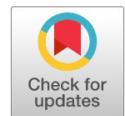


# Review of Plant Genetic Resources, Utilization and Conservation of Genetic Resources

Bekele Kindie, Tahir Abdala



**Abstract:** According to the review, genetic resources are derived from native plant landraces and wild species. Material originating from plants is referred to as genetic resources. These genetic resources are very important for nutrition and the development of agricultural productivity. Cereals, pulses, oilseeds, and cash crops are a group of field crops grown in Ethiopia. The group of forest genetic resources includes plantations, forests, scrub, natural closed forests, and trees on farms. Ethiopia has rich plant genetic resources with its diverse agro-ecological region but faces several threats. In order to conserve plant genetic resources, the Ethiopian Biodiversity Institute uses a diverse strategy that includes gene banks, on-farm conservation, education, and policy lobbying. Genetic resources preserved by ex situ and in situ conservation. This review article was intended to discuss plant genetic resources, utilization, threats, and conservation strategies.

**Keywords:** Genetic Resources, Diversity, Conservation, Threats

## I. INTRODUCTION

Ethiopia has immeasurable biological resources and a huge diversity of ecosystems, which encapsulate its geographical location, range of altitudes, prototype rainfall, and different soil types. Biological resources are important to human well-being in terms of agriculture, logging, export earnings, economic production, and ecological services and purposes [2] and [57][59][60]. Among these resources, the most important is the massive genetic diversity of the various species of cultivated plants grown in the country [2] and [56]. In addition, these plant species are the ones with the highest potential for genetic diversity [2]. Genetic diversity in plant species is the occurrence of diversity among individuals due to variation in their genetic framework and environment. Diversity of a species is vital for improving its ability to adapt to biotic and abiotic environments [11] and [48]. These are the cornerstones of crop improvement programs, agricultural development, and world food security [37], [45] and [48].

**Table 1 Shows the Main Field Crop Categories and Species Cultivated in Ethiopia**

Field Crop Category	Species
cereal crop species	Avena sativa, Pennisetum glaucum, Zea mays, Oryza sativa, Eleusine coracana, Hordeum vulgare, Triticum spp., and Eragrostis tef.
Pulses crop species	Phaseolus vulgaris, Cicer arietinum, Lens culinaris, Trigonella foenum-graecum, Vicia faba, and Pisum sativum Vigna radiata, Canavalia ensiformis, Lablab purpureus, Cajanus cajan, Vigna unguiculata, Lupinus albus, Glycine max, and Cordeauxia edulis.
oil crop species	Ricinus communis, Carthamus tinctorius, Helianthus annuus L., Crambe abyssinica, Guizotia abyssinica, Linum usitatissimum, Sesamum indic, and Arachis hypogea L.
industrial crop species	Cotton (Gossypium barbadense and G. hirsutum)

Manuscript received on 12 April 2024 | Revised Manuscript received on 06 May 2024 | Manuscript Accepted on 15 May 2024 | Manuscript published on 30 May 2024.

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Genetic diversity can be detected at the morphological, biochemical, and molecular levels [3]. These are also used in systematic research through pathological, molecular, phylogenetic, evolutionary, cytogenetic, biochemical, and physiological studies [48].

However, due to anthropogenic and natural factors such as climate change, genetic susceptibility, habitat conversion, overexploitation and invasive species, plant genetic resources are disappearing and declining at an alarming rate [27]. Conservation of genetic resources is a way of protecting living materials used in agriculture, industry, forestry, and aquaculture to provide food, feed, medicine, fiber for clothing and housing, fuel for cooking and heating, and food and industrial products of microbial activity [18] and [54]. In order to preserve and use plant genetic resources, generally appropriate and strict legal procedures must be applied [21]. However, plant genetic resources can be conserved by in situ and ex situ conservation as well as by biotechnological methods [48]. Thus, this review was intended to assess plant genetic diversity and resources, as well as uses, threats, and conservation strategies.

## II. PLANT GENETIC DIVERSITY

### A. Field Crop Diversity

The range of crop species that have been grown on farms and in agricultural areas is known as field crop diversity. In order to advance resilient agricultural practices, food security measures, improved nutrition, and sustainable agriculture, it is very important to address crop species diversity [2] and [35]. Genetic resistance to pests and diseases can be derived from the extensive gene pool found in many field crop species [35]. Cash crops, pulses, cereals and oilseeds are the main field crops grown in Ethiopia (Table 1) [28].

### B. Forest Plant Diversity

Forest resources are vital to the population, which is heavily dependent on forests for food security, household use and income generation from timber and non-timber forest products. The world forest covered about 3.9 billion ha, of which 47% was in the tropics, 33% in the boreal zone, 11% in temperate areas and 9% in the subtropics.



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Ethiopia is home to a variety of plant types and has 1017 tree species [53]. The majority of forest tree species are characterized by extensive natural ranges and high levels of natural diversity. Almost one-third of the total surface area on Earth is covered by forests, of which half of the two million hectares are in warm regions. Ethiopia has less than 3.5% of closed forests [1]. Both natural and planted forests are important for harboring important wildlife, pharmaceutical products, offering recreational opportunities, tourist attractions, socio-economic growth of communities, medicinal value and world-class food and environmental stabilization. The country's forest resources were divided into

five groups: plantations, forests, scrub, natural closed forests, and farm trees [23].

### C. Horticultural Plant Diversity

Ethiopia has diversified types of horticultural crops, which is very important for farmers' livelihoods and food security around the world. The five categories of horticultural plant species cultivated in Ethiopia are presented (Table 2). These types of crops play an important role in the diet of the population, in medicine, and as a raw material for industry [2].

**Table 2 Shows the Main Horticultural Crop Categories and Species Cultivated in Ethiopia**

Horticultural Category	Crop	Species
Root and Tuber Crops		Dioscorea spp., Ensete venricosum, Coccinia abyssinica, Coleus edulis, Colocasia esculenta, Xanthosoma saqitiffoliu, Manihot esculenta, Solanum tuberosum, and Ipomoea batatas.
Beverage and stimulant		Cocoa, Rhamnus prinoides, Camellia chinensis, Coffea arabica, and Catha edulis
Fruit and Nut Crop		Cordeauxia eduli; Citrus reticulata; Arachis hypogea L.; Macadamia integrifolia; Adansonia digitata; Malus domestica Borkh; Ziziphus Mauritiana; Carica papaya L.
wild-edible		Cordia africana; Tamarindus indica; Ficus mucoso Ficalho; Ziziphus mauritiana; Syzygium guineense; Carissa spinarum; Phoenix reclinata; Rosa abyssinica.
herb and spice		Z. officinale Roscoe; Curcuma longa L.; Rosmarinus officinalis L.; Allium sativum; Nigella sativa L.; Piper capense; Capsicum species; Aframomum corrorima, Trachyspermum ammi, Coriandrum sativum, Diplolophium abyssinicum, Anethum graveolens, Allium cepa, Thymus schimperi, Ruta chalepensis; Lippia abyssinica.

### D. Medicinal Plant Diversity

Medicinal plants are essential to Ethiopian traditional medicine, ecological balance, and cultural practices. Over 80% of Ethiopia's population receives primary healthcare from traditional medicines, with approximately 95% of these preparations derived from plants [2] and [5]. Due to its widespread acceptance, accessibility, and affordability, traditional medicine plays a significant role in Ethiopian healthcare practices [15] and [5]. Currently, approximately 887 different species of medicinal plants are used by the Ethiopian people. Medicinal plants principally come from herbs, followed by trees and shrubs, respectively [2] and [31]. Combining spiritual healing, medications, bone-setting, and minor surgery, Ethiopian traditional healers employ a comprehensive therapeutic approach. Even in the face of Western medicine, Ethiopians retain a great deal of faith in their traditional medicines [15].

## III. IMPORTANCE OF GENETIC RESOURCES

Genetic resources are a crucial source of information for taxonomy, naming species, and the building blocks of life on earth. It supports human and animal prosperity and a diversity of food sources, as well as the production of fibers, fuel, medicines, textiles, textile-related products, soil erosion prevention, food, water regulation in the environment, and ecotourism [48]. Plant breeders can select better genotypes via genetic resources and genetic diversity of species [21] and [56]. Farmers and plant breeders can develop new varieties of plants with improved yields, increased resistance to pests and diseases, and greater adaptation to certain growing environments [18], [39] and [44]. Genetic resources can also be used to produce plants with desirable characteristics, such as better nutrition or flavor [6] and [26].

### A. Threats to Genetic Resources and Conservation Techniques

#### a. Threats of Genetic Resources

Ethiopia has numerous genetic resources and centers of genetic resources. Due to its diverse agro-ecological zones and high biodiversity poses a threat to its plant genetic resources. Changes in land use, genetic susceptibility, invasive species, pollution, climate change, pollution, unsustainable use of plant genetics, and the replacement of old varieties with contemporary ones were a few of these challenges [32] and [37].

#### b. Habitat Loss

In Ethiopia, continued deforestation for construction materials, unsustainable resource and fuel consumption by a densely populated, rapidly expanding population, and urban expansion have resulted in habitat alteration [16]. The conversion of natural habitats to urban or agricultural land poses a risk to plant species and genetic resources. In general, ecosystems can be disrupted and the availability of wild plant species and genetic resources reduced by deforestation, urban growth, exploitation and land-use change [14] and [37].

#### c. Climate Change

The statistical mean and variability of significant meteorological parameters over time for a certain location is known as climate change. These days, climate change is a process that modifies the average climate over time in a particular location due to human activities or natural factors [32]. Plant genetic resources and the environment are negatively impacted by climate change [8]. Therefore, climate change regularly poses a major threat to Ethiopia's plant genetic resource conservation [44] and [51].

#### d. *Unsustainable Utilization*

Ethiopia's diverse range of settings and tremendous biological diversity make it a center of huge plant genetic resources. However, Ethiopia has distinctive genetic diversity due to unsustainable agricultural methods, monoculture farming, overharvesting plant genetic resources, replacing native crop types with new ones, and overusing chemical inputs are causing plant genetic resources and unique genetic diversity [37] and [46].

#### e. *Lack of Awareness and Education*

In order to obtain valuable information about the genetic resources that are being collected, it is necessary for a highly technical person to have a basic knowledge of the collected materials, such as their nature, biology and other unique characteristics. However, sometimes the individual collecting genetic resources lacks basic understanding and continues, resulting in the same kind of genetic resources being repeated over time [46]. Many people are not aware of the conservation of important genetic resources. Without awareness, there are gaps in understanding the importance of maintaining genetic diversity [57]. Inadequate education can lead to unsustainable agricultural practices involving the replacement of local landrace varieties with modern varieties. Lack of awareness can lead to biopiracy, where genetic resources are misused without fair sharing of benefits [57].

#### f. *Gene Bank Problems*

The efforts of gene banks contribute significantly to the conservation of plant genetic resources. However, there are several concerns about gene banks and their effectiveness in Ethiopia [45]. Limited access to preserved materials prevents the efficient use of protected genetic resources [22]. Despite their underrepresentation in plant genetic resource conservation efforts, farmer groups and NGOs have begun to formally facilitate linkages [25].

#### g. *Population Growth*

Urbanization and population growth pose serious challenges to the protection of plant genetic resources. As urbanization grows and the population rises, natural landscapes are often converted into urban areas [33]. Alter the environment to meet their needs, which would inevitably result in a suffocating demand for land and other natural resources for agriculture, industry, shelter, and food, ultimately causing habitat degradation and the loss of plant genetic resources [55]. Over-reliance on natural resources leads to over-exploitation and the loss of wild plant genetic resources, which is linked to social unrest such as conflicts and starvation [37].

#### h. *Alien Invasive Species*

Invasive Species are native species that have been accidentally or purposely introduced, colonized, or invaded into an area outside of their natural habitats. As a result, they pose a threat to biological diversity, ecosystems, and human health [38] and [49]. Invasive alien plant species provide major challenges to Ethiopia's efforts to preserve its plant genetic resources [50]. Invasive alien species, which include genetic resources, are the primary cause of biodiversity and the second biggest threat to it after habitat loss [12]. Several well-known invasive plant species in Ethiopia include *Prosopis juliflora*, *Lantana camara*, *Eichhornia crassipes*,

*Parthenium hysterophorus* and several *Acacia* species [49]. Plant genetic resources are essential for both sustainable agriculture and the world's food security [48].

#### i. *Replacement of Traditional with Modern Varieties*

The substitution of contemporary, homogenous cultivars for diversified crop types and traditional landraces poses a severe threat to the preservation of Ethiopia's plant genetic resources. As part of agricultural modernization, traditional crop kinds are often replaced by homogeneous contemporary cultivars. This alteration may lead to a decrease in the genetic diversity of crops as well as the loss of significant traits and adaptations [17]. Modern cultivars are now often selected on the basis of traits including high yield, uniformity, and resistance to pests and diseases. Traditional landraces contain unique characteristics that have been adapted to the particular environmental conditions of their environment, such as resilience to biotic and abiotic stresses. Traditional cultivars are closely associated with certain regions, dialects, and cultural practices because of their adaptation to local temperatures, soils, and farming practices [24].

#### j. *Genetic Vulnerability*

A plant population's susceptibility to adverse conditions that could reduce its fitness, adaptability, or survival is referred to as its genetic vulnerability [10]. A crop that is widely planted has a genetic composition that renders it persistently susceptible to environmental risks, viruses, and pests. Significant agricultural losses could result from this. Numerous distinct crop types and geographical areas are still seriously threatened by this issue [43]. The gene pool of wild relatives and landraces is more diverse than the genes determining fundamental traits since most modern cultivated genotypes are descended from a small number of landraces [7] and [46]. The following factors contribute to genetic vulnerability like: Restricted Genetic Diversity: Populations with less genetic diversity are more susceptible to pests, illnesses, and changes in the environment [10].

### B. *Genetic Resource Conservation Techniques*

A global system that provides access to plant genetic resources for researchers, farmers, and plant breeders is the aim of the International Treaty on Plant Genetic Resources for Food and Agriculture [30]. This also promotes and enables the conservation and sustainable use of plant genetic resources, as well as the just and equitable distribution of the benefits arising from their use for food and agriculture, in compliance with the Convention on Biological Diversity [29]. Ethiopian Biodiversity Institute (EBI), on the other hand, is essential to the preservation of Ethiopia's plant genetic resources. The Ethiopian Biodiversity Institute conserves plant genetic resources through gene banks, field gene bank collections, on-farm conservation, education and awareness campaigns, cooperation with partnerships, and policy advocacy strategies [4].

#### a. *Ex-situ Conservation*

The strategy of conserving plant genetic resources without their natural habitat or environment is known as ex-situ conservation.

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This conservation strategy involves the collection, preservation and care of plant genetic diversity for long, medium or short periods in a controlled environment [9], [19] and [46]. It provides scientists and breeders with access to a wide range of genetic material for crop development and adaptation to changing environmental conditions [47]. Cryopreservation, greenhouses, tissue cultures, gene banks, botanical gardens, field gene banks and seed gene banks are examples of ex-situ conservation strategies [46]. The goal of ex-situ conservation is to breed animals that can be returned to their natural environment in situations where that environment is threatened, as well as to preserve genetic material that faces extinction. For vegetatively propagated and heat-resistant seed species, suitable locations for the preservation of living plants are field gene banks and botanical gardens [46]. Propagation of unusual species is encouraged in botanical gardens.

### b. *In-situ Conservation*

In Ethiopia, various strategies are used to conserve plant and animal species in their natural environment called in-situ conservation [40]. In-situ conservation of plant genetic resources is the preservation of genetic resources in their natural environment [58]. This technique preserves a wide variety of wild plant species and wild fruit crops, especially forests. On-farm conservation and genetic pool conservation are the two main in situ conservation tactics [19] and [37]. The search, management and monitoring of genetic diversity in natural wild populations over a longer period of time is a process of genetic reserve conservation [46]. The long-term maintenance of the genetic diversity of land races and species through farmers' agricultural, horticultural and agricultural plans is known as "on-farm conservation" [46].

### c. *Biotechnological Approaches*

Plant genetic resources must be conserved, and biotechnological techniques provide new opportunities for genetic resource conservation. Biotechnological techniques are used in cell and tissue culture procedures to rapidly generate and propagate plant genetic resources in large quantities for transport [54]. These technologies facilitate the conservation of forest, ornamental, rare, endangered and medicinal plant species and other materials used in vegetative propagation [40]. Although the biological material found in plant genetic resources cannot be replicated or preserved by conventional methods, biotechnological techniques such as molecular biology, cryopreservation and in vitro cultivation can be used. Therefore, problems with reproductive barriers in rare and endangered plant species can be solved by biotechnological interventions [13]. They also used pathogen-free plant protection in the long, medium and short term.

## IV. CONCLUSION

Ethiopia has abundant plant genetic resources due to its diverse habitats and rich biodiversity. Any material obtained from plants with vegetative and reproductive material that has valuable units for agriculture and food production is considered a plant genetic resource. Plant genetic resources are disappearing and declining at an alarming rate in Ethiopia due to a combination of natural and anthropogenic factors, including invasive alien species, habitat loss,

overexploitation, genetic susceptibility and climate change. Ethiopia is home to 1017 species of wood. Plant genetic resources can be preserved using in-situ or ex-situ techniques. For effective conservation, attention and emphasis must be given to the evaluation and characterization of plant genetic resources. Effective use of plant genetic resources could help solve problems limiting crop productivity for food security.

## DECLARATION STATEMENT

Funding	No, I did not receive.
Conflicts of Interest	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material	Not relevant.
Authors Contributions	Each author has made an independent contribution to the article. The individual contributions of each author are presented below for clarity and transparency. Bekele Kindie (MSc.), writing original draft; Review and Editing, Tahir Abdala (MSc.), Revised and enriched the published version of the manuscript.

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