

EFFORTS TOWARDS ASSESSING THE GLOBAL STATUS OF FOREST GENETIC RESOURCES¹

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Abstract

Developments and applications of forest genetic resources are becoming wider in coverage, more specialized and more accessible throughout the world. Efforts to assess, monitor and report on the state of the world's forests and biological diversity have so far only partially addressed the genetic level, although several frameworks exist for a global assessment of forest genetic resources. Such an assessment presents special challenges. This paper reviews past and on-going efforts to review the status and trends of forest tree genetic resources, and provides options for future developments.

1. INTRODUCTION

Forests are the single most important repositories of terrestrial biological diversity. Forest trees and woody plants have developed complex mechanisms to maintain high levels of genetic diversity. This genetic variation, between and within species, is mainly conserved on site (*in situ*), and allows tree and shrub species to react against variations in the environment, pests, diseases and climatic change. It provides the foundation for future evolution, selection and breeding. And, at different levels, it supports the aesthetic, ethical and spiritual values given to forests and trees by human beings.

Although anthropological influences are found in most of the world's forests, trees have only been partly domesticated in the past half century. In effect, very few trees are only removed one or two generations from their wild congeners, unlike most agricultural crop plants.

Forest genetic resources (FGR) have traditionally been associated with the provision of forest reproductive material, through tree selection and improvement. In the past two decades, the FGR field has increasingly integrated genetic conservation and management considerations. The scope of forest genetic resources is now rapidly expanding to include advances in biotechnology, biosecurity (management of biological risks), and legal developments concerning access rights and benefit-sharing.

The FGR field is mainly driven by three technical sectors, namely forestry, environment and agriculture (policies related to FGR trade, technological and regulatory developments are often dealt with under crop genetic resources). The relative importance of these three driving sectors varies over space and time.

FGR are the subject of active scientific and technical research worldwide. However, information on applications of the research to forestry or biodiversity management is generally patchy and inconsistent. FGR research can find broad application in:

¹ Paper prepared for the International Workshop "The role of biotechnology for the characterization and conservation of crop, forestry, animal and fishery genetic resources". Turin, Italy, 5-7 March 2005.

1. Commercial plantations. Forest plantations tend to follow an agricultural model, with significant private sector investment, a focus on few species, best sites and short rotations, for the provision of wood for industrial purposes. Commercial plantations cover 3% of the global forest area and already provide 35% of the global industrial wood. Their share of industrial wood products is expected to increase in the next decades.

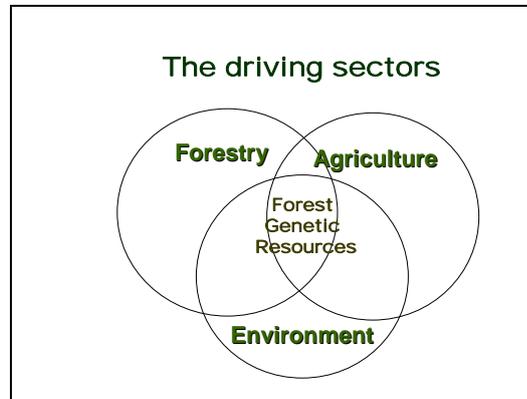


Figure 1: The main sectors driving policy, regulatory and technical developments in forest genetic resources

2. Specific niches, including tree domestication for agro-forestry, applications for species survival, soil conservation, habitat restoration and urban & amenity forestry.

3. Natural and semi-natural forests. Significant research efforts use biotechnology, although few applications have so far been reported. Research areas include ecosystem functioning, tree biology, and patterns of genetic variation. Integrating FGR in management policies and plans will be a global challenge.

2. GLOBAL ASSESSMENT/REPORTING OF RELEVANCE TO FGR

2.1 Global assessment of crop genetic resources

There is no forestry equivalent to the Global Plan of Action for the Conservation and Use of Plant Genetic Resources for Food and Agriculture which focuses on agricultural crops. The Global Plan makes reference to wild relatives of cultivated plants, often found in forest ecosystems, and to domesticated trees such as fruit trees and rubber, but explicitly excludes forest tree genetic resources.

A first State of the World's plant genetic resources for food and agriculture, published in 1997 by FAO, is currently being revised and updated. The 1997 State makes several references to forest tree genetic diversity, and to methodologies developed for *in situ* conservation. In the second version (planned for 2006), several developments related to trade, biotechnology and genetic modification, and regulatory frameworks on biosecurity and biosafety, are likely to apply to forestry.

2.2 Global assessment, monitoring and reporting on forests

The high-level international forest policy dialogue initiated after UNCED, and now continued through the United Nations Forum on Forests (UNFF), has generated more than 270 proposals for action towards sustainable forest management. Few references are made to forest genetic resources (mainly on intellectual property issues), and there is no reference to forest genetic resources assessment. However, the Collaborative Partnership on Forests, gathering 14 forest-related international organizations, institutions and convention secretariats to support the work of the UNFF, has set up a Portal on streamlining forest-related reporting.

The Portal is designed to help users access country reports, some of which address genetic diversity.

The FAO *Forest Resources Assessment* (FRA) programme regularly gathers, compiles and publishes global statistics and analyses on forest cover and related fields. The FRA 2000 assessment made a first attempt to review information on forest biological diversity, and its links with forest resources assessment. While useful indications were given on the extent of information available by species groups (Table 1), it was recognized that assessing biological diversity at global level represents a major challenge. FRA2000 highlighted that no single, objective measure of biological diversity, but only complementary measures appropriate for specific and restricted purposes, could be used. Equally important, no agreed methodology was identified for linking changes in forest area, structure and composition to their impacts on forest landscapes, species, populations and genes, especially when information was aggregated at the global level. More generally, the introduction of complex and intangible values, such as biological diversity, raises the need for a review of concepts and themes to be covered in global forest assessments.

The next issue of FRA, planned in 2005, will include country-based information of relevance to biodiversity, including forest extent, categories and characteristics, tree species occurrence, and tree species abundance, composition and vulnerability.

Group	All species occurring in country				Forest-occurring species			
	All species		Endemic species		All species		Endemic species	
	Total	Endangered	Total	Endangered	Total	Endangered	Total	Endangered
Ferns	Good	Good	Limited	Good	Good	Good	Limited	Good
Palms	Good	Good	Good	Good	Good	Good	Good	Good
Trees	No data	Good ^{1/}	Limited	Good	No data	Good ^{1/}	Limited	Good
Amphibia	Good	Good	Partial	Good	No data	No data	No data	Good
Reptiles	Good	Good	Partial	Good	No data	No data	No data	Good
Birds	Good	Good	Partial	Good	No data	No data	No data	Good
Mammals	Good	Good	Partial	Good	No data	No data	No data	Good

Table 1: Data availability by species group in Forest Resources Assessment 2000.1)
For most countries. Source: FAO, 2001

A *State of the Art Report on the Research on Forest Tree Genetic Diversity* was prepared for the XXI IUFRO World Congress by the IUFRO Task Force on Management and Conservation of Forest Genetic Resources in 2000. The report concluded that, in general, the state of scientific knowledge on the importance of FGR in various research areas and in particular in forest management, was far from satisfactory. Conservation and utilisation of gene resources were reported perceived as mainly biological and ecological issues, with limited linkage to policy and land use, economy and other issues.

2.3 Global reporting on biological diversity

The legally binding Convention on Biological Diversity (CBD) adopted an expanded work programme on forests at the sixth Conference of the Parties in 2002. The programme (VI/22) makes specific reference to the genetic level and includes activities to (1) develop, harmonize and assess the diversity of forest genetic resources; (2) provide guidance for countries to assess the state of their forest genetic resources, and (3) develop a holistic framework for the conservation and management of forest genetic resources at national, sub-regional and global levels. The formal inclusion of forest genetic diversity in a work programme of the CBD provides an important vehicle for national institutions to further

justify and strengthen activities on forest genetic resources assessment, monitoring and reporting.

A preliminary assessment of the status and trends and identification of options for the conservation and sustainable use of forest biological diversity was carried out under the CBD in 1999. Information was used in a Global Biodiversity Outlook compiled by UNEP/CBD in 2001. The genetic level was addressed, mainly through qualitative statements and case studies.

The work of the Convention has more recently focused on the development of targets and indicators for assessing progress in the various work programmes. Some targets are of relevance to genetic resources. In 2002, for example, target: “70 per cent of the genetic diversity of crops and other major socio-economically valuable plant species conserved, and associated indigenous and local knowledge maintained” was adopted for the Global Strategy for Plant Conservation. Specific targets for forest biological diversity, which will include genetic-level indicators, are still under development.

Efforts by the CBD to review trends in genetic diversity of domesticated animals, cultivated plants and fish species of major socioeconomic importance, have concluded in 2004 that “There are very rarely many, if any, quantitative data on population size changes upon which to monitor variations in the genetic diversity of forest tree species, at least in tropical areas, which account for 80% of the world total forest tree species”. Other reviews have recognized that most of the approaches to genetic diversity monitoring have problems in being too complex, not sufficiently representative of the global status, or involve too many measures. A major difficulty is that the analytical work needed to combine different measures into one or two simple and understandable indicators has yet to be done.

3. ASSESSMENT, MONITORING AND REPORTING AT REGIONAL AND NATIONAL LEVELS

3.1 Criteria and Indicators for Sustainable Forest Management

Criteria define the concept and the main aspects of sustainable forest management as well as the related values. Indicators are quantitative and/or qualitative attributes of each criterion and are used to assess the current status and to monitor trends over time.. Some 150 countries formally adhere to one of nine major inter-governmental criteria and indicators processes. Biological diversity indicators in general, and genetic diversity indicators in particular, have presented difficulties for all processes. Some processes assign more importance to quantitative indicators, while others have taken a more pragmatic approach and specified qualitative indicators.

Process	Theme	Instrument	Species	Population
African Timber Organisation	Biodiversity		√	
Dry forests Asia	Biodiversity	√		
Dry-Zone Africa	Biodiversity	√	√	√
International Tropical Timber Organisation	Biodiversity	√		
Lepaterique (Central America)	Environment		√	
Montreal (temperate & boreal forests)	Biodiversity		√	√
Near East	Biodiversity		√	√
Pan-European	Biodiversity	√		√
Tarapoto (South America)	Biodiversity	√		

Table 2: themes under which forest genetic resources issues are addressed in criteria and indicators processes; and broad categories of indicators assessed.

A study conducted for FAO in 2002 concluded that the issue of genetic diversity was not well addressed in any process, except perhaps in the Pan-European initiative. Many indicators of genetic diversity were not effective or lacked practicality, and their relevance to sustainable forest management was tenuous. Further development and testing of different surrogate attributes were found necessary, but the impetus for this appeared to be waning.

3.2 Regional workshops on forest & tree genetic resources

A number of workshops on forest genetic resources have been convened with the support of FAO, the International Plant Genetic Resources Institute (IPGRI), the Danida Forest Seed Centre (DFSC), Denmark, and many other organizations. Regional workshops have supported the development of national status reports and regional action plans for conservation and sustainable use of forest genetic resources. During the process, methodologies for assessing the state of forest tree genetic diversity at country level were developed by local experts to describe the genetic management of important species. In most regions covered, country-based status reports have been prepared and synthesized in regional syntheses. Summarized information on species management has partly been compiled in the FAO information system on forest genetic resources (REFORGEN).

Eco-region	Number of countries	Country status	Priority species	Regional summary	Regional action plan
Temperate North America (1995)	3		+	+	+
Boreal Forests (1995)	20		+	+	+
Sahelian Africa (1998)	15	+	+	+	+
Pacific Islands (1999)	18	*	+	+	+
Eastern, Southern Africa (2000)	9	+	+	+	+
South East Asia (2001)	8	+	+	+	+
Central America (2002)	9	+	+	+	+
Central Africa (2003)	6	*	+	+	*
South Asia (2003)	13	+	+	+	+

Table 3. Workshops on forest tree genetic resources supported by FAO, IPGRI and DFSC from 1995 to 2003 (+ indicates achievement; * indicates work in progress)

This information was gathered using methodologies developed with a regional objective. In some areas, countries have focused on native tree species, excluding introduced trees. Patchy data structure and data quality control represent major challenges for a global use of the dataset in a global forest genetic resources assessment.

Many other organizations have established information systems of relevance to forest/tree genetic resources, with different focus and purposes. They include:

- the Tree Seed Supplier Directory and the Agroforestry Database (ICRAF)
- the Red List of Threatened Species (IUCN)
- the Tree Conservation Database on Endangered Species (WCMC)
- the Forestry Compendium (CABI)
- the database on approved forest materials, by species and country (OECD)
- the collection of forest tree genome databases, Dendrome (University of California)
- the World Directory of Forest Geneticists and Tree Breeders (NAFC & IUFRO)

In summary, although rationales and frameworks exist for a global assessment of forest genetic resources, such an assessment is still to be undertaken.

4. THE WAY FORWARD

In 2003, the FAO Panel of Experts on Forest Gene Resources recognized the relevance and discussed the feasibility of a global forest genetic resources assessment. The assessment, as a source of official, harmonized and validated information, could guide national and international processes and institutions towards sustainable forest and biodiversity management. Further discussions highlighted that such assessment should include thematic issues and case studies, trends and options for the future, rather than being a mere assembly of baseline statistics. Follow-up action towards a global forest genetic resources assessment is currently being discussed.

It is generally acknowledged that the complexity of genetic diversity at the global level must be expressed in a simplified, uniform and easily understood set of variables that represent the major values. Such variables must, by necessity, be based on generalizations that use indirect (surrogate) measures, typically indicators based on the general (qualitative) condition of the resource.

Prerequisites to the assessment include clarification of the concept (forest genetic *resources* or forest genetic *diversity*?); harmonisation of definitions to be used globally; scope of the assessment; development of agreed methodology; identification of value (utility) given to genetic resources by stakeholders/users; identification and ranking of important (priority) tree species²; classification of management practices and threats; actual attributes and potential use of trees; and clarification of what can reasonably be done in a given timeframe (4-5 years).

The assessment will likely be constrained by the availability of country-based statistics, and rely on complementary thematic studies, including on species/genera of global importance. The assessment will also emphasize status and trends in major FGR issues. Very basic indicators on genetic diversity (for example distribution of major tree species in different ecological zones) could then be considered. Both the genetic resources and their conservation and use are essentially dynamic, and underlying genetic processes may also have to be considered. Priority will be given to carefully defining the end result and using information sources and analyses in a scientifically sound and transparent way.

Themes that may be considered in a global forest genetic resources assessment

Concept, scope, definitions
Estimators and surrogates of forest tree genetic diversity
Important forest tree genera, species, provenances and varieties
State of conservation *in situ*, *ex situ*
State of use, selection and breeding programmes
Seed and reproductive materials: pathways, supply and demand
Legal issues, property rights, access, benefit sharing, material transfer agreements
State of biotechnology research and application
Economic rationales in conventional and biotechnology-based programmes
Biosecurity issues: invasive alien tree species, genetic pollution, GM tree deployment
Research and education, national/public/private capacities status and trends
Institutional framework, international and national programmes
State of diversity and vulnerability of major genera/species
Other thematic/case studies

² Reference is often made of three groups of species: 1. Species of current socio-economic importance; 2. Species with clear potential or future value; 3. Species of unknown value given present knowledge and technology.

5. CONCLUDING REMARKS

Global priorities in forest genetic resources have changed from an early focus on seed, species and provenance research of a few timber species in the 1960s and 1970s, to the wider management of genetic diversity of a range of trees and shrubs for a number of purposes and end uses, in a variety of contexts. These developments are often led by, and under the umbrella of, agreements in other sectors, including trade and economics, agriculture, and the environment, rather than being integral parts of forestry-led initiatives. Some developments may, to some extent, be anticipated. Globally, increased movement of people, goods, services, information and know-how contributes to a constant change in demands on and value of forests, wood and non-wood products and environmental services, and to shifts in the boundaries, and priorities, of the forest genetic resources sector.

The availability of reliable information is essential for the decision-maker, the manager and the scientist. What type of resource will be used, for which purpose, by which customer, in which region, over which period, are important parameters that will condition the perception of forest genetic diversity and the degree of attention given to the subject. While several initiatives have sought to better define FGR status and trends, a global assessment will bring added value to scattered efforts and help place genetic diversity issues in the local, national or global context in which they are best analyzed and understood. A global perspective is increasingly necessary in some areas: industrial wood and wood products, and reproductive materials, have become global commodities. However, a number of major challenges must be faced in designing such an assessment. Besides biological and ecological features, the multiplicity of values and uses of forests, trees, biodiversity and genetic resources need to be considered with relevant stakeholders.

With the assistance of national partners and international collaborators, FAO is willing to further elaborate on the foundation and process of a first global assessment of forest genetic resources.

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