

The Status of Plant Genetic Diversity and Genetic Erosion in Ethiopia A Review

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Abstract

The plant genetic resources of Ethiopia exhibit an enormous diversity. Different literatures showed that Ethiopia is one of the twelve Vavilov centres of origin and/or genetic diversity for crop plants and their wild relatives. The country's heterogeneous environmental conditions and the diverse cultural history of the people make Ethiopia an important primary gene pool centre for many cultivated species. Most recent studies indicated that the Ethiopian flora is estimated at more than 6500 species of higher plants of which 10-12% are known to be endemic. The review showed that there are over 300 tree species, 719 horticultural species, 887 medicinal plant species used for different purposes. The current paper also overviewd that the different thearts of genetic resources of the Ethiopia. The review showed that there has already been a 13 percent genetic loss of 13 major indigenous crops in Ethiopia. Nine species of crops (cereal, pulse and oil crops) have been reported to be in danger of total extinction from the country. The major factors causing this loss includes the displacement of the indigenous farmers' varieties by new genetically uniform crop cultivars, changes in agricultural systems or land use, destruction of habitats and ecosystem, drought and civil strife. Therefore; collection of plant genetic diversities which are at risk and conseravation on farm management, in-situ as well as ex-situ is required.

Keywords/phrases: genetic diversity, genetic erosion, Ethiopian origin

1. Introduction

According to Vavilov (1951) there are certain areas in the world where crop plant diversity is extremely high. These areas of greatest diversity are referred to as centre of origin of the crops concerned (Hawkes 1983). Sheffield (1986) also reported that the genetic diversity in crops is concentrated in certain areas of the world. Ethiopia is among such areas in the world where crop domestication started, and considered as a primary gene centre for several crop plants (Vavilov 1951). Other scientists (Frankel, O.H, 1973) reported the existence of many cultivated crops in Ethiopia which show considerable genetic diversity. The tremendous genetic diversity that exists in Ethiopia deserves much more attention than received so far. Scientists from many parts of the world have collected Ethiopian germplasm (Mengesha 1975) and many plant breeders have discovered some highly desirable genetic characteristics such as disease resistance in barley (Qualset 1975).

Diversity in crop plants is conditioned by geographic, climatic and edaphic factors, cultural and ethnic differences, farming practices, and religious and cultural beliefs (Hawkes 1983). Ethiopia is endowed with diverse ecosystems, and edaphic and climatic conditions. As the result, the country is inhibited by amazingly great diversity of plant, animal and microbial genetic resources (FAO 2001). It is also reported that the genetic diversity found in the Ethiopian landraces are being used worldwide for developing new crop varieties and addressing different production constraints. Most of this diversity is found in farms of small-scale farmers who have been playing central roles in the maintenance and use of these resources (Melaku Worede et al. 2000). In countries like Ethiopia where agriculture is dominated by subsistence farming, diversity among crop species is especially significant. The diversity represents an important resource to the farming communities (Melaku Worede et al. 2000). There are between 6500 and 7000 higher plant species, out of which about 12 per cent are endemic to Ethiopia (Tewolde Berhan, 1991; IBC, 2004).

Despite the genetic diversity and origin, the current agricultural policies largely focus on national or regional important crops without due consideration of indigenous crop production. Major agricultural development programs are biased towards the cultivation of high yielding commercial crops. However, this does not seem realistic, especially to subsistence farmers in developing countries like Ethiopia, who prefer to increase their option by diversifying their small plots of land rather than homogenizing them with high external inputs and varieties (Yeshitila Mekbib, 2007). Therefore; the objectives of this review were to evaluate the genetic diversity and endemic plant resources of Ethiopia and their major causes of genetic diversity in Ethiopia.

2. Plant Genetic Diversity

2.1 Field crop diversity

The major field crops grown in Ethiopia are classified in four groups: cereals, pulses, oil seeds, and industrial crops ((Tewolde Berhan, 1991; IBC, 2007, IBC, 2008, IBC, 2009)

The widely cultivated cereal species are teff (*Eragrostis tef*), barley (*Hordeum vulgare*), Emmer and other wheat species (*Triticum* spp), sorghum (*Sorghum biocolor*), finger millet (*Eleusine coracana*), maize (*Zea mays*), rice (*Oryza sativa*), oat (*Avena sativa*), and pearl millet (*Pennisetum glaucum*).

The major pulse species are faba bean (*Vicia faba*), field pea (*Pisum sativum*, including the endemic var. *abyssinicum*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), haricot bean (*Phaseolus vulgaris*), grasspea (*Lathyrus sativus*), and fenugreek (*Trigonella foenum-graecum*). Additionally white lupin (*Lupinus albus*), soyabean (*Glycine max*), pigeon pea (*Cajanus cajan*), cowpea (*Vigna unguiculata*), jackbean (*Canavalia ensiformis*), hyacinth bean (*Lablab purpureus*), and mungbean (*Vigna radiata*) are produced by some farmers. Yeheb nut (*Cordeauxia edulis*) is also found in the bushlands of Somali Regional State.

The major oil seed species are *Brassica* spp., niger seed (*Guizotia abyssinica*), linseed (*Linum usitatissimum*), sesame (*Sesamum indicum*), castor bean (*Ricinus communis*), safflower (*Carthamus tinctorius*), sunflower (*Helianthus annuus* L.), crambe (*Crambe abyssinica*) and groundnut (*Arachis hypogea* L.).

The widely cultivated industrial crop is cotton (*Gossypium barbadense* and *G. hirsutum*). Cotton also includes *G. arboreum* and *G. herbaceum* which are grown in home gardens and are locally important in traditional handicrafts.

3. Forest plant diversity

It is often reported that about 35 per cent of the landmass of Ethiopia was once covered with closed forests, but this figure is based on a study of the possible climatic climax vegetation types of the country which was included in reports by FAO. Historical records and archeological studies indicate that the forest cover has been much lower since prehistoric times. The revised estimate of the closed forest cover of Ethiopia is less than 3.5 per cent (Anonymous, 2004). The total number of woody species of Ethiopia is estimated to be 1017, out of which 29 tree species, 93 shrub species and 2 liana species are endemic. These species represent 104 families and 387 genera (Taye *et al.*, 2003). A new tree species, *Acacia fumosa*, has been identified from the Ethiopian Somali Region.

Endangered woody species in these field gene-banks include *Hagenia abyssinica*, *Podocarpus falcatus*, *Juniperus procera*, *Olea europaea* subsp. *cuspidata*, *Prunus africana*, *Cordia africana*, *Milletia ferruginea*, *Calpurnia aurea*, *Acacia abyssinica*, *Acacia albida*, various *Ficus* spp. and one pioneer species, *Croton macrostachys*. Although *Oxytenanthera abyssinica* is the main species targeted to be conserved in the Asosa and Mandura ex-situ sites, other economically and socially important species such as *Zizipus spina-christi* and *Piliostigma thonningii* have been included. In addition, a collective ex-situ conservation site has been established at Adulala, in Liben Chiquala Woreda, East Shewa Zone of the Oromia Region. Species in this site include: *Cordia africana*, *Ficus vasta*, *Hagenia abyssinica*, *Acacia senegal*, *A. albida*, *A. seyal*, *Calpurnia aurea* and *Olea europaea* subsp. *Cuspidate* (IBC, 2007, 2008 and 2009).

4. Horticultural plant diversity

The major horticultural plant species grown in Ethiopia are categorized in five groups: root and tuber crops, fruits and nuts, stimulant and beverage species, herbs and spices, and wild-edible species. The most important root and tuber crops, which are native to Ethiopia are anchote (*Coccinia abyssinica*), enset (*Ensete venricosum*), yams (*Dioscorea* spp.), and "Oromo dinich" (*Coleus edulis*). The major exotic root and tuber crops include taro (*Colocasia esculenta*), tannia (*Xanthosoma saqiifolium*), yam (*Dioscorea alata*), Cassava (*Manihot esculenta*), potato (*Solanum tuberosum*), and sweet potato (*Ipomoea batatas*). Some of the exotic crops, such as taro and tannia, are naturalized and diverse. The most important stimulant and beverage species are coffee (*Coffea arabica*), tea (*Camellia chinensis*), gesho (*Rhamnus prinoides*) and khat (*Catha edulis*). There are about 40 tropical, sub-tropical and temperate fruit crop species grown in Ethiopia. The number of wild-edible species recorded so far is 233. There are about 30 herb and spice species that are commonly grown and used in Ethiopia (IBC, 2007, 2008 and 2009).

5. Medicinal plant diversity

At least 80 per cent of the Ethiopian people depend on traditional medicine for their health care (Dawit and Ahadu, 1993), and more than 95 per cent of traditional medicinal preparations in Ethiopia are made from plant origin (Dawit, 1986). There are about 887 plant species recorded as having medicinal uses for people. The majority of the medicinal plants are herbs, followed by shrubs and trees. Twenty four (2.7 per cent) of the medicinal plant species are endemic to Ethiopia, and most are found in the wild.

6. Genetic Erosion of Ethiopian Genetic Resources

The status of field crop diversity is currently declining at an alarming rate. The major threats to field crop diversity are the replacement of farmers' varieties by a few genetically uniform crop cultivars, invasive species, drought and climate change. The famine that persisted in some parts of Ethiopia in the 1980s forced farmers to

utilize the seeds of their own varieties for food. Native barley and durum wheat are probably among the most threatened by new improved/introduced varieties and/or replacement by other crop species such as forage oats (*Avena sativa*) and bread wheat, which are expanding within the cereal growing highlands. Farmers' varieties of durum, emmer and 'bonde' wheat, maize, sorghum, 'Semereta' barley are being lost by the extensive introduction of improved varieties into the farming system. The threat is more on wheat followed by maize and pulses. Late maturing farmers' varieties are being eroded as a result of the shortening of the growing season due to the change in climate. These late maturing varieties are also being threatened due to replacement by early maturing varieties in areas where there is shortage of rain. Local varieties of some pulses, such as cowpea, primitive or diploid wheats and barley are disappearing from production (Edwards, 2007, IBC, 2007, 2008 and 2009).

Concerning the horticultural plant species, the major threats are severe and prolonged drought, pests and disease, replacement by food grains, deforestation, frost and hail storms (Tesema *et al.*, 2003). Wild medicinal plant species and their associated traditional knowledge are getting eroded due to natural and man made factors (IBC, 2009)

Generally the major threats to the biodiversity of the country are unsustainable utilization of natural resources (over-harvesting), deforestation, conversion of natural vegetation to farmland, forest fires, land degradation, habitat loss and fragmentation, extensive replacement of farmer's/local varieties/breeds by improved ones, invasive species, wetland destruction and climate change. But all these are related to the root causes of poverty, which are lack of alternative viable livelihoods, increasing population pressure and inadequate awareness of the threats and possible solutions at all levels (IBC, 2007, 2008 and 2009).

Table 1 Some important plant genetic resources of the Ethiopian Center of Origin/Diversity

No	Common names	Botanical name	No	Common names	Botanical name
1.	Anchote	<i>Coccinia abyssinica</i>	14	Gesho	<i>Rhamnus prinoides</i>
2.	Barley	<i>Hordeum vulgare</i>	15	Gomenzer	<i>Brassica carinata</i>
3.	Cabbage tree	<i>Moringa stenopetala</i>	16	Kosso	<i>Hagenia abyssinica</i>
4.	Caster bean	<i>Ricinus communis</i>	17	Lentil	<i>Lens culinaris</i>
5.	Chat	<i>Catha edulis</i>	18	Noug	<i>Guizotia abyssinica</i>
6.	Chick pea	<i>Cicer arietinum</i>	19	Okra	<i>Abelmoschus esculentus</i>
7.	Coffee	<i>Coffea arabica</i>	20	Oromo potato	<i>Plectranthus edulis</i>
8.	Cowpea	<i>Vigna unguiculata</i>	21	Pearl millet	<i>Pennisetum glaucum</i>
9.	Durum Wheat	<i>Triticum durum</i>	22	Suf	<i>Carthamus tinctorius</i>
10.	Enset	<i>Ensete ventricosum</i>	23	Seasme	<i>Sesamum indicum</i>
11.	Faba bean	<i>Vicia faba</i>	24	Sorghum	<i>Sorghum bicolor</i>
12.	Field pea	<i>Pisum sativum</i>	25	Teff	<i>Eragrostis tef</i>
13.	Finger millet	<i>Eleusine coracana</i>	26	Yams	<i>Dioscorea spp</i>

(IBC, 2007, 2008 and 2009).

7. Conclusions

The review showed that in Ethiopia there are between 6500 and 7000 higher plant species of which about 12 per cent are endemic). There is an immense variation in the farmer's varieties of different crops. More than 100 crop plant species are cultivated with a sizeable proportion of them having their center of origin or diversity in Ethiopia. This biodiversity is of crucial importance in the socio-economic, cultural and political life of the people.

The rich biodiversity of the country is under serious threat from deforestation and land degradation, overexploitation, overgrazing, habitat loss, invasive species and some water pollution. The underlying causes for these problems emanate from poverty, population growth, lack of alternative livelihoods, inadequate policy support, inappropriate investment and inadequacy of law enforcement. A number of endemic trees and herbaceous plants are reported to be endangered or critically endangered. Farmer's varieties are being replaced by uniform improved varieties. Resettlements and agricultural investment in commercial crop farms are also exerting pressure on the country's precious biodiversity.

8. Recommendation

Efforts to save some of the vegetation by a number of government institutions, NGOs and public-private partnership initiatives are being made and progress is being achieved.

Though the *in-situ* sites are established for the conservation of the target species mentioned above, the whole ecosystem should be conserved for the sustainability of the genetic resources. Reports from the monitoring and evaluation activities show that these conservation sites are very susceptible to human and livestock encroachment, and hence becoming severely degraded. This calls for urgent and rational measures by the concerned bodies and other stakeholders in order to develop and implement proper management plans for

these *in-situ* conservation sites.

Acknowledgements

I would like to thanks to wife W/ro Sinknesh Facha for her moral, material, financial support and for looking after our children in the process of writing this review. My children, Barkot & Dagim, thanks for being so understanding me!!

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