ETHIOPIA: SECOND COUNTRY REPORT ON THE STATE OF PGRFA TO FAO

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ACRONYMS

AMCEN	African Ministerial Conference on Environment
CBD	Convention on Biological Diversity
CBDC	Community Biodiversity Development and Conservation
CGB	Community Genebank
CGIAR	Consultative Group on International Agricultural Research
CSA	Central Statistical Authority
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
EAPGREN	East Africa Plant Genetic Resources Network
EIAR	Ethiopian Institute of Agricultural Research
EPA	Environmental Protection Authority
EPHI	Ethiopian Pioner Hi-bred International
ESE	Ethiopian Seed Enterprise
FAO	Food and Agriculture Organization
GEF	Global Environmental Fund
GIS	Geographic Information System
GPA	Global Plan of Action
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IAR	Institute of Agricultural Research
IBC	Institute of Biodiversity Conservation
ICARDA	International Centre for Agricultural Research in the Dryland Areas
ICRISAT	International Crop Research Institute for Semi-Arid Tropics
ILRI	International Livestock Research Institute
MoARD	Ministry of Agriculture and Rural Development
NARES	National Agricultural Research System
NBSAP	National Biodiversity Strategy and Action Plan
NBT	National Biodiversity Task Force
NGO	Nongovernmental Organization

NISM	National Information Sharing Mechanism
NVRC	National Variety Release Committee
ODAP	β-N-Oxalyl-α, β-diaminopropanoic acid
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
TSW	Thousand Seed Weight
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

The existence of diverse farming systems, socio-economics, cultures and agro-ecologies has endowed Ethiopia with a diverse biological wealth of plants, animals, and microbial species, especially crop diversity. Crop plants such as coffee (*Coffea arabica),* safflower (*Carthamus tinctorius*)*,* tef (*Eragrostis tef*)*,* noug (*Guizotia abyssinica),* anchote (*Coccinia abyssinica)* and enset *(Ensete ventricosum)* originated in Ethiopia. High genetic diversity is found in major food crops (wheat, barley, sorghum and peas); industrial crops (linseed, castor and cotton); cash crop (coffee); food crops of regional and local importance (tef, noug, Ethiopian mustard, enset, finger millet, cowpea, lentil) and in a number of forage species of world importance (clovers, medics, oats).

Plant genetic inventories and surveys have been conducted by the Institute of Biodiversity Conservation (IBC) and its partners to gather and document information on the types and distribution of farmers' landraces, forest and aquatic resources and medicinal plants. Following extensive surveys, about twenty areas rich in biological diversity, distributed across six regional states, have been identified for conservation purposes. A programme of landrace conservation supports the farming communities in their efforts to maintain crop/plant diversity, and produce food for their family and for the country as a whole. Systematic crop germplasm exploration and collection operations resulted in collections of indigenous landraces, including unique breeders' collections of economically important crops with rich genetic diversity such as barley, wheat, sorghum, tef, maize, noug, linseed, lupin, finger millet, haricot bean, field pea, lentil and horse bean.

The current holdings of the IBC genebank reach over 60,000 accessions of about 200 crop/plant species. Germplasm is maintained for long term storage at -10 ^{0}C and for the medium term at +4 ^{0}C with 35 - 45 percent relative humidity. Samples are kept in laminated aluminium foil bags for long term storage. Plant species with recalcitrant and intermediate storage behaviour seeds are maintained in ten field genebanks.

Regeneration activities are regularly performed to effectively maintain quality of stored germplasm collections for sustainable use. To date 13336 accessions have been regenerated and over 7400 accessions need immediate regeneration.

Characterization is essential for effective utilization of conserved germplasm. Characterization and preliminary evaluation on basic morpho-agronomic characteristics have been undertaken on about 70 percent of the crop germplasm accessions, including 34648 cereals, 8037 oil crops, 5355 pulses, 424 coffee and 360 accessions of fenugreek.

IBC is the national focal point for plant genetic resources conservation for food and agriculture. A National Policy for the Conservation and Development of Plant Genetic Resources and a Conservation Strategy of Ethiopia have been developed. Ethiopia has also signed and ratified the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture. The key to protecting the biological heritage of Ethiopia lies in the involvement of local people. A proclamation was approved in 2006 to regulate access to genetic resources and associated community knowledge, innovations, practices and technologies, and to protect the rights of local communities. Strong international collaboration supports these efforts.

More efficient use of plant genetic diversity is a prerequisite to meeting the challenge of development, food security and poverty alleviation. The inclusion of germplasm in plant breeding programmes and development of released cultivars are the most generally recognized uses of genetic resources. About 81000 seed samples have been distributed from the genebank. On average about 5000 seed samples per year are distributed to local research activities for national crop improvement programmes.

Despite these efforts, much remains to be done to fully conserve the diverse crop genetic resources in Ethiopia. Future needs for additional activities, training and funding gaps have been identified. With collaboration and support, Ethiopia will meet its commitments to conserve and use its plant genetic resources for food and agriculture for present and future use.

INTRODUCTION

PHYSIOGEOGRAPHIC AND CLIMATIC FEATURES

Ethiopia is located in the tropics in the horn of Africa between 3° and 15° N, 33° and 48° E, bordering Somalia, Sudan, Djibouti, Kenya and Eritrea.. It has diverse physiogeographic features with high and rugged mountains, flat topped plateaux, deep gorges, incised river valleys and rolling plains. The altitudinal variation ranges from 116m below sea level in the Dalol depression in the Afar region, to 4,620 masl at Ras Dashen. The Great Rift Valley runs from northeast to southwest of the country and separates the western and southeastern 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.

The highlands cover the central lava highlands and massifs consisting of the Gondar, Wello and Gojam highlands; and the southwestern plateau of Gamo Gofa, Illubabor and Wellega. In the Southeastern parts are found highlands of Arsi, Bale, Hararge and Sidamo. These highlands have high mountains on their western rim with continuous slopes running from the highest peak of Mt. Batu towards the southeastern lowlands (Figure 1).

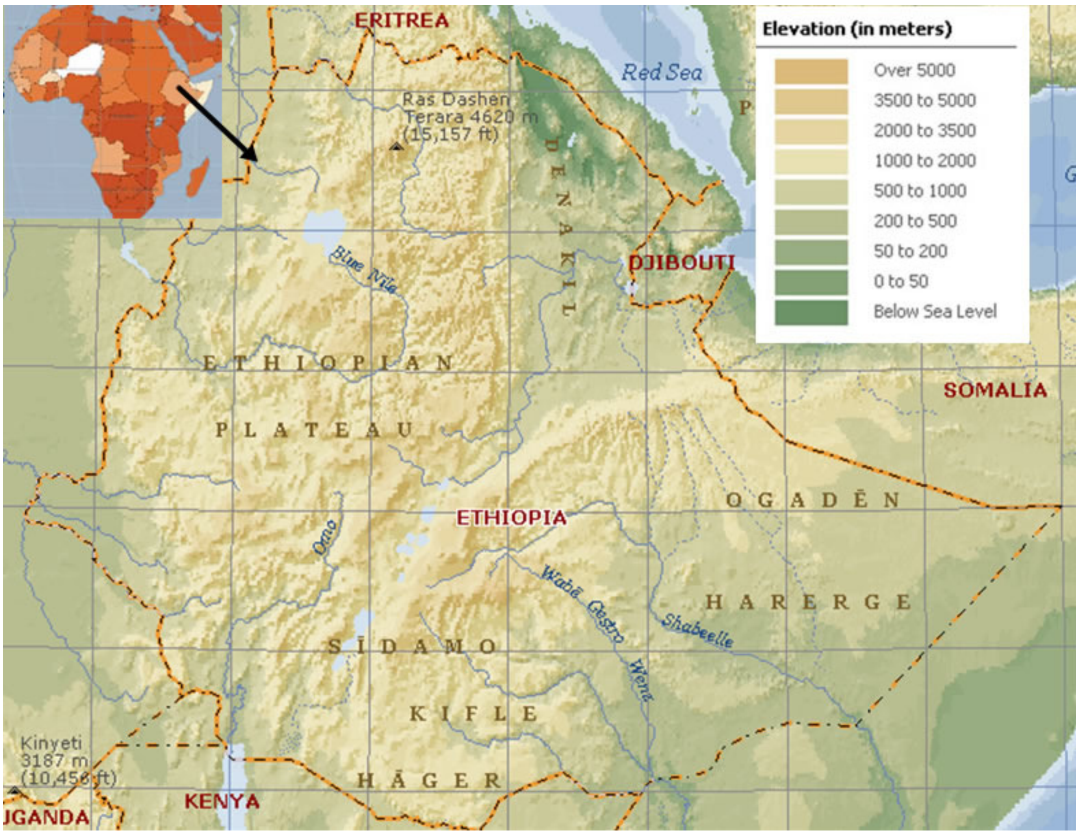

Figure 1. Map of Ethiopia showing physical features (Source: Encarta 2006)

Although Ethiopia is a tropical country with typically hot and dry lowland areas, it has 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 of both animals and plants. The rainfall distribution is seasonal and is mainly governed by the inter-annual oscillation of the surface position of the Inter-Tropical Convergence Zone (ITCZ) that passes over Ethiopia twice a year. This causes variations in the wind flow patterns and the onset and withdrawal of winds from north and south.

The mean annual rainfall patterns range from below 350 mm to 2,800 mm. The South western region receives the heaviest annual rainfall which goes up to 2,800 mm in some areas. The central and northern central regions receive moderate rainfall that declines towards northeast and eastern Ethiopia, and the southeastern and northern regions receive an annual rainfall of about 700 mm and 500 mm. respectively. The relative humidity regimes that closely follow the rainfall pattern, the rainfall pattern itself and the high variation in temperature (> 30 ^{o}C and < 10 ^{o}C) influence types and diversity of the vegetation and their distribution over the country.

POPULATION

Ethiopia has an estimated population of approximately 75 million, and about 86 percent of the total population is considered as rural dwellers. The estimated population growth is about 2.8 percent per annum. The settlement pattern of the population is influenced by environmental factors such as altitude, climate, soil fertility and by commercial economic activities which have skewed the population distribution towards the highlands. The Ethiopian highlands (>1,800 masl), which cover 37 percent of the total area is 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 vegetation, while the lowlands, being affected by insufficient rainfall and high temperature are sparsely populated. This uneven human population distribution throughout the country is one of the important factors that have impacts on the productivity of agricultural lands and the conservation and management of biological resources.

MAJOR FARMING SYSTEMS

The Ethiopian region 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: the highland mixed farming system, the low plateaux and valley mixed agriculture and the pastoral livestock production of the arid and semi-arid zones. Agriculture in Ethiopia is a basis for the entire socioeconomic structure of the country and has a major influence on all other economic sectors and development processes of the country. It provides about 85 percent of the total employment and generates about 40 percent of the country's earnings from export, contributing about 57 percent of the country GDP and 90 percent of the export earnings (CSA, 2005; FAO, 2005). Of the total area, which is 122 million hectares, 84 million hectares (69 percent) is classified as agricultural land suitable for crop and livestock production. Of this, about 32 million hectares is cultivated with about 12 million hectares under major crop production annually.

a. The highland mixed farming system

This farming system is typically found in areas of higher elevation which are usually above 1800 masl. In these areas of high population density, farm sizes are small and decreasing in size, therefore land is more intensively used. Crop production under this farming system is diverse and multiple cropping with limited inter-cropping is intensively employed. 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/plants 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 landraces are still used in the system. Traditional and cultural indigenous crops are commonly grown, especially in back yards and home gardens. The highland mixed farming system includes the mixed crop livestock complex. The livestock component within this system is essential where animals are used 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 pasture and stubble.

b. Low plateaux and valley mixed agriculture

This is a sedentary agriculture system of the intermediate or low highlands, mountain foothills and upper valleys, often practiced at an altitude ranging from 1,500 to 2,000 masl. 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 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 with crop residues.

c. Pastoral livestock production of the arid and semi-arid zone

Pastoral agriculture is practiced mainly at an elevation below 1,500 masl 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, nomadic and semi-nomadic pastoral livestock production dominates with camels and goats as important components. In the semi-arid, semi-nomadic or semi-sedentary zone, livestock production is practiced. The major components of the livestock production here are cattle and sheep, although camels and goats are also found. Range development and improved access to water are important to improve livestock production. In recent years, there has been a move away from the nomadic 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.

CURRENT STATUS OF THE AGRICULTURAL SECTOR

The highlands of Ethiopia comprise a vast area of the country and receive reasonably good rainfall for crop production. In Ethiopia, small scale farming systems are traditional and managed with simple production technology. Ploughing is usually oxen driven and weeding and harvesting uses simple farm tools. Most crops show high levels of diversity and local landraces are used extensively. Traditionally, farmers select seeds for various traits and purposes, and also exchange seeds through traditionally established networking. Large scale farming was managed previously by state farms for production of seeds of improved varieties.

Crop production in Ethiopia has not kept up with the rapid population growth. Among the major factors that cause this low crop productivity is the topography, which is dissected and mountainous. This together with over-exploitation due to the high population density in the highlands makes the land vulnerable to degradation, and restricts the availability of suitable land for farming. The situation has been exacerbated by the cultivation of very steep slopes and over grazing. Low soil fertility remains a problem in many areas; especially as traditional land management practices have given way to more intensive cropping. Manure is also used as fuel in the highlands and may not be put back on the land and subsistence farmers are unable to cover the high costs of inorganic fertilizer. Crop production is also constrained by climate and low rainfall in the pastoral areas.

Crop production under the diverse agro-ecological conditions of the country requires seeds of a number of modern varieties that could fit these ecologies, in addition to the traditionally adapted landrace seeds. The existing national breeding and seed multiplication capacity is not sufficient to address the critical seed shortages for new varieties at the national level. Less than two percent of the cultivated area is sown to improved varieties mostly due to the high price of improved seeds and the preference of farmers to grow traditional landraces.

The national average yield of the major crops has also been very low due to; inter alia, changes in environmental conditions and indiscriminate diffusion of seeds of varieties with poor adaptation to the local conditions. 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 the 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. This is leading to increased interest in new more productive varieties of traditional crops, such as the kabuli chickpea, and new crops, such as chat and flowers for export.

CHAPTER 1

1. THE STATE OF DIVERSITY

The flora of Ethiopia is estimated to be between 6,500 and 7,000 species, of which 10 - 12 percent is considered to be endemic. Endemism is reportedly high on the plateaus, mountains, in the Ogaden region and in the western and south western woodlands. The centre of endemism on the highlands of Ethiopia can be identified as follows:

- the southwestern centre, which is characterized by endemism of montane rainforest and evergreen bushland;
- the central plateau centre, which contains endemic deciduous woodland and montane grassland;
- the eastern escarpment and southeast slop centre, which has species such as *Spiniluma oxycantha* in dry evergreen forests and bushlands;
- the high montane centre, which contains endemic ericaceous bushland and Afroalpine grasslands such as *Rosularia semiensis*.

About 23 vegetation types are recognized in Ethiopia, which could be grouped into the following eight major categories:

- Desert and semi-desert scrubland
- *Acacia - Commiphora* woodland
- Moist evergreen montane forest
- Lowland (Semi-) evergreen forest
- *Combretum-Terminalia* Woodland
- Dry evergreen montane forest and montane grassland
- Afroalpine and Subafroalpine
- Riparian and swamp vegetation

1.1 DIVERSITY IN MAJOR CROPS

Ethiopia is one of the richest genetic resource centres in the world in terms of crop diversity. This is principally attributed to the diverse farming systems, socio-economics, cultures and agro-ecologies. Crop plants such as coffee (*Coffea arabica),* safflower (*Carthamus tinctorius*)*,* tef (*Eragrostis tef*)*,* noug (*Guizotia abyssinica),* anchote (*Coccinia abyssinica),* enset *(Ensete ventricosum),* are known to have originated in Ethiopia. Very high genetic diversity is found in Ethiopia in four of the world's widely grown food crops (wheat, barley, sorghum and peas); in three of the world's most important industrial crops (linseed, castor and cotton); in the world's most important cash crop (coffee); in a number of food crops of regional and local importance (tef, noug, Ethiopian mustard, enset, finger millet, cowpea, lentil) and in a number of forage species of world importance (clovers, medics, oats).

The major crops of Ethiopia include the following:

1.1.1 Cereals

Tef (*Eragrostis tef*) is the most important staple food crop covering over two million ha and accounting for over 20 percent of the land allotted for cereal production in the country. It is grown at a range of altitudes, rainfall and on a variety of soil types. It shows immense phenotypic diversity in plant height, size and compactness of panicle, and seed colour.

Sorghum is a traditional food crop widely grown in the country, in 13 of the 18 major agro-ecological zones, covering over 1.3 million hectares. It is predominantly used for food, 80 percent of it for injera (flat pancake like traditional bread) making. The crop is second only to tef for injera making. Ethiopia has a diverse wealth of sorghum germplasm adapted to a range of altitudes and rainfall conditions. The crop is mainly grown in the lowland arid and semiarid areas. Of the five morphological races of sorghum (bicolor, guinea, caudatum, durra, and kafir) all except kafir are grown in Ethiopia. Important traits reported from 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.

Barley is one of the first domesticated cereals in Ethiopia. Many authors have identified the country as a centre of diversity for barley. The cultivated area devoted to barley is over one million hectares. The barley landraces existing in the country are of varied morphology (two and six rows, irregular types) and colour (black, white and pink). In addition to phenotypic diversity, the Ethiopian barley is important source of genes for barley yellow dwarf virus resistance, high lysine, drought resistance, resistance to diseases such as powdery mildew, leaf rust, spot blotch, septoria, loose smut and barley stripe mosaic virus.

According to Vavilov, the diversity in Ethiopian wheats comprises six wheat species: *Triticum durum* subsp. Abyssinicum; *T. turgidum* subsp. abyssinicum; *T. dicoccum*; *T. aestivum*; *T. polonicum* and *T. compactum*. Currently, the five tetraploid species listed above are classified under *Triticum turgidum*. All these species of wheat observed by Vavilov in the mid-1920s are still grown by farmers as landraces. Although Vavilov regarded the Ethiopian region as a centre of origin and diversity for tetraploid wheats, 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 centre. Durum wheat is a major industrial and food crop and it is grown on over 500000 ha of land. Until 2001, about 49 improved varieties of durum wheat of Ethiopian origin were developed and released.

1.1.2 Pulses

Ethiopia is probably one of the primary centres of diversity for faba bean. Although the small-seeded type of the Ethiopian faba bean is not well studied, there are some reports of tremendous diversity in protein content, chocolate spot and leaf rust resistance.

Field pea is the second most important legume crop in Ethiopia after faba bean in terms of both area and total amount of production. According to CSA, field pea covers over 254000 ha with a total production of 230000 tonnes which accounts for 17 percent of the total grain legume production. The origin of field pea is controversial. Ethiopia is undoubtedly the centre of diversity for this crop, and wild and primitive forms are known to exist in the high elevations of the country. Field pea, one of the oldest crops in the country, has a unique subspecies developed in Ethiopia - *Pisum sativum* subsp. *abyssinicum*. The existing germplasm in the country shows tolerance/resistance to disease.

Chickpea (*Cicer arietinum*) is one of the ancient crops in 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. Chickpea covers over 160000 ha with a total production of 160000 tonnes which accounts for 12 percent of the total grain legume production. 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 colour, seed colour, anthocyanin in the leaves, disease and drought resistance. The related wild species of chickpea (*C. cuneatum*) has been found in northern Ethiopia.

Lentil is among the principal food legumes widely grown in diverse agro-ecological zones, ranging from hot sub-moist low lands to cool humid mid highlands. Lentil covers over 76000 ha with a total production of over 54000 tonnes. The crop is cultivated mostly for domestic consumption. There are conflicting reports as to the origin of lentil. Some authors regard Ethiopia as a centre of origin/diversity whereas some have reported lentil to be an early introduction to Ethiopia. The Ethiopian germplasm is diverse in earliness, seed yield, harvest index, number of seeds per pod and cold tolerance. The wild species *Lens ervoides* grows in montane grassland in the north and central regions of the country.

Grass pea is drought resistant and can tolerate low soil fertility and is an important pulse, especially in drought years. The crop covers over 110000 ha with a total production of over 125000 tonnes. Ethiopia is considered as one of the primary centres of diversity for grass pea. Germplasm collected from Ethiopia exhibited high diversity for seed coat colour, primary branches/plant and anti-nutritional factor called ODAP in the seed. Land race cultivars with high ODAP content are grown by the great majority of Ethiopian farmers.

1.1.3 Oil crops

Ethiopia is one of the major centres of origin and diversity for several oil crops. Gomenzer (*Brassica carinata*), noug (*Guizotia abyssinica*), sesame (S*esamum indicum*) and linseed (*Lens culinaris*) are the major, indigenous oil crops having considerable diversity in the country. These crops are primarily used as sources of oil for local consumption and also contribute to the national economy through import substitution by helping save scarce foreign currency spent for importing cooking oil. The total allotted area for the production of oil seeds is nearly 0.8 million ha, accounting for about 8 percent of the total cultivated area.

Gomenzer (Ethiopian mustard), which is grown extensively in the highlands, has a considerable diversity for several vegetative traits. Gomenzer covers over 40000 ha with a total production of over 35000 tonnes. There are weedy forms of *Brassica* growing through out the high lands of Ethiopia that are gathered and eaten as leafy vegetables. Since no wild relative of gomenzer is known, the hypothesis is that gomenzer is a tetraploid hybrid between *Brassica nigra* and *Brassica oleracea*.

Noug is an important oilseed crop in Ethiopia. It is one of the widely cultivated indigenous oil seed crops particularly in the highlands of Ethiopia. Noug stands first in both total area and production among the Ethiopian oil seeds. It covers 358828 ha with a total production of over

187000 tonnes. Legend has it that the crop originated as a selection from its wild relative (*Guzotia scabra*), which is also considered native to Ethiopia. The phenotypic diversity in noug is more obvious for characters related to flowering, maturity, head size and other morphological characters.

Linseed is the second major oil seed crop of the highlands of Ethiopia. Linseed is known for its high quality oil and its use as a raw material for agro-industries. It covers 250700 ha with a total production of over 150000 tonnes. Ethiopia is considered as a centre of diversity for linseed. Linseed, grown for oil production, has a relatively high variability in flower colour, plant height, flowering and maturity duration, and capsule size and wilt resistance.

Sesame is the third most important oil seed crop in Ethiopia, showing substantial genetic diversity. The crop is largely produced for export. Sesame is grown in 136220 ha with an annual production of over 115000 tonnes. It occurs both as a cultivated crop and in the wild exhibiting a high phenotypic diversity for number of days to maturity, plant height, pod shape and size, and for seed size and colour.

1.1.4 Root and Tuber Crops

There are several indigenous cultivated or semi-cultivated root and tuber crops in Ethiopia. These crops have an important place in the diet of the population.

Enset is endemic to Ethiopia and occurs throughout the country both cultivated and wild. It is an important staple to a large number of people in the south and southwest of the country. Although the plant is propagated vegetatively, there is tremendous variation in several characters, including colour of pseudostem and leaf midribs, earliness, disease resistance and product quality.

Potato plays a significant role for food security, though it has very limited genetic variability in the country. Similarly, sweet potato is one of the major root crops in the country with a limited variability.

1.1.5 Stimulant Crops

There are several important stimulant crops of Ethiopian origin. Among the ones with high commercial value are coffee (*Coffea arabica*) and chat (*Catha edulis*). These two stimulant crops are primarily produced for local consumption and the export market. Although exact statistics are hard to come by, coffee and chat are extensively produced on a vast expense of land in many parts of the country.

Coffee is one of the major global stimulants. This is a genetic resource that Ethiopia has given to the world community. It is a moist montane forest shrub, or a cultivated crop and garden plant, growing together with fruit trees and herbs in backyards. Coffee grows in many parts of the country; however, the bulk of the produce comes from western and southern part of the country, and a limited area in the east. 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, liquoring quality and other traits.

Chat is one of the early domesticates in Ethiopia. It is consumed in Ethiopia as a stimulant plant and exported to neighboring countries such as Yemen and Djibouti. Although there is no systematic study, a striking variation can be observed in morphology and leaf colour in the major growing areas.

1.1.6 Industrial 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. se-marense) and those of the E genome (*G. somalense*, *G. bricchettii* and *G. benadirense*) are recorded.

1.2 DIVERSITY IN MINOR CROPS

1.2.1 Cereals

Finger millet (*Eleusine Africana)* is very likely of Ethiopian origin. At present, it is mainly grown in the northwestern parts of the country and shows considerable diversity. The wild species, the possible progenitor of the cultivated species, occurs as a weed in finger millet fields. Pearl millet (*Pennisetum glaucum*), though less important in production, is believed to have originated in Ethiopia. Emmer wheat is also grown to a limited extent, though its diversity is believed to be narrow.

1.2.2 Pulses

Cowpea is mainly cultivated in Konso and Gambella in the west and south-western parts of the country. The two cultivated subspecies - *Vigna unguiculata* subsp. *unguiculata* and *V. unguiculata* subsp. *cylindrica* are found as landraces in the eastern part of the country. The two wild species *V. aconitifolia* and *V. vexillata* are found in the northern, south-western and southern part of the country. Although there is not sufficient information on the magnitude of the diversity in this crop, it is believed that the African species might have been domesticated in Ethiopia. The species is divided into three cultivated and two wild sub-species.

Fenugreek is locally used as a pulse, spice and medicinal plant, and has a long history in Ethiopia. Even though the hectarage is limited, the species has a considerable genetic diversity in seed colour, maturity and other morpho-agronomic characters.

Diversity information on grass pea is limited. The crop is commonly grown in the highlands and has an important trait of drought resistance. The wild species *Lathyrus pratensis* and *L. sphaericus* are found in upland grassland.

Hyacinth bean (*Lablab purpureus*) is grown in Konso (southern Ethiopia) and around Gondar and Gojam in central and Northern areas. Although this is under dispute, some authors have regarded Ethiopia to be the centre of origin/diversity for this species. Considerable agro-morphological diversity is seen in this species for plant height, leaf size, flower and seed colour, number of seeds per pod, seed size and shape and seed yield.

Pigeon pea (*Cajanus cajan*) is a common pulse traditionally cultivated on terraces in the Konso area and now spreading to the drier northern areas. There is no common agreement on the centre of origin of pigeon pea. Nevertheless, Vavilov and other authors have indicated Ethiopia as a probable centre of origin. The larger woody types are more commonly cultivated, although diversity in plant height, woodiness and flower, pod and seed colour are found in the local material.

1.2.3 Oil Crops

Some authors consider Ethiopia to be the probable centre of domestication of safflower (*Carthamus* spp.). At present the crop is grown on a small scale. Insufficient information is available on its diversity, although ecotypes found in Ethiopia are tall red flowered spiny types.

Both cultivated fields and wild population of crambe (*Crambe abyssinica*) are found in the highlands of Ethiopia. However, the distribution is shrinking and crambe fields are rare at present, indicating that there are conditions that threaten the existing diversity.

1.2.4 Root and Tuber Crops

Oromo dinich (*Coleus edulis*) occurs both in the wild and cultivated. The genus *Coleus* has about 30 wild species in Ethiopia. The cultivated species is grown in the wetter south and southwestern regions of Ethiopia whereas the wild species are found throughout the country.

Anchote (*Coccinia abyssinica*) is an endemic species found both cultivated and in the wild in Ethiopia. Although the genus in Ethiopia is not well studied, there are more than eight taxa recorded, distributed throughout the country.

Yam (*Dioscorea spp.)* might have its origin in Ethiopia. Even though yam is not a staple crop in Ethiopia, there are ten species recorded, distributed throughout the country. Some of the species have both cultivated and wild forms. It is reported that aerial tubers are more common than root tubers in western Ethiopia. Some of the species are highly drought resistant.

1.2.5 Vegetables

Ethiopian mustard (kale), pumpkin, and chilli are important vegetable crops having a narrow range of diversity.

Cabbage tree (*Moringa stenopetala*) is an important vegetable tree in the konso area of south-western Ethiopia. Five species of this genus are recorded in Ethiopia. One of this five species is horse-radish tree (*Moringa oleifera*) which is used as a source of oil and for the purpose of purifying water.

Several authors have indicated that okra (*Abelmoschus* spp.) might have been domesticated in Ethiopia. It has high diversity in Ethiopia and it is an important vegetable in some parts of the country particularly in the south-western lowlands (550 to 650 masl) region. In addition to the cultivated species, the distribution of two other species *A. manihot* and *A. moschatus* are reported recently.

1.2.6 Stimulant crops

Gesho (*Rhamnus prinoides*) is an important garden plant used extensively in home brewing of local beverages such as ‘Tella’ and ‘Tej’. It is a crop grown in a wide range of ecologies across the country.

1.2.7 Industrial crops

Both cultivated and weedy/wild types of castor bean are widely distributed under a range of ecological conditions in Ethiopia. Because of the immense diversity in plant, fruit and seed characters, some authors consider Ethiopia as the origin of cultivated castor bean.

Kenaf is reported by many authors being Ethiopia origin. *Hibiscus cannabinus* occurs wild in a range of habitats. The cultivated species is *H. sabdariffa*. In addition to these, six wild *Hibiscus* spp. have been observed in Ethiopia.

Thirty different species of *Vernonia galamensis* have been identified in Ethiopia. It is a semi-arid plant. The oil characteristics make it suitable for industrial use in the plastic formation and coating industry.

1.2.8 Spices

There are several important spices which are of Ethiopia origin. The most important species include *Aframomum corrorima*, *Trachyspermum ammi*, *Coriandrum sativum*, *Nigella sativa*, *Capsicum spp*., *Cuminum cyminum*, *Diplolophium abyssinicum*, *Anethum graveolens*, *Ocimum basilicum*, *Allium cepa*, *Foeniclum vulgare*, *Ruta chalapensis* and *Piper longum*.

1.2.9 Forage species

Ethiopian agriculture is heavily dependent on livestock. The forage and browse for these comes largely from grazing natural vegetation and crop residues. The Ethiopian flora is rich in grass and legume forage species. Although the magnitude of the diversity in the indigenous forage crops is not well studied, recent observations indicate that Ethiopia is a centre of diversity for *Trifolium,* and of its twenty six indigenous species, ten are found to be endemic. The major forage species 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.

1.2.10 Aromatic and medicinal plants

There are a number of indigenous and introduced aromatic and medicinal plants in Ethiopia. Some of these are *Commiphora* spp., *Boswellia* spp., *Cymbopogon citrates, Myrtus communis, Artemisia* spp., *Cinnamomum cassia, Hagenia abyssinica, Rumex spp., Dodonaea angustifolia, Glinus lotoides, Embellia schimperi*, *Juniperus procera*, *Echinops* spp., *Olea europaea* subsp. *cupsidata*, *Otostegia* spp., *Ocimum* spp., and *Cyperus bulbosus*.

1.3 WILD SPECIES AND WILD RELATIVES OF CROP PLANTS

In Ethiopia there are many wild plants which are used for food, especially during period of food shortages. The majority of such plants are those used as leafy vegetables, edible fruits, tubers and roots. *Corchorus* for example has nine species which are found in Ethiopia and collected at a young stage and eaten as a cooked vegetable, although, none of them are cultivated. There are also grasses, such as *Snowdenia polystachya*, whose seeds are used for similar purposes to tef in some parts of the country. Examples of semi-domesticated plant species also occur in Ethiopia such as *Avena abyssinica*.

Some of the domesticated plants still occur with their wild relatives in some parts of the country. Examples are *Thymus* spp. in the Afro-alpine regions of the country; *Enset ventricosum* which occurs both in wild and cultivated state in the medium to higher altitudes; *Gossypium* spp. in the lowlands, as wild and cultivated; and *Sesamum* spp. which is found both cultivated and wild at an elevation below 1800 masl. There are other wild plants currently attracting attention as potential crops, primarily for their use value. *Vernonia* spp. with thirty species identified in Ethiopia is a potential source of industrial oil; *Cordeauxia edulis* which is used in the arid areas as both feed and food source; *Amaranthus* spp. found as common weed in some parts of the country of which young plants are cooked as vegetable and seeds used for porridge and local beer, are among few of them.

There is a considerable wealth of plants of various importance used by Ethiopians, though it is not fully possible to tell their current status of use. Those plants that are used in traditional medicine are species of important social and economic value. Although it is estimated that the traditional medicinal plants cater for the health care needs of over 80 percent of the population, the major medicinal plants of Ethiopia are not cultivated except few herbs that are grown in the backyards. Among the major known Ethiopian plants of medicinal value are *Hagenia abyssinica*, *Glinus lotoides*, *Rumex* spp which are used as a source of taeniacide; and *Taverniera abyssinica* for treating stomach ache, headache and fever. *Senecio* spp., *Adhatoda schimperiana*, *Chenopodium* spp., *Dioscorea* spp., *Solanum* spp., *Datura stramonium*, *Aloe* spp., *Ricinus communis*, *Plantago lanceolata* and many other wild species are used as a source of traditional medicine.

The Ethiopian region is also rich in resins and gums which mainly come from the three genera - *Acacia*, *Boswellia* and *Commiphora*. *Acacia senegal* is a source for the true gum arabica and is widely distributed in the lowlands of Ethiopia. Fifty two species of *Commiphora* were recorded in Ethiopia, and thirty five of these are found in south and south-eastern Ethiopia.

1.4 CROP VARIETIES

Variety development for major crops began in 1966 with establishment of the Institute of Agricultural Research (IAR) now EIAR, a semi-autonomous public organization. It is a principal plant breeding institution, responsible for cereals, legumes, oil seeds, fibres, horticultural and forage crops. Apart from EIAR, the regional research institutes and the universities are also involved in agricultural research and variety development. The Ethiopian Pioneer Hi-bred International (EPHI) introduces and tests maize hybrids from its parent company for adaptation and release in Ethiopia. The variety development, evaluation, release and registration procedures have several stages: observation nursery, preliminary yield trial, pre-national yield trial, national yield trial. Promising lines are evaluated on farmers' fields where new varieties are intended for release. The variety release and registration system has evolved over a number of years. Since 1984 variety release and registration has become the responsibility of the National Variety Release Committee (NVRC). Many varieties of cereals, legumes, oilseeds, fibre crops and vegetable crops have been developed and were recommended or released for use by farmers in Ethiopia. The major requirements for release of varieties are distinctness, uniformity and stability as well as quality parameters.

In Ethiopia, public and private companies are involved in the production and supply of seed. Farmers are also encouraged to participate in local level seed production and marketing within their communities. Formal seed production is dominated by the public sector. Ethiopian Seed Enterprise (ESE) is an autonomous parastatal organization governed by a Board of Directors and is responsible for production, processing, marketing and quality control of seed. The government, however, encourages the participation of the private sector both in variety development, seed production and supply. The government provides both technical advisory services and training support for private seed enterprises. Since 1991, the EPHI and some private investors are involved largely in hybrid maize seed production and supply. The seed production follows a generation system: breeder, pre-basic, basic and certified seed.

The maintenance of released varieties and the production of breeder and pre-basic seed continue to be the duty and responsibility of the agricultural research institutions and universities that have developed the varieties. Modern varieties in production might loose their genetic purity through time. It is thus important to conserve seed samples of new cultivars in seedbanks. With respect to this, the IBC has started a programme to conserve old and new varieties developed by the National Agricultural Research System (NARES) over the years.

The major constraints to further development of the seed system in the country includes limited capacity of NARES to supply adequate quantities of breeder and pre-basic seed, the weak formal seed sector, the fact that the farming community is resource poor and unable to purchase seed, inadequate credit facilities, inadequate capacity to forecast demand/supply requirements, inadequate distribution and marketing systems, mainly due to poor infrastructure. Use of improved varieties of major crops is only 15 percent of the cultivated land in the country due to these constraints. The remaining 85 percent is cultivated using farmers' own varieties. Nevertheless, some of the crops are enjoying an increasingly expanding market acceptance. For instance, coffee, haricot bean and sesame are widely grown for export. Tef, wheat, malt barley, lentil, chickpea, pepper, tomato and onion are more important in the local market. Similarly, there is a fast growing floriculture industry and tremendous market potential for spices, fruits and industrial crops, even though it is not yet fully exploited. Agricultural research and development institutions are collaborating on scaling up and scaling out activities to help the country better exploit recent export market opportunities.

1.5 FACTORS AFFECTING THE STATE OF DIVERSITY

Until the 1970's, the diversity in the landraces was unaffected significantly. However, due to repeated drought in some areas of high crop diversification in the country, and diffusion of exotic seed varieties that have been displacing the landraces, the pace of genetic erosion tremendously increased after 1970's. Displacement of indigenous landraces by genetically uniform varieties, changes in crop pattern and land use have largely affected the magnitude of the genetic diversity of the indigenous crops. For instance, the highlands of Arsi and Bale have been farmed with modern agricultural practices for over three decades. In these and other regions, the native barley is suffering serious genetic erosion due to gradual displacement of the crop by other crops, especially by introduced varieties to the region. Durum wheat is giving way to tef and new bread wheat varieties, particularly in areas where extensive wheat breeding activities have occurred since the sixties. A recent study conducted in north-eastern Ethiopia revealed that drought and replacement of landraces with improved varieties were among the major factors contributing to genetic erosion of sorghum. Commercialisation and planting of uniform varieties over large expanses of land have resulted in previously unknown diseases and pest problems, leading to genetic vulnerability. In the central highlands, including the northern Shewa and Gojam regions, introduced varieties of oats have replaced a wide range of crops grown in these areas.

Although much of the diversity is still in the hands of farmers, much has already been lost and the threat has also been extended to the traditional management systems of the varieties of crops developed and used by the local people through generations. The situation therefore, has created awareness that long term food security depends on the ability to systematically maintain and use the existing genetic diversity of the indigenous crops. As one of the strategies to meet the challenge, the Institute of Biodiversity Conservation (IBC) has developed *in situ* landrace conservation and enhancement programmes that involve breeders, farmers and others, in several stages of maintenance, restoration and improvement processes of traditional crop varieties. Based on a number of previous empirical data surveys conducted under a project entitled: A Dynamic Farmers'-Based Approach to the Conservation of Ethiopia's Plant Genetic Resources, which ran from 1997 - 2002 funded by Global Environmental Facility (GEF), IBC identified twelve major areas of crop genetic diversity which have been used as Community Genebanks (CGB). The CGBs have involved 22 crop species consisting of 400 farmer varieties in six agro-ecological zones of the country. A similar initiative has been proposed by IBC for conservation of crop wild relatives and wild plants relevant to food production.

The establishment of the CGBs on crops has served a useful purpose in terms of conserving crop diversity. The conservation of wild plant species could play an additional role for food security. However, lack of adequate financial support and skilled human resources have constrained the efforts being made to expand conservation programmes aimed at ensuring food security.

Collection, conservation and utilization of plant genetic resources are continuing processes. The IBC currently holds over 60000 accessions constituting more than 200 plant species. The vast majority of these materials are landraces. To further strengthen and enhance not only the collection but also the conservation and sustainable utilization of this vast resource for food security, short, medium and long term strategies are in place. At the regional level, through the East Africa Plant Genetic Resources Network (EAPGREN), efforts are under way to build the necessary capacity (laboratory equipment, training) and to support the genebanks to undertake further collections and multiplication and rejuvenation of plant genetic resources for sustainable use.

CHAPTER 2

2. 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 management of diversity through their production strategies.

The primary objective of on-farm *in situ* conservation is to conserve the biodiversity of traditional crop varieties in the area where it was adapted/evolved. On-farm *in situ* conservation is one of the most important *in situ* conservation methods where farmers' knowledge and traditional practices are exercised. On-farm conservation of agro-biodiversity is conservation in a dynamic agro-ecosystem, ideally one which is self-supporting and favouring evolutionary processes. Thus, it allows ongoing host-parasite co-evolution, which is likely to provide material resistance to pests and diseases. This contrasts the efforts to conserve crop diversity in static off-farm (ex situ) genebanks. However, *in situ* maintained diversity is more difficult to access for breeders who like to use specific materials for their breeding programmes.

CBD recognizes *in situ* conservation as a primary approach to conserve biodiversity. In Ethiopia this conservation method is considered important and implemented primarily by IBC. Other institutions involved in *in situ* conservation include the NARES, the Federal Ministry of Agriculture and Rural Development (MoARD) and the Regional Bureaus of Agriculture and Rural Development.

2.1 PLANT GENETIC RESOURCE INVENTORIES AND SURVEYS

Plant genetic inventories and surveys have been conducted by the IBC in collaboration with partner organizations, such as the MoARD, in order to gather and document information on the types and distribution of farmers' landraces, forest and aquatic resources, medicinal plants etc. Following extensive surveys, about twenty areas rich in biological diversity, distributed across six regional states, have been identified for conservation purposes. Subsequently, a number of habitat rehabilitation initiatives have been launched, contributing to food security and rangeland recovery.

The implementation of surveying and inventorying of Plant Genetic Resources for Food and Agriculture (PGRFA) has been constrained mainly because of a lack of financial resources and skilled manpower, and poor institutional capacities. There is also a lack of skilled manpower in using modern technologies such as Geographic Information Systems (GIS). The information and documentation systems being used for registering the PGRFA of the country are poorly organized and they are not amenable for upgrading and networking, requiring substantial improvement in the future.

2.2 CONSERVATION OF WILD PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE IN PROTECTED AREAS

The conservation of PGRFA is one of the most challenging tasks for human kind today. Many of the species from which the crop plants were selected still exist in the wild. This 'pool' of wild species comprises the 'wild relatives' of crops. Many wild relatives have evolved to survive droughts and floods, extreme heat and cold, and they have become adapted to cope with natural hazards. They have often developed resistance to the pests and diseases that have caused so much damage to the related crops. This is why they are still so valuable to agriculture today. In Ethiopia there are numerous wild grass species, legume and oil seeds, fruits, vegetables, root and tubers, medicinal plants, spices etc. that are extensively used for food, feed, medicine and other traditional uses.

To date, a wide range of wild plants that can be used as gene sources for future improvement work on some of the economically important crops vis. coffee, sorghum and tef, have been identified. Many wild plants are known and widely used by the rural communities as alternative food sources, especially in dry years, for curing illnesses and making household items. Although it is still at a limited scale, IBC has made an effort to document indigenous knowledge and wild plants use in some parts of the country.

2.3 ECOSYSTEM MANAGEMENT FOR CONSERVATION OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Ethiopia's boundaries encompass the major part of the eastern African highland massif. On the northern and western boundaries lie the foothills of the main massif. The Great Rift Valley cuts diagonally across the country from the Red Sea to Kenya, creating a vast depression. The dry areas have isolated the highlands. There is great variation in altitude from 116 m below sea level to 4620 m.a.s.l. Rainfall also varies widely in amount and distribution. These factors strongly influence Ethiopia's extraordinary range of terrestrial and aquatic ecosystems and contribute to the high rate of endemism and biological diversity.

Over the years, this diversity has been exposed to various biotic and abiotic stress factors that have diminished its diversity. Attention given to diversity conservation and sustainable use has been inadequate. Some of the major contributory factors to the accelerated decline of biodiversity are the size and pattern of the distribution of human and animal population, the level of resource consumption, market factors and policies. Under-valuation of environmental resources due to a low awareness level of the role of ecosystems and the rate at which it is being deteriorated or lost, and low consideration of conservation problems have also contributed to an under-investment in biological resource management.

Records on ecosystem conservation efforts in Ethiopia date back to the days of Emperor Zera-Yakob (1434-1468 E.C.). The Emperor brought juniper seedlings from Wof Washa of North Shewa and planted in Managesha - Suba area, located in the south-western fringes of Addis.

Modern conservation began by Emperor Menilik in 1908 E.C. This conservation initiative eventually evolved to the creation of protected areas in the 1960s and led to the establishment of the Ethiopian Wildlife Conservation Organization (EWCO).

Although there are some conservation efforts taking place in the country, the attention given to ecosystem conservation and management has been very low. There has also been a very low awareness level of the role of ecosystem conservation in securing biological diversity. By recognizing the existing gaps and with the present worldwide concept of ecosystem approach to biodiversity conservation, IBC is currently undertaking some activities. Although achievements are limited, conservation of natural forests is developing through the establishment of protected areas and national parks. In Ethiopia 57 National Forest Priority Areas have been identified and studies on the general floristic composition of the natural forest and other protected areas are under way.

There are currently 10 national parks, 13 wildlife and bird sanctuaries, and 14 controlled hunting areas in Ethiopia. There are also protected forest areas and areas proposed for conservation. The Menagesha - Suba natural forest, which has been heavily exploited for many decades, has now been declared a protected forest area. The Megada natural forest in the southern part of the country is a protected forest where no forest exploitation is allowed, due to low regeneration and poor under-growth establishment. The Wof Washa natural forest, because of the ruggedness of the terrain and poor regeneration, is also considered a protected forest where no exploitation is allowed.

2.4 ON-FARM MANAGEMENT AND IMPROVEMENT OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Practical measures were taken in the area of on-farm *in situ* conservation with a programme of landrace conservation that was initiated in 1989. The major objective of this Ethiopian *in situ* on-farm conservation for landraces is to support the farming communities in their efforts to maintain crop/plant diversity, and produce food. The *in situ* on-farm maintained landraces is a source of material with a wide range of adaptation. These traditional varieties are important to mitigate famine and provide the basic material from which farmers select special lines to meet their changing needs.

Ethiopian *in situ* on-farm conservation aims at conserving diversity in crop species, multi-crop association and cultural practices. Traditional crop variety improvement components are integrated in the conservation and multiplication activities in order to fill production gaps. Both formal and informal efforts in crop selection serve the need to utilize high-input varieties and sustainable production through the use of better adapted materials.

The integration of the formal and informal crop improvement programmes and the promotion of community based seed networking are other components used to fill the gaps. Through community seed systems, farmers are supported in the selection of crop types and cultivars, and provided with reliable access to locally adapted planting materials. The community seed system also includes seed production and multiplication, marketing and distribution and community seed banks. The community seed banks intend to increase the access to diverse crop types, and to decrease seed shortage and genetic erosion.

Ethiopian *in situ* conservation is decentralized with the participation of farmers and other relevant stakeholders like local agricultural and rural development offices. It is also complemented by *ex situ* conservation systems, which at the same time serves as a source of genetic diversity for restoration and introduction. Farmers participating in the programme perceive the benefits from the *in situ* conservation and enhancement activities as being long term. In order to make the system sustainable it is important that the farmers themselves perceive an advantage in continuing to grow traditional crops and varieties. This condition however, requires at a certain stage, a minimum level of centralised technical support to the farmers or the farming communities.

The IBC has developed *in situ* landrace conservation and enhancement programmes that involve farmers, agricultural research institutions, local agricultural and rural development offices, and NGOs. A project entitled 'A Dynamic Farmer Based Approach to the Conservation of Ethiopia's Plant Genetic Resources' funded by the Global Environment Facility (GEF) was initiated in 1994 addressing the neglected aspects of plant diversity of indigenous crop varieties. This community-based *in situ* conservation project is designated to link farming communities and their varieties with the existing formal genetic resources conservation efforts of IBC. This has been done by establishing 12 CGBs in 6 zones (2 CGBs in each zone). Conservation at the farm facilitates farmer selection, and gene exchange with the wild species so that the evolution of landraces may continue.

The CGBs contain currently 22 crop species consisting of 400 farmer varieties in six agro-ecological zones of the country. Farmers' conservation associations have been formed for each *in situ* conservation site. Agro-morphological, nutritional, biochemical and ethno-botanical studies were conducted for some of the crop species. In some cases germplasm originally collected from the *in situ* sites and maintained at the genebank, was restored at their respective sites of origin. Indigenous knowledge such as methods of selection, cultivation and crop use, women's role and knowledge, seed exchange and movement, were surveyed and documented.

In situ conservation areas for coffee have been identified in six administrative regions. The implementation of this approach can be of a great help not only for the conservation of wild coffee, but also for other forest and plant species. Medicinal plants, on which 80 percent of the Ethiopian population depends, are mainly derived from forest species, and *in situ* conservation schemes would help conserving the nation's pharmacopoeia from being lost.

Ethiopia's indigenous and diverse PGRFA needs to be enhanced on-farm through research, conservation and sustainable utilization activities. Ethiopia needs to raise funds and promote PGRFA for the wellbeing of the world community. Inputs from the regional and international community are here essential. There is a need for awareness raising among policy makers, stakeholders and the public on on-farm management of PGRFA. The recognition of farmers' contribution to PGRFA management could enhance the sustainable use and management of PGRFA in the country.

2.5 ASSESSEMENT OF MAJOR NEEDS FOR *IN SITU* MANAGEMENT OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

The country has experienced disasters at different times. So far, there has been very little effort to systematically assess the magnitude of such disasters on loss of genetic materials and to reintroduce locally adapted germplasm. Based on the information gained from a number of empirical data and surveys, IBC has made an effort to restore local varieties of field crops in 12 districts of the country. There have also been efforts by the Food and Agriculture Organization (FAO) of the United Nations on organizing seed fairs. They have also supplied traditional sorghum varieties in eastern Ethiopia. However, the support from the international community to restore locally adapted varieties has been low.

The expansion of modern farming practices, which relies on improved, uniform crop cultivars, is a threat to local plant genetic resources. Furthermore, the resettlement programme currently launched in different regions of the country has forced farmers to leave their valuable plant genetic resources behind. There is therefore to establish a national programme for the restoration of locally adapted germplasm. This should be financially supported by the international community. The reintroduction of locally adapted germplasm is necessary and requires technical and financial assistance from regional and international organizations.

Thus, there is an urgent need to assess the strengths and weaknesses of the existing on farm *in situ* conservation schemes and to develop appropriate strategies for improving the effectiveness of these. The existing CGBs are positively impacting the conservation and sustainable utilization of farmers' varieties. Support should be ensured both in terms of finance and technique. Furthermore, similar CGBs should be established in the remaining agro-ecological zones of the country. Loss of valuable plant species assessments should be carried out to identify gaps in the coverage of Ethiopia's ecosystems. For the future there is a need to be proactive and rally concerned stakeholders for an extensive environmental impact assessment of current practices and to launch a concerted effort to put in place an organized nation wide on farm *in situ* management programme.

More importantly, farmer-based research to address challenges, gaps and opportunities in order to make on-farm management sustainable, is required. The genetic diversity of the traditional crops and their wild relatives enables the research community to develop improved varieties. It is not only important to conserve material that has direct economic value today, but also material that may turn out to be economically valuable in the future. There are diverse wild edible plant species that could be domesticated to alleviate food insecurity situation in the future. There is a plan already in place to conserve crop wild relatives and wild food plants *in situ*. Ethiopia needs to prioritize crop wild relatives and wild edible plants to be conserved *in situ* for the purpose of enhancing crop genetic diversity and food security. This could be achieved through the mitigation of habitat destruction, the implementation of a good land use policy, the promotion of on-farm conservation activities and awareness raising. The regional and international community could help in information exchange, training, collaborative research and financial support. NGOs could also play a significant role in this regards.

CHAPTER 3

3. THE STATE OF *EX SITU* MANAGEMENT

The Convention on Biological Diversity specifically recommends that *ex situ* measures should be adopted in situations where *in situ* conservation programmes do not prove to be adequate. These measures have most extensively been applied to conserve agro-biodiversity, employing techniques such as seed banks, field genebanks, in- vitro storage, and adaptive breeding measures. *Ex situ* conservation is complementary to the rehabilitation and restoration of degraded ecosystems, and the recovery of threatened species. In Ethiopia, IBC which was established in 1976 to lead *ex situ* conservation in the country has the basic facilities necessary for collection, conservation, distribution and documentation of PGRFA. Other institutions involved in *ex situ* conservation of biodiversity include EIAR and ILRI.

Since the establishment of the IBC, systematic crop germplasm exploration and collection operations have been undertaken in the different administrative regions of the country, covering a wide range of agro-ecological zones. Collection priorities were set based on factors like economic importance, degree of genetic erosion and diversity, researchers' needs, the rate of diffusion of improved varieties, clearing of natural vegetation, market and agricultural policies, natural disasters and resettlement programmes. In most of the cases, the collecting strategy was based on broad or non-crop specific rather than targeted collecting.

3.1 THE STATE OF COLLECTIONS

The collections held at IBC are mostly of indigenous landraces, including unique breeders' collections. There are also some accessions that were repatriated from countries that hold large quantities of genetic material from Ethiopia, some of which are not seen today in the fields of farmers. Over the years, a number of collection missions have been organized to collect economically important crops and/or with rich genetic diversity. These include crops like barley, wheat, sorghum and tef. The collection missions were conducted in Gojam, Gonder, Wello and north Shewa for a range of crops, including wheat, barley, maize, tef, sorghum, noug, linseed, lupin, finger millet, haricot bean, field pea, lentil and horse bean. At the time these were threatened by severe drought. About 446 samples were collected during this mission. The current holdings of the IBC genebank reach over 60,000 accessions (increased by 6000 the past ten years) of more than 200 crop/plant species (more than 90 species). About 7000 collections are in the short term storage mainly due to insufficient seed sample; these are pending for long term storage.

About 90 percent of the total germplasm holdings in the genebank consist of field crops. The total collection is composed cereal seeds, pulses, oil crops, spices and species of medicinal and industrial value. Aside from the crop collections, the genebank also holds 650 collections of micro-organisms. Over 9000 accessions of horticultural crops, medicinal plants and herbs are kept in field genebanks. The type and nature of collection missions, and number and lists of plant species and landraces collected, have been documented in number of manuals and reports.

Regular monitoring activities are performed for seed viability (at 5 to 10 year intervals depending on specific crop species) and stock inventories. The germplasm collection activities are primarily supported by the Ethiopian Government and to a limited extent by regional and global networks, including the EAPGREN.

3.2 SEED PURITY, DRYING, VIABILITY TEST AND STORAGE FACILITIES

Before storage, physical purity and quantity analysis are carried out in the laboratory, including the determination of purity percentage and proportion of impure seeds as well as the Thousand Seed Weight (TSW) of a given sample. The latter is essential to decide whether the seed sample is sufficient for long term storage. Samples with insufficient number of seeds are refused or multiplication recommended. The laboratory has the capacity to process more than 3000 accessions annually. Seed accessions that qualify for long term storage in terms of quantity and purity are dried at the temperature of 15 ^{0}C – 20 ^{0}C, with a relative humidity ranging from 15 - 18 percent. The required storage seed moisture content is 5 - 7 percent for cereals, 4 - 6 percent for oil cops and 6 - 8 percent for legumes. The minimum number of seeds required for long term storage of heterogeneous sample is 8000, and 3200 for genetically homogeneous materials with TSW less than 200 grams. For pragmatic and economic reasons, the sample size for species with TSW greater than 200 g is reduced to a reasonable level to maintain the initial genetic integrity of a sample. Seed samples fulfilling the required physical purity and quantity for long term storage will then be dried. IBC has two seed drying rooms with an annual capacity of drying about 4500 accessions.

It is also essential that the curator is able to assess accurately the initial viability of accessions prior to storage and then to monitor the viability of the samples during storage. Initial viability (before storage) and monitoring viability of stored seeds is undertaken in the seed viability testing laboratory. If the initial germination percentage is less than 85 percent, immediate rejuvenation is recommended to ensure longevity during storage. The laboratory has a capacity of testing about 3600 seed samples of field crops annually. In the future seed samples from species requiring dormancy breaking and those samples taking a long period of time to germinate (e.g. forest seeds) are expected to rise. Thus the laboratory is working to increase capacity both in terms of skilled personnel and laboratory facilities.

Four cold rooms running at -10 ºC with capacity of nearly 350 m^3 and one other cold room kept at +4 ^{0}C with a capacity of 50 m^3 are currently used for long term and temporary storages, respectively, at IBC. In 2007/2008, the Institute is planning to install a new cold room with a capacity of approximately 100 m^3 which will noticeably boost the long term storage capacity of the genebank. The storage temperature for long term storage is -10 ^{0}C and for the short term 4 ^{0}C, with 35 - 45 percent relative humidity. Samples are kept in laminated aluminium foil bags for long term, and in paper bags for medium term storage. The storage system is computerised with an easy access for monitoring the decline in sample size. A monitoring of the decline in viability is carried out every 5 - 10 years during storage and any necessary rejuvenation will be made if the standard germination result is less than 85 percent.

Although the genebank of the IBC has made a remarkable effort in conserving germplasm of major food crops, there are still a lot that needs to be conserved *ex situ* in the genebank. A number of species (suspected of having seeds exhibiting orthodox storage behavior) are in the medium term storage pending long term storage. A large majority of these are from horticulture, forages, medicinal and trees species. Major constrains for not being able to build up the genebank's long term holdings are: lack of adequate information on germination related problems (e.g. dormancy breaking mechanisms, storage behaviour) and lack of alternative storage facilities for the existing conventional cold rooms (e.g. in-vitro and cryo-preservation methods).

For plant species with recalcitrant and intermediate storage behavior, there are ten field genebanks under IBC control, and small sized fields in the various research stations of the Ethiopian Institute of Agricultural Research (EIAR) and at universities. The plan for the immediate future is to increase the number of field genebanks in different agro-ecological zones. Community gardens, back yards, and holy places are being considered for inclusion in the future plan. Spices, root and tuber crops and medicinal plants require such management on a large scale, and with the full involvement of the local communities.

3.3 SECURITY OF STORED MATERIALS

For security reasons, the collected and stored germplasm need to be conserved in duplicate genebanks. However, except from the limited samples of Ethiopian germplasm held by the Consultative Group on International Agricultural Research (CGIAR), United States Agency for International Development (USAID) and the Nordic genebank, the majority of collections are still kept in single copy at the national genebank. Greater efforts need to be made to store duplicate collections to avoid future genetic erosion. The new Svalbard global seed vault could provide this. Ethiopia, as signatory of the world wide bio-diversity conventions, is entitled to get support in terms of access to duplicate germplasm collections in case of natural disasters.

Regeneration activities are regularly performed to effectively maintain the quality of the stored germplasm collections. Complimentary activities such as timely viability testing during storage, selection of suitable regeneration environments, use of appropriate sampling strategies, use of adequate isolation distances, and proper handling of regenerated materials are followed according to internationally accepted standard procedures for each specific crop type. A reliable power supply is also critical. The Ethiopian genebank has therefore an independent power supply in the form of a stand by generator in case of shorter power cuts or in case of a more severe national energy crisis.

To date 13,336 accessions have been regenerated and over 7,400 accessions need immediate regeneration (Table 1). Limited capacity is hindering this. However, a plan is now in place to complete the regeneration within 5 years. Urgently required activities include viability tests and collaboration with partners to secure access to land in a range of agro-ecologies to carry out the multiplication and rejuvenation. The regional governments could provide sites in different agro ecological zones of the country. The research activities being carried out and new academic institutions being established could be an opportunity to address the problem of regeneration of threatened *ex situ* accessions. There is an opportunity for regional collaboration and cooperation as well as support from the international community in the regeneration and conservation of germplasm held ex situ.

Table 1. Accessions regenerated and in need of regeneration

Crop	Accessions regenerated	Accessions in need of regeneration currently (< 85percent viability)
Wheat	2464	577
Barley	6000	506
Maize	7	22
Tef	409	87
Sorghum	3738	5510
Noug	128	161
Field Pea	31	23
Linseed	34	23
Finger millet	102	61
Faba/Horse bean	2	12
Lentil	11	8
Cowpea	1	5
Caster bean	8	35
Sunflower	3	7
Fenugreek	5	20
Safflower	17	15
Mustard	260	207
Sesame	74	79
Chickpea	35	21
Total	**13329**	**7379**

3.4 DOCUMENTATION AND CHARACTERIZATION

Characterization is conducted by IBC, other research organizations, and graduate students. This is done to select materials for further breeding and other crop improvement programmes. The descriptors in use for characterization are those developed by local research institutes and

Bioversity International.

Since the establishment of the IBC, characterization and preliminary evaluation of basic morpho-agronomic characteristics have been undertaken for about 70 percent of the accessions. Additional evaluations of characters such as tolerance to drought, soil salinity and diseases, and nutritional value have been undertaken on some crop accessions. Cytogenetic studies have also been carried out on indigenous crop species. Furthermore, characterization and diversity studies have been conducted on various field crop species using agro-morphological, bio-chemical and molecular techniques.

Compilation of information starts with passport data from the collecting field. Genebank management data such as purity percentage, seed moisture content after drying, initial germination percentage, storage and monitoring date, are all documented. Characterization and evaluation data, as well as distribution data, are also registered. In the farmers' fields and format local markets, farmers are important sources of information on the collected germplasm. The information collected at this level include sowing season, maturity length , gastronomic value, local variety names , resistance to pests and diseases and to other stress, storability, soil types and growing environment. All collected information through the entire process is documented and computerised with an easy access to users. Information is released in to the user through consultation, delivery of printouts or by letter, except in cases where the repatriated or donated materials have come with no or with poor information that do not match the standard of the genebank.

The IBC has now a well organized documentation system and is currently upgrading the existing database. In addition IBC also has information on *in situ* maintained sites, including parks and protected areas. Data from *in situ* conservation for landraces includes information on indigenous knowledge such as traditional agronomy, farming systems and ethno-botany. Information on wild relatives and plant species used for traditional medicine is also included. This activity requires additional expertise in the fields of taxonomy and ethno-botany. More resources and integrated efforts are required to strengthen this work.

3.5 GERMPLASM MOVEMENT

In Ethiopia, the source of germplasm for national breeding programmes is mainly indigenous germplasm. One of the key responsibilities of the genebank is to make germplasm available for breeding purposes. About 81,000 seed samples have been distributed from the genebank until 2007. Since 2001, the genebank has dispatched on average 5,000 seed samples per year for national research activities. About 80 percent of these samples are used in national crop improvement programmes.

Germplasm is also distributed to national breeding programmes of other countries upon formal request and negotiation of conditions of access such as companies of the Netherlands (Crop type: *Eragrostis tef*) and England (Crop type: *Vernonia galamensis* var. galamensis). International research centres, such as International Centre for Agricultural Research in the Dry Areas (ICARDA) and International Crop Research Institute for Semi-Arid Tropics (ICRISAT), are potential users of Ethiopian germplasm. Germplasm supplied by the institute has already helped generate improved crop cultivars with valuable traits such as increased yield and resistance to biological and environmental stress, for example, Yellow Dwarf Resistant Barley.

3.6 ROLE OF BOTANICAL GARDENS

In botanical gardens plants are grown and displayed primarily for scientific and educational purposes. A botanical garden consists of living plants, grown out-of-doors or in greenhouses. It usually includes also a herbarium, lecture rooms, laboratories, libraries, museums, and experimental fields. They can be taxonomic collections of a particular family, genus or group of cultivars; native plants; plants of same geographical or ecological origin; wild relatives; medicinal, aromatic or textile plants. The initiative at national level is still in its infancy and there is currently no well established national botanical garden in Ethiopia.

3.7 AN ASSESSMENT OF MAJOR *EX SITU* NEEDS

A well organized *ex situ* conservation system is indispensable for Ethiopia because of the wealth of rare plant genetic resources and accelerated environmental and biodiversity degradation. Therefore, there is a need to expand *ex situ* conservation both in genebanks and botanical gardens. In depth characterization, evaluation and documentation, as well as the establishment of core collections for major crops, are considered as a prerequisite for setting up an improved *ex situ* management system. For crops with recalcitrant or intermediate seed, botanical gardens and field genebanks should be established.

Setting priorities for PGRFA *ex situ* conservation is essential. Priorities should consider factors such as threats to crop genetic resources, use value of genetic diversity, crop endemism and areas of high diversity. Cooperation and collaboration between the regional states of Ethiopia on the exchange of genetic materials for research and conservation would help expand *ex situ* conservation. The IBC and relevant international institutions need to cooperate to strengthen collaborative research and build capacity to apply alternative *ex situ* conservation methods. International financial institutions could also contribute.

The evaluation of existing collections for biotic and abiotic stresses and quality should be intensified in collaboration with the national crop research programme. Attention should also be given to the establishment of duplicate collections. In this regard, IBC is making an effort to establish a duplicate genebank. Collection gaps will be assessed and potential sites identified using GIS for further collections.

The conservation of germplasm is a very expensive task, especially for developing countries with considerable crop diversity. Hence, the international community should be encouraged to share the costs for the maintenance of the *ex situ* management system, which conserves plant genetic resources that are not only the property of the country but also the global community at large.

CHAPTER 4

4. THE STATE OF USE

Plant genetic resources used in Ethiopia include food and forage crops and their wild relatives, and semi-wild and wild species valued for traditional and cultural use. Spices and medicinal plants are widely used in the country. Indigenous plant genetic resources are also potential sources of genes/genetic material for developing varieties that are tolerant to pests and diseases , drought and salinity.

4.1 UTILIZATION AND CONSTRAINTS TO USE

Indigenous germplasm is the basic source of genetic materials for national crop improvement programmes. The national germplasm collections at IBC genebank comprise over 60,000 accessions belonging to more than 200 plant species from which about 80,400 seed sample have been distributed to users. Some of the major crops are intensively used by the national crop improvement programmes and higher educational institutions (Table 2). All genetic resources used in the national coffee improvement programme come from the national coffee germplasm collections. About 80 percent of the demand for medicine is covered by using traditional medicinal plants. However, there is still a multitude of underutilized plant species in Ethiopia. There are now encouraging developments in the country to promote the wide scale use and commercialisation of some of these species.

Table 2. Major Germplasm holdings of the genebank and distribution (until 2007)

Crop	Total holdings (Accessions)	Number of seed samples distributed
Barley	15282	19619
Wheat	12689	7926*
Sorghum	9249	8667
Tef	4702	5114
Finger millet	1819	3306
Maize	960	858
Pearl millet	152	207
Horse bean	2070	4485
Field pea	1711	5199
Brassica	1320	3490
Chickpea	1125	2210
Lentil	719	2275
Grasspea	576	599

Lupin	286	99
Cow pea	72	65
Ground nut	30	-
Linseed	2293	5676
Noug	1126	4420
Sesame	614	1427
Caster bean	436	634
Safflower	208	407
Sunflower	70	109
Fenugreek	533	3254
Hot pepper	249	125
Coriander	117	109
Black cumin	65	50
African spinach	50	-
Lepidium	101	-
Vernonia	65	50
Forest seed	50	-
Medicinal	165	8
Forage	620	35

* Refers to *Triticum durum*, *T. diccocum*, and *T. aestivum*

Plant breeders and scientists from different countries have for a long period recognised the importance of Ethiopian crop diversity to the world's agriculture. Since the first exploration of H.V. Harlan, in 1923, many international expeditions have been made to Ethiopia to collect barley and other crops. Vavilov's collections of Ethiopian wheat made in 1927 have been extensively used by breeders in many East and West European countries, as well as in North America. A large number of samples have also been collected and extensively utilised by ICARDA, ICRISAT and ILRI. Ethiopian germplasm has therefore, actively been utilised in breeding activities worldwide.

Over 1,800 accessions of Ethiopian wheat were introduced to CIMMYT from genebanks in the USA, Germany and Italy. ICARDA holds over 2,500 systematically collected accessions of Ethiopian barley, mostly 6-rowed and deficient types, which have a high value in early heading and maturity as well as high protein content. ICARDA also holds over 900 accessions of Ethiopian chickpea and more than 375 accessions of lentil that are used in its breeding programmes. More than 300 accessions of minor millet and 4,500 sorghum accessions of Ethiopian material are held by ICRISAT, of which the sorghum line E 35-1 has been selected from a zera-zera landrace sorghum of Ethiopia. The E-35-1 line has now been introduced for direct cultivation and is used in breeding programmes in many countries. ILRI holds over 3,000 accessions of forages collected in Ethiopia in the 1980s.

Through the International Research Centres, many national programmes and foreign seed companies have full access to Ethiopia's germplasm. In general, genes from varieties selected by Ethiopian farmers have been widely used in many countries to sustain crop production, while insignificant or no benefits derived from the use of these germplasm materials is accrued to Ethiopian farmers. For instance, the benefits obtained from the "Yellow Dwarf Virus Resistant Barley" have never been shared by Ethiopian farmers.

Characterization is essential for effective utilization of conserved germplasm. To date 34,648 accessions of cereals, 8,037 accessions of oil crops, 5,355 accessions of pulses, 424 accessions of coffee and 360 accessions of fenugreek have been characterized for morpho-agronomical traits. Large numbers of germplasm accessions have also been characterized using bio-chemical and molecular markers largely by graduate students. The data is often handled by Microsoft Excel, Microsoft Access, National Information Sharing Mechanism (NISM) and/or the IBC Database Management System.

Characterization and evaluation of conserved germplasm carried out to define core collections is important to facilitate the utilization of genetic materials in Ethiopia. Morphological and molecular data on the germplasm will support in-depth evaluation of genetic materials for utilization. Well equipped molecular laboratories and skilled manpower to carry out genomic analysis of the germplasm is urgently needed for this.

Data has to be properly documented and made available for the research community. National and regional institutions collaborate in the characterization and evaluation of Ethiopia's germplasm mainly through information exchange, training, collaborative research and genetic material exchange. International financial institutions should contribute to increase the capacity to carry out this work effectively. Data on characterization and evaluation handled by different organizations, as well as data on the use of germplasm, should be shared among the stakeholders. In this respect, the initiative by the NISM of sharing information on PGRFA at a global level should be further strengthened.

Ethiopia has a well organized plant breeding programme addressing major cereals, pulses, oil seeds, horticultural crops, coffee and fibre crops. Genetic enhancement and pre-breeding work has been done for a limited number of crops, such as tef for lodging resistance and wheat for rust resistance.

As a result of national plant breeding efforts, a large number of improved crop varieties have been released. However, their commercial production is constrained by the limited capacity of the national seed system. To overcome seed production and distribution problems, a National Seed Policy has been formulated to strengthen public seed enterprises and private seed growers. Mechanisms have been developed for the continuous multiplication of breeders and basic seeds, with well maintained genetic purity, uniformity, and stability, in order to solve problems of seed shortage. Improvement and enhancement of elite landraces by farmers is also an important national priority area.

4.2 ASSESSEMENT OF NEEDS TO IMPROVE UTILIZATION

The ultimate goal of conservation is to make germplasm of plant genetic resources available for utilization so as to contribute to the livelihoods of the Ethiopian people. Ethiopia has had limited success with the utilization of the conserved germplasm. Rather, other countries have better benefited from Ethiopian germplasm. In this regard, fair and equitable sharing of benefits arising from the use of Ethiopia's germplasm needs to be recognized as clearly stated in Article 15 and 19 of the Convention on Biological Diversity.

In order to achieve the objectives of conservation, attention should be given to genetic enhancement and base broadening efforts for economically important crops and crop varieties. Identification and information sharing of promising varieties has to be a first priority. Research on genetic diversity and evaluation should strengthen both conservation and utilization efforts. These activities are currently constrained in Ethiopia due to: 1) lack of appropriate laboratories, 2) limited skilled personnel, 3) inadequate research sites (land) and 4) insufficient finance.

To enhance the implementation of conservation and utilization activities there is a need for national and regional collaboration among institutions. With respect to this, the NISM and awareness raising about the conserved germplasm is an opportunity to boost the utilization of the country's plant genetic resources. The international community should put this into its priority agenda in order to strengthen Ethiopia's capacity to conserve and use plant genetic resources in a sustainable way.

CHAPTER 5

5. THE STATE OF NATIONAL PROGRAMMES, TRAINING AND LEGISTLATION

5.1 NATIONAL PROGRAMMES

The IBC is the national focal point for PGRFA conservation. The overall objective of the institute is to undertake conservation and promote the development and sustainable utilization of the country's biological resources. Ethiopia has set clear national policy directives for the conservation of biological resources. In the past, conservation efforts focused on plant genetic resources with priority given to crops. In 1998, the institute was given a wider mandate to also cover the conservation and sustainable utilization of all forms of biological resources, including plants, animals and microbial genetic resources. Ecosystem management is also recognized as one of the areas to be given top priority. With the importance of biodiversity and dependence on biological resources in Ethiopia, biodiversity conservation efforts emphasize local and national needs and values. IBC is also responsible for maintaining and developing international relations with bilateral and multilateral institutions with the potential to provide technical assistance. On the basis of national legislation, IBC has the responsibility to implement international conventions, agreements and obligations on biodiversity.

The involvement of local people and competent institutions is the key to conservation and sustainable use of biodiversity in Ethiopia. To enhance the conservation and sustainable utilization of PGRFA, the institute launched a project entitled: ’A dynamic farmers' based approach to the conservation of Ethiopian plant genetic resources’. This project was implemented in 1997 and ended in 2002, and took place in twelve districts representing six agro-ecological zones with the full participation of farming communities.

In the preparation of the Conservation Strategy of Ethiopia the government of Ethiopia recognised the importance of protecting biodiversity. In 1992 signed the CBD, and it was finally ratified in 1994. Other relevant agreements and treaties for which Ethiopia is a party include: The Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, International Treaty on Plant Genetic Resources for Food and Agriculture, National Information Sharing Mechanism on the Implementation of the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture.

As a member of the EAPGREN, IBC is benefiting from enhanced networking and exchange of information among national programs in the region. Activities include capacity building, training of experts, and provision of laboratory facilities and to some extent collection and conservation of under-utilized plant species.

5.2 TRAINING

Long term and short term training sessions have been organized with the support of donors and regional networks. These training sessions were tailor-made on informal seed multiplication schemes, genebank database management systems, and the role of genebanks in combating desertification and promoting sustainable utilization of plant genetic resources. The training focused on supporting seed production and distribution, agro-ecological and eco-regional survey methods, sustaining existing *ex situ* collections, constructing comprehensive information systems for PGRFA, indigenous knowledge, supporting on-farm management and improvement of PGRFA, assisting farmers in disaster situations to restore agricultural systems, and promoting *in situ* conservation of crop wild relatives and wild plants for food production.

The trainings so far conducted are indispensable for PGRFA conservation and sustainable utilization in the country. In the national education system plant breeders and researchers are trained at the higher education level and there is an opportunity to expand and diversify the field of trainings in the future. The country's capacity need assessment has revealed that special trainings are needed on the following areas abroad: Geographic Information Systems for Biodiversity assessment and planning, browser-based database design, development and management system, alternative ex-situ conservation methods (in-vitro, DNA and cryopreservation), genebank management, molecular techniques, seed physiology and seed technology, information and communication, international and national policies, regulations, laws and rights on biodiversity, surveying and inventorying PGRFA, supporting on-farm management and improvement of PGRFA, promoting *in situ* conservation of crop wild relatives and wild plants for food production, supporting planned and targeted collecting of PGRFA, expanding *ex situ* conservation activities, promoting sustainable agriculture through diversification of crop production and broader diversity in crops, promoting development and commercialization of under-utilized crops and species, supporting seed production and distribution, increasing genetic enhancement and base-broadening efforts, and developing new markets for local varieties and 'diversity-rich' products.

5.3 NATIONAL LEGISTLATION

The absence of clear policy guidelines on plant genetic resources has for many years contributed to the loss of valuable indigenous genetic resources and the introduction of diseases, pests, weeds and genetic material not adapted to local agro-ecological systems.

At present, it is recognised that conservation and development of genetic resources is unlikely to succeed without a national commitment through an appropriate government policy. A National Policy for Plant Genetic Resources Conservation and Development has therefore been formulated based on the rationale that the conservation of PGRFA is one of the bases for overall socio-economic development and sound environmental management. The main objectives of the National Policy for Plant Genetic Resources Conservation and Development are to: ensure that Ethiopian plant genetic resources are conserved, developed, managed, and sustainably used; assert national sovereignty over genetic resources, and develop mechanisms that will ensure the effective control of movement and management of genetic resources; build scientific capacities in order to explore, collect, assess, study, systematize, introduce, improve, manage and sustainably use biological resources; develop capacities for the improvement, generation, development and sustainable use of biotechnology and its transfer; integrate programmes for

PGRFA conservation and development into national and regional development strategies and plans; recognise, foster and augment the traditional methods and the knowledge of local communities relevant to the conservation, development and sustainable use of PGR; and encourage the participation and support of local communities in PGR conservation and development, and ensure that farmers/communities share the benefits accrued as a result of using indigenous germplasm; create a functional and efficient organizational structure and inter-institutional linkage to facilitate cooperative action and coordination PGR conservation and development; promote international and regional cooperation in PGR conservation and development.

National Environment Protection and Seed and Quarantine Laws are already in place. The policy and strategy for PGR conservation and use are covered in these laws. Rules and regulations for the flow of genetic resources in and out of the country are pending for ratification. Within its environmental law Ethiopia has legislations for biological resources conservation which deal with the definition of commitments of the Federal Government and Regional States, with the rights and obligation of communities and citizens, with ownership and use rights, and with monitoring, development and sustainable use of plant genetic resources.

In line with national seed legislation, the crop genetic resources legislation will define legal provisions for germplasm ownership and control, accessibility, exploration, collection, conservation, distribution, introduction, regeneration, testing, exchange, utilization, and rights of Ethiopia's farming communities and plant breeders. The existing legal instruments regarding plants of traditional medicine will be adjusted to sustain the conservation, development and use of medicinal plants and to define obligations and intellectual property rights of local traditional medicine practitioners. The legislation on flora and vegetation will address ownership and control, accessibility, exploration, landscape and ecosystem conservation; and ecological restoration of degraded landscapes, ecosystems, biological communities and species. The legal environment for the sustainable management of protected areas; participation, responsibilities, rights and obligations of the communities and individuals; accessibility, introduction and exchange, monitoring, ownership and the use rights of the communities and individuals will be defined. Legal instruments dealing with the conservation, importation, translocation, development and use of microbial genetic resources and products of biotechnology and biosafety mechanisms to minimize public and environmental risks will be set.

5.4 ASSESSMENT OF MAJOR NEEDS

Conservation of plant genetic resources for food and agriculture and its sustainable utilization is not an activity to be accomplished by a single institute or country. Rather, there is a need for collaboration and cooperation among institutions within and outside Ethiopia. At present Ethiopian institutional networks within the country and collaborative linkages with international institutions on conservation and sustainable utilization of PGRFA are weak. As a result, the country's enormous diversity of plant genetic resources has not been properly utilized to improve the livelihoods of its people. To better use this potential, there should be a project designed to promote national and international networking. Support from international institutions in the area of human resource development and training on information technology is very crucial to improve the country's capacity for efficient networking.

There is no comprehensive and standardized information system on Ethiopia's PGRFA. In many institutions there is also a lack of hardware and software resources and trained personnel. This has constrained the research activity for the efficient management of PGRFA in the country. For this to be solved there is a need to develop a comprehensive and standardized database and information system that could easily be accessible to all users. A strong national information sharing mechanism supported by modern technologies, such as database driven websites, GIS and trained manpower is needed. Technical and financial support from the regional and international community is very important to strengthen these activities.

There is an urgent need for creating a critical mass of high caliber professionals in PGR conservation, management and utilization. Short term consolidated training opportunities are needed in some of the GPA priority activity areas including: surveying and inventorying plant genetic resources for food and agriculture, supporting on-farm management and improvement of plant genetic resources for food and agriculture, assisting farmers in disaster situations to restore agricultural systems, targeted collection of plant genetic resources for food and agriculture, characterization and evaluation of plant genetic resources for food and agriculture, genetic enhancement and base broadening, molecular biology with special emphasis on alternative *ex situ* conservation methods (in-vitro, DNA banking and cryo-preservation), seed physiology and seed technology, and national and international policies, laws, regulations, and biodiversity rights .

One of the major problems facing today's PGRFA conservation efforts is lack of awareness among the public on their importance for food security and sources of breeding materials. Although there is experience with the conservation of PGRFA in Ethiopia, still there is no adequate awareness among policy makers, government officials, development workers and the public. A comprehensive curriculum should be developed and integrated into the formal education system in order to train people at different levels on effective use and management of PGR. Finally, the government should give due consideration to further strengthening of intuitions involved in conservation and promotion of PGRFA.

CHAPTER 6

6. STATE OF NATIONAL, REGIONAL AND INTERNATIONAL COLLABORATION

PGR related activities in Ethiopia have global and regional links with partner institutions. The federal and regional research institutes and the universities have various collaborative research activities in the area of crop improvement. To develop a full-fledged national PGR conservation system and to ensure improved access to and sustainable use of the resources, the participation and contribution of global, regional and national organizations is of paramount importance.

6.1 COLLABORATION AT NATIONAL LEVEL

There are many national stakeholders that have an interest in the PGRFA of Ethiopia. Effective collaboration of all sectors is essential for the conservation, management and utilization efforts to be successful. The federal and regional governments are the most important stakeholders with the overall responsibility for providing an adequate policy and legal framework, enforcing regulations, building capacity and providing incentives and funds for the conservation of plant genetic resources. The policies and programs of key federal ministries (Ministry of Agriculture and Rural development, Finance and Economic Development, the Ethiopian Science and Technology Agency) and regional bureaus are crucial for the conservation and sustainable use of PGRFA. IBC is the lead agency for the coordination and implementation of the National Biodiversity Strategy and Action Plan (NBSAP) in collaboration with the Environmental Protection Authority (EPA). Implementation of the NBSAP is carried out at both federal and regional levels by establishing linkages with the planning process.

Research and higher learning institutions are responsible for documenting PGRFA in Ethiopia and monitoring ecosystem conditions. Training institutions play an important role in building professional capacity in the fields of conservation and sustainable use. As direct users and potential managers of biological diversity, local communities have one of the most important stakeholder roles in resource conservation and use. NGOs can help bridging the existing gap between the government and local communities to enhance conservation efforts. NGOs can be particularly valuable in providing technical tools and building capacity and awareness about the need for environmental stewardship, both locally and nationally. An initiative is in place to strengthen the collaboration and coordination effort at the national level, to bring together key actors and agree on a mechanism that would enable them to understand their relative roles and act synergistically to protect and enhance the country’s PGR .

6.2 COLLABORATION AT REGIONAL AND INTERNATIONAL LEVEL

Over the years, national institutions involved in the conservation, management and utilization of PGR have been working in close collaboration with the CBD, FAO, GTZ, CGIAR, and with other regional and global networks towards the shared goal of protection and sustainable utilization of PGRFA. ILRI, Bioversity International, ICARDA, EAPGREN, CIMMYT and ICRISAT are also among the collaborators. The IBC has a cooperative link with Bioversity International covering the development of conservation techniques, data management and training. Through this collaborative link Bioversity International has financially supported long and short term training. ICARDA and ICRISAT have also supported some short-term training programmes. There is also a strong collaboration with international and regional NGOs that are directly or indirectly involved PGR conservation and utilization activities.

Most of the research programmes have germplasm collection as a major component. Partners have been using Ethiopian germplasm ,and in some cases duplicates of these materials have been deposited outside of Ethiopia through joint programmes and activities. Some collaborative research programmes are short term in nature and do not develop local capacity and facilities. Existing experience shows that national programmes rarely have long term benefits from such collaboration. This is one of the gaps to be addressed in the implementation of future joint research programmes.

Through regional intergovernmental initiatives such as the African Ministerial Conference on Environment (AMCEN), Ethiopia plays an important role in the regional biodiversity activities and serves as the coordinating unit of the African Biodiversity Network and the African programme of the Community Biodiversity Development and Conservation (CBDC). The CBDC is a global programme for Africa, Latin America and Asia which brings government institutions and NGOs together at global, regional and national levels.

Ethiopia is making every effort to fulfil its commitments to the international agreements that its government has signed and ratified, such as Agenda 21 and the CBD. Policies are formulated to meet the commitments and institutional structures are organised to effect policies and strategies. It is also a firm position of Ethiopia that all nations prepare themselves to fulfil the International Agreements they are committed to. Developed nations and the international community are expected to support the developing nations to meet their global commitments. Support coming through international funds would be more productive when based on country driven programmes and priorities, rather than being top-down, donor driven programmes.

6.3 ASSESSMENT OF NEEDS TO IMPROVE NATIONAL AND INTERNATIONAL COLLABORATION

Ethiopia supports the creation of an efficient global mechanism for addressing issues relevant to genetic resources, such as the use, ownership rights, and fair and equitable sharing of benefits derived from use of plant genetic resources. These issues are well addressed under the CBD, but it is important that relevant international agencies support developing nations in the practical process of implementing the convention. Contracting parties play an active role in resolving issues of special concern for developing countries, such as Farmers' Rights and the status of some *ex situ* collections excluded from the CBD, which are now managed as trust collections under the International Treaty for PGRFA.

International agencies are expected to strongly support and facilitate the protection of neglected interests of farmers and indigenous communities of the developing nations. Like all other developing nations that have signed the CBD, Ethiopia believes that international agencies should develop strong mechanisms for protecting the gene donors' rights.

At the national level, a National Biodiversity Taskforce (NBT) could be established to coordinate and follow up the NBSAP implementation process in the country. This body should include IBC, EIAR, EPA, MOARD, Ethiopian Wildlife Development and Protection Department, Ministry of Water Resource, Ethiopian Science and Technology Agency, The National Herbarium and other relevant NGOs and higher learning institution's representatives. All other environmental units, which are established in the federal ministries, should work closely with the NBT. The NBT will have regular meetings and produce reports to be submitted to the environmental protection council. The NBT will organise annual national meetings to discuss progress made and challenges faced by the NBSAP implementation process.

At the regional level, a similar body will have to be established to coordinate biodiversity conservation efforts in the different parts of the country. The mandates and roles will be the reflection of the NBT at the regional level. A system should be established to link the regional and national bodies and to harmonize their operations. Awareness raising and capacity building must be strengthened in order to carry out monitoring and evaluation (M & E) at all levels. Local communities should be given the necessary support to be involved in the whole process. A substantial budget is required to carry out the M & E process. Technical guidelines and monitoring methodologies must be formulated to assess the performance of the NBSAP at national, regional and local levels.

CHAPTER 7

7. THE STATE OF ACCESS TO PLANT GENETIC RESOURCES AND BENEFIT SHARING

Ethiopia has a strong interest in the creation of an efficient global mechanism for addressing issues of genetic resources use, ownership rights, and fair and equitable sharing of benefits deriving from their use. These issues are also well addressed by the CBD. The role of international agencies is crucial in supporting the developing nations in the process of implementing the convention.

7.1 STATE OF ACCESS AND BENEFIT SHARING OF PLANT GENETIC RESOURCES

Indigenous material is the main source of germplasm for breeding programmes. One of the responsibilities of genebanks is to make germplasm available and accessible for national breeding programs. To promote the broad utilization of plant genetic resources both within the country as well as at international levels, the genebank of Ethiopia dispatches annually about 5,000 seed samples. Germplasm can be acquired through a formal request followed by negotiations over the terms and conditions of access determined by local regulations and international treaties. The requesting parties from within the country submit a formal letter as well as a short proposal on the intended use according to the Access to Genetic Resources and Community Knowledge, and Community Rights proclamation (no. 482/2006). The proclamation is designed to regulate access to genetic resources and associated community knowledge, innovations, practices and technologies, and to protect the rights of local communities. The second part of the proclamation covers the protection of community rights, community rights , access regulations, user rights and rights to share benefits. Subsequent parts of the proclamation cover: access to genetic resources, access permit and basic preconditions and conditions for denial of access; special access permit, which grants specific access permits to the Ethiopian national public research and higher learning institutions; and required follow up and compliance mechanisms for execution of access agreements. Based on the provisions of the above proclamation, the IBC is expected to work closely with the communities at different levels to facilitate access to PGR and related indigenous knowledge, and work out the benefit sharing arrangements thereof.

The CBD is the first international convention that acknowledges the states' sovereign rights over the genetic resources and the resulting authority to regulate and control access to these resources (article 15). However, the degree and extent to which the state could exercise its rights has to be determined by national laws. Parties to the convention are also required to promote the fair and equitable sharing of benefits arising from the use of genetic resources (article 15 and 19).

With its wealth of plant genetic resources, conservation activities are very extensive in Ethiopia. To effectively execute the broad conservation and management programmes and facilitate improved access of the international community to the rich genetic resources in the country, availability of adequate financial resources is essential. According to Article 20 of the CBD each party is required to provide financial support in accordance with its capabilities, for the national activities which are undertaken to implement the convention. Article 20 also commits the developed nations to provide financial resources to assist developing countries with their biodiversity conservation and management programmes. Ethiopia is a beneficiary of such arrangements through the GEF. The successful implementation of NBSAP requires a significant financial investment, which is largely expected to be covered by the Ethiopian government. The successful execution of the NBSAP will result in strengthened PGR conservation activities, creating an environment for increased collaboration and networking, and exchange of germplasm within and outside the country.

7.2 IMPLEMENTATION OF FARMERS RIGHTS

Farmers' rights is an important issue that is yet to be addressed by an international convention. Resolution 3 of the Nairobi Final Act addresses the need to consider farmers' rights. In order to support farmer's rights, international agencies and national governments should enforce the International Code of Conduct for Plant Germplasm collecting and transfer and the CBD. This process should strongly support and facilitate the protection of the neglected interests of the farming and indigenous communities of developing nations. Ethiopia expects that international agencies develop strong mechanisms and take the responsibility of protecting the gene donors' rights.

At the national level, the Access to Genetic Resources and Community Knowledge, and Community Rights proclamation (no. 482/2006) covers access to germplasm also covers farmers' rights. Detailed regulations are currently being drafted for its implementation. One of the important components of the proclamation is farmers' rights to the benefits arising from use of PGR.

7.3 NEEDS REGARDING ACCESS AND BENEFIT SHARING OF PLANT GENETIC REOURCES

Information about the Ethiopia's biodiversity is presently scattered among a wide range of institutions (national and international), and current capacity to collect, store, analyse, and disseminate information is limited. If Ethiopia is to fulfill its commitments under the CBD, collaboration is needed from both national and international communities to address these data gaps. Mechanisms should be established to address the issues of rights and rewards for past, present and future contributions to the PGR conservation and development. The provisions of the proclamation (Proclamation no. 482/2006) on access to genetic resources, community knowledge, and community rights must also be enforced.

Access to germplasm is particularly important in times of environmental stress and following natural disasters. An international Treaty on PGRFA is in place for rapid acquisition of PGRFA from international, national and regional sources following disasters. Major benefits are also gained by countries through PGRFA networks through the GPA for the Conservation and Sustainable Utilization of PGRFA. However, there is still a gap in exchange of germplasm and information between national programs. Forums will have to be created to bring together concerned parties to work out a more efficient system that could facilitate an enhanced collaboration and facilitate access to and exchange of PGR.

Access to PGR information is unequally and poorly distributed among contracting parties of the International Treaty on PGRFA. In particular, there is an information gap between developed and developing countries that must be bridged. A provision on the exchanging of information for PGR conservation has now become a standard addition to international environmental and conservation agreements. Article 17 of the CBD urges parties to take into account the special needs of developing countries and include repatriation of information, where feasible. Much original and unique information about species and ecosystems in developing countries is held by museums and research institutions in developed countries. This information is often very difficult to access by the country where those plant specimens were collected. The convention encourages the holders of such information to ensure that the information is shared with the countries of origin.

CHAPTER 8

8. THE CONTRIBUTION OF PGRFA MANAGEMENT TO FOOD SECURITY AND SUSTAINABLE DEVELOPEMENT

As outlined by the FAO in the GPA for the conservation and sustainable utilization of plant genetic resources, more efficient use of plant genetic diversity is a prerequisite to meet the challenge of development, food security and poverty alleviation. Poverty reduction is the main target for economic and social development in Ethiopia.

The genetic improvement of PGR, followed by successful cultivation and marketing or consumption of the improved materials, is probably one of the most sustainable ways to 'conserve' valuable resource for the future. The use of accessions in plant breeding programmes and the subsequent development of released cultivars are the most recognized uses of genetic resources. Over the years, conserved accessions crop species have been widely utilized by plant breeders, farmers and other users. Many underutilized species have also been used as unique sources of genes for stress tolerance. In addition to the use of conserved accessions for crop improvement, there has been an increasing interest in the direct use of PGR as part of responses to natural disasters and other events that result in severe loss of planting materials.

Information on the scale of use of conserved material are readily not available in Ethiopia, due to the poor feedback system and linkages between research and development partners in the country. However, using exploratory surveys on the pedigrees of released varieties, the IBC has gathered some preliminary information on the extent of use of conserved germplasm for food crop improvement programmes.

8.1 CONTRIBUTION AND IMPORTANCE OF PGR FOR FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

Ensuring food security and economic development in Ethiopia presupposes wide use of locally adapted and indigenous PGR. As a holder of a wide range of plant species of high economic value, Ethiopia is better placed to make use of such resources to overcome food shortage problems, by increasing agricultural production and by that improving the overall household incomes of the farming community. As a primary gene pool center, there exists tremendous diversity in Ethiopia particularly for coffee, tef, durum wheat, sorghum, field pea, chickpea, noug and enset. This resource has been put to use to benefit the farming communities within the country and beyond. The state of use of conserved germplasm of major indigenous crop species and their relative contribution to food security, agricultural sustainability and economic development in general is briefly described below.

8.1.1 Cereals

Cereal crops play a major role in Ethiopian agriculture. The recent data from CSA indicates that from the total cultivated of 9.8 million hectare, 7.6 million hectare is covered by cereals, accounting for 77 percent of the total cultivated area and 84 percent of the total agricultural production. The major indigenous cereal crops grown in Ethiopia are tef, durum wheat, barley and sorghum.

Tef is the most important staple food crop in Ethiopia. The versatility of tef, the relatively high market price for its grain and straw make it one of the very few cereal crops which play a very important role in the livelihoods of Ethiopian farmers. Apart from its importance locally, official figures in 1997/98 and 1998/99 indicated that 9 million and 14.6 million birr, respectively, were obtained from the export of tef. The trend indicates that there is a good export market for this crop in the Middle East, North America and Europe, mainly for the immigrant Ethiopians. The IBC recently signed an agreement with a Netherlands food company interested in commercialization of tef products. As tef is an indigenous cereal to Ethiopia, most of the available genetic variation has been generated naturally and through crop improvement research. Germplasm collections that exist cover new and old varieties, landraces, breeding lines and related wild species.

Durum wheat is a major industrial and food crop in Ethiopia. Farmers involved in the production of durum wheat varieties have managed to increase their income substantially in recent years. At present, the demand for durum wheat is growing. The local pasta manufacturing industries in Ethiopia import thousands of tons of durum wheat, but are showing increased interest in locally available varieties. The ever increasing demand for durum wheat, both in the global and domestic market, combined with availability of high quality varieties developed from local germplasm, offer an excellent opportunity for commercialization of the crop. This will also to a large extent contribute to reducing foreign currency expenditures required to import durum wheat products.

Sorghum is one of the traditional crops that is well utilized by the crop improvement programmes in the country. Over 10,000 accessions have so far been evaluated for the highlands and intermediate elevations, where the indigenous landraces are widely cultivated. Developing varieties for lowland areas depends on introduction and evaluation of materials from exotic sources owing to the low diversity associated with recurrent drought and stalk borer in the Ethiopian germplasm. For the highlands where there is immense diversity, the emphasis has been on the evaluation of indigenous germplasm. To date, the national and regional research institutions in Ethiopia have released about 33 varieties for commercial production. Six of the nineteen varieties on the current recommendation list were developed from local sources.

Barley is one of the first domesticated cereals in Ethiopia. Its research dates back to the 1960s. Ethiopian barley landraces have been widely used as sources of resistant material to Barley Yellow Dwarf Virus, powdery mildew and other foliar diseases. Landraces with high lysine content have been discovered and used in the development of varieties with improved protein content. In the early 1970s, when exotic cultivars appeared to show narrow adaptation and susceptibility to pests and diseases, research became directed towards evaluation and selection of local landraces. In total over 8,000 accessions were evaluated. Out of these accessions, 547 were selected based on high tillering capacity, medium height, erect leaves, resistance to foliar diseases, good vegetative vigour and plump grains. These selections were intensively used by the national crop improvement programme and the international community to develop improved varieties. Currently there are about 50 released varieties. A number of these are of local origin.

8.1.2 Pulses

Ethiopia is one of the major centres of diversity of grain legume crops, like field pea, grass pea, chickpea, lentil and wild species of cowpea. In Ethiopia, pulses are next to cereals in terms of production and are cheap sources of protein. They also play an increasingly important role in the export market. The total allotted area for the production of pulses is nearly 1.4 million ha, accounting for 13 percent of the total cultivated area and 11 percent of the total grain production.

For the last few decades, the IBC has distributed a total of over 11,000 locally collected accessions of grain legumes to research institutions, universities, and development organizations; constituting about a 21 percent share of the total germplasm of field crops distributed. Although the germplasm utilization feedback system is poor, evidences on the pedigrees indicate that the supplied germplasm has been successfully utilized in legume crop improvement.

Field pea is the second most important legume crop in Ethiopia. Out of the hundreds of landrace accessions used by the crop improvement programme, a number of varieties have been selected and released for their superiority in yield and other agronomic traits. The landrace accessions were reservoirs of genetic variability and were sources of valuable genes especially for adaptation.

Chickpea is one of the ancient food crops in Ethiopia. There are two types of chickpeas; dessi and kabuli. In Ethiopia, the dessi type chickpea accounts for more than 90 percent of production and is grown across a wide range of ecologies. Improved varieties of chickpea, which were released for production, were selected from the Ethiopian chickpea collections. Currently, there is considerable interest in the kabuli type for export. Six varieties have been released and are in various stages of multiplication by the Ethiopian Seed Enterprise.

Lentil is cultivated mostly for domestic consumption. Several local accessions of lentils were identified as resistant to rust, tolerant to drought and early maturing. These form the basis for the development of the varieties currently under cultivation in the country.

Ethiopia is also considered as one of the primary centres of diversity for grass pea. Development of improved varieties of grass pea is very challenging because of the high ODAP content. Past breeding efforts resulted in the identification of promising varieties. However, the grass pea production in the small scale agriculture system of the country is still largely dominated by local landraces. Exotic germplasm with low ODAP content has been introduced in collaboration with ICARDA and is currently being tested by the national system for variety release.

8.1.3 Oil crops

Noug is one of the widely cultivated indigenous oil seed crops, particularly in the highlands of Ethiopia. Noug is famous for its high quality oil, although productivity per unit area is still very low. The national oil seed improvement program has released five varieties that are currently under production. There is little research on this indigenous oil crop, which has very high edible oil quality.

Linseed is the second major oil seed crop in the highlands of Ethiopia. Linseed grown for oil production has a relatively high variability in flower colour, plant height, duration of flowering and maturity and capsule size and wilt resistance. Six improved varieties of linseed have so far been developed and released through selection from local germplasm collections.

Sesame is the third most important oil seed crop in Ethiopia, showing substantial genetic diversity. The high quality oil makes Ethiopian sesame varieties popular and competitive in international markets. The intensive improvement research conducted on the crop so far resulted in the development of 10 improved varieties for commercial production.

Ethiopian mustard (*Brassica carinata*), which is grown extensively in the highlands, has a considerable diversity for several vegetative traits. Studies conducted on Ethiopian mustard landraces for oil content and productivity reveal that the indigenous crop is more productive, resistant to diseases and more droughts tolerant compared to their exotic ones. The oil seed improvement program has so far released seven varieties from local selections which are extensively grown around the country.

8.1.4 Stimulant crops

Coffee (*Coffea arabica*) is one of the major global stimulants. Fairly adequate research attention has been given to this important crop which is the number one foreign currency earner for the country. Over the years, the research sector has released 32 varieties among which 26 are still under production

Chat (*Chata edulis*) is one of the early domesticates in Ethiopia. It is locally consumed and exported to neighbouring countries such as Yemen and Djibouti. The national research system has not given due attention to the improvement of this important commercial crop. However, there are certain widely recognized farmers' varieties which can fetch a relatively higher market price.

8.1.5 Other crops

Ethiopia is either a primary or secondary centre of origin for many spices, such as korerima (*Aframomum korerima*), long pepper (*Peper longum*), black cumin (*Nigella sativa*), white cumin (*Carum copticom*), coriander (*Coriandrum sativum*), and fenugreek (*Trigonella foenum-graecum*); and root and tuber crops such as enset (*Ensete ventricosum*) and anchote (*Coccinia abyssinica*). These crops are very important in local diets and for local and foreign markets. Enset is extensively produced and consumed locally. It is particularly known for its value as an insurance crop in dry seasons, when annual crops fail. It is estimated that about 15 - 20 percent of the Ethiopian population in south and south-western Ethiopia depend on this crop. There is a tremendous untapped potential for Ethiopia to exploit the rich and diverse plant genetic resources of spices and underutilized root and tuber crops. However, in spite of their potential for food security and export, very little research has so far been done to improve the productivity of this important crop category.

The country is also known for its wide range of other crop species that can potentially be used for industrial and medicinal purposes. A wide array of wild plant species have been used as sources of medicine for centuries. About 80 percent of the rural population in Ethiopia and 95 percent of their livestock depend on traditional medicine, and more than 95 percent of the traditional medicines are of plant origin. Efforts are being made to promote a wider use of indigenous medicinal plants in pharmaceutical industries. Among the crop species generating renewed interest is Vernonia (*Vernonia galamensis*). Its seed contains about 42 percent oil of which about 75 percent is vernolic acid. The oil characteristics make it suitable for industrial use in plastic formation and coating. An increasing number of investors are now showing interest to start commercial production. Thirty different species have been identified for this.

8.2 NEED ASSESSEMENT ON FUTURE USE OF PGRFA FOR FOOD SECURITY AND SUSTAINABLE DEVELOPEMENT

Ethiopia is recognized as one of the gene pool centres in the worlds, and is home to a wide diversity of crop and wild plant species. However, past efforts to exploit this untapped resource in an organized manner and help the country lift itself out of poverty has not yet met their goals. Attention should be given to assess and catalogue the extent of existing diversity (the number of species conserved so far is considered very low in view of the immense genetic diversity of the country) and establish a mechanism that can bring stakeholders together to make focused and organized efforts for the sustainable utilization of these resources. It can be argued that with regards to PGR conservation and utilization, the country is not yet operating at an optimal level.

Lack of awareness by the general public is a major weakness that is hampering the protection, enhancement and sustainable utilization of PGR in Ethiopia. Agricultural research and development agencies should assist in awareness raising among the public. The general public and particularly the rural community require support to understand the diverse uses and benefits that can be accrued from PGR. Community approaches to the conservation and sustainable utilization of PGR are indispensable. The public, the rural community in particular, must be made aware of the benefits of working jointly together with agricultural research and development partners to identify and categorize PGR according to use and potential value.

There has been limited use of the already conserved PGR in the country. The main reasons for this are;

- Poor networking and collaboration between research and development institutions leading to a lack of concerted efforts and weak synergies and complementarities. This partly emanates from the wrong perception that conservation and utilization of PGR is the business of one institution.
- Lack of awareness on the range of conserved germplasm existing, has lead to a demand centering on only a limited range of species from the genebank.

In addition to the use of conserved accessions for crop improvement, there is an increasing interest in the direct use of PGR as part of the national response to mitigate drought disasters and other events that result in severe losses of plant materials. In many cases, governmental institutions and NGOs respond to such events by providing materials that are not suitable for the affected areas, rather than providing locally adapted materials from the genebank (or from local sources). In the future such trends have to be rectified to help farming communities getting access to adapted germplasm and preferred varieties.

References

1992: Convention on Biological Diversity

1996: Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture.

1999: Diversity among germplasm lines of the Ethiopian cereal tef [*Eragrostis tef* (Zucc.) Trotter]

2003: A Dynamic Farmers'-Based Approach to the Conservation of Ethiopia's Plant Genetic Resources Project Terminal Report

2004: A Proclamation to Amend the Institute of Biodiversity Conservation and Research Establishment Proclamation

2005: Diversity study based on quality traits and RAPD markers and investigation of heterosis in Ethiopian mustard

2006: Brief Crop Genetic Resources Field Collecting Manual

2006: International Treaty on Plant Genetic Resources for Food and Agriculture.

2007: Achievements and Prospect of Barely Research in North Shewa

2007: Chickpea Variety Development in Vertisol Areas of Amhara Region

2007: Diversifying Cropping Systems in the Mountainous Landscape of Galessa, Ethiopia

Access to Genetic Resources and Community Knowledge, and Community Rights proclamation (no. 482/2006)