

Biological Diversity and Current *Ex Situ* Conservation Practices in Ethiopia



Girma Balcha

Institute of Biodiversity Conservation and Research (IBCR), P.O. Box 30726, Addis Ababa, Ethiopia

Tim Pearce

Seed Conservation Department, Royal Botanic Gardens, Kew, Wakehurst Place, Ardingly, West Sussex RH17 6TN, UK

Abebe Demissie

Institute of Biodiversity Conservation and Research (IBCR), P.O. Box 30726, Addis Ababa, Ethiopia

Summary

An overview of the current status of *ex situ* conservation activities and available seed collections of native Ethiopian plant genetic resources is given. The current holdings within the seed bank of the Institute for Biodiversity Conservation and Research are presented and the future plans for the further development of these collections, through a new Forest Genetic Resources Conservation Programme, are explained.

Introduction

Ethiopia has a great topographical diversity with high, rugged mountains, flat topped plateaus, deep gorges, incised river valleys and rolling plains. The altitudinal variation ranges from 100 m below sea level to 4,620 m above. The Great Rift Valley separates the western and southeastern highlands (S. Edwards, pers. comm.). The highlands on each side of the Rift Valley give way to extensive semi-arid lowlands to the east and southwest of the country.

There are 92 high forests in Ethiopia out of which 56 are found in dry evergreen montane forests, 29 in moist evergreen montane forest, 5 in transitional dry moist evergreen montane forests and 2 in lowland semi-evergreen forests (EFAP, 1994). The moist evergreen forest and the dry evergreen forest are home to a high number of endemic plants and birds and a few of the mammals. Moreover, the afro-alpine habitats, represented by the Simen and Bale parks and the lowland habitats represented by Abjata-Shala, Awash, Nechsar and Yangudi-Rasa parks give sanctuary for large mammals, threatened and endemic birds and spectacular game animals (EPA, 1997).

The size of the Ethiopian flora is estimated to be over 7,000 species of vascular plants, 12% of which are considered endemic to Ethiopia. Endemism is reportedly high on the plateaux and in the mountains, in the Ogaden region and the western and southwestern woodland. The country, with an area of about 1.15 million km², has an estimated population of 60 million, about 85% of which is classified as rural (EPA and MEDaC, 1997; Teketay, 1999). Influenced by factors such as altitude, climate, soil fertility, security, health and economic activities, the settlement density of the population is skewed to the highlands. The cooler highlands are over-populated and, consequently, over-grazed, resulting in a significant level of degradation of the land and a depletion of vegetation resources.

In the past, conservation activities have focused on high value and internationally important crop types. Priority for conservation has been given to those crops that were considered to be facing immediate danger of genetic erosion and whose socio-economic importance was high. Recently, however, appropriate emphasis is being placed on the conservation and sustainable use of all forms of plant biological resources, and groundwork is being done to address this in terms of institutional capacity building, national policies and strategy development.

The need for improved seed handling technologies has come about not least because of the extensive planting programmes of wild species. Lack of adequate knowledge with respect to collection, handling and treatment of seeds often impedes the planting of indigenous trees and shrubs. Inadequate work has been done on establishing the seed storage behaviour of native species resulting in only limited availability of *ex situ* conservation seed collections especially with respect to native forest species.

Current Status of *Ex Situ* Conservation Activities

1. Seed Banks

Seed banking is the major *ex situ* conservation method employed by national natural resource institutions. There are currently three major seed banks operative in Ethiopia. The National Tree Seed Project (NTSP) processes seed from a narrow range of tree species and uses short-term storage facilities. It aims to cater for the annual seed demand from commercial and small-scale forestry enterprises. Of the 70 species regularly collected and processed, 20 are indigenous. Throughput of material is low with the NTSP supplying only 30% of the national annual demand.

The Forage Genetic Resources Centre maintained by the Consultative Group on International Agricultural Research (CGIAR) at the International Livestock Research Institute (ILRI), based in Addis Ababa, maintains long-term conservation collections of a wide range of native and exotic forage species. Accessions from about 525, Ethiopian species have been collected and are maintained by ILRI.

The Institute for Biodiversity Conservation and Research (IBCR) holds active collections of seeds mainly for research and distribution and a base collection for long-term conservation. IBCR currently holds some 56,558 accessions covering 209 species from 107 genera (IBCR, 2000b). Some 85% of the collection consists of cereals, millets and pulses (IBCR, 2001) and well over 43% of this current holding has been collected by staff of IBCR (formerly the Ethiopian Plant Genetic Resources Centre) staff since its establishment in

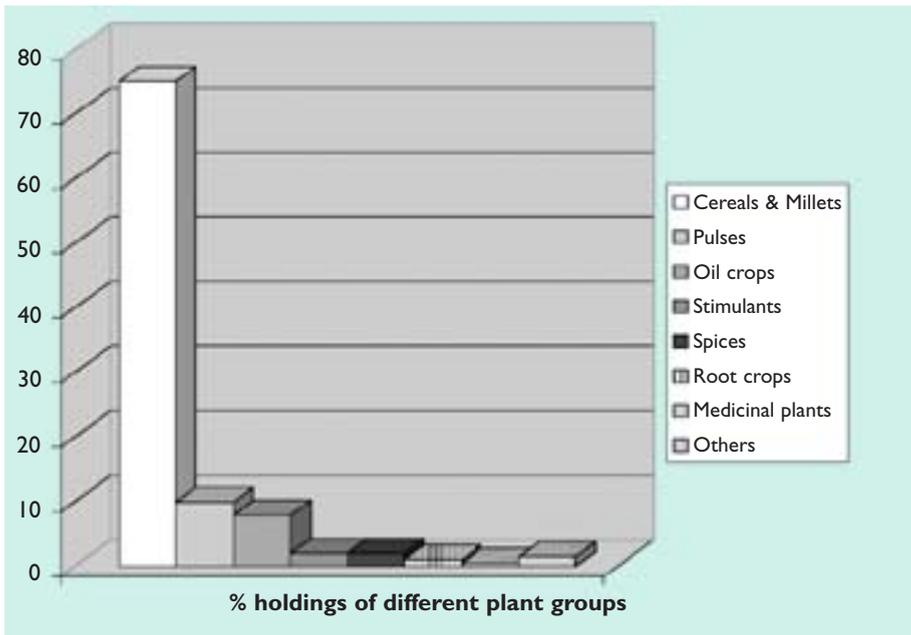


Figure 45.1 Percentage holdings at the IBCR seed bank

1976. The remaining germplasm has been obtained through repatriation (6%), donation (4%) and previous collection by other national institutions (25%) (IBCR, 2001).

IBCR adopts standard seed bank practices. Seeds are dried to 3–7% moisture content in a drying room operating at 15–20% relative humidity and 18–20°C before they are hermetically sealed in aluminum foil bags. Seeds meant for immediate use and multiplication are kept in a temporary storage temperature of +4°C whilst long-term conservation collections are stored in the base seed bank operating at -10°C.

2. Field Gene Banks

Desiccation-intolerant seeds and species that do not readily produce seeds are conserved *ex situ* in field gene banks. For example, accessions of coffee (*Coffea arabica* L.); root crops such as yam (*Dioscorea bulbifera* L.) and ‘Oromo dinich’ (*Coleus edulis* Vatke); and spices like ginger (*Zingiber officinale* Roscoe) and Korrorigima (*Aframomum corrorima* (Braun) P.C.M. Jansen), are conserved at appropriate agro-ecological zones in field gene banks. Being maintained in close proximity to the major research stations, this facilitates the utilisation of these materials in national research programmes.

3. On-farm Conservation

In addition to the above, farming communities also play a pivotal role in the conservation of landraces as they hold the bulk of the within-species variation of the genetic resource. Farmers always retain some seed stock in traditional storage systems for security purposes, even at difficult times, unless circumstances do not allow them. A landrace conservation and enhancement programme has been embarked upon which provides a unique opportunity to conserve and develop traditional seed materials that are adapted to often high environmental stresses within certain local agro-ecological zones (Demissie *et al.*, 2000). This approach has been encouraged to help farmers maintain their plant diversity by protecting major crops from extinction while improving the crop genetic performances. This “on-farm” conservation strategy has been evident throughout the history of wild plant domestication in Ethiopia and the approach is currently operational at 12 sites in the country and integrates community knowledge with conventional *in situ* methods.

4. Germplasm Exchange and Collaborative Links

Whilst recognising its sovereignty over its biological resources, Ethiopia adheres to the principle of free exchange of germplasm with *bona fide* users, in accordance with its national policies and reference to international norms and practices. Germplasm is sent to, or exchanged with, foreign countries as long as mutual advantage in such an exchange exists. It is generally based on a three-point contact policy whereby Ethiopian breeders, and scientists from both IBCR and the co-operating international and multinational partners, are involved. Exemplary recent collaborative work in this regard has been mainly through the CGIAR members such as the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) for sorghum, millet and chickpea; the International Center for Agricultural Research in Dry Areas (ICARDA) for pulses, wheat and barley; and the International Rice Research Institute (IRRI) for rice.

Similarly, IBCR maintains working links with a number of international seed banks such as those at Gatersleben and Braunschweig in Germany, Bari in Italy, and the Russian genetic resource system, among others (see Worede, 1986). There are no known examples of material being duplicated at other East African gene banks.

5. Capacity Building

IBCR, along with other co-operating national institutions have hosted and actively participated in a series of training courses on the conservation of plant genetic resources in the last ten years. The Unitarian Service Committee (USC) of Canada sponsored the first two sessions. The beneficiaries included staff of non-governmental organisations working in the field of agriculture

and development-related fields, from various African and Asian countries. A regional training workshop, sponsored by the Food and Agricultural Organisation of the United Nations (FAO), the United Nations Environment Programme (UNEP) and the Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA), on the evaluation and utilisation of genetic resources of local crops of agricultural importance in Africa, was recently hosted by IBCR.

Biodiversity of Wild Species

Many data exist to testify that significant genetic erosion and species extinction continues globally as a result of tropical deforestation and other non-sustainable land management practices. Yet in several countries, such worldwide concern about the depletion of those resources still needs to be translated into action. While conservation and sustainable use of wild biological resources maintains a high priority, limited knowledge of the impacts of such depletion and resulting ecosystem fragmentation, uncontrolled exploitation and other threats, constitute a serious gap limiting the activities of national and international institutions (Ouedraogo, 1999). This global trend is certainly mirrored in Ethiopia and the current Government recognises the need to develop appropriate methods and strategies for conservation, and to encourage wise utilisation of plant genetic resources. The Conservation Strategy of Ethiopia clearly identifies the contribution that wild plants play in the livelihoods of local communities as well as to the development of the national economy (EPA, 1997).

Ethiopia shares similar trends in land degradation with many other countries within sub Saharan Africa. A particular impediment to improving land management has been the issue of land ownership. In the past, land ownership has been in the hands of 'absentee landlords' and this did not encourage, or provide the opportunities for, the conservation and sustainable use of plant resources. Currently, it is the Government of Ethiopia that owns nearly all land in rural areas. There may be little equity in land holdings between members of the same administrative unit, such as the peasant associations, and no incentive exists to plant native species. Consequently, people with little or no land to farm are frequently forced to extract and deplete natural vegetation to support their livelihood.

Agro-biodiversity Conservation in Ethiopia

Ethiopia is considered to be one of the richest centres of plant genetic resources in the world. Wide altitude and temperature ranges, high humidity and extreme forms of rainfall pattern, coupled with complex topography, make the country a major region of genetic diversity for many crop plants. It is believed that indigenous crops such as teff (*Eragrostis tef* (Zucc.) Trotter), Noug (*Guizotia abyssinica* (L.f.) Cass.) and Enset (*Ensete ventricosum* (Welw.) Cheesman) were first domesticated in Ethiopia. Numerous major crop species including durum wheat (*Triticum durum* Desf.), barley (*Hordeum vulgare* L.), sorghum (*Sorghum bicolor* (L.) Moench), sesame (*Sesamum indicum* L.), castor (*Ricinus communis* L.), and coffee (*Coffea arabica* L. var. *abyssinica* A. Chev.), are also known to show significant diversity in the Ethiopian region (Vavilov, 1951).

Collections of root crops, medicinal plants, weedy species, and wild relatives of cultivated species, are still relatively scant within existing *ex situ* collections. Until now, no systematic collection of these resources has been undertaken. Despite the rapid depletion of these types of species in Ethiopia, only 804 accessions of 14 species are currently held by IBCR in long-term conservation collections. This is an area where a critical gap exists and one that undoubtedly deserves intervention.

Appropriate conservation techniques, especially for plants that produce seeds intolerant to desiccation, are inadequate and need improvement. The skills required to facilitate *ex situ* conservation of these 'recalcitrant' species will need to be strengthened in order to manage these species effectively.

It is generally acknowledged that priority should be given to strengthen the capacity of Ethiopian institutes to ensure *ex situ* conservation of key ecological and economic plant species threatened with extinction (Balcha, 1999). Genetic, species and ecosystem diversity conservation should be encouraged through an integrated approach that unites local farmers, scientists and governmental agencies, as well as non-governmental agencies.

***Ex Situ* Conservation Activities in Ethiopia:**

The Future

A major recent change to the capacity of *ex situ* conservation in Ethiopia is the development of the Forest Genetic Resources Conservation Strategy (IBCR, 2002a). With support from the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), a Forest Genetic Resources Conservation Programme started in 1997, and is now entering its second phase, with planned activities to 2006. Achievements thus far include the establishment of a new gene bank development with capacity for a large dry room, cold stores, laboratory, offices, and conference facilities. This new facility was inaugurated in November 2002 and will become operational during 2003.

The strategy and plans adopted by IBCR are actively being implemented. The first phase has consisted of prioritising the targeting of woody forest species from the major forest areas of the country for *ex situ* conservation collections as well as prioritising them for the implementation of *in situ* measures both for protection and sustainable utilisation. These current plans will result in multi-provenance collections from some 150 forest species of high conservation and utility value. Supporting programmes address the identification of reproductive biology, phenology, storage behaviour, safe harvesting methods, cultivation practices and the establishment of *ex situ* plantations. Whilst this major conservation effort to secure *ex situ* seed collections of priority forest species represents a significant contribution to plant conservation in Ethiopia, plans are being developed to extend the programme to include other priority wild plant species. In addition, some other *ex situ* resources facilities will also be planned, such as a botanic garden, field gene banks and those for *in-vitro* culture.

The national conservation and development programmes have, for a long time, been the responsibility of the Ministry of Agriculture. Consequently, programmes addressing the conservation and sustainable utilisation of wild plants have been marginalised *vis-a-vis* other agricultural activities. Whilst considerable effort to finalise appropriate policies to safeguard the non-domesticated flora of Ethiopia is evident, necessary policies such as guidelines for access and benefit sharing have not yet been finalised. Despite this, there have been significant changes in the institutional structure to facilitate such conservation activities. With the recent elevation of IBCR to a national research institute, complete with partial autonomy from the parent government ministry, there is now an institutional focus with a well-defined set of responsibilities for the conservation and research on plant, animal and microbial genetic resources. The commitment to the future development of seed banking as a contributory tool to the conservation and sustainable utilisation of plant genetic resources in Ethiopia is clear. This new era brings in many opportunities for Ethiopia to manage her resources for the benefit of national development as well as regional and global plant conservation objectives.

References

- Balcha, G. (1999). *Status of forest seed research in Ethiopia: Consequences for development of a forest genetic resources conservation strategy*. Proceedings of the National Forest Genetic Resources Conservation Strategy Development Workshop, 21–22 June 1999, Addis Ababa, Ethiopia.
- Demissie, A., Sisay, L., Mulat, G. and Zewdu, M. (2000). *Biodiversity conservation in Ethiopia*. Institute of Biodiversity Conservation and Research, Addis Ababa, Ethiopia.
- EFAP (1994). *Ethiopian forestry action programme. Volume 2*. EFAP Secretariat, Ministry of Natural Resources Development and Environmental Protection Authority, Addis Ababa, Ethiopia.
- EPA (1997). *Conservation Strategy of Ethiopia: executive summary*. Environmental Protection Authority, Addis Ababa, Ethiopia.
- EPA and MEDaC (1997). *Environmental policy*. Environmental Protection Authority in collaboration with the Ministry of Economic Development and Cooperation, Addis Ababa, Ethiopia.
- Ouedraogo, A.S. (1999). Conservation, management and use of forest genetic resources. Conservation and use of forest genetic resources. Proceedings of the Training Workshop in the conservation and sustainable use of Forest Genetic Resources in Eastern and Southern Africa, 6–11 December, Nairobi, Kenya.
- IBCR (2001). *Institute of Biodiversity Conservation and Research*. Institute of Biodiversity Conservation and Research, Addis Ababa, Ethiopia.
- IBCR (2002a). Forest Genetic Resources Conservation Strategy of Ethiopia, Addis Ababa, Ethiopia.
- IBCR (2002b). Institute of Biodiversity and Conservation Database, update of 2002.
- Taketay, D. (1999). Past and present activities, achievement and constraints in forest genetic resources conservation in Ethiopia. Proceedings of the National Forest Genetic Resources Conservation Strategy Development Workshop, 21–22 June 1999, Addis Ababa, Ethiopia.
- Vavilov, N. I. (1951). The origin, variation, immunity and breeding of cultivated plants. *Chronica Botanica* **13**: 1–366.
- Worede, M. (1986). An Ethiopian perspective on conservation and utilization of plant genetic resources, pp. 197–211. In: J.M.M. Engels (ed). *The conservation and utilization of Ethiopian germplasm. Proceeding of an international symposium, Addis Ababa, Ethiopia 13–16 October, 1986*. Cambridge University Press, Cambridge, UK.