plan (GTP).

Less than five percent of the cultivated area is sown to improved varieties mostly due to the high price and inaccessibility of improved seeds, and the preference of farmers to grow farmers’ varieties. The national average yield of the major crops has also been very low due to changes in environmental conditions and indiscriminate diffusion of seeds of varieties with poor adaptation to the local conditions. Recently, there has been considerable interest in market-oriented agriculture to meet both the growing local demand and take advantage of the export market. Prices of agricultural products are rising sharply, encouraging farmers to enter markets, and invest in seeds of better varieties and fertilizer applications.

1.5.1. Major farming systems

Ethiopian is characterized by a wide range of agro-climatic conditions with diverse cultural and farming practices that can be grouped into three major agricultural systems: a) the highland mixed farming system; b) the low plateau and valley mixed agriculture; and c) the pastoral livestock production of the arid and semi-arid zones.
a) The highland mixed farming system

This farming system is typically found in areas of higher elevations of usually above 2000 m.a.s.l. Crop production under this farming system is diverse and multiple cropping, with limited intercropping practices. Traditionally, continuous cropping was exercised through crop rotation, where cereal production alternated with the production of legume crops as a means of maintaining soil fertility. The types of crops grown for food and as a source of cash income or other purposes varies, being influenced by diversified agro-climates, and by the diverse social and cultural nature of the people. Diversity in the crops is very high and many farmers’ varieties are still used in the system. Crops with cultural significance are commonly grown near the homesteads. The highland mixed farming system includes the mixed crop livestock complex. The livestock component within this system is essential where animals are used as draft power for ploughing, threshing and transport, and their products serve as a major source of fuel, food and manure for soil fertility. Livestock is kept throughout the year, mostly grazing on natural pastures and crop residues (stubbles).

b) Low plateau and valley mixed agriculture

This is a sedentary agricultural system in the intermediate highlands, mountain foothills and upper valleys, often practiced at altitudes ranging from 1500 to 2000 m.a.s.l. Under this system, both crop and livestock productions are economically important. However, the diversity of crops grown and the degree of integration of crop and livestock production is less pronounced. Sorghum and maize dominate the crop production along with some oil crops, wheat and tef. Pulses such as chickpea and root and tuber crops may be included in the system, and in recent years there has been more emphasis on cash crops for export, including chat and banana. Within this farming system, livestock are usually shifted off the cropping zone during the crop growing season and brought back after the harvest of the crops when animals are partly fed on crop residues.

c) Pastoral livestock production of the arid and semi-arid zone
Pastoral production system is practiced mainly at an elevation below 1500 m.a.s.l. and with an annual rainfall of below 450 mm. Pastoral areas cover about 60 percent of the land area and support about 10 percent of the population. In the arid zone, pastoral and semi-pastoral livestock production dominates with camels and goats as important components. In the semiarid, semi-pastoral or semi-sedentary zone, livestock production is practiced. The major components of the livestock production here are cattle, camels and goats. Range development and improved access to water are important to improve livestock production. In recent years, there has been a move away from the pastoral system to cropping in areas with sufficient water. The main crop in this area is maize. Low moisture is the major production constraint particularly in the arid zone. In this zone, there is a high potential for irrigated agriculture, especially for production of fiber crops, sugar cane, oil seeds, horticultural and forage crops for export.

1.5.2. Seed supply systems

Ethiopia is endowed with diverse agro-ecological conditions comprising 32 agro-ecological zones (MoARD 2005). This implies that, crop production under these diverse agro-ecological conditions of the country requires the use of crop varieties that could fit these agro-ecologies. The capacity of the existing national agricultural research system (NARS) and the formal seed system is not sufficient to address the farmers’ seed requirement. Less than five percent of the cultivated area is sown with improved varieties. This is mainly attributed to unavailability of improved varieties suitable for the different agro-ecologies, shortage improved variety seeds supply, high price of improved seeds and the preference of farmers to grow their own varieties.

In general, the multiplication and distribution of seeds of improved varieties in Ethiopia involves the formal and informal seed systems. The informal seed system under the Ethiopian context is defined as seed production and distribution along with the different actors where there is no legal certification involved in the process. This includes retained seed by farmers, farmer-to-farm seed exchange, cooperative-based seed multiplication and distribution, NGO-based seed multiplication and distribution, and the likes. The formal seed system, on the other hand, is a
system that involves the production and distribution of basic seed mainly by the research system or certified multipliers like the Ethiopian Seed Enterprise (ESE), the Regional Seed Enterprises and also recently licensed private seed companies (like ANO and Agri-Ceft Ethiopia), and the production and distribution of certified seed along with all actors involved in the production, marketing and regulation.

Overall, the dominant portion of seeds used in crop production is local seeds from the informal sector. During the 2008 main growing season, it is estimated that at least 95% of the seeds used were local seeds obtained from the previous harvest either by the farmers themselves (through the traditional on-farm selection process whereby the farmer identifies next year’s seed stock while it is still maturing in the field and gives it special protection) or by buying from preferred seed stock kept by other farmers in the same locality (FAO and WFP 2009).

The average contribution of the formal seed sector as a percentage of land covered by seeds from the formal sector is 4.3% with considerable variability among different crops in 2008 production season (NSPDC 2009). In the same year, about 5.24% for cereals, 0.71% for pulses, 0.54% for oilseed crops was covered with improved seed. Among the major cereals, 18.98% of the maize, 6.37% of the wheat and 0.85% of the tef areas were covered with seed from the formal sectors.

The formal seed system in Ethiopia is dominated by few cereal crops mainly due to the perceived productivity gains, availability of improved varieties, and commercial interests of the different actors. The formal seed sector covers only 5% of the tef, but 53% of the maize and 20% of the wheat seed requirements (Alelu et al. 2007). The greatest involvement of the formal seed sector in Ethiopia is predominantly in hybrid maize. Due to the fact that it cannot be recycled, there is huge demand by farmers, and all public and private seed companies are engaged in its multiplication creating competition among these actors. The seed for open pollinated varieties (OPV) maize is produced by ESE only in limited volume whereas the seed for hybrid maize is produced by both the public and private sectors. The demand for hybrid maize
under the Ethiopian agricultural production system is very variable due to the agro-ecological diversity and with considerable dependence on weather conditions. For instance, during the 2008/09 production season, when the demand for hybrid maize was covered by less than 30 percent, there was certified hybrid maize seed left over mainly in the Rift Valley area.

Seeds of improved varieties of bread and durum wheat are produced by the ESE and also recently by the Regional Seed Enterprises. Farmers normally practice reuse of wheat seed ranging from 3 to 5 years. In general, smallholder tef farmers in Ethiopia depend on the informal system involving farmer to farmer seed exchange and use of their own recycled seeds. About 50% of farmers in Lume and Minjar areas reported that seed exchange among farmers is the major source of tef seed (Ferede 2011). Tef seed is generally multiplied by research centers and Ethiopian Seed Enterprise. In addition, some cooperative unions and their respective member primary cooperatives are also involved in multiplication of tef seeds in addition to farmers to farmers exchange. Farmers normally practice recycling of tef seed for more than 3 years.

The seed of improved malt barley is distributed by ESE and Regional Seed Enterprises. In addition, the national barely research program is extensively promoting the varieties by linking farmers with Assela Malt Factory through cooperatives. Sorghum seed multiplication is very limited and farmers dominantly use their local varieties. However, due to the serious impact of both biotic and abiotic stresses including water stress and striga problem on the production and productivity of the crop, the demand for recently released tolerant varieties is increasing considerably. The seed of improved sorghum varieties are mainly produced by ESE in a limited amount. Project based sorghum seed production and dissemination is also undertaken by NARS mainly for drought and striga tolerant varieties. The recently released hybrid sorghum varieties are not yet multiplied by any seed producers. However, if the demand for the hybrid sorghum variety is created, both the public and private seed companies are expected to be involved in their seed production.
The seed of improved millet varieties is not multiplied by the formal sector but it is promoted by NARS. Rice seed was under multiplication by ESE and also regional seed enterprises since the 2009 production season. Similarly, farmers-based rice seed multiplication is promoted by SG 2000 and Japan International Cooperation Agency (JICA), Ethiopia. Considering the declaration of rice by the government as the ‘Millennium’ crop, its seed system will get due emphasis along with the implementation of the National Rice Research and Development Strategy (MoARD 2010).

1.5.3. Trends in crop production

The Ethiopian agricultural crop production sub-sector is complex involving considerable variation in crops grown across the country’s different regions and agro-ecologies. Five major cereals (tef, wheat, maize, sorghum and barley) are the core of Ethiopia’s agriculture and food security, accounting for about three-quarters of total area cultivated, 29% of the agricultural GDP (14% of the total GDP) and 64% of the calories consumed. There has been substantial growth in cereals, in terms of area cultivated, yields and production since 2000, but yields are low by international standards and overall production is highly susceptible to weather shocks, particularly droughts.

In the main agricultural regions in Ethiopia, there are two rainy seasons: the MEHER (main rainy) and the BELG (short rainy) season. Consequently, there are also two crop seasons corresponding to the two rainy seasons. The MEHER is the main crop season. It encompasses crops harvested between September and February. Crops harvested between March and August are considered as part of the BELG season crop. Three important issues emerge concerning the crop production in the two seasons. First, the MEHER season accounts for about 90% the total yearly production. Secondly, the yield and productivity of crops is always greater in the MEHER than in the BELG season. Third, smallholder farmers cultivate crops during the BELG season, while large farms concentrate their production entirely on the more productive MEHER season.
During the 2012 MEHER season, Ethiopia harvested more than 21.85 million tons of grain crops (CSA 2012). This produce which comes from smallholder farms represents 7.4% annual growth rate as compared to the same harvest season of the previous year which amounted to 20.34 million tons. The smallholder farmers managed to cover more than 12.8 million hectares of land to produce the grain crops. The country harvested more than 18.8 million tons of cereals, 2.3 million tons of pulses, and 0.7 million tons of oilseeds. This is, on average, a productivity of 1.8 tons per hectare.

The total area cultivated during the 2011/2012 MEHER season has increased by almost one million hectares as compared to the previous season. Though the statistical information gathered portrayed a growth in the overall crop production, the contribution of cereals and oilseeds were the highest. Cereal contributed more than 18% and oilseeds 15%. Generally, the cultivated crop area (about 13 million hectares) accounts for a relatively small share of the total land area of the country.

1.6. Methodology used for preparing this country report

The following steps were undertaken for the preparation of the country report:

- The National Focal Person for the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) has assigned, the Biodiversity Conservation and Use, Directorate of the Institute to serve as a focal point for the preparation of the Third Country Report
- A Steering Team was established from IBC and the Ethiopian Institute of Agricultural Research (EIAR)
- A team comprised of 8 experts from government and non-government organizations were identified by the focal point after interaction with experts working in the Biodiversity Conservation and Use Directorate of the Institute of Biodiversity Conservation
- Questionnaires were prepared based on the guidelines for collecting information from different government and non-government organizations directly working on issues of PGRFA
• Several meetings of the experts were organized to prepare a draft report based on the Guidelines
• The draft report has been presented to stakeholders on a one-day workshop in order to enrich the document with the comments and suggestions
• The working team has incorporated the comments and suggestions forwarded by stakeholders, and compiled this report
CHAPTER 2: STATE OF DIVERSITY

2.1. Diversity of major crops and their relative importance

Ethiopia is one of the world's eight major Vavilovian centers of origin and diversity of crop plants (Vavilov 1951). The country has enormous wealth in crop genetic resources. This is mainly attributed to its diverse agro-ecologies, farming systems, socio-economic conditions and cultures. Many crop plants have their primary center of origin in Ethiopia. Some of these include Coffee (Coffea arabica L.), TEF [Eragrostis tef (Zucc.) Trotter], ENSET (Ensete ventricosum (Welw.) Cheesman), NOUG [Guizotia abyssinica (Lf.) Cass.], ANCHOTE [Coccinia abyssinica (Lam.) Cogn.], Ethiopian potato (Plectranthus edulis (Vatke) Agnew, CHAT (Catha edulis Forsk.), Ethiopian mustard or GOMENZER (Brassica carinata A. Braun), GESHO (Rhamnus prinoides L'Herit.), GODERE (Colocasia esculenta (L.) Schott.), African finger millet (Eleusine coracana (L.) Gaertn.), and Ethiopian cardamom (Aframomum corrorima (Braun) Jansen). In addition, Ethiopia is a center of great diversity for many globally important crops. These include: food crops such as tetraploid wheat, barley, sorghum and peas, industrial crops such as cotton, castor bean and linseed, a number of important forage and pasture crops such as clovers, oats, and a multitude of food crops of localized or regional importance (e.g. finger millet, tef, ENSET, cowpea, chickpea and lentil).

The valuable genetic diversity of Ethiopian crop species, as well as their related wild species, has been built up over the centuries by the natural selective forces of the environment and the human selection activities of the farming community. Ethiopian farmers' selection criteria have got considerable roles in adding genetic and economic value to farmers' varieties. Most of the parameters used to select their seeds are based on environmental factors, which have positive impact in adapting to climate change (Seeds for Needs Project 2011). According to the unpublished result of the Seeds for Needs Project, the women farmers’ selection criteria have contributed in adding value for the climate change adaptable variants.
It is generally recognized that genetic diversity of crops at all level is essential for sustainable agricultural production and food security. Experiences of Ethiopian elder farmers who have indigenous knowledge and research findings have shown that genetic diversity of crops can: i) increase productivity, food security and economic returns; ii) make farming systems more stable and sustainable; iii) contribute to sustainable intensification, and iv) reduce dependency on external inputs. It is also needed to sustain genetic improvement for polygenic traits such as yield, response to changing pathogen pressures such as new races or introduction of new pathogens, and provide both within and among cultivars ‘genetic buffering’ that can reduce losses due to unusual environmental fluctuations or race-specific pathogens.

2.1.1 Cereals

Cereals dominate the Ethiopian crop production. During the 2011/12 main crop production season, cereals covered over 70% of the total cultivated area, and gave an estimated annual production of 18.81 million tons. This constitutes 86% of the country’s gross grain production. The five major cereals are tef, maize, wheat, sorghum and barley. Tef accounts for 28.5% of total cereal area, while maize accounts for 32.3% of total annual cereal production.

Tef (*Eragrostis tef* (Zucc.) Trotter)

Tef is the most important cereal crop of Ethiopia accounting for about 28.5% of the total acreage and 18.6% of the gross grain production of all cereals (CSA 2012). It is grown by over 6.3 million farming household and constitutes the major staple food grain for over 50 million Ethiopian people. This implies that tef is very important in the overall national food security of the country.

The continued extensive cultivation of tef by the Ethiopian farmers is accentuated, among others, by i) versatile agro-ecological adaptation (0-3000 m.a.s.l.) including conditions marginal
for most other crops; ii) resilience to both drought and water logging conditions; iii) fitness for various cropping systems and crop rotation schemes; iv) use as a catch and low-risk reliable crop especially as a replacement crop at times of failures of long-season crops (such as maize and sorghum) due to drought, pest and/or other calamities; v) relative healthiness of the crop in the field since it suffers little or no serious threats from disease and pest epidemics; vi) preference in the national diet as the grain gives the best quality and consumer-preferred “INJERA” which constitutes the major staple dish ingredient of most Ethiopians; vii) high returns in flour upon milling and in “INJERA” upon baking; viii) minimal post-harvest losses and high longevity during storage; ix) importance of the straw mainly as fodder for cattle and as a binder of mud used for plastering walls of local houses; and x) cash crop value owing to the high market prices of both the grains and the straw. The crop shows immense phenotypic diversity in phenology, plant height, panicle morphology (size, form and color) and seed color.

**Sorghum (Sorghum bicolor L.)**

Ethiopia has a diverse wealth of sorghum germplasm adapted to a range of altitudes and rainfall conditions. Of the five morphological races of sorghum (*bicolor, guinea, caudatum, durra* and *kafir*), all, except *kafir*, are grown in Ethiopia. Important traits reported from the Ethiopian sorghum include cold tolerance, drought resistance, resistance to sorghum shoot fly, disease and pest resistance, grain quality and resistance to grain mould, high sugar content in the stalks, and high lysine and protein content.

Sorghum is one of the crop types for which Ethiopia has been credited as being a Vavilovian centre of origin or diversity (Harlan 1969). In the different agro ecological zones of the country, germplasm resources representing the major races of sorghum are found. In addition, the existence in the Ethiopian sorghum germplasm of wide variation in grain, inflorescence and fruit characteristics is well documented (Gebrekidan 1973; Gebrekidan and Kebede 1977). Among the sorghum growing population in the rural areas, the importance of this crop is exemplified also in the folklores, songs and some of the local names by which the sorghum
varieties are known. Sorghum is the fourth most important cereal next to maize, tef and wheat in terms of annual production. It is one of the country’s most important cereals, with over 25% of the total population in East, West and Southern parts of the country being dependent on it. It is considered as one of the leading traditional food cereals in Ethiopia in terms of both total production and area. Major research efforts have been directed towards the improvement and stabilization of sorghum yields. Sorghum is very hardy, and can be grown in areas where other crops cannot be grown successfully (Dumitru 2008, Evan 2009). It is especially important for food security in arid and semi-arid areas of the country because of its biotic and abiotic stress tolerance (Kebede 1991; Abdi et al. 2002). Sorghum displays significant genetic variability in different agro ecological zones. At a national level, sorghum improvement involves the manipulation of indigenous landraces to develop adapted types for the various ecological zones. There is a huge diversity in the Ethiopian sorghum for panicle types, seed color, growth habit, striga resistance, drought tolerance, lysine content and the likes.

**Barley** (*Hordeum vulgare* L.)

Barley is one of the earliest cereals grown in Ethiopia, and while some authors have attributed the country as the origin of the crop (e.g. Negassa 1985), that Ethiopia is a center of diversity for barley is unequivocal. The cultivated area devoted to barley is over one million hectares, and the crop is grown in many areas both during the main rainy (MEHER) and short rainy (BELG) seasons.

The barley landraces widely grown by the smallholder farmers in the country exhibited considerable variation in morphology (two and six rows, irregular types), seed and glume color (black, white and pink), and phenology. In addition to the broad phenotypic diversity, the Ethiopian barley is the important source of genes for resistance to barley yellow dwarf virus (BYDV), resistance to other diseases such as powdery mildew, leaf rust, spot, blotch, septoria, loose smut and barley stripe mosaic virus, high lysine content and drought tolerance. To that end, the Ethiopian barley germplasm has been extensively used worldwide as a source of gene
(s) in breeding for resistance to powdery mildew (mlo genes) and also to Barley Yellow Dwarf Virus (BYDV). The genus *Hordeum* contains about 32 species, and one of the 32 species is *Hordeum vulgare*. Within this species there are endemic varieties evolved in Ethiopia that couldn’t be found in other parts of the world. These unique varieties that evolved in Ethiopia have been used for different medicinal and food values.

**Wheat (Triticum spp.)**

In general wheat is one of the most important cereals in Ethiopia in terms of both acreage and production. It is the third principal cereal in Ethiopia next to maize and tef in terms of production.

Ethiopia is a center of diversity for tetraploid wheats which according to Vavilov (1951) comprise five species: *Triticum durum* subsp. *abyssinicum*; *T. turgidum* subsp. *abyssinicum*; *T. dicoccum*; *T. polonicum* and *T. compactum*. All these five species are currently classified under *Triticum turgidum*. In addition to the five tetraploid species, Vavilov (1951) mentioned that the Ethiopian wheat also comprise a sixth species corresponding to the hexaploid species, *Triticum aestivum*. All of the above listed tetraploid wheats observed by Vavilov in the mid-1920s are still grown by farmers as farmers' varieties. However, the area covered with farmers' varieties of the tetraploid wheat s is dwindling from time to time mainly due to the expansion of the bread wheat species, *Triticum aestivum*. Although Vavilov regarded Ethiopian as a centre of origin and diversity for tetraploid wheats, recent arguments on the basis of the absence of wild relatives and lack of archaeological evidences suggest that Ethiopia could be a secondary centre of origin. The diploid einkorn and the hexaploid wheat do not seem to be native to the Ethiopian gene center.

Durum wheat is a major industrial and food crop in Ethiopia. Although wheat in general is annually grown on about 1.44 million ha land in the country (CSA 2012), the statistics showing the exact share of durum or tetraploid wheats from the total wheat area is lacking. Ethiopian
wheats are being widely used in wheat breeding programs in the world for the improvement of mainly durable disease resistance.

The agro-ecology of the country coupled with the farmer’s selection criteria endowed the country to have immense unique variants that can adapt to adapt to the climate variability. According to Dullo et al. (2011), five unique variants of wheat which are adapted to three variable climates were found. The elder women farmers’ selected the purple seeded wheat because of its wide adaptability for different climate factors. A Similar study also indicated that the maturity dates of different variants of wheat species also vary. This character is valuable in adapting to climate variability. The existing variants have been selected by farmers considering their elasticity to adverse environmental effects and other factors. The varieties selected by farmers have adaptable nature to the rainfall variability. When there was heavy rain during maturity; the smooth, long and bended awn variant was found to be tolerant. When there was humid and high heat, the hairy glume variant was found to be tolerant. In general, the existing variety selected by farmers has got great value in adapting to climate variability.

2.1.2. Pulses

Pulses are members of the Fabaceae family, which, among many others, includes horse beans, peas, soybeans, lentils, chickpea and grass pea. They are an important source of proteins, vitamins and carbohydrates. Pulses generally lack adequate levels of the essential amino acid methionine. However, this limitation can be overcome by consuming pulses and cereals together. Most of the middle and the lower class of the population use pulse stews or sauce with INJERA which is prepared from cereals. Pulses also play an important role in fixing atmospheric nitrogen, which helps to maintain soil fertility. Hence, Ethiopian farmers use pulses for crop rotation (IKIR) to improve soil fertility. Pulse crops also form a significant portion of the available genetic resource base for plant breeding programs. **Horse beans** (Vicia faba L.)
Ethiopia is probably one of the primary centers of diversity for faba bean. Although the small-seeded types of the Ethiopian faba bean are not well studied, there are some reports of tremendous diversity in protein content, and chocolate spot and leaf rust resistance. Horse bean is the most important pulse crop in terms of area coverage (400,000 ha) and total annual production. This crop has assorted advantages in the economic lives of the farming community in the highlands of the country. It is a source of food, feed and cash for farmers. It also plays a significant role in enhancing the fertility of the soil. From planting to maturity, it takes 135-160 days at high altitude and 118-135 days at mid-altitude areas.

**Chickpea** (*Cicer arietinum* L.)

Chickpea is one of the ancient crops of Ethiopia. Archaeological evidence from Lalibela caves dated seed samples as over 2500 years of age. Ethiopia is also considered by some authors as a centre of origin and diversity for this crop.

The chickpea area of production has been increasing greatly in recent years. In the 2011 main (MEHER) season, about 232,000 hectares of cultivated land is used for the production of 400,200 tons of chickpea (CSA 2012). As such, chickpea accounts for about 14.31% (third) of the acreage and 17.28% (second) of the total production of all grain legumes grown in the country. The crop is widely used in different forms. There are two types of chickpeas: *dessi* and *kabuli*. The phenotypic diversity observed in farmers' fields is considerable, particularly in flower and seed color, anthocyanin in the leaves and stems, and disease and drought resistance. The related wild species of chickpea (*C. cuneatum*) has been found in Northern Ethiopia. In recent years, chickpea is getting to be an important export commodity for Ethiopia, and high preferential export demands for the large-seeded *kabuli* types have been pulling the production aspect to these types of chickpeas. However, the small-seeded *dessi* types are still popular for domestic consumption.
**Field pea** (*Pisum sativum* L.)

With annual acreage of about 213,000 ha, field pea is the fourth most important legume crop in Ethiopia after faba bean (460,000 ha), haricot beans (332,000 ha), and chickpeas (232,000 ha) in terms of area (CSA 2012). The annual production of field peas is about 263,000 tons, and this accounts for about 11.37% of the country's total grain legume production. While the origin of field pea still remains controversial, Ethiopia is undoubtedly a center of diversity for this crop, and its wild and primitive forms are known to exist in the high elevations of the country. Being one of the oldest crops in the country, a unique subspecies known as *Pisum sativum* subsp. *abyssinicum* has developed in Ethiopia. The existing germplasm in the country shows resistance to diseases and insect pests. There is a huge diversity in for morphological and phenologic characters.

**Lentil** (*Lens culinaris* Medik.)

Lentil is one of the principal food legumes of Ethiopia widely grown in diverse agro-ecological zones of the country. It is annually cultivated on about 110,000 ha with corresponding production of about 128,000 tons of seeds (CSA 2012). The crop is cultivated mostly for domestic consumption, but there has also been high export potential. The reports as to the Ethiopian origin of lentil are controversial. Some authors have regarded Ethiopia as a centre of origin/diversity whereas some have reported lentil to be an early introduction to Ethiopia. The Ethiopian germplasm exhibits considerable variation in maturity, seed yield, harvest index, number of seeds per pod and cold tolerance. The wild species of lentil called *Lens ervoides* grows in montane grassland in the north and central regions of the country. Lentil is one of the pulse crops grown in the highlands of Ethiopia and widely used as whole or split in stews, soups and various forms of sandwiches. It is a popular ingredient of every day diet in the majority of the households, and the local consumption is very high.

**Grass pea** (*Lathyrus sativus* L.)
With annual acreage of about 180,000 ha and harvests of about 305,575 tons, grass pea is the fifth and fourth important grain legume in Ethiopia in terms of area and production, respectively (CSA 2012). The crop is grown mainly on residual moisture as the heavy rains recede. It is resistant to drought being an important crop especially in drought years. Grass pea also performs well under marginal fertility and water-logged soil conditions. Ethiopia is considered as one of the primary centers of diversity for grass pea in the world. Most of the Ethiopian regions, and particularly, Gondar, Tigray and Shewa exhibited high genetic diversity. The observed diversity is mainly for seed coat color, primary branches/plant, and contents of the anti-nutritional factor called ODAP in the seed. Farmers' varieties with high ODAP content are grown by the great majority of the Ethiopian farmers. So far, a single grass pea variety presumed to be low in ODAP content has been released in Ethiopia by Debre Zeit Agricultural Research Center (MoA 2011). However, evidences have shown instability of the low-ODAP content which increases greatly when the crop grown under stress conditions.

**Haricot bean** (*Phaseolus vulgaris* L.)

Haricot bean is one of the most important grain legumes grown in the lowland parts of the country, particularly in the rift valley. In these areas, farmers grow white colored beans for export and home consumption. Haricot bean is also a principal food crop particularly in western, southern and eastern part of the country. In eastern and western Ethiopia, it is widely intercropped with maize and sorghum to supplement farmers with additional income and to maintain the soil fertility. The crop shows wide diversity in seed color, size and shape, in plant height, formation of tendrils and other characters.

**Lima bean/butter bean** (*Phaseolus lunatus* L.)

Lima bean/butter bean is one of an important grain legume grown in South Western Ethiopia. The dried seeds are eaten after getting them boiled with other cereals and pulses known as
NIFRO. It is cultivated in the home gardens or intercropped with cereals in the field. Seeds are variable in size, shape and colour.

2.1.3. Oil crops

Ethiopia is one of the major centers of origin and diversity for several oil crops. Of these, *Gomenzer* (*Brassica carinata*), *Noug* (*Guizotia abyssinica*), sesame (*Sesamum indicum*) and linseed (*Linum usitatisimum* L.) are the major indigenous oilseeds displaying considerable diversity in the country. The total area allotted for the production of oil seeds is nearly 0.88 million ha and this accounts for about 6.5% of the total cultivated area in the country (CSA 2012).

**Niger seed**/ Noug (*Guizotia abyssinica* (Lf.) Cass.)

Niger seed is the second most important oilseed crop in Ethiopia next to sesame in both acreage and total production (CSA 2012). With annual coverage of about 310,000 ha from which about 186,320 tons are harvested, niger seed accounts for about 35% of the total acreage and 25.5% of the total production of oilseeds in Ethiopia. It is one of the widely cultivated indigenous oil seed crops particularly in the highlands of Ethiopia. The crop is said to have originated as a selection from its wild relative (*Guzotia scabra*), which is also considered native to Ethiopia. The phenotypic diversity in niger seed is significant for characters related to flowering, maturity, head size and other morphological characters.

**Mustard** (*Brassica carinata* A. Braun)

Gomenzer or Ethiopian mustard is an oilseed crop grown extensively in the highlands of Ethiopia. It is annually grown on about 45,200 ha of land with a total harvest of about 74,700 tons (CSA 2012). And, as such it constitutes about 5% of the total acreage and about 1% of the
gross oilseed crop production of the country. The crop exhibits considerable diversity for several vegetative traits.

**Linseed** (*Linum usitatisimum* L.)

In Ethiopia, linseed is the third important oilseed next to sesame and NOUG both in terms of acreage and total production. Annually, a total of 112,760 tons of linseed is harvested from about 117,000 ha of land, and as such the crop accounts for over 13% of the total cultivated area and over 15% of the total production of oilseeds in the country (CSA 2012). Linseed is the second major oil seed crop next to NOUG in the highlands of Ethiopia. It is known for its high quality oil, and its use as a raw material for agro-industries. Linseed is grown for oil production and shows high variability in flower color, plant height, flowering and maturity periods, and capsule size and wilt resistance.

**Sesame** (*Sesamum indicum* L.)

Sesame is the first most important oil seed crop in Ethiopia in terms of both area coverage and production. With annual harvests of about 244,800 tons from cultivation on about 337,000 ha, it accounts for about 38% of the total acreage and 34% of the total production of oil crops in the country (CSA 2012). Whereas GOMENZER and linseed are grown in the highlands, sesame, groundnuts and safflower are lowland oil crops grown in Ethiopia. Sesame is largely produced for export, and it is nowadays one of the major export revenue commodities of Ethiopia. Generally, sesame occurs in Ethiopia both as a cultivated crop and in the wild, and it exhibits broad phenotypic diversity for days to maturity, plant height, pod shape and size, and for seed size and color.

**2.1.4 Fruits**

There are about 38 species of fruits currently cultivated in Ethiopia. Among these fruits like, pineapple (*Ananas comosus* (L.) Merr.), papaya (*Carica papaya* L.), sweet orange (*Citrus sinensis*
(L.) Osb.), mango (*Mangifera indica* L.), banana (*Musa paradisca* L.), avocado (*Persea americana* Mill.), are naturalized to the Ethiopian agro-ecologies and have many landraces. Most of them are cultivated in home gardens (e.g. pineapple, papaya, sweet orange, mango, avocado, peach, guava) and some as field crops (e.g. banana, sweet orange).

### 2.1.5 Root and tuber crops

There are many indigenous cultivated or semi-cultivated root and tuber crops grown in Ethiopia. These crops play important roles in the diet and food security of a large number of the Ethiopian population.

**Enset** (*Ensete ventricosum* (Welw.) Cheesman)

Enset is endemic to Ethiopia and occurs throughout the country both as cultivated crop and in the wild form. It is an important traditional staple food for a large number of people in the densely populated south and south-western parts of the country. In 2011, the cultivated area of **ENSET** amounted to about 312,170 ha with total production of about 728,870 tons (CSA 2012).

Records suggest that enset has been grown in Ethiopia for more than 10,000 years. It is virtually unknown as a foodstuff outside Ethiopia, and in western countries variants are often grown as ornamental garden plants. The root of the plant provides food in the form of starch, the stem is used to produce a coarse fibre, and the leaves are fed to cattle, whose manure is in turn used to fertilize the plant. Generally, enset is a protein-poor crop, but its deep roots give it a greater resilience to drought than other cereal crops and consequently, a greater degree of food security to those who grow it. Although the plant is asexually (vegetatively) propagated, there is tremendous variation among ENSET clones in several characters including color of pseudo-stem and leaf midribs, earliness, disease resistance and product quality.

**Potato** (*Solanum tuberosum* L.)
Potato plays a significant role for food security. It is yearly grown on over 40,000 ha of land with harvests of 475,440 tons (CSA 2012). It has got very limited genetic variability in the country.

Sweet potato (*Ipomea batatas* L.)

Sweet potato is also one of the major root crops in the country with a limited variability. It is cultivated on about 51,310 ha of land with total production of over 390,000 tons (CSA 2012).

2.1.6. Stimulant crops

Coffee (*Coffea arabica*) and chat (*Catha edulis*) are the important stimulant crops of Ethiopian origin with high commercial value. They are primarily produced for local consumption and export market on vast areas of farm lands in many parts of the country.

Coffee (*Coffea arabica* L.)

Coffee, one of the major global stimulants, is a gift of Ethiopia to the world especially with the respect to the species *Coffea arabica* L. It is found both in the cultivated and wild states. Coffee grows in many parts of the country; however, the bulk of the produce comes from the western and southern parts of the country, and from a limited area in the eastern parts. The phenotypic diversity of Arabica coffee in Ethiopia is overwhelming in both quantitative and qualitative characters. There is an extremely high variability in disease and pest resistance, liquorining quality and other traits. Recently, low or no caffeine genotypes are said to have been isolated in Brazil from germplasm originating from Ethiopia.

Chat (*Catha edulis* Forsk.)

Chat is one of the early domesticated crop species in Ethiopia. It is consumed in Ethiopia as a stimulant plant and exported to neighboring countries such as Yemen and Djibouti. Currently, chat is an important cash crop bringing about substantial foreign exchange revenues to
Ethiopia. Although there is no systematic study, a striking variation can be observed in morphology and leaf color in the major chat growing areas of the country.

2.1.7. Industrial crops

The term "industrial crops" embraces any crop that must first be processed in an industry before use as food or any other useful item. Hence, the term includes many crops categorized as cereals (e.g. wheat), stimulant or drug crops (e.g. coffee, tobacco) and almost all oil crops which must first be processed for the extraction of oils to be used for consumption and/or different other purposes, and fiber crops (e.g. cotton, sisal, kenaf, jute).

From the industrial fiber crops, there are indigenous diploid cultivated and wild species of cotton in Ethiopia. It is believed that Gossypium herbacium var. acerifolium might have been domesticated in Ethiopia. The indigenous cultivated species include G. arboreum and G. herbaceum. The distribution of the wild species of the B genome (G. anomalum subsp. semarense) and those of the E genome (G. somalense, G. bricchettii and G. benadirense) have been documented.

2.1.8. Medicinal Plants

Most people in Ethiopia have relied heavily on plants; almost 80% of the total population has been using medicinal plants for health care. It is also observed that urban people also use medicinal plants. In most urban backyards, conserving 3 to 4 medicinal plants is a normal practice. However, the extent of species diversity and variability is not discriminated and documented based on scientific grounds. According to traditional healers, the concentration of the chemical composition of Ethiopian medicinal plants varies across altitude, temperature and moisture regimes. From the corner of modern research, Ethiopian medicinal plants were not properly studied and utilized.
2.2. Minor and under-utilized crops and their state of diversity

The varied climatic and agro-ecological conditions prevailing in Ethiopia have contributed to the evolution and presence of tremendous variability in the types and diversity of crops grown by farmers. As a result, each of the farms in different parts of the country possesses very different levels of plant diversity. Considering the agro-ecology and the farming system in which crops are grown, the attention given by research and development, and the area allocated for their production, some of the crops are categorized as minor and under-utilized.

Minor and under-utilized crops are often cultivated by farmers following traditional farming practices. These crops are adapted to extreme edaphic and climatic conditions. However, due to lack of genetic improvement, minor and under-utilized crops give lower yield. Hence, these crops are not widely grown by farmers. Processing difficulties and economic and cultural changes have also affected the wider use of minor and under-utilized crops. Like major crops, minor and under-utilized crops are grouped as cereals, pulses, root and tuber crops, vegetables, spices and fruit crops. The following crops can be grouped as minor and under-utilized crops in Ethiopia.

2.2.1. Cereals

**Finger millet** (*Eleusine coracana* (L.) Gaertn.)

Finger millet is one of the crops that have originated in Ethiopia and Uganda (National Research Council 1996). In Ethiopia, it is mainly grown in the north and north-western parts of the country. It is adapted to a wide range of climatic conditions. The close relatives of finger millet have been reported to exist in Ethiopia (IBCR 2001). Compared to that given to major cereal crops, finger millet has received little research and development attention. The limited studies conducted on this crop indicated the existence of diversity that has not been exploited to its full potential (Yemane *et al.* 2006, Bezawieletaw 2011, Fetene *et al.* 2011).
Pearl millet (*Pennisetum glaucum* (L.) R.Br)

Pearl millet, is believed to have originated in Ethiopia (Harlan, 1969). It is adapted to the semi-arid areas where other crops tend to fail because of inadequate rainfall and poor soil conditions (Demissie 2006). Pearl millet is cultivated at small-scale level, and consumed mainly in the western lowlands of the country. Little attention has been paid to this crop to improve the productivity and enhance its use values.

Emmer wheat (*Triticum dicoccum* (Schrand) Schub)

Emmer wheat, is a tetraploid *Triticum* species with hulled grain, and it is said to have been introduced to Ethiopia 5000 years ago. It is an important minor crop grown in the highland parts of the country. It is a hardy crop, and performs well under poor soil and management conditions compared to other cereals. Hence, it gives the farmers security against adverse growing conditions. Moreover, farmers believe that emmer wheat has special medicinal and nutritional values (Tesfaye 2000, D’andrea and Mitiku 2002). Despite all these importances, emmer wheat has received little attention in terms of research and development. Now, the crop is being replaced by hulless tetraploid and hexaploid wheat species (Tesfaye and Ayana 2007). Currently, emmer wheat is grown on a limited area, and comprises only 7 % of Ethiopia's entire wheat production (National Research Council 1996). The problem of threshability in emmer wheat is the major factor cited by growers for its decline in production. The study conducted by Tesfaye (2000) indicated that there is a huge diversity in glume and seed colors.

Ethiopian oat, Abyssinian oat (*Avena abyssinica* Hochst.)

Ethiopian oat, known as Abyssinian oat (*Avena abyssinica* Hochst.), is native to Ethiopia and is cultivated for its grain in northern parts of Ethiopia. The genus *Avena* comprises about 30
species, which are diploid \((2n = 14)\), tetraploid \((2n = 28)\) or hexaploid \((2n = 42)\). The tetraploid *Avena abyssinica* belongs to section *Ethiopica* (PROTA data base by Brink, M., 2006). It can be distinguished from the common oat (*Avena sativa* L.) by the presence of two bristles at its lemma tip. It is a tetraploid species with chromosome number \(2n = 4x= 28\). In Ethiopia, the grain of *Avena abyssinica* is used mixed with barley to make pancake-like bread (*INJERA*), local beer (*TELLA*) and other products. The grain is also eaten roasted as a snack (*KOLLO*) (Brink, M., 2006). This little-known grain has potential to improve nutrition, boost food security and foster rural development.

### 2.2.2. Pulses

**Pigeon pea** (*Cajanas cajan* (L.) Millsp)

Pigeon pea is a grain legume mainly cultivated as a garden crop in Konso special district (*EIAR 2010*), Gamo Gofa and Wolaita zones (*Ali et al. 2003*) and Benishangul Gumuz Region (Awas 2007). It is rarely found in other parts of the country, and it can be grown at the altitude range of 1000 - 2400 m.a.s.l. (Hedberg and Edwards 1989). Pigeon pea is cultivated as intercrop with sorghum and cotton. It is drought resistant, and grows with rainfall as low as 600 mm per year when other crops fail to yield satisfactorily (*EIAR 2010*). Pigeon pea is cultivated for its edible seeds, and is mainly consumed at the local scale. Little study has been conducted on this crop and the state of diversity of the crop is not well known.

**Cow pea** (*Vigna unguiculata* (L.) Walp.)

Cow pea, is the least cultivated and sparsely distributed grain legume in Ethiopia. It mainly grows in Gamo Gofa zone, and Konso and Derashe special districts of the SNNP Regional State. Besides, it grows in limited areas in Gambella Region, and in some pocket areas in Amhara and Oromia Regional States. *V. unguiculata* subsp. *unguiculata* and *V. unguiculata* subsp. *cylindrica* are the cultivated sub species found as farmers' varieties in the eastern parts of the country (*IBCR 2001*). Cow pea has its wild species in the northern, south-western and southern parts of
the country. It grows in adverse growing conditions with little annual rainfall distribution (Ali et al. 2003). It can grow up to 2000 m.a.s.l. (Westphal 1974), and performs well with only 400 mm of rainfall per year (EIAR 2010). Unlike major pulses, little research attention has been given to this crop mainly due to its restricted geographical and economic importance. Hence, the state of diversity of the crop is not well known.

**Hyacinth bean** (*Lablab purpureus* (L.) Sw.)

Hyacinth bean is mainly grown in Konso special district of southern Ethiopia, and in some parts of the Amhara Regional State. It is cultivated as a hedge crop for its edible seeds and grows at altitudes ranging from 400 to 2350 m.a.s.l. (Hedberg and Edwards 1989). Hyacinth bean is also reported to grow in Benishangul Gumuz Region (Awas 2007). It can grow in areas with 600 to 800 mm annual rainfall (Westphal 1974). Diversity in agro-morphological characters such as plant height, leaf size, flower days and seed color, number of seed per pod, seed size and shape has been reported in this crop.

**Fenugreek** (*Trigonella foenum-graecum* L.)

Fenugreek is commonly cultivated as a garden spice or as a field crop. It is widely grown in the mid-altitude and highland agro-ecological zones of the country (Amare 1976). The crop is cultivated at altitudes ranging from 1600 and 2300 m.a.s.l. (Hedberg and Edwards 1989). It is mainly grown for its edible seeds and used as spice and medicinal plant. Limited area is allocated for its production. It has considerable diversity in seed color, maturity and other agro-morphological characters.

**Lupin** (*Lupinus albus* L.)

Lupin is mainly cultivated in Amhara, Tigray and SNNP Regional States on small plots of land and on farm borders. Both the wild and cultivated species of lupin exist in Ethiopia (Ali et al. 2003).
It is mainly grown in Gojam, and at altitude ranges of 1800 to 2400 m.a.s.l. (Westphal 1974). Little study has been conducted on this crop; hence, the state of diversity is not well known.

2.2.3. Oil Crops

**Safflower** (*Carthamus tinctorius* L.)

Safflower is an oilseed crop which probably originated in Ethiopia. It grows on a small scale level in some parts of Tigray, Amhara and Oromia Regional States at altitudes ranging from 1000 to 2400 m.a.s.l. (Tadesse 2004). Insufficient information is available on the diversity of this crop.

2.2.4 Vegetables

**Okra** (*Abelmoschus esculentus* (L.) Moench.)

Okra, is one of the under-utilized vegetables of Ethiopia. It has high diversity in Ethiopia (ICBR 2001), and it is mainly used in south-western lowlands with altitudes ranging from 550 to 650 m.a.s.l. Several authors have indicated that okra might have been domesticated in Ethiopia. Awas (2007) reported the existence of *Abelmoschus ficulneus*, the close wild relatives of the cultivated species in western Ethiopia. Little attention has been paid to this crop in research, conservation and development. Awas (2007) recommended the need for immediate action to conserve okra germplasm.

**Cabbage tree** (*Moringa stenopetala* (Backf.) Cufod.)

Cabbage tree is an important vegetable indigenous to Ethiopia. It belongs to the genus Moringa, and five species of this genus are recorded in Ethiopia (IBCR 2001). Cabbage tree is distributed in the lowland agro-ecology of the southern parts of the country mainly in Keffa, Gamo Gofa, Sidama and Konso zones, and Derashe special districts. It is grown mainly for
consumption of the leaves as vegetable. Moreover, the seeds can be used to purify water (Edwards et al. 2000). Cabbage tree has not received the attention it deserves both in the conservation and development programs. Hence, the state of diversity of the crop is not well documented.

2.2.5 Spices

The production and use of spice crops in Ethiopia has a long history. They are used in the preparation of daily dishes, and as traditional medicines. The popular indigenous spices of Ethiopia include: black cumin (Nigella sativa L.), coriander (Coriandrum sativum L.), sweet basil (Ocimumum basilicum L.), garden cress (Lepidium sativum L.), Ethiopian cardamom (Aframomum corrorima (Braun) Jansen), wild pepper (Piper capense L.), Ethiopian caraway (Trachyspermum ammi (L.) Sprague ex Turrill), and KOSERET (Lippia adoensis Hochst. ex Walp var koseret Sebsebe). They are cultivated in small plots of land in home gardens often as secondary crops. They grow all over the country, and have huge diversity with regard to agro-morphological characters (EIAR 2008).

Korarima and long pepper exist both under cultivation and in the wild states. However, the bulk of the product comes from the natural forests in the south and south western parts of the country where coffee grows. Farmers collect these spices from these forests and sale at the local market. These days, however, the destruction of the natural forests for various uses has significantly reduced the diversity of these shade obligate spices.

2.2.6 Root and tuber crops

ANCHOTE (Coccinia abyssinica (Lam.) Cogn)

ANCHOTE, is an endemic under-utilized root crop of Ethiopia. It can be found both in cultivated and wild state. Anchote is mostly cultivated in backyards and grows in the south, south west
and western parts of the country (EIAR 2008). It grows in areas with altitudes ranging from 1300 to 2400 m.a.s.l. (Edwards et al., 1995). Little is known about the crop, and less research emphasis has been given to it. No improved variety and agronomic practices of the crop have been developed. The study conducted by Desta (2011) indicated the existence of agro-morphological diversity within the crop.

**OROMO DINCH/WOLAITA DONUWA/AGEW DINCH- Ethiopian potato** (*Plectranthus edulis* (Vatke) Agnew)

Ethiopian potato is one of the under-utilized root crops indigenous to Ethiopia (ENBSAP 2005, Asfaw and Zerihun 1997). It grows in the wetter south and south-western parts of the country whereas the wild species are found throughout the country (Edwards 1991). *P. edulis* is little studied crop in Ethiopia (Abera 1995), and it does not appear in the national research programs (Mulugeta et al. 2007). Today, the production of the crop has been declining due to shortage of land, long maturation period, short shelf life and shortage of seed tubers. *P. edulis* has enormous phenotypic diversity in leaf and stem color, tuber size and color, growth habit, maturity period, shelf life and drought tolerance. This variability can be used in future breeding program aimed at developing varieties that best suit farmers' requirements (Mekbib and Weibull 2012). It is known by different vernacular names in different parts of the country. For instance it is called Oromo DINCH in Oromia region, Wolaita DONUWA in Woliata zone, Agew DINCH in Awi zone and the like. The crop is grown within the altitudinal ranges of 1300 to 2600 m.a.s.l.

**Yam** (*Dioscorea spp.*)

Yam is a root crop that has been cultivated for its root or aerial tubers mainly in south and south western parts of the country. Westphal (1975) has reported about nine (cultivated and wild) yam species in Ethiopia. Out of these, *Dioscorea bulbifera, Dioscorea abyssinica* and *Dioscorea shimperiana* are native to Ethiopia. Other types of yam species such as *Dioscorea*
alata and Dioscorea esculenta are also cultivated in Ethiopia mixed with other species (Westphal 1975). The study conducted by Tamiru et al. (2008) in Wolaita and Gamo Gofa zones has recorded 37 local varieties of yam, thereby indicating the presence of considerable yam diversity in the region. Edossa (1998) has also reported the existence of variability in leaf type, nature of stem, roots and tubers. Currently, there is a decreasing trend in the number of local varieties maintained by farmers.

Cassava (Manihot esculenta Crantz)

Cassava, is cultivated in south, south west and western parts of the country (Nebiyu 2006). It is grown at altitudes ranging from 450 to 1800 m.a.s.l. Cassava tolerates drought and gives high yield per unit area. Cassava consumption needs careful processing so as to remove the toxic chemical substance, cyanide (Cherinet et al. 2008). The survey conducted in major cassava growing areas of southern Ethiopia indicated the presence of phenotypic variation in local varieties with regard to plant height, leaf color, petiole color, level of cyanide content, maturity, root size, color and shape, and yield.

2.2.7 Stimulant crops

GESHO (Rhamnus prinoides L'Herit.)

GESHO grows in a wide range of ecologies across the country at the altitude ranges of 1400 and 3200 m.a.s.l. (Hedberg and Edwards 1989). Gesho is used to flavor traditional alcoholic drinks, and it is an important cash crop for growers. Kidane et al. (2006) reported that farmers grouped their local varieties based on morphological characters, flavor and fermentation rates of leaves.

2.2.8 Forage species

There are diversified forage resources adapted to different ecosystems of the country. These resources have great potential to be used as sources of feed for animal production. Various
indigenous and exotic forage species are reported to grow in Ethiopia. Little efforts have been made to study the diversity of the indigenous forage species of the country. The limited study conducted, however, indicated that Ethiopia is a centre of diversity for *Trifolium*. Out of the twenty six indigenous species of Trifolium, ten are found to be endemic to Ethiopia. In general, the major forage species of the country include: *Stylosanthes fruticosa, Neonotonia wightii, Alysicarpus* spp., *Indigofera* spp., *Tephrosia* spp., *Acacia* spp., *Erythrina* spp., *Pennisetum* spp., *Rhynchosia* spp., *Trifolium* spp., *Medicago* spp, *Brachiaria* spp., and *Crotalaria* spp.

### 2.3. Diversity of edible wild plants (EWP)

Since ancient time, people have used wild plants as source of food. Utilization of wild plants for food occurs both in times of surplus production and food shortage (Lepofsky *et al*. 1985, Zinyama *et al*. 1990). More than 300 million people around the globe gain part or the entire livelihood from forests (Pimentel *et al*. 1997).

Knowledge about wild plants is important to enhance the utilization and conservation of diversity. People in rural areas of Ethiopia, particularly elders, have a deep and time-tested indigenous knowledge concerning the availability, management and use of Edible Wild Plants (EWP). Edible wild fruits are mainly consumed by herdsmen and children who spend pass most of their time in the natural forests. The wild leafy vegetables, roots and tubers are collected, cooked and consumed by the whole family. Some of the edible wild fruits include: *Berchemia discolor, Carissa spinarium, Cordia africana, Dovyalis abyssinica, Grewia* spp., *Ficus* spp., *Mimusops kummel, Opuntia ficus-indica, Rosa abyssinica, Rubus apetalus, Rubus steudneri, Syzigium guineense, Ximenia americana, Oncoba spinosa* and *Ziziphus spina-Christi*. EWP are also used as source of income. As a result, it is common to find wild edible fruits, leafy vegetables, roots and tubers harvested from wild and sold at local, national and to some extent at international level. The widely sold wild indigenous fruit species at local level are *Dovyalis abyssinica, Mimusops kummel, Ximenia americana, Adansonia digitata, Annona senegalensis, Balanites aegyptiaca, Flacourtia indica, Oncoba spinosa* and *Syzygium guineense*. Whereas
Mimusops kummel and Ziziphus spina-christi are marketed at national level, Balanites aegyptiaca and Tamandus indica marketed internationally (Teketay and Abeje 2004).

EWP are consumed during periods of ample food production to supplement the staple food and to fill the gap of seasonal food shortage, while others are consumed during famine, drought, war and other hardships. Examples of EWP consumed during famine are: Amaranthus graecizans, Amorphophallus galaensis, Balanites spp., Commelina spp., Corchorus olitorius, Cyprus bulbosus, Dobera glabra, Erucastrum arabicum, Guizotia scabra, Maerua angolensis, Piliostigma thonningii, Portulaca spp. and Urtica simensis (Guinand and Dechassa 2000)

These days, anthropogenic and natural factors are threatening the natural ecosystem. As a result, the diversity of EWP is decreasing from time to time. Besides, due attention has not yet been given to study the genetic erosion of EWP and factors affecting it. As such, the state of intra-specific diversity of EWP is not well known. Even the available limited studies on EWP covered only about 5% of the country’s districts (Lulekal et. al. 2011).

The limited studies conducted in some parts of the country have indicated the presence of EWP of significant importance for local people. For instance, Awas (1997) reported 84 EWP in Gambella Region. Awas and Zemede (1999) have also reported 25 EWP used by the Bertha People of the Benshangul Gumuz Region. In addition, the limited available information indicates the following: i) more than 80 wild-food species were identified in North and South Omo Zones of SNNP (Southern Nations, Nationalities and Peoples) Region of Ethiopia (Guinand and Dechassa 2000); ii) one-hundred-thirty species of wild plant species were reported to be edible in Alamata, Cheha, Goma and Yilmana Densa districts of Tigray, SNNP, Oromia and Amhara regional states, respectively (Addis et al. 2005); iii) sixty-six edible plant species were documented in Derashe and Kucha Districts of South Ethiopia (Balemie and Fassil 2006); iv) forty-six species of edible wild fruits were documented in Adiarkay, Debark and Dejen districts of Amhara region of the country (Mengistu and Herbert 2008); v) thirty-eight wild plant species were reported as food sources in Kara and Kwego semi-pastoralist people in Lower
Omo River Valley, SNNP region of the country (Teklehaymanot and Mirutse 2010); vi) in Benna Tsemay district of the SNNP Region of Ethiopia, 30 wild edible trees and shrubs were identified and documented (Assefa and Tesfaye 2011); and vii) in Boosat and Fantalle districts of Oromia region 37 WEPs were identified and documented, and about 24.3 % of them were locally marketed (Hunde et al. 2011).

There are also studies conducted which have wider area coverage and has national perspective, mostly based on herbarium specimens, literature review and also field studies. Some of the studies include the following: 1) Asfaw (1997) reported the presence of 170 species of non-cultivated angiosperms consumed by Ethiopians, and of these 29% are wild and weedy indigenous vegetables; 2) Teketay et al. (2010) documented information on 378 EWP of Ethiopia; 3) according to Asfaw and Mesfin (2001), there are 203 EWP in Ethiopia; and 4) the study conducted by Lulekal et al. (2011) also revealed the presence of 413 EWP in the country.

2.4. The trend in use of farmers’ varieties

Ethiopia is a country of tremendous biological and cultural diversity. The country is particularly rich in crop genetic diversity as it is the center of diversity for several crop species. The centuries of selection by farmers and the natural environment, has led to the development of farmers’ varieties which are typically adapted to specific agro-ecological conditions. These farmers’ varieties are usually grown with very little inputs, such as fertilizers and pesticides. Most of farmers’ varieties of the different crops are still in the hands of the farmers, but a lot of them might also have been lost. One of the reasons for the loss of the farmers' varieties was their replacement with improved varieties. In order to see the trend in the use of these farmers’ varieties in the country, the five year major crops area coverage and production data for the farmers' varieties were considered as indicators. The years included were from 2005/06 to 2010/11 with the exception of the year 2006/07.

Over, all the years, cereals shared the largest area from the total cultivated area as compared to the other crops (pulses, oil crops, vegetables, root crops and other annual crops) (Table 1).
The average percentage production of farmers’ varieties of cereals was about 95% of the area devoted to the cultivation of all cereals grown in the country (Fig. 2). The annual farmers’ varieties percentage coverage of cereals was the least of all other crops except in the year 2010/11 (Fig 3). This percentage, however, was the highest in 2009/10 and the least in 2010/11. The least percentage in 2010/11 stems from the fact that the area covered with improved varieties of cereals has doubled.

![Graph](https://via.placeholder.com/150)

**Fig 2.** The average percentage production coverage of farmers’ varieties of cereals, pulses, oil crops, vegetables and root crops cover the years from 2005/06 to 2010/2011

Tef, maize, wheat and sorghum were the major cereals based on area coverage. Tef from the cereals had the largest area coverage and even larger than the total area devoted to pulses. The percentage coverage of farmer’s varieties of tef showed increasing trend from 98.9% in 2005/06 to 99.32% in 2007/08 then 99.34% in 2009/10 (Table 2). Farmers’ varieties of maize had relatively the lowest percentage coverage of all grain crops. In the first three years (2005/06-2008/09), there was no significant difference in the percentage coverage of farmers’ varieties of maize. But there was increasing trend in area coverage. In the year 2009/10, the area coverage decreased but the percentage coverage increased significantly. The area of production of farmers’ varieties of wheat had increasing trend throughout from 1.2 million ha
to 1.4 million ha. The percentage coverage was highest in 2009/10 (97%) and lowest in 2010/11 (94%). The area of production of farmers’ varieties of sorghum showed significantly increasing trend all over the years except in 2009/10. Their percentage area coverage was the highest of all cereal crops.

Pulses were second most important category of crops after cereals. Farmers’ varieties of these crops covered on average about 99% of the area allotted over the five years (Fig. 2). There was no significant variation between the years as far as percentage production coverage of the farmers’ varieties is concerned (Fig.3). But in the year 2005/06, the percentage coverage was the highest of all crops. The area of production of the farmers’ varieties of these crops has increased significantly from 2005/06 to 2008/09 and declined over the next two years.

Fig. 3. The percentage production coverage of farmers’ varieties of cereals, pulses, oil crops, vegetables and root crops cover the years from 2005/06 to 2010/2011

Horse bean, field pea, haricot bean and chick pea were major pulse crops grown by farmers. Farmers’ varieties of horse bean showed increasing trend in the area of production from 2005/06 to 2008/09 and declining trend from 2008/09 to 2010/11. Except in 2010/11, farmers’ varieties percentage coverage of horse bean was the highest of all the pulse crops. Like that of
horse bean the area of production devoted to the farmers’ varieties of field pea decreased significantly from 2008/09 to 2010/11. The highest percentage coverage of farmers’ varieties of field pea was recorded in 2005/06. Farmers’ varieties of haricot bean exhibited an increasing trend in the area of production and decreasing trend in area coverage percent from 2005/06 to 2008/09. The percentage coverage of the farmers’ varieties of this crop was the lowest of all the pulse crops across the five years. In the years from 2005/06 to 2008/09, the area of production of farmers’ varieties of chickpea showed a sharp increase. Farmers’ varieties percentage coverage of chickpea was the highest in 2007/08.

The average farmers’ varieties percentage area coverage of oil crops in the five years was the highest of all crops (Fig. 1). Similarly, the annual percentage area coverage of the farmers’ varieties of oil crops was the highest of all crops across all the years except in 2009/10. The area of production of farmers’ varieties of vegetables exhibited a significantly increasing trend in all the years except in 2009/10. The percentage coverage of the farmers’ varieties had wider range than any other crop over the years. The percentage coverage in 2010/11 was the lowest of all the years and the crops. This percentage coverage had also a decreasing trend from 2007/08 to 2010/11.

In the course of the years that are considered in this report, the area covered with farmers’ varieties overall ranged from about 73% for vegetable crops in 2010/11 to 99.9% for oil crops in the same year (Fig. 3). Within cereals, maize farmers’ variety showed area coverage ranging from 72% to about 86%. This was the least of all other cereals in terms of area coverage of farmers’ varieties. Sorghum farmers’ varieties instead exhibited the highest of percentage area coverage amongst all the cereals ranging between 98.83% and 99.97%. From pulses and oil crops haricot bean and sesame respectively showed a relatively lower area devoted to farmers’ varieties. Generally, the farmers’ varieties of cereals and vegetables had percentage of area coverage below the average over the five years (Fig.2). All the above facts revealed that despite the release of more than 733 improved varieties until 2011, the Ethiopian farmers are still highly dependent on farmers’ varieties of crop plants.
Table 1. Total area of production of cereals, pulses, oil crops, vegetables and root crops in the years from 2005/06 to 2010/11

<table>
<thead>
<tr>
<th>Year</th>
<th>Cereals</th>
<th>Pulses</th>
<th>Oil crops</th>
<th>Vegetables</th>
<th>Root crops</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005/06</td>
<td>8,066,471</td>
<td>1,283,564</td>
<td>792,304</td>
<td>116,298</td>
<td>167,189</td>
<td>11,270,987</td>
</tr>
<tr>
<td>2007/08</td>
<td>8,722,528</td>
<td>1,515,703</td>
<td>704,791</td>
<td>118,527</td>
<td>182,875</td>
<td>12,359,210</td>
</tr>
<tr>
<td>2008/09</td>
<td>8,764,034</td>
<td>1,583,441</td>
<td>853,594</td>
<td>161,525</td>
<td>144,560</td>
<td>12,475,852</td>
</tr>
<tr>
<td>2009/10</td>
<td>7,983,379</td>
<td>1,371,291</td>
<td>715,500</td>
<td>125,620</td>
<td>186,975</td>
<td>11,343,799</td>
</tr>
<tr>
<td>2010/11</td>
<td>9,689,809</td>
<td>1,357,509</td>
<td>772,744</td>
<td>170,053</td>
<td>214,328</td>
<td>13,358,189</td>
</tr>
</tbody>
</table>

Table 2. Percentage production coverage of farmers’ varieties of some cereal and pulse crops in the years from 2005/06 to 2010/11

<table>
<thead>
<tr>
<th>Year</th>
<th>Tef</th>
<th>Maize</th>
<th>Wheat</th>
<th>Sorghum</th>
<th>Faba bean</th>
<th>Field pea</th>
<th>Haricot bean</th>
<th>Chick pea</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005/06</td>
<td>98.90</td>
<td>80.00</td>
<td>94.27</td>
<td>99.62</td>
<td>99.87</td>
<td>99.81</td>
<td>99.31</td>
<td>99.42</td>
</tr>
<tr>
<td>2007/08</td>
<td>99.32</td>
<td>81.00</td>
<td>97.10</td>
<td>99.86</td>
<td>99.80</td>
<td>99.59</td>
<td>98.87</td>
<td>99.60</td>
</tr>
<tr>
<td>2008/09</td>
<td>99.34</td>
<td>80.24</td>
<td>96.15</td>
<td>99.91</td>
<td>99.86</td>
<td>99.81</td>
<td>96.82</td>
<td>99.13</td>
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<td>2009/10</td>
<td>98.05</td>
<td>85.63</td>
<td>97.40</td>
<td>98.83</td>
<td>99.05</td>
<td>99.05</td>
<td>98.32</td>
<td>99.01</td>
</tr>
<tr>
<td>2010/11</td>
<td>98.30</td>
<td>72.00</td>
<td>93.78</td>
<td>99.97</td>
<td>99.49</td>
<td>99.77</td>
<td>99.18</td>
<td>99.51</td>
</tr>
</tbody>
</table>

2.5. The trend in use of improved crop varieties

Until 2011, a total of 733 improved varieties of different crops have been officially released and registered in Ethiopia through the National Agricultural Research System (NARs) involving the Ethiopian Institute of Agricultural Research (EIAR), Regional Agricultural Research Institutes (RARI) and Higher Learning Institutes (HLI). Of the total crop varieties so far released and/or registered, 37.93% are cereals, 20.9% are pulses, 15.83% are tubers, roots and vegetables, 9.41% are oil crops, 5.05% are stimulant crops (coffee), 3.54% are fruit crops, 2.59% are condiments and medicinal plants, 2.46% are cotton (fiber crops), and 2.32% are forage and pasture crops. Crop-wise, the highest number of varieties released was 53 for bread wheat followed by maize (45), haricot bean (41), coffee (37), sorghum (36), field pea (31) and durum wheat (31).
In spite of the release of numerous crop varieties, only few of them have been in use in cultivation by the farmers. The national average yield of the major crops has also been relatively very low due, amongst others, to poor adoption of suitable varieties arising from lack of seeds and weak extension system, use of varieties with poor adaptation to local conditions outside their recommendation domains, poor management conditions, and changes in environmental conditions. Shortfalls in supply, decreasing seed quality and delayed deliveries may explain the generally disappointing adoption of improved maize seed. Similarly, there is evidence suggesting that many farmers have not adopted the seed-fertilizer inputs over time due to unavailability of preferred varieties and other inputs from suppliers, a preference for local varieties, or other such factors (Bonger et al. 2004, EEA/EEPRI 2006, Spielman 2008).

Over the years, most of the efforts on seed production and distribution have remained centralized and uncoordinated. Only few regions of the country could be covered with seed distribution and with little or no penetration into off-the-road sites. Recently, there has been considerable interest in market-oriented agriculture to meet both the growing local demand and take advantage of the export market. Prices of agricultural products are rising sharply, encouraging farmers to enter markets and invest in seeds of better varieties and fertilizer use.

In summary, it is important to note that the trend in the use of improved varieties of crops is the converse of that of the trend in the use of farmers' varieties discussed under section 2.4 above. This is because if farmers' varieties are used then it means the exclusion of improved varieties and vice versa. Hence, much of the data in the use of improved varieties be it in terms of acreage or production could be taken as the converse of what has been presented under the section on the trends in the use of improved varieties. However, it is also important to mention that some alarming instances of recent trends in the use of improved varieties of crops such as tef in some localized parts of the country (Table 3). During the 2011/12 main season, the use of the improved tef variety Quncho in four districts in the central highlands of Ethiopia averaged about 62% of the total tef area, while the range was from about 5% of the total tef acreage in Gimbichu to about 98% of the total tef area in Ada district (Table 3).
Table 3. Area coverage of the improved Quncho tef variety in some districts in the central highlands of Ethiopia during the 2011/12 main season

<table>
<thead>
<tr>
<th>District</th>
<th>Total acreage of tef (ha)</th>
<th>Coverage of Quncho tef variety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acreage</td>
</tr>
<tr>
<td>Ada</td>
<td>28744</td>
<td>28039</td>
</tr>
<tr>
<td>Lume</td>
<td>15500</td>
<td>9300</td>
</tr>
<tr>
<td>Minjar Shenkora</td>
<td>19943</td>
<td>4008</td>
</tr>
<tr>
<td>Gimbichu</td>
<td>2231</td>
<td>112</td>
</tr>
<tr>
<td>Total</td>
<td>66418</td>
<td>41459</td>
</tr>
</tbody>
</table>

2.6. Factors affecting the state of crop diversity

In Ethiopia, agricultural production mainly depends on farmers' varieties that are adapted to local conditions. They are highly valued by farmers for their useful agronomic traits and give sustainable yield in the diversified agro-ecological conditions of the country where improved varieties may not perform satisfactorily. These days, however, the agricultural ecosystem is becoming more dynamic compared to other ecosystems. This is mainly attributed to the changes in cropping patterns in response to market pressure, changing human needs and environmental factors. As a result, farmers switched to the cultivation of high yielding varieties and crops with high market values. The current extension system in Ethiopian also encourages farmers to produce high value crops for export. Hence, the frequency of occurrence of and/or the cultivated area under farmers' varieties is dwindling from time to time.

In general, there is an overall consensus in Ethiopia among stakeholders working on PGRFA that the major factors affecting the state of diversity are: displacement of local varieties by improved varieties, displacement of local varieties by other crops, market oriented crop production, pests and diseases, population pressure, genetic uniformity in improved varieties, drought, and invasive alien species.

Displacement of local varieties by improved varieties
Though it varies among crops more than 733 improved varieties were released until 2011. Wheat and maize were the leading with more than 45 varieties each. In the western parts of the country, particularly in the area known as the maize belts it is now becoming hard to get farmers’ varieties of maize in the field. For instance, in Gutten kebele of Gida Ayana (one of the district of west Wellega zone), the maize field in 2011/12 was totally occupied by improved varieties. There was no farmer who had planted local varieties of maize. Similarly, “Dudude” variety of barely was totally lost from Jima Arjo district of the same zone. In areas like Ejerie (in central highlands of the country), Kabuli type of improved variety of chickpea is mainly replacing the local varieties.

**Displacement of local varieties by other crops**

With a significant increase in the prices of agricultural inputs like fertilizers, farmers tend to grow crops with lower external input demand. Hence, pulse crops such as chickpea are now mainly replacing other crops like wheat in the central highlands of the country. Emmer wheat is being replaced by bread and durum wheat due to difficulty in threshability. As a result, the area covered by emmer wheat is decreasing from time to time. Durum wheat is also giving way to tef and new bread wheat varieties. In addition, the introduced oat varieties have replaced a wide range of crops grown in central highlands of the country.

**Market oriented crop production**

With a sharp increase in the market prices of the pulse crops particularly for lentil and chickpea, there is now a strong tendency by farmers to grow these crops. Particularly in the central highlands, considerable land that used to be planted to wheat is being covered either with lentil, chickpea and/or fenugreek. Higher market price expectations have also been affecting
the production of PGRFA in such a way that those crops that fetch high market price will cover the majority of the cultivated area at the expense of other crops. A case in point is the tef improved variety (QUNCHO) which is replacing tef farmers' varieties in many parts of the country. Farmers switched to 'QUNCHO' production due to its wide acceptance for its white seeded grain, and its high yield per unit area than the farmers' varieties.

**Pests and diseases**

In line with "the gene for gene concept" most improved varieties of crops such as wheat are being hit by diseases some years after their release due to resistance break to diseases such as rusts. In the 2010 crop production season, for instance, the improved varieties of bread wheat particularly “Kubsa” variety were severely attacked throughout the country by yellow rust. This resulted in total crop loss in some localities. Farmers in Arsi highlands started to shift from bread wheat to barely because of the repeated occurrence of yellow rust of wheat in the area. Similarly, the bread wheat variety “enkoy” went out of production because of its susceptibility to stem rust some years after its release.

**Population pressure**

The increase in population has resulted in fragmentation of agricultural lands. As a result, the landholding per household has been declining significantly over time. This situation has forced farmers to grow limited number of crops that are used for home consumption or that have high market values.

**Genetic uniformity in improved varieties**

In situations where most or all farmers’ varieties have been replaced by improved varieties, crop genetic diversity might be declining because of (1) reductions in total number of varieties, (2) concentration of the area planted with few favored varieties, and (3) the reduction in the genetic distance between these varieties. For instance, 'QUNCHO', the released tef improved
variety, is replacing not only the farmers' varieties but also improved varieties of tef themselves.

**Drought**

As a result of climate change, crops that were fit to a particular agro-ecology fail to perform well. Especially, for crops with prolonged maturity period like okra, as the duration of the rainy season shortens, they fail to attain physiological maturity due to shortage of moisture at flowering and grain filling stages. As such, they give immature or shriveled seeds of low viability..

### 2.7. Future needs and priorities

Ethiopia’s economy and the well-being of its population largely depends on the productivity of agriculture for which PGRFA constitute the backbone. Food security of the country depends on the sustainable use of the existing genetic diversity. PGRFA are also reservoirs of genetic diversity for utilization as raw materials (source of genetic variability) for breeding new crop varieties. Thus, the conservation and sustainable use of PGRFA is important to increase agricultural production, and ensure food security and economic development of the country. Moreover, integration of PGRFA conservation into the activities of various development programs is important to enhance the conservation and use of these resources.

Therefore, to ensure the long-term conservation and use of PGRFA the following activities are identified as the major priority areas of the country:

- Identify threats to PGRFA and prioritize species for conservation
- Establish more *ex situ* and *in situ* conservation sites
- Enhance the use of PGRFA
• Strengthen the mining of the plant genetic resources of the country in terms of unraveling what is in there in the genetic resources, and knowledge of extent and patterns of diversity
• Involve NGOs in PGRFA conservation program
• Assessment of the diversity of PGRFA at regular intervals
• Characterization and evaluation of PGRFA
• Incorporation of PGRFA course curricula in higher learning institutions
• Linkages with institutions involved in the management of PGRFA at local, national, regional and international levels
• Awareness creations on issues of PGRFA at all levels
• Extension support/ and development of agronomic packages for farmers' varieties
• Establish incentive mechanisms to farmers involved in conservation
• Adequate environmental impact assessment
• Develop marketing channel and value addition to farmers' varieties
• Restoration of farmers' varieties
• Provision of adequate financial and material resources
CHAPTER 3: THE STATE OF IN SITU MANAGEMENT

In the broad sense, *in situ* conservation is defined, according to the Convention on Biological Diversity (CBD), as the conservation of the ecosystems and the natural habitats and the maintenance of recovery of viable populations of the species in their natural surroundings and, in the case of the cultivated species, in the surroundings where they have developed their distinctive properties. *In situ* conservation can be done on farmers' fields, on pasture lands and in national parks or other types of natural reserves. For cultivated species, *in situ* conservation concerns the maintenance of the local intra- and inter- population diversity available in ecological and geographical sites. The populations are those cultivated and maintained by farmers from generation to generation. This approach to conservation concerns whole agro-ecosystems and implies that communities of farmers are direct actors in the management of diversity through their production strategies. In general, *in situ* conservation of PGRFA comprises: i) on-farm conservation; and ii) conservation in and outside protected areas.

3.1. Plant genetic resources survey and inventory

PGRFA survey and inventory is necessary to monitor the status of PGRFA in a given time interval. The information could also use by gene bank managers or curators to take appropriate conservation decisions and strategies. However, this activity is rarely conducted in Ethiopia, and it is often done in uncoordinated manner.

3.1.1. Survey and inventory of cultivated plants

The majority of farmers in Ethiopia still depend on farmers' varieties of crop plants. The varied agro-ecologies and farming systems prevailing in the country have greatly influenced the types and diversity of crops maintained by farmers in different parts of the country is different. These days, changes can be seen in cropping patterns particularly in areas with market access where the market influences the crop types. This has an impact on the occurrence of diversity of crops on farms and also the diversity within crops. In Ethiopia, inventory of cultivated plants has not
been conducted on regular basis. The limited attempts made so far were also not well coordinated. These days’ farmers are producing crops that have high market demand and strong government extension support. As a result, farmers tend to ignore other crops types that have high local importance. These scenarios obviously reduce the food basket that the farmers used to depend upon. For instance, the rescue collection mission that has been conducted in 2011 has showed a sharp decline in the number of farmers’ varieties of different crops. Therefore, regular survey and inventory of farmers' varieties of crop plants is imperative not only to collect, conserve and enhance their sustainable utilization, but also to devise appropriate and timely conservation strategies and measures.

3.1.2. Survey and inventory of edible wild plants and crop wild relatives

3.1.2.1. Survey and inventory of edible wild plants (EWP)

In Ethiopia, adequate attention has not been given to EWP research and development. The socio-economic, cultural, traditional, and nutritional aspects of EWP are not well studied and documented (Guinand and Dechassa 2000; EHNRI 1997). Studies on EWP of Ethiopia covered only about 5% of the country’s districts (Ermias Lulekal et. al. 2011). Even though, a national level comprehensive documentation, inventories and surveys of wild plants in Ethiopia are still lacking, several works have been done in some parts of the country to document the information on EWP.

Teketay et al. (2010) compiled the information on scientific names, families, local names, phenology, habitat, distribution, food and feed values, and other uses of 378 EWP of Ethiopia. These EWPs represented 79 families and 226 genera. Of the 262 EWPs studied in detail, shrubs accounted for 45.8%, herbs 33.6% and trees 20.6%. Thirty-two different edible plant parts were recognized and species with edible fruits ranked first (152 spp.) followed by those with leaves (103 spp.), seeds (57 spp.), stems (47 spp.), roots (23 spp.), bark (19 spp.), tubers (15 spp.) and ash (13 spp.). Among the families, Fabaceae is the most diverse one represented by 32 EWP in
18 genera; followed by *Tiliaceae* represented by 18 EWP in three genera. Among the genera, *Grewia* and *Ficus* were the most diverse each having 11 EWP and followed by *Acacia* with ten species.

The study on wild flowering plants in Ethiopia by Asfaw and Mesfin (2001) showed the presence of 203 EWP in the country. These accounted for 3% of the higher plant species in the country, and the 203 EWP species comprised herbs, shrubs and trees in the proportions of 37%, 32% and 31%, respectively. About 15% of the EWP are considered as famine foods. The majority of EWP are obtained from forest habitat, and they are distributed within the altitude range of 1500 to 2400 m.a.s.l. The study of Ermias Lulekal et al. (2011) showed that out of 413 EWP species belonging to 224 genera and 77 families, shrubs, trees, herbs and climbers comprise 31%, 30%, 29% and 9%, respectively. *Fabaceae* is the most diverse family represented by 35 EWP.

### 3.1.2.2. Survey and inventory of crop wild relatives

Crop wild relatives (CWR) are plant species which are genetically closely related to crops but, unlike crops, they have not been domesticated. Most CWR are found growing as weeds in field margins, traditionally managed agricultural lands and in disturbed habitats such as roadsides. They are important source of genes and genetic variations used in breeding programs to develop new, high yielding and better adapting crop varieties that are resistant to biotic and abiotic stresses. Hence, CWR will be ever more important in safeguarding future agricultural production particularly to adapt the impacts of climate change.

In most cases, the distribution of crop wild relatives is correlated with the diversity of flora within a country. That means that the greater the diversity of plant species a country has, the greater would the number of CWR occurring within that country be. Therefore, Ethiopia, being one of the Vavilovian Centers of crop domestication, it is not only a centre of origin and diversity of many cultivated plants, but also an important source of the associated crop wild
relatives (CWR). This further implies that some of the domesticated plants still occur with their wild relatives in the country.

Consequently, the country is an important gene pool for many crop species and their wild relatives including cereals, pulses, oil crops, vegetables, tubers, fruits, spices, stimulants, fibers, dyes and medicinal plants.

3.1.2.2.1. Wild relatives of cereal crops

As one of the biggest genera in the Poaceae (Grass) family, the genus *Eragrostis* includes about 350 species (Watson and Dallawizt, 1992), and of these 43% are thought to have originated in Africa, 18% in South America, 12% in Asia, 10% in Australia, 9% in Central America, 6% in North America and 2% in Europe (Costanza et al., 1979). Of the 54 *Eragrostis* species found in Ethiopia, 14 (about 26%) are endemic (Cufodontis, 1974).

Many wild *Eragrostis* species have been suggested to be close relatives or progenitors of the cultivated tef. These include *Eragrostis aethiopica*, *E. barrelieri*, *E. bicolor*, *E. cilianensis*, *E. curvula*, *E. heteromera*, *E. minor*, *E. papposa*, *E. pilosa*, *E. mexicana*. (Endeshaw 1978; Ponti 1978; Tavassoli 1986). There are 54 *Eragrostis* species found in Ethiopia and 14 species (26%) are endemic to the country (Phillips 1995). *Eragrostis pilosa* which has morphologically similar spikelets and is a tetraploid annual is generally considered as the most probable wild progenitor of tef. It is a widespread annual found in diverse habitats such as n open places, as a weed of cultivation and often near ditches in central, north and northwest parts of the country within altitudes ranging from 1400 to 1900 m.a.s.l.

*Eleusine africana*, the possible progenitor of the cultivated finger millet (*Eleusine corocana*), occurs as a weed in finger millet fields and in disturbed places in the north, northwest and southwest parts of the country within altitude ranges of 500 to 2200 m.a.s.l.
There are two wild/weedy tetraploid oat species endemic to Ethiopia (*Avena abyssinica* and *Avena vaviloviana*), which are found within altitude ranges of 1650 to 2800 m.a.s.l. in the central, northern, northwestern, western and southeastern part of the country. The oat species, *A. abyssinica* is cultivated in the northern parts of Ethiopia, but it is also considered as a weed in arable lands, particularly in barley fields, despite the fact that it is often tolerated and harvested with the crop. *Oryza barthii* and *O. longistaminata* which are the wild relatives of rice are found in the western plains and around Lake Tana area in the northern parts of the country, respectively.

*Sorghum arundinaceum* is a wild and fully fertile species with the cultivated grain sorghum and the cultivated grain sorghum (*S. bicolor*) is presumed to have been derived from it by human selection. It is found in many parts of the country from 600 to 2400 m.a.s.l. Many forms of grain sorghum have wild and weedy relatives in the country, which occur as weeds within, along roadsides and fallow lands of cultivated sorghum fields.

**3.1.2.2.2. Wild relatives of pulses**

*Lens ervoides* is the wild relative of Lentil (*Lens culinaris*). It grows in montane grassland in the north, northwest and central regions of the country from 2500 to 3300 m.a.s.l. *Vigna vexillata*, which is a relative of cowpea is wide-spread in many parts of the country between 1350 to 2500 m.a.s.l. The wild species of grass pea (*Lathyrus stativus*), namely: *L. pratensis* and *L. sphaericus* are found in upland grasslands of the country within altitude ranges of 3000 to 3200 and 1800 to 3000 m.a.s.l, respectively. *Lablab purpureus* subsp. *unciatus* verdc., is the wild and also sometimes cultivated sub species of *Lablab purpureus*. It is widespread in the country.

**3.1.2.2.3. Wild relatives of oil crops**

There are weedy forms of *Brassica* growing throughout the highlands of Ethiopia and gathered for consumption as leafy vegetables. Since no wild relative of *Brassica carinata* (Ethiopian mustard/GOMENZER) is known, the hypothesis is that gomenzer (Ethiopian mustard) is a
tetraploid hybrid between *Brassica nigra* and *Brassica oleracea*. *Guzotia scabra*, which is considered to be native to Ethiopia, is a wild relative to NOUG (*Guzotia abyssinica*), an important indigenous oilseed crop widely cultivated particularly in the highlands of Ethiopia. The genus *Guzotia* Cass., consists seven species confined to the Afromontane regions of Africa. The highlands of Ethiopia appear to be the centers of diversification of the genus which consists six of species. Recent cytological studies on the genus also showed that, *G. schimperi* is closer to *G. abyssinica* than to *G. scabra*.

3.1.2.2.4. Wild relatives of root and tuber crops

Ethiopian potato (*Plectranthus edulis*) occurs both as wild and cultivated species. The genus *Plectranthus* has 32 species in Ethiopia. Among these, *P. garckeanus* is endemic to the country and it is often found in montane forest, forest openings and ticket within altitude ranges of 1750 to 2700 m.a.s.l. in the central, northwestern, southwestern and southern parts of the country. The cultivated species is grown in the wetter south and south western parts of Ethiopia, whereas the wild species are found throughout the country.

*ANCHOTE* (*Coccinia abyssinica*) is an endemic species found both in cultivated and wild state in Ethiopia. Although the genus in Ethiopia is not well studied, there are eight taxa recorded and that are distributed across different parts of the country.

Bagana (*Amorphophallus abyssinicus*) and two other species are endemic to Ethiopia. *Bagana* grows wild in southern Ethiopia at altitudes ranging from 900 to 1200 m.a.s.l. It is drought tolerant, and the tubers are edible particularly during times of food shortages. The wild carrot *Daucus carota var. abyssinica* and a second species *D. hochstetteri* which is endemic to Ethiopia occur in several regions of the country. The genus *Dioscorea* has got 11 species in Ethiopia distributed in different parts of the country. Some of the species have both cultivated and wild forms, and some of them are highly drought resistant. It is reported that aerial tubers are common than root tubers in western Ethiopia.
3.1.2.2.5. Wild relatives of vegetables

*Abelmoschus ficulneus* is the wild species of Okra (*A. esculentus*). Okra has got high diversity in Ethiopia, and it is an important vegetable in some parts of the country particularly in the southwestern lowlands (550 to 650 m.a.s.l.). *Amaranthus spp.* are found as common weeds in some parts of the country, and the young plants are cooked as vegetable and seeds used for porridge and local beer. Other examples of CWRs diversity of the country are *Thymus spp.* in the Afro-alpine regions of the country; *Ensete ventricosum* which occurs both in wild and cultivated state in the medium to higher altitudes; *Gossypium spp.* occurring as wild and cultivated forms in the lowlands.

3.2. On-farm conservation of plant genetic resources

Practical measures were taken in the area of on-farm conservation with a programme for landrace conservation that was initiated in 1989. The major objective of the on-farm conservation is so as to support the farming communities in their efforts to maintain crop diversity and produce food. "Conservation through use" is the guiding principle that is being used in the implementation of on-farm conservation in Ethiopia. The principle is based on Ethiopia’s conservation strategy that has been promoted since the late 1980s through which the importance of integration of off-farm and on-farm conservation activities was proven to be essential in centers of diversity such as Ethiopia.

The on-farm maintained farmers' varieties are a source of germplasm with a wide range of adaptation from which farmers select special lines to meet their changing needs. In Ethiopia, there were 12 community seed banks established through the financial assistance obtained from GEF. Of these, six community seed banks (CSB) /on-farm conservations sites are in a good status meeting the objectives for which they have been established. The sites are strategically selected to develop corresponding on-farm conservation practices that can be replicated in other similar parts of the country. The sites include the fairly potential areas of Eastern and
Western Shewa with diminishing diversity within and among crops, the highly mono-cropped highlands of Arsi in which restoration of the displaced diversity is required, the fragile lowlands of South Wello and the Rift valley agro-ecologies where climatic and environmental stresses are challenging, and the highlands of South Wello that are spots of diversity for some crops such as durum wheat.

The community seed banks are used for the farmers as sources of seeds with wide ranges of adaptation. The conserved materials are also used to restore farmers' varieties lost due to different factors. The community seed banks obtain technical support from IBC and Ethio-Organic Seed Action (EOSA) to strengthen their capacity and to enhance the continued cultivation of farmers' varieties. Recently, additional five on-farm conservation sites have been established in the SNNP Regional State with the financial resources obtained from the government. Restoration of the displaced farmers' varieties of different crops has been undertaken from the national gene bank. The community seed banks are intended to increase access to diverse crop types, and to minimize the problem of seed shortage at planting.

Ethio-Organic Seed Action (EOSA), a local NGO, has built on the experience of IBC, and it has promoted integrated conservation, use and management of PGRFA. Besides, EOSA is working on the genetic enhancement and on-farm conservation of farmers' varieties. Enhancement of local varieties is practiced as a means to increase the use values of the crop genetic resources, and that, in turn, would help sustain the occurrence of different forms of local varieties on farms. EOSA also assists small-scale farmers produce seeds of enhanced local varieties. Farmers in Eastern and South Wello who are legally established as Farmers' Conservator Associations are also organized as legally established farmer seed producers. For example, EOSA's program member farmers at Ejere are currently producing quality seeds of different crops types after being trained as seed producers. The support of the United Nations Food and Agricultural Organization (FAO) by providing seed cleaning machine for Ejere farmers' seed producers has encouraged and increased the capacity of the farmers to produce quality seeds of different forms and crops.
3.3. Conservation of wild PGRFA within and outside protected areas

Many EWP, crop wild relatives (CWR) and other plant species which are extensively used for food, feed, medicine and other traditional uses still exist in the wild. Many crop wild and weedy relatives have evolved to survive droughts and excessive water, and extreme heat and cold since they have become adapted to cope up with natural hazards. They have often developed resistance to the pests and diseases that have caused damages to the respective related crops. From utilization and practical merite point of view, the ability to evolve and cope up with such biotic and a biotic stresses makes them still so valuable to safeguard today’s agriculture by serving as source of important genes which enable modern crop varieties to adapt to changing environments.

3.3.1. Conservation of wild PGRFA within protected area

In Ethiopia, there are 16 national/regional parks, three sanctuaries, seven wildlife reserves and 26 controlled hunting areas which are considered as protected areas. About 14% of the country is a protected area, and this is above the global average (SDPASE, 2009). Even though in Ethiopia protected areas were primarily intended for the conservation of wildlife resources, they also harbor huge plant diversity including EWP, CWR and many other plant species, and they can be considered as in situ conservation sites for PGRFA. Information about EWP and CWR found in the protected areas is, however, still lacking, and needs further research. Currently, the Yayu and Kafa National Forest Priority Areas (NFPAs) are designated as Biosphere reserves by UNESCO; hence, these sites are used to conserve many EWP, CWR and the wild gene pool of Coffea arabica.

3.3.2. Conservation of wild PGRFA outside protected areas
Conservation of wild PGRFA particularly EWP and CWR outside protected areas mainly accomplished by the surrounding communities. These forests are not designated as protected areas or as NFPAs and their ownerships are communal, private or state owned. The premises of churches, monasteries, mosques, graveyards and other sacred and worship places have been important places for the conservation of indigenous plants, EWP and CWR. These places can contribute a lot for the conservation of the genetic resources and can be treated as in situ conservation sites outside protected areas. There are no in situ conservation sites devoted merely for wild PGRFA (EWP and CWR) except that of Yayu and Kafa coffee forest biosphere reserves. Recently, the GEF/UNDP supported project namely “Mainstreaming Agro-biodiversity Conservation into the Farming Systems of Ethiopia”, is being implemented in the country. The project is working on the conservation of wild relatives and farmers’ varieties of coffee (Coffea arabica), durum wheat (Triticum durum) or tetaploid wheats (Triticum spp.) in general, enset (Ensete ventricosum), and tef (Eragrostis tef) by providing policy and market incentives.

3.4. Assessment of major needs for in situ management of PGRFA

Assessment of the major needs for in situ conservation is important to develop appropriate strategies and policy frameworks that enhance the conservation and sustainable use of PGRFA. The assessment would also help identify the major threats on PGRFA, gaps in conservation and devise possible solutions to overcome these problems. The following activities are identified as major and priority needs to improve on-farm conservation of PGRFA in the country.

- A focal institution for conservation of PGRFA should be organized and structured with appropriate tentacles at the grassroots level in all parts of the country
- Capacitate institutions involved in in situ/on-farm conservation of PGRFA with human, material and financial resources
- Conduct effective inventories and assessment of the state of PGRFA on regular basis
- Include in situ/on-farm conservation courses at different levels in the education system of the country
- Establishment of more in situ/on-farm conservation sites
• Establishment of incentive mechanism to conservator farmers to enhance the continued use and management of farmers' varieties
• Establishment and development of a national database on the diversity of PGRFA
• Enhance PPB and PVS activities/programs in all the crop improvement endeavors throughout the country
• Promote market channels and value addition of farmers' varieties to encourage their use in cultivation
• Acknowledge farmers engaged in on-farm conservation of PGRFA through awarding official certificates and other means of recognition
• Strengthening partnerships and coordination among stakeholders involved in the in situ/on-farm conservation of PGRFA
• Adequate environmental impact assessments prior to any agricultural investment activities and proper implementation of the results/outcomes and recommendations of the assessments there-of
• Increase public awareness
• Restoration of locally adapted varieties
• Link the community seed banks with formal seed bank at IBC
• Adequate financial and material support
CHAPTER 4: THE STATE OF EX SITU MANAGEMENT

Ex situ conservation activities for plant genetic resources for food and agriculture are mainly carried out by the Institute of Biodiversity Conservation (IBC). The size of the collections has increased by 13% over the period 2007 to 2012. Field gene banks hold accessions of coffee, root and tuber crops, herbs, spices, forage species and medicinal plants. Forage germplasms are also held by the International Livestock Research Institute (ILRI). Agricultural research centers and some universities also maintain working collections in smaller quantities. This chapter addresses issues associated with ex situ conservation i.e. collection, characterization, regeneration and documentation. It also gives an overview assessment of ex situ conservation needs and priorities for the future.

4.1. Sustaining and expanding ex situ collections

Systematic crop germplasm exploration and collection operations have been undertaken throughout the country at different times. Collection priorities were set based on factors such as natural disasters, economic importance of the crop and its diversity, the level of threat and to some extent the national research priorities. Most collection missions conducted so far were non-crop specific. This has resulted in disparity in species representation in the genebank. Currently, 200 plant species are conserved in the genebank, and of the total collections, 58% is occupied by three crops - barley (24%), wheat (19%) and sorghum (15%).

A major inventory on the genebank’s holding and associated information has been carried out in 2010. The current holding of the genebank is 68,014 accessions (increased by 13% in the past 5 years). The majority (about 97%) plant species conserved in the genebank are grain crops. The lion’s share of the germplasm conserved in the gene bank belongs to farmers varieties. But few breeding lines and wild species are also being conserved in the genebank. Some collections are maintained in the short-term storage due to insufficient seed quantity, waiting to be multiplied
so as to attain the minimum required seed amount and thereby fulfil the requirements for long-term storage.

The institute has established field gene banks in different agro-ecological zones of the country as part of the ex situ conservation program meant to especially conserve vegetatively propagated species and species with recalcitrant types of seed. Over 6,704 accessions of coffee, spices, root and tuber crops, medicinal plants and forage species are being conserved in the field gene banks (Table 4). The number of accessions of minor crops is minimal and crop wild relatives (CWR) are very few (0.11%). The effort to increase the number of field gene banks in different agro-ecological zones is undergoing. Efforts are also underway to establish duplicate genebank to conserve additional crop plants of the country.

Table 4. Number of accessions conserved in the field gene banks

<table>
<thead>
<tr>
<th>Field genebank</th>
<th>Size of the area (ha)</th>
<th>Type of species</th>
<th>Number of accessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choche</td>
<td>21</td>
<td>Coffee, root and tuber crops, herbs and spices</td>
<td>4906 coffee, 337 root and tuber crops, 155 spices</td>
</tr>
<tr>
<td>Bedessa</td>
<td>7.8</td>
<td>Coffee</td>
<td>738</td>
</tr>
<tr>
<td>Wondo Genet</td>
<td>1.6</td>
<td>Medicinal plants</td>
<td>320</td>
</tr>
<tr>
<td>Bale-Goba</td>
<td>3</td>
<td>Medicinal plants</td>
<td>248</td>
</tr>
</tbody>
</table>

The International Livestock Research Institute (ILRI) holds over 3000 accessions of forages species collected from Ethiopia. The Ethiopian germplasms of different crops are also found in many institutions and gene banks all over the world. CIMMYT (Mexico), IPK (Germany), ICARDA (Syria), ICRISAT (India) and USDA (USA) are among the institutions that hold Ethiopian accessions of different species. The GENESYS which is a global portal to information about PGRFA shows that about 15,636 accessions of barley, 13,159 accessions of wheat, 12, 133 accessions of sorghum, and a number of accessions of other food and agricultural crops of Ethiopian origin are available in various institutions around the world.
4.2. Germplasm conservation and maintenance

Prior to storage, seed processing which involves cleaning the seed samples from extraneous materials, drying them to optimum moisture levels, testing their germination level and packaging them in appropriate containers is conducted on the collected germplasm materials. Accessions that qualify for long term storage in terms of seed quantity and purity are dried at temperatures of 15 °C to 20 °C, and relative humidity ranging from 15 to 18 percent. The required seed moisture content for storage varies according to the seed type (5 to 7 percent for cereals, 4 to 6 percent for oil cops and 6 to 8 percent for legumes). For long-term storage, the minimum number of seeds required particularly for species with thousand seed weight (TSW) less than 200 grams is 8000 (for heterogeneous samples) and 3200 for genetically homogeneous materials. For species with TSW greater than 200gram the sample size is reduced to a reasonable level to maintain the initial genetic integrity of the sample.

After drying, samples are taken for seed viability test. If the initial germination percentage is less than 85 percent, immediate rejuvenation is recommended to ensure longevity during storage. Upon storage, the viability of stored seeds decreases slowly. For this reason, accessions are regularly monitored for viability. The monitoring interval depends on the species and its initial seed viability prior to storage or prior test. Over time, the quantity of the seeds will also decrease, since a certain amount will be used for distribution and timely viability testing. Seed quantity is monitored by recording seed withdrawals for distribution, regeneration and characterization.

Four cold rooms each with capacity of nearly 350 m³, and a cold room with a capacity of 50 m³ are currently used for long-term and short-term storages, respectively. While the atorage relative humidity is consistently 35 to 45% for both long- and short-term storages, the storage temperature is -10 °C for long-term and +4°C is for the short-term storage.. Samples are kept in laminated aluminum foil bags for long-term, and in paper bags for short-term storage.
4.3. Security of stored materials

For security reasons, the collected and stored germplasm need to be conserved in duplicate gene banks. IBC’s collections have not been duplicated elsewhere; consequently, having safety duplications has been a top priority. The institute is constructing a genebank in Fiche town to serve as a duplicate genebank which is expected to be functional in 2016. Having an additional genebank is also crucial for expanding the number of ex situ collections since the present storage facility is almost saturated.

Viability of conserved seed is monitored every 5 to 10 years depending on the species. Rejuvenation is done, if the germination test results become less than 85%. For rejuvenation, selection of suitable regeneration environments, use of appropriate sampling strategies, use of adequate isolation distances, and proper handling of regenerated materials are implemented according to some standard procedures to be followed for each crop type. To-date, 5606 accessions have been regenerated and 3089 accessions need immediate regeneration (Table 5).
Table 5. Accessions regenerated and in need of regeneration

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Accessions regenerated</th>
<th>Accessions in need of regeneration currently (&lt;85 % viability)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>928</td>
<td>563</td>
</tr>
<tr>
<td>Barley</td>
<td>719</td>
<td>924</td>
</tr>
<tr>
<td>Maize</td>
<td>18</td>
<td>139</td>
</tr>
<tr>
<td>Tef</td>
<td>299</td>
<td>119</td>
</tr>
<tr>
<td>Sorghum</td>
<td>2839</td>
<td>580</td>
</tr>
<tr>
<td>Niger seed</td>
<td>161</td>
<td>33</td>
</tr>
<tr>
<td>Field Pea</td>
<td>18</td>
<td>67</td>
</tr>
<tr>
<td>Linseed</td>
<td>70</td>
<td>2</td>
</tr>
<tr>
<td>Finger millet</td>
<td>121</td>
<td>84</td>
</tr>
<tr>
<td>Faba bean</td>
<td>38</td>
<td>34</td>
</tr>
<tr>
<td>Lentil</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Phaseolus spp.</td>
<td>0</td>
<td>112</td>
</tr>
<tr>
<td>Caster bean</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>Sunflower</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Fenugreek</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Safflower</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Mustard</td>
<td>197</td>
<td>32</td>
</tr>
<tr>
<td>Sesame</td>
<td>63</td>
<td>20</td>
</tr>
<tr>
<td>Chickpea</td>
<td>18</td>
<td>69</td>
</tr>
<tr>
<td>Amaranths</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Forage</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>Spices</td>
<td>0</td>
<td>185</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5606</strong></td>
<td><strong>3089</strong></td>
</tr>
</tbody>
</table>

4.4. Characterization

Characterization is carried out within the institute using international descriptor lists for the various species, while evaluation is primarily carried out by users. Genetic diversity studies are vital to undertake a rational germplasm collection and management. Though genetic diversity studies have been conducted on various field crop species using morphological and biochemical techniques within the institutes and molecular techniques elsewhere, it is not in a situation where the information obtained is utilized to manage the conservation activity. Lack
of data impedes the implementation of rational collection strategy. Hence, genetic diversity studies should be given a priority to define variability in important characters and their patterns of distribution, and generate information for planned germplasm collection as well as utilization. Lack of facilities and skilled manpower are the major constraints hampering the undertaking of molecular characterizations.

4.5. Documentation

Combinations of manual and computer data handling methods are employed in documenting information on ex situ plant genetic resources. The manual system consists of a set of data sheets which are used to organize and record raw data for eventual input into a computer system. Although all accessions conserved in the genebank are supposed to have the required passport data from the collection field, not all the collections have got the necessary passport data since these data are lacking particularly for the former accessions obtained in the form of repatriations. The information gathered during initial field collection of germplasm include vernacular name, geographic position system (GPS) information, sowing season, maturity time, food value, level of resistance to pests, diseases and other stresses, soil types and growing environment. Genebank management data such as, seed moisture content (after drying), initial germination percentage, storage and monitoring date, are all documented. Efficient database design and information management systems need to be implemented to handle the large amount of data generated on the collections. IBC Germplasm Database Management System stores information on passport data, characterization data, evaluation data, and genebank management data. Information can be released to users upon request either in hard or soft copy. Though characterization data are also documented the relational database between the characterization data and passport data has not yet been created, and the information is not integrated into a single searchable database.
4.6. Major constraints and needs of ex situ management

IBC is committed to conserve the PGRFA of the country to sustain agriculture and food security not solely in Ethiopia alone but also elsewhere in the world. Therefore, there should be collaborative efforts at the local, national and international levels concerning PGRFA management. The following constraints are hindering the ex situ conservation of PGRFA in Ethiopia.

- Insufficient genebank space (though there is a need to carry out rescue collections, the current genebank is fully occupied, thereby, hindering the expansion of the collections)
- Limited information on seed storage behavior of some species
- Limited facility for seed viability testing (incubators, growing chambers, etc.)
- Insufficient human resource capacity in the areas of seed physiology or technology, taxonomy, GIS, database management, genetics, and other fields of botany
- Inefficient seed quantity for monitoring mechanism
- Lack of controlled glass-house for seedling growing and regeneration of species that require careful handling
- Lack of alternative conservation mechanism for recalcitrant crops (*in vitro* and cryo-preservation)
- Inadequate information on the potential value of the conserved germplasm, thus, limiting their use by interested users such as plant breeders
- Lack of successive training (knowledge updating)
- Lack of funding
- Lack of technical and financial backstopping and support
- Lack of facilities and chemicals to carry out molecular characterization
- Weak data base systems
As a future plan of the institute so as to sustain and expand the existing *ex situ* collections of PGRFA, the following activities need to be fulfilled.

- Identifying major gaps (major crops, minor crops, underutilized species, forages, wild plants for food production, and wild relatives) in *ex situ* collections, and prioritize and fill the identified gaps
- Competition of the safety duplicate genebank
- Conduct in depth characterization and evaluation
- Establishment of core collections for major crops
CHAPTER 5: THE STATE OF USE

Wide diversity found in Ethiopian germplasm has helped in the identification of important traits that can be manipulated through breeding. For example, a study on barley collections from east Africa revealed accessions resistance to various diseases and the resistant accessions are of Ethiopian origin. Ethiopia has also been recognized by researchers as a source of stem rust resistance genes since a long time ago. Good sources of resistance to stem rust infection have been identified among emmer and durum accessions collected and conserved at IBC. This signifies that extensive study on Ethiopia’s diverse germplasm will assist in the identification of genes that possess traits of agricultural and economic importance.

5.1. Utilization of conserved plant genetic resources

IBC is distributing germplasms mainly to agricultural research centers to be used for national breeding programmes. Researchers and students in higher learning institutions also utilize the plant genetic resources already collected and conserved at the genebank for their research and study objectives. Though well characterized materials save both energy and money for the users, so far evaluation of the germplasm for desirable traits (specific biotic and abiotic stress) is not extensively conducted by IBC. Besides, researchers/users who accessed germplasm rarely give feedback to IBC. Hence information on the genetic materials’ yield potential, agronomic performance, stress, pest and disease resistances etc are lacking.

IBC, since its establishment, has distributed about 109,257 seed samples to various users (Table 6). Each year, the genebank on average dispatches about 6000 seed samples for local research activities. Seventy five percent of the users are research centers, followed by universities (17%), private researchers (6%) and others (0.1%). Though the majority of these samples are requested by agricultural research centers, there is no mechanism to monitor the contribution of the accessions to the national crop breeding programs. Upon formal request and agreement, germplasms can also be distributed to international research centers such as the International
Centre for Agricultural Research in the Dry Areas (ICARDA) and International Crop Research Institute for Semi-Arid Tropics (ICRISAT).

Table 6. Germplasm holdings of the genebank and their distribution

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Total holdings (Accessions)</th>
<th>Number of seed samples distributed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>16652</td>
<td>22719</td>
</tr>
<tr>
<td>Wheat</td>
<td>13157</td>
<td>15377</td>
</tr>
<tr>
<td>Sorghum</td>
<td>10365</td>
<td>14882</td>
</tr>
<tr>
<td>Tef</td>
<td>5971</td>
<td>5972</td>
</tr>
<tr>
<td>Finger millet</td>
<td>2345</td>
<td>4069</td>
</tr>
<tr>
<td>Maize</td>
<td>1512</td>
<td>740</td>
</tr>
<tr>
<td>Pearl millet</td>
<td>147</td>
<td>162</td>
</tr>
<tr>
<td>Horse bean</td>
<td>2648</td>
<td>5494</td>
</tr>
<tr>
<td>Field pea</td>
<td>1736</td>
<td>6527</td>
</tr>
<tr>
<td>Pigeon pea</td>
<td>95</td>
<td>25</td>
</tr>
<tr>
<td>Brassica</td>
<td>1727</td>
<td>3937</td>
</tr>
<tr>
<td>Chickpea</td>
<td>1176</td>
<td>3733</td>
</tr>
<tr>
<td>Lentil</td>
<td>728</td>
<td>2986</td>
</tr>
<tr>
<td>Grasspea</td>
<td>593</td>
<td>696</td>
</tr>
<tr>
<td>Lupin</td>
<td>309</td>
<td>234</td>
</tr>
<tr>
<td>Cow pea</td>
<td>60</td>
<td>184</td>
</tr>
<tr>
<td>Ground nut</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Linseed</td>
<td>2442</td>
<td>5624</td>
</tr>
<tr>
<td>Niger seed</td>
<td>1521</td>
<td>4777</td>
</tr>
<tr>
<td>Sesame</td>
<td>699</td>
<td>2443</td>
</tr>
<tr>
<td>Safflower</td>
<td>209</td>
<td>569</td>
</tr>
<tr>
<td>Sunflower</td>
<td>77</td>
<td>103</td>
</tr>
<tr>
<td>Common oat</td>
<td>65</td>
<td>22</td>
</tr>
<tr>
<td>Fenugreek</td>
<td>593</td>
<td>3519</td>
</tr>
<tr>
<td><em>Lepidium</em></td>
<td>116</td>
<td>141</td>
</tr>
<tr>
<td>Spices</td>
<td>356</td>
<td>120</td>
</tr>
<tr>
<td>Horticultural crops</td>
<td>560</td>
<td>313</td>
</tr>
<tr>
<td><em>Phaseolus</em> spp.</td>
<td>456</td>
<td>990</td>
</tr>
<tr>
<td>Wild species</td>
<td>75</td>
<td>65</td>
</tr>
<tr>
<td>Industrial crops</td>
<td>447</td>
<td>913</td>
</tr>
<tr>
<td>Fiber crops</td>
<td>72</td>
<td>0</td>
</tr>
<tr>
<td>Rice</td>
<td>142</td>
<td>16</td>
</tr>
<tr>
<td>Forest</td>
<td>340</td>
<td>26</td>
</tr>
<tr>
<td>Medicinal plants</td>
<td>121</td>
<td>34</td>
</tr>
<tr>
<td>Forage</td>
<td>445</td>
<td>104</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>68014</strong></td>
<td><strong>107516</strong></td>
</tr>
</tbody>
</table>
In order to be used by breeders, *ex situ* conserved plant genetic resources should be evaluated for their useful characters. To enhance the use of plant genetic resources, there was scheme to split an accession into morpho-agronomic components that are kept separately from the base collection. Such samples would result in the duplication of the mother sample, and they were believed to be necessary to support research programmes achieve their objectives in a relatively shorter period of time. However, due to the constraints created on the genebank's space, this activity is no longer practiced. When the new duplicate genebank becomes functional, it would create possibility to split samples based on morpho-agronomic characterization and evaluation data.

### 5.2. Access to farmers

Except in rare cases, farmers are not accessing and utilizing germplasm maintained in the *ex situ* reserves. IBC and Bioversity International have run ‘Seeds for Needs’ project aimed at working with women farmers to identify varieties of most important crops that are adapted to cope up climate change and climate change variations. Through this approach, farmers got access to the landraces conserved in the genebanks so that that they can get materials that are more suitable to the local condition than the seeds that they already have at hand.

### 5.3. Constraints of use

Ethiopia has faced constraints to enhance the use of conserved PGRFA. Some of the constraints include: i) lack of adequate evaluation information; ii) lack of core collections; iii) lack of adequate funds and training; iv) lack of sufficient facilities; v) lack of data sharing mechanisms between the institute and users; and vi) lack of coordination among researchers, breeders, genebank managers and farmers.
CHAPTER 6: THE STATE OF NATIONAL PROGRAMS, TRAININGS AND LEGISLATIONS

Ethiopia has been committed to participate in international forum and treaties that are concerned with biodiversity conservation, and sustainable development and use of biological resources. That is why Ethiopia has been among the countries that first ratified the CBD, ITPGRFA and other international conventions and treaties related to the biological resources. The three objectives of the convention on biological diversity (CBD) are: i) the conservation of biological diversity; ii) the sustainable use of its components; and iii) the fair and equitable sharing of benefits arising from the utilization of genetic resources.

The international community has taken quite long time to negotiate on the CBD's third objective, the fair and equitable sharing of benefits arising from the utilization of genetic resources. After six years of negotiation, the Nagoya Protocol on "Access to Genetic Resources and Fair and Equitable Sharing of Benefits Arising from their Utilization" was adopted at the tenth meeting of the Conference of the Parties on the 29th of October 2010, in Nagoya, Japan. Ethiopia has been actively contributing in the negotiation processes from the very beginning to the date of its adoption. The present report, therefore, focuses on the pre-Nagoya Protocol implementation of ABS and challenges the country had, the current situation, and future prospects of access and sharing of benefits arising from the utilization of PGRFA.

6.1 Ethiopia’s status on International and National legal frame works regarding Biological Resources

Ethiopia has ratified the Convention on Biological Diversity (CBD) and International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), and it has as well as adopted the African Model Law and the Bonn Guidelines. After entering into these commitments, Ethiopia has issued a Proclamation on Access to Genetic Resources and Traditional Knowledge and Community Rights (Proclamation No 482/2006) and Regulation 169/2009. According to these laws, the Institute of Biodiversity Conservation (IBC) is the Competent National Authority for
CBD and the focal point for both CBD and ABS. IBC is also the focal institution for ITPGRFA. Access to genetic resources and the associated traditional knowledge are subjected to prior informed consent (PIC) of the concerned local community which is the custodian of the genetic resources and community knowledge. According to the laws, the PIC should be given by the concerned community directly or by a provisional committee of the regional council representing different Woredas (districts) or Zones or if the community falls in an area in different regions, by the provisional committee of the House of Peoples’ Representatives depending on their residence. After provision of PIC, the Institute of Biodiversity Conservation negotiates on mutually agreed terms (MAT).

6.2. New development in the international legal frame work

One of the remarkable developments in the international legal framework in relation to Convention on Biological Diversity is the adoption of the Nagoya Protocol on Access to Genetic Resources and Fair and Equitable Sharing of Benefits arising from their Utilization at the meeting of the Conference of the Parties on 29 October 2010. This is a significant advance in the convention’s third objective to provide a strong basis for greater legal certainty and transparency for both providers and users of genetic resources.

Specific obligations to support compliance with domestic legislation or regulatory requirements of the party providing genetic resources and provisions for user country obligations to support compliance are a significant innovation of the Protocol. These compliance provisions as well as provisions for establishing more predictable conditions for access to genetic resources will contribute to ensuring the sharing of benefits when genetic resources leave a party providing the genetic resources. In addition, the Protocol’s provisions on access to traditional knowledge held by indigenous and local communities when it is associated with genetic resources will strengthen the ability of these communities to benefit from the use of their knowledge, innovations and practices.

By promoting the use of genetic resources and associated traditional knowledge, and by strengthening the opportunities for fair and equitable sharing of benefits from their use, the
Nagoya Protocol will create incentives to conserve biological diversity and sustainably use of its components, and further enhance the contribution of biological diversity to sustainable development and human well-being.

6.3. New Development in Access and Benefit Sharing Activities in Ethiopia

6.3.1. Reengineering Organizational Structure for Accommodating ABS Issues

The Institute of Biodiversity Conservation has recently restructured its business process to accommodate different activities of which access and benefit sharing activities is among the major ones. According to the new structure, access and benefit sharing activities come under the "Genetic Resources Transfer and Regulation Directorate", which is responsible for ABS implementation. The Directorate is responsible for processing requests to access genetic resources for different purposes including for research and commercialization, and for receiving application for accessing traditional knowledge associated with genetic resources, although, the latter is to eventually be referred to the concerned local community. The Directorate processes both import and export request for genetic resources. Although, there have been certain cases where material transfer permit is given by some other governmental organizations, this has been due to lack of awareness of the existing ABS laws, and it needs correction by identifying the interface. Since the Directorate is also responsible for awareness creation on ABS and its implementation, it has already started discussion over the matter with these organizations. Facilitation of prior informed consent (PIC) and mutually agreed terms (MAT), and the signing of the Material Transfer Agreement (MTA) are also handled by the same Directorate.

In addition to the above-mentioned activities, the Directorate: i) develops guidelines, code of conducts, booklets and brochures; ii) coordinates awareness raising and capacity building of stakeholders; and iii) conducts researches related to ABS such as bio-prospecting, bio-piracy and traditional knowledge associated with genetic resources. These activities are believed to promote the implementation of access to genetic resources and the sharing of benefits arising
from their use. Recently, the Directorate has taken up a lead in awareness raising campaign for the ratification of the Nagoya Protocol, and has successfully achieved the ratification of the protocol.

6.3.2. Policies, regulations and legislations at national level

Being signatory to CBD, Ethiopia has formulated the relevant policies such as Environmental Protection Policy in 1997, and Biodiversity Conservation and Research Policy in 1998, and in line with this it has issued a Proclamation on Access to genetic Resources and Community Knowledge and Community Rights (Proclamation No 482/2006) and Regulation 169/2009. Based on these frameworks, the country has been implementing the access and benefit sharing objective of the CBD. However, Ethiopia has encountered various challenges during exercising ABS agreements. And, the main challenges have arisen because of the absence of any binding international regimes that ensure legal certainty, transparency, and support compliance. The adoption and enforcement of the Nagoya Protocol is believed to enhance the implementation of the National ABS Laws by creating conducive environments for cooperation between parties, providing for user country obligations to support compliance, and establishing proper follow up mechanisms and harmonization of existing ABS legislation. That is why the country has taken a firm stand to ratify and enforce the Nagoya Protocol on 28 June 2012.
CHAPTER 7: THE STATE OF REGIONAL AND INTERNATIONAL COLLABORATIONS

7.1. Regional, Sub-Regional and International Networks

There have been a very large number of networks currently addressing one or more aspects of plant genetic resources particularly PGRFA (Table 7). While all of these networks aim at promoting and supporting collaboration among the partners for a common purpose, there is a huge variations in their objectives, size, focus, geographic coverage, membership, structure, organization, governance, funding, and so on.

Networks are very important for promoting cooperation, for sharing knowledge, information and ideas, for facilitation of exchange of germplasm, and for carrying out joint research and other activities (FAO, 2010). They support the sharing of expertise and help compensate or provide backstopping, and enable synergies to be captured. Collaboration is also critical to gaining maximum benefits under legal and policy instruments such as the CBD, GPA and ITPGRFA, and to meeting associated obligations.

The objectives and working areas of the most active and prominent regional and sub-regional networks associated with genetic resources and biodiversity activities in Ethiopia are briefly outlined below (IBC, 2012). Ethiopia is a member to many of the networks such as EAPGREN, ANAFE and SAFORGEN represented by different institutions, and it has benefited considerably from such collaborations.

7.1.1. Eastern Africa Plant Genetic Resources Network (EAPGREN)

EAPGREN is a regional Network of National Agricultural Research Systems (NARS) of the ASARECA member countries (http://www.asareca.org/eapgren/about/about_us.htm). The Network was established to promote the sub-regional collaboration and networking through exchange of information and material, research and development, capacity building, adoption
of common approaches and methods, and regional integration in plant genetic resources activities. EAPGREN has three main activity areas, namely: capacity building; research activities; and Plant Genetic Resources (PGR) support services. Thus, Ethiopia is actively participating and benefiting from this network.

7.1.2. **African Network for Agriculture, Agro-forestry and Natural Resources Education (ANAFE)**

ANAFE is a network of African colleges and universities teaching agriculture and natural resource sciences (http://www.anafe-africa.org). The network was launched by 17 universities and 12 technical colleges in 1993, and now has 131 member educational institutes in 35 African countries. ANAFE is involved in curriculum development, teaching and training materials development and provision as well as in sharing information among the network members. Wondo Genet College of Forestry and Natural Resources from Ethiopia is a member of ANAFE.

7.1.3. **Consultative Group on International Agricultural Research (CGIAR)**

CGIAR is a global partnership that unites organizations engaged in research for a food secure future (http://www.cgiar.org/who-we-are). CGIAR research is dedicated to reducing rural poverty, increasing food security, improving human health and nutrition, and ensuring more sustainable management of natural resources. It is carried out by 15 Centers that are members of the CGIAR Consortium, in close collaboration with hundreds of partner organizations, including national and regional research institutes, civil society organizations, academia, and the private sector. In 2008, the CGIAR underwent a major transformation, keeping CGIAR as its name. The 15 Research Centers generate and disseminate knowledge, technologies, and policies for agricultural development through the CGIAR Research Programs.
7.1.4. *Bioversity International*

Bioversity International is a recognized leader in agricultural biodiversity research working with more than 700 partners around the world to improve the lives of smallholder farmers and rural communities (http://www.bioversityinternational.org/about_us.html). In 2006, IPGRI and INIBAP became a single organization, and subsequently changed their operating name to Bioversity International. The new name reflects an expanded vision of its role in the area of biodiversity research for development. Bioversity International is a member of the CGIAR Consortium and a partner with the Rome-based food and agriculture agencies, the Food and Agriculture Organization of the UN (FAO), International Fund for Agricultural Development (IFAD) and World Food Programme (WFP). Bioversity International's purpose is to investigate the conservation and use of agricultural biodiversity in order to achieve better nutrition, improve smallholders’ livelihoods and enhance agricultural sustainability. Nonetheless, it is imperative to indicate at this juncture that the selection of the current Sub-Regional Office of Bioversity International in Uganda would by no means be justifiable as compared to having it in Ethiopia in lieu of the fact that Ethiopia is one of the Eight Vavilovian Centers of diversity and origin of crop plants, while it is also known that the country generally harbours huge wealth of biodiversity in general.

7.1.5. *African Biodiversity Network (ABN)*

The Purpose of ABN is to ignite and nurture a growing African network of individuals and organizations working passionately from global to local level, with capacity to resist harmful developments and to influence and implement policies and practices that promote recognition and respect for people and nature (http://www.africanbiodiversity.org). ABN is a network that supports and builds relationships and links between groups and individuals that share a common vision and values.
Table 7. Summary of the networks and member institutions in Ethiopia

<table>
<thead>
<tr>
<th>Network Title (Acronym)</th>
<th>Institution responsible for coordination</th>
<th>Member/Partner institution in Ethiopia</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Africa Plant Genetic Resources Network (EAPGREN)</td>
<td>ASARECA</td>
<td>Institute of Biodiversity Conservation</td>
<td>Eastern Africa</td>
</tr>
<tr>
<td>African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE)</td>
<td>World Agroforestry Centre (ICRAF)</td>
<td>Wondo Genet College of Forestry and Natural Resources</td>
<td>Africa</td>
</tr>
<tr>
<td>Consultative Group on International Agricultural Research</td>
<td>CGIAR</td>
<td>International Livestock Research Institute (ILRI)</td>
<td>Global</td>
</tr>
<tr>
<td>Bioversity International</td>
<td>Bioversity International ABN</td>
<td>Institute for Sustainable Development (ISD)</td>
<td>Global</td>
</tr>
<tr>
<td>African Biodiversity Network (ABN)</td>
<td></td>
<td>MELCA Mahiber</td>
<td>Regional</td>
</tr>
</tbody>
</table>

7.2. Future needs and priorities for international collaboration and networking

So far Ethiopia’s participation in international collaborations and networking in PGRFA conservation is minimal. Thus, future needs and priorities are shown in Table 8.

Table 8. Needs for international collaboration and networking

<table>
<thead>
<tr>
<th>Needs</th>
<th>Level of priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Understanding the state of diversity</td>
<td>✓</td>
</tr>
<tr>
<td>• Enhancing <em>in situ</em> management and conservation</td>
<td>✓</td>
</tr>
<tr>
<td>• Enhancing <em>ex situ</em> management and conservation</td>
<td>✓</td>
</tr>
<tr>
<td>• Enhancing use of PGRFA</td>
<td>✓</td>
</tr>
<tr>
<td>• Enhancing research</td>
<td>✓</td>
</tr>
<tr>
<td>• Enhancing education and training</td>
<td>✓</td>
</tr>
<tr>
<td>• Enhancing legislation</td>
<td>✓</td>
</tr>
<tr>
<td>• Enhancing information management and early warning systems for PGRFA</td>
<td>✓</td>
</tr>
<tr>
<td>• Enhancing public awareness</td>
<td>✓</td>
</tr>
</tbody>
</table>
CHAPTER 8: ACCESS TO PGRFA, SHARING OF BENEFITS ARISING OUT OF THEIR USE AND FARMERS’ RIGHT

8.1. Access and benefit sharing legislations

Ethiopia has put in place Proclamation 482/2006 to provide legal frameworks for accessing genetic resources and sharing benefits from their use. The basic objective of this Proclamation is to ensure fair and equitable sharing of benefits arising from the use of genetic resources and to promote the conservation and sustainable utilization of the country’s biological resources. Statements of the Proclamation includes a range of issues such as ownership, user rights, and conditions for access, benefit sharing, types of benefits, powers and responsibilities among others. The law bears the necessity of prior informed consent (PIC) to access genetic resources or community knowledge. Following PIC, the Institute including relevant stakeholders negotiates on mutually agreed terms (MAT) with the user of the genetic resource.

8.2. Access and Movement of PGRFA

Movements of genetic resources into and out of the country have a long history in Ethiopia. As there were no regulations in place until recent past, genetic resources have been freely accessed. The understanding was that genetic resources are considered as “a common heritage of human kind”. Students, researchers, tourists, and other travelers have been involved in the transfer of genetic resources into and out of Ethiopia. The ABS law of Ethiopia does not allow free access to genetic resources. Over the past ten years, most of the access requests have come from post graduate students pursuing their MSc and PhD studies and researchers working in agricultural research organizations. These access requests have been facilitated through Material Transfer Agreement (MTA). Recently, requests for material transfer have increased due to easy access system created as a result of restructuring of the business process of IBC. Regarding germplasm distribution activity over 5000 accessions of germplasm were delivered to researchers and higher learning institutions On the other hand, the status of genetic
resources found outside the country is not known. Even the research status of germplasms accessed and transferred through MTA is unknown because of lack of information exchange between the users and the provider. There has been no follow up mechanisms in place to monitor the development of the GRs. However the Genetic Resources Transfer and Regulation Directorate is trying to network the different players to establish follow up mechanism and getting feedback from all stakeholders.

8.3. Implementation of ABS in Ethiopia

8.3.1. ABS agreements in Ethiopia

8.3.1.1. ABS agreement on tef (Eragrostis tef)

Ethiopia has been exercising ABS since it has established the national legal framework. ABS agreement on tef (Eragrostis tef) genetic material was signed on April 2005 between Ethiopia and Dutch Company for a duration of 10 years. Although legal processes for accessing tef was concluded more or less successfully, the benefit sharing component has never been properly implemented.

8.3.1.2. ABS agreement on Vernonia galamensis

In July 2006, a British Biotechnology firm, Vernique Biotech Ltd - UK “Company”, signed access and benefit sharing agreement with the Institute of Biodiversity Conservation to commercialize the oilseed plant Vernonia galamensis. The agreement was signed based on Mutually Agreed Terms (MAT) set by the two parties. Vernonia galamensis is considered as a potential replacement for petroleum in a variety of industrial uses. According to the agreement, the Company has exclusive access to Vernonia seed to export and use for the purpose of developing and commercializing the 27 Vernonia seed oil products for ten years. In exchange, the Ethiopian government agreed to receive royalty payments and profit shares, while hundreds of local farmers are believed to have an opportunity to boost their earnings by
growing the oilseed on their farm lands. The agreement excludes intellectual property rights over *Vernonia galamensis* or any genetic components there-of.

With regards to benefit sharing, the agreement includes both monetary and non-monetary benefits. Veronique agreed to pay an upfront payment of €35,000 upon signing the agreement. Also, Veronique has agreed to source at least 75% of its annual requirements for Vernonia seed by producing it and/or by buying it from contract growers or local communities in Ethiopia. This was aimed to benefit the local communities from the agreement of Vernonia. As part of the non-monetary benefits, Vernique has agreed to train local communities. The agreement had also included sharing of research results and technologies with the provider. On the other hand, license/ or upfront payment was obtained after the agreement.

The implementation of the ABS including the Vernonia agreement is challenged by various factors. The most important ones are: i) limited negotiation capacity and lack of effective enforcement; ii) lack of follow up mechanisms for the ABS agreement; and iii) lack of clear and transparent market information regarding the value of genetic resources. As a consequence, the value is often determined by the users, which frequently determine the value of the genetic resource by comparison to a non-genetic substance that is currently in use. Lack of information about the commercial status of the accessed genetic resource products is another challenge affecting the benefit sharing agreements.

### 8.3.1.3. ABS agreement on Aloe species

On the 3rd of December 2009, access to Aloe genetic resources agreement was signed between IBC and the G Seven Trade and Industry PLC Company. The Provider (IBC) agreed that the company could access and use three species of Aloe for extracting naturally existing oils in order to replace the batching oil the company has been importing from abroad. The company is not allowed to access the traditional knowledge of local communities on the use and application of Aloe species nor claim any right over such traditional knowledge without a prior
informed consent (PIC) of the local communities. The benefits agreed upon were non-monetary. These include, involvement of staff of the provider in the research carried out by the company and sharing of the results of the research, and training of the local community in the collection and supply of Aloe leaves to the company.

8.3.1.4. ABS agreement on Withania somnifera, Osyris species and Dichrostachys cinerea

On the 6th of July 2012, DOCOMO Plc. has signed access and benefit sharing agreement with the Institute of Biodiversity conservation (IBC) on germplasms of three forest species, namely: Withania somnifera; Osyris species; and Dichrostachys cinerea. The agreement was specifically for the former to process various herbal, cosmetics and medicinal products from these genetic resources. The competent authority (IBC) has received the application and examined the access request in accordance with article 14 of the access Proclamation and procedure for commercial access outlined under article 3 of the regulation. Following public comments, PIC was obtained from the concerned local communities and IBC has carried out a negotiation process on mutually agreed terms with the company, and finally signed mutual agreements with the Company. Different stakeholders were involved in the negotiation process. The company agreed to share both monetary and non-monetary benefits that arise out of the utilization of the genetic resources. The monetary benefits included upfront payment, royalty payment, annual license fee and a lump sum of net profit. The non-monetary profit agreed upon were: i) participation of Ethiopian scientists in the research plan of the company; ii) sharing of knowledge or technologies it may generate using the genetic resources; and iii) training of the concerned local communities to enhance local skills in genetic resources conservation, evaluation, development, propagation and use at least once a year through the time of contract so as to ensure sustainable utilization of the genetic resources. In the agreement, the company is not permitted to use the stated genetic resources for any other purposes whatsoever unless explicit written permit is given by the provider. Similarly, the company is allowed to access and use the genetic resources only to the amount not greater than the sustainability threshold.
through the time of contract. The company shall neither claim nor obtain intellectual property rights over the genetic resources or any parts of them.

8.3.2. Stakeholders involved in PGRFA transfer/movement and their roles

Genetic resource transfer regulation involves a broad range of stakeholders. Concerning Ethiopia, the following institutions are mandated to regulate access and movement or transfer of genetic materials.

(i) **Local Communities**: Being the custodian of Ethiopian biodiversity, access and benefit sharing legislation states that local communities are responsible to give PIC to access community knowledge related to genetic resources. Moreover, they are empowered to regulate genetic resources in their localities. They can prohibit any person, who does not belong to their communities, from collecting or taking genetic resources without having the necessary permit.

(ii) **Responsibilities of Regional Bodies**: Local administrations and regional bodies at all levels who are responsible for the conservation of genetic resources are empowered to:

- regulate that accessing of genetic resources from their respective jurisdiction without permit by any person who does not belong to the communities thereof; and require access permit from any person, who does not belong to the communities thereof and who is collecting or taking genetic resources from their respective jurisdiction, and if he is without permit, seize the genetic resource and present him to the law and notify the IBC on the detailed particulars of the genetic resource and the person found in possession.

(iii) **Ethiopian Revenue and Customs Authority**: The Proclamation on ABS empowered the Ethiopian Customs offices to regulate transfer of any genetic resources being taken out of the country. The Customs Authority is responsible to seize genetic resources being transported out of the country and the person transporting them without permit.
(iv) **Institutions involved in Mail Services:** Postal and other courier service institutions are also responsible to require their clients to show permit before receiving and transporting genetic resources out of the country via mails.

(v) **Ministry of Agriculture:** The Plant and Animal Health and Regulatory Directorate under the Ministry of Agriculture (MoA) is responsible to regulate plant and animal health of imported and exported genetic resources to protect the country’s biodiversity from invasive pests and diseases. Based on a pre-import evaluation, the Directorate issues import permit. The Ministry is empowered to ensure that the quarantine certificate it issues to export genetic resource products, contain a statement indicating that the certificate does not constitute a permit to use the product as genetic resource and that doing so is prohibited and would constitute an offence. It also prohibits or restricts the importation of living plants, plant parts, and seeds for planting. It ensures that the clients are aware of the quarantine status of the organisms they accept into and store in their collections. The organization provides lists of controlled organisms’ exotic species.

Although many stakeholders are involved in genetic resources regulations, there is weak or no collaboration or coordination among them. As a result, genetic resources are not adequately regulated. Effective genetic resource regulation very much depends, among other things, on the meaningful and effective collaboration, integration and implementation of the regulations.

**8.4. Needs regarding ABS**

Although the needs regarding genetic resources and benefit sharing of plant genetic resources may be multiple, the following are few among these needs:

- Information on the value of genetic resources is not available at the national level. This is one of the gaps in the exercising of ABS provisions. The estimates of the values of genetic resources are usually guessed rather than being based on scientific data sources. The country needs to conduct research on valuation of its biological resources.
• Another important problem in implementing ABS provisions is lack of strong cooperation and links between the ABS focal point (IBC) and the various organizations having responsibilities for different aspects of plant genetic resources. Therefore, there is an urgent pressing need for making and ensuring a stronger coordination in order to implement ABS smoothly and effectively.

• There is also a critical gap in trained manpower especially in negotiating agreements that have an international nature, and in research on the valuation of biological resources. Building the capacity of staff in these areas needs financial support for short- and long-term trainings, and for participation in relevant workshops and conferences to enrich the experiences and capacity of human resources at the national focal point.

• Awareness raising on ABS also needs serious considerations, if we are to narrow the knowledge gap within and among the stakeholders working in the area. This activity needs financial and material support from national and international partners. The cooperation and creation of favorable working conditions between the different governmental and non-governmental organizations can be improved through concerted and regular awareness raising activities.

• Compliance to contractual agreements that are signed between the provider of the genetic resources and the user country or company is among the vital issues that create destruction of confidence and good working conditions. Due to non-compliance, the credibility of dealing on access to genetic resources and the associated traditional knowledge and benefit sharing from their use has a discouraging impact on the community that are custodians of these resources, instead of being incentive for conservation and sustainable use of genetic resources.
CHAPTER 9: CONTRIBUTION OF PGRFA MANAGEMENT TO FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

The importance of PGRFA to people stems from their use as sources of food, feed and raw materials to develop crops that meet ever-changing need of the people. These resources are also vital for normal functioning of the agro-ecosystems, nutrient cycling and stabilize crop harvests from year to year. There are also various species of plants that have actual and potential values that contribute to economic growth and sustainable development of the country. In a nutshell, the sustainable development, conservation and utilization of genetic resources would entail equitable and fair advantages and benefits, only and only if the "genetic resources" can be turned into wealth for the economic benefit and improved livelihoods of the communities.

9.1. Food security and economic development

Agriculture is the backbone of the Ethiopian economy; crop and livestock productions are of the major components of the sector. It generates immediate benefits for over 83% of the country’s population. PGRFA provide raw materials for the agriculture sector on which the country's over all economic development relies. The conservation of the available diversity of cultivated and wild species of PGRFA also provide an opportunity for satisfying changing needs, and support a continuous or sustainable supply of food. There are also many wild plants which are used during food shortage, and as medicinal plants. For instance, the majority of Ethiopians still depend on traditional medicines derived from PGRFA. This has reduced the dependency on modern pharmaceuticals for health care, and thereby reducing the hard currency that would have been otherwise incurred for importing modern medicines. This indicates that PGRFA play significant roles in the entire socio-economic development of the country.
9.2. Agricultural sustainability

PGRFA constitutes the foundation upon which agriculture and food security depends. They are reservoirs of genetic diversity, and provide the raw material for breeding new plant or crop varieties. PGRFA are critically important for promoting sustainable production and for minimizing risks arising due to unpredictable environmental conditions. Under normal conditions, the diversity of PGRFA is essential for intensifying production with limited resources and for promoting access to a variety of food and income sources. It also provides stability for farming systems by balancing yield variability through the maintenance of a wide range of diversity. Under unfavorable conditions, failure of a particular crop or variety is compensated for by the yield of other crops or varieties. As a matter of fact, subsistence farmers in Ethiopia, grow several genetically distinct varieties of crop on small plots of land in order to reduce and/or spread the risk of crop failure due to biotic and abiotic factors.

Genetic diversity gives species the ability to adapt to changing environments, including new pests and diseases and new climatic conditions. Different varieties adapt to different micro-climates and soil types. Diversity also ensures the availability of various essential nutrients and ensures food security. The genetic variation in wild and cultivated PGRFA is used to develop new crop varieties with desirable traits. Besides, an agro-ecosystem rich in PGRFA offers various services and is more stable than monoculture agricultural fields. The tremendous diversity of species in home gardens, for instance, contributes to conservation of species, nutrient recycling, improvement of soil fertility, biological pest control, soil and water conservation, year-round production of different crops, and reducing risks. However, farmers’ varieties with variable adaptive genes that have sustained the livelihoods of farmers have been affected by various biotic and abiotic stresses. The immense diversity of PGRFA found in Ethiopia have also contributed to the world economic development. For instance, the identification of the Barley Yellow Dwarf Virus (BYDV) resistance gene from Ethiopia’s barley has enabled to revitalize the barley production in California. Besides, the naturally decaffeinated coffee genotypes that have been developed in Brazil, are originally taken from Ethiopia.
9.3. Cultural values

In Ethiopia, farmers continue to produce farmers’ varieties of crops because of their contribution to food security and cultural values. Certain cultivated and wild species of PGRFA are especially maintained in specific communities for cultural reasons as they are used for social gatherings and religious events. For instance, Anchote (*Coccinia abyssinica*) is used during religious holidays in western parts of the country.

9.4. PGRFA and climate change

Climate change is affecting the agricultural production and food security of the people around the globe. Ethiopia is also experiencing the effects of climate change. An increase in average temperature and change in rainfall patterns are the direct effects of climate change. Thus, adapting agriculture to the ever-changing climate requires more drought tolerant varieties. Therefore, wider genetic bases of PGRFA are a pre-requisite for the required adaptation of climate change. In line with this, the Government of the Federal Democratic Republic of Ethiopia has initiated the Climate-Resilient Green Economy (CRGE) to protect the country from the adverse effects of climate change, and to build a green economy that will help realize its ambition of reaching a middle income status country in the world before 2025. Therefore, diversity of PGRFA could be used for the adaptation strategy and ensure agricultural sustainability. However, there is low level of awareness on the rate at which the resources are being affected. As a result, several values and services offered by PGRFA are disappearing from time to time.
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