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COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Item 5 of the Provisional Agenda
Intergovernmental Technical Working Group on Forest Genetic Resources
Second Session
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TARGETS AND INDICATORS FOR FOREST GENETIC RESOURCES

Table Of Contents

	Paragraphs
I. INTRODUCTION	1-4
II. FOREST GENETIC RESOURCES INDICATORS	5-11
III. STATE/RESOURCE INDICATORS AND TARGETS	12-13
IV. INDICATORS AND TARGETS FOR MEASURES AND POLICY RESPONSES	14-16
V. TENTATIVE LIST OF INDICATORS FOR FOREST GENETIC RESOURCES	17-19
VI. GUIDANCE SOUGHT	20-21

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I. INTRODUCTION

1. At its Thirteenth Regular Session, the Commission on Genetic Resources for Food and Agriculture (the Commission) considered the document *International targets and indicators for biodiversity for food and agriculture*¹ and welcomed FAO's work in the development and use of international indicators for biodiversity for food and agriculture as part of the Biodiversity Indicators Partnership. The Commission stressed the view that indicators should be policy relevant, scientifically sound, understandable, feasible to obtain and sensitive to changes. The Commission encouraged FAO to continue to develop, test and apply biodiversity indicators, and thereby contribute to the Strategic Plan for Biodiversity 2011–2020.¹
2. The Commission reaffirmed that it would take a lead role in the development and use of targets and indicators for biodiversity for food and agriculture and requested FAO to:
 - identify targets and indicators within the planned or ongoing processes of global assessments or action plans under the mandate of the Commission; and continue efforts to develop indicators and associated targets at the genetic level, to facilitate status and trends reporting on animal, plant, forest and aquatic genetic diversity for food and agriculture at regular sessions of the Commission, which could also contribute to other biodiversity reporting requirements, and
 - consider, and advise on, how such indicators may provide a basis for countries to assess progress towards the Aichi Biodiversity Targets, as relevant, in particular Target 13.
3. The Commission also requested its Intergovernmental Technical Working Groups to continue to review targets and indicators for genetic diversity and biodiversity within their respective sectors, and to provide recommendations to the Commission on their further development.²
4. This document, drawing on key findings from a background thematic study for *The State of the World's Forest Genetic Resources*, briefly analyses the main issues related to indicators for forest genetic diversity, provides information on targets and indicators used, and identifies a series of indicators for the consideration by the Working Group.

II. FOREST GENETIC RESOURCES INDICATORS

5. Forest genetic resources comprise the genetic variation of trees and other woody perennial species, found in forests and outside, that are of present or potential value to humankind.
6. Of the possible 100 000 tree species on Earth, the FAO Panel of Experts on Forest Gene Resources lists almost 500 species important in food and wood production that are considered of high global, regional and/or national priority for exploration, collection, conservation and use.³ Some of these species are being utilized for various purposes, to a large extent in their wild stage. An even more limited number have been brought into cultivation. Only a very few tree species have been tested for their performance in different environments, and very little is known about their genetic variation.
7. In other sectors of genetic resources for food and agriculture, a distinction is often made between domesticated genetic resources and the genetic resources of wild relatives. Such a distinction can be regarded as less prominent and less relevant in the case of forest genetic resources, as most utilized tree species are wild or subject to limited levels of domestication and are managed in natural ecosystems. Tree species valuable for food have been subject to some degree of incipient or semi-domestication over the centuries, but little is known about how the patterns and levels of genetic

¹ CGRFA-13/11/Report, paragraphs 95-97.

² Report CGRFA-13 paragraphs 95–100.

³ FAO/DFSC/IPGRI. 2001. *Forest genetic resources conservation and management Vol. 2. In managed natural forest and protected areas* (in situ). Rome.

diversity may have changed as a result. Much more is known about the genetics of these species than about those of other species, and more specific indicators of their state of genetic diversity will therefore be available. It could therefore be relevant to distinguish between the more intensively used plantation species (a few hundred) and the vast majority of wild tree species (many thousands), which no doubt harbour large untapped potential but of which very little is known.

8. Indicators for forest genetic resources need to take proper account of the natural dynamic genetic processes taking place in forest plant communities. Management activities and their impact, be it positive or negative, on the genetic diversity of trees should also be appropriately accounted for in the definition of indicators.

9. The Strategic Plan for Biodiversity 2011–2020 identifies twenty targets, referred to as the Aichi Biodiversity Targets, organized under five strategic goals. Strategic goals A and B address the underlying causes and direct pressures causing the loss of biodiversity. Strategic goal C deals with the conservation status of biodiversity and the improvement thereof. Strategic goal D covers benefits, and strategic goal E covers responses that enhance implementation. The work of FAO and the Commission contributes to the ongoing process of identifying indicators for these goals and targets. The Commission and its Working Groups should be supporting the development of indicators for Aichi Target 13 *“By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity”*. Target 5 *“By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced”*⁴ is also of interest to the Working Group on Forest Genetic Resources.

10. The eleventh Conference of the Parties to the CBD (COP11) adopted Decision XI/3 *“Monitoring progress in implementation of the Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets”*, which identifies an indicative list of indicators for the Strategic Plan for Biodiversity 2011–2020 and, among other things, requests its Executive Secretary to collaborate with organizations, including FAO to: further develop the global indicators identified; propose a limited number of simple, easily applicable and cost-effective indicators that can potentially be used by Parties; promote the further harmonization of global indicators and their use between the Convention on Biological Diversity and other conventions, regional agreements and processes and promote further collaboration; promote further collaboration on biodiversity monitoring and indicators with the forestry, agriculture, fisheries and other sectors at global, regional and national levels. Decision XI/3 also invites FAO to contribute to assessing progress towards the achievement of selected Aichi Targets.⁵

11. The work initiated on indicators for the Strategic Plan for Biodiversity 2011–2020 involves proposals for new indicators related to genetic diversity. For Target 13, COP11 adopted an indicative list of the three most relevant operational indicators (see bulleted list below). According to the classification used by the CBD, two of these indicators are suggested for development at global level (class B) and a third for development at subglobal level (class C). None of them are considered ready for use at global level (class A).

- Headline Indicator: Trends in genetic diversity of species
 - Most relevant operational indicators: Trends in genetic diversity of cultivated plants, and farmed and domesticated animals and their wild relatives (class B) (Decision VII/30 and VIII/15)
 - Trends in genetic diversity of selected species (class C)

⁴ See CBD Decision X/2.Strategic Plan for Biodiversity 2011-2020.

⁵ UNEP/CBD/COP/11/35

- **Headline Indicator:** Trends in integration of biodiversity, ecosystem services and benefits sharing into planning, policy formulation and implementation and incentives.
 - **Most relevant operational indicators:** Trends in number of effective policy mechanisms implemented to reduce genetic erosion and safeguard genetic diversity related to plant and animal genetic resources (class B)

III. STATE/RESOURCE INDICATORS AND TARGETS

12. A number of forest policy processes, at national, regional or global levels, have in past years worked extensively on the identification of genetic diversity indicators as part of biodiversity-related indicators. The indicators identified through these processes serve either to monitor the state of the resources or to monitor management or policy responses. The identification of indicators for the state of forest genetic resources should take into consideration both genetic diversity patterns, which have been recorded in species from different ecosystems, and genetic processes, which represent the natural response of species to the environment.

- i. *Genetic patterns of variation at different hierarchical levels*
 - a) Between ecosystems/populations: this level may reflect important adaptation to different environmental conditions. This is important because many studies have revealed substantial geographic differentiation of trees into ecotypes suitable for different planting sites.
 - b) Between individuals within populations: this level may reflect the presence of important genetic variation in terms of polymorphisms in expressed genes. It is also important in terms of genetic variation in adaptive traits, which allows efficient breeding. Expected genetic response to selection is proportional to the level of genetic diversity, and the presence of genetic variation is therefore crucial to the ability of the species to react to environmental changes, and adapt to future changes in needs and uses.
- ii. *Genetic processes related to continued adaptation*
 - c) Continued genetic differentiation through ongoing natural selection, allowing species and populations to maintain their adaptation at various sites. It is important to note that anthropogenic influence does not *per se* hinder the efficiency of natural selection.
 - d) Processes that protect species and populations against adverse effects of small population size, i.e. protect against inbreeding, genetic erosion and/or random genetic drift. In this context it is important that mating (gene flow) occurs between individuals and/or forest fragments to an extent that allows maintenance of viable population sizes.

13. For most species, knowledge of genetic variation is minimal. This points to the central dilemma of genetic resource conservation: a recognized need of conservation without exact knowledge of what to conserve. Assessment of genetic variation will therefore to a large extent have to be based on proxies combining ecological factors and the autoecology of the species.

IV. INDICATORS AND TARGETS FOR MEASURES AND POLICY RESPONSES

14. Responses are measures taken to correct or remedy losses. Response indicators should measure the implementation of policies or actions that aim to prevent or reduce genetic diversity loss. Indicators may reflect five different kinds of response: (i) integration of response measures in policy, planning and implementation of programmes, including legislation; (ii) availability, accessibility and uptake of adequate knowledge and capacity, in policy as well as practice; (iii) the extent of physical management and conservation activities in the field; (iv) the complicated issue of access and benefit sharing of genetic resources (where response related to benefit rather than to the state of the resource

is considered); and (v) the general response issue of mobilizing adequate financial resources for the measures required to reduce loss to acceptable levels.

15. The Working Groups on Animal and Plant Genetic Resources have agreed on indicators and targets to monitor the implementation of the relevant Global Plans of Action.⁶

16. The Working Group may wish to recommend that, in the process of finalizing priority areas for action, the Commission also consider indicators and targets.

V. TENTATIVE LIST OF INDICATORS FOR FOREST GENETIC RESOURCES

17. In the forest sector, considerable theoretical progress in identifying relevant indicators has been made over the past 20 years. State indicators have been difficult to use, and attempts to use indicators in practise have therefore often been limited to response indicators. However, indirect indicators of response, pressure or benefit cannot on their own reveal the extent to which the processes that maintain genetic variation are conserved, and should therefore not be used in isolation.

18. The State-Pressure-Benefit-Response (SPBR) loop provides a well-considered and appropriate framework for ensuring that a set of indicators meets requirements in terms of being scientifically sound, realistic and policy relevant. It is proposed that this framework be used in the development of indicators for forest genetic diversity, i.e. that a set of SPBR indicators be developed:

- State indicators analyzing the condition and status of aspects of biodiversity
- Pressure indicators monitoring the extent and intensity of the causes of biodiversity loss
- Benefit indicators quantifying the benefits that humans derive from biodiversity
- Response indicators measuring the implementation of policies or actions to prevent or reduce biodiversity loss.

19. A tentative list of indicators for forest genetic resources is proposed in *Appendix I*. The types (state, pressure, benefit or response) and the levels considered (global, regional/national or local) are shown. The table should not be considered exhaustive, but rather as set of examples.

VI. GUIDANCE SOUGHT

20. The Working Group may wish to:

- i. Review the provisional list of indicators for trends in the genetic diversity of tree species presented in *Appendix I* to this document;
- ii. Recommend that the Commission adopt the list of indicators for trends in the genetic diversity of tree species; and
- iii. Recommend that the Commission consider the need to identify indicators to monitor the status of implementation of the priority areas and options for follow-up to *The State of the World's Forest Genetic Resources*.

21. The Working Group may further wish to recommend that the Commission request FAO to further work on the development of indicators to monitor the state of forest genetic resources and the status of implementation of the priority areas and options for follow-up to *The State of the World's Forest Genetic Resources*.

⁶ CGRFA/WG-AnGR-7/12/REPORT; CGRFA/WG-PGR-6/12/REPORT.

APPENDIX I – Provisional list of indicators

The table below provides a provisional list of indicators for trends in the genetic diversity of tree species. Some possible operational indicators at different scales are presented. Primary measures (parameters) are listed. Derived (proportional) figures will in some cases have to be calculated to provide information on trends. The table should not be considered exhaustive.

Scale	Operational indicator	Type of indicator (SPRB)	Verifiable indicator	Verifiable measure (direct or proxy)	Genetic process ⁷ /indicator and threat addressed
Global	Trends in knowledge of the genetic diversity of species	R, B	Increase in the number of species that are described for which distribution and/or genetic parameters are known	Increase in number of articles on genetic diversity by species	Ns
Global	Trends in the genetic diversity of selected species	S	Number of species with known distribution for which allelic diversity is declining	Number of species with known distribution for which distribution is declining	Ns
Global	Trends in genetic conservation	R	Number of tree species directly targeted in conservation programmes	Same	Ns
Global	Trends in the sustainable use of tree genetic resources	R,B	Number of tree species for which regulations for the use of forest reproductive material exist	Same	Ns
Global	Trends in education on forest genetic resources	R	Number of tree geneticists and tree breeders	Number of university courses offered in forest genetics-related subjects	Ns
Global/ regional/ national	Species distribution of selected species	S	Natural distributional range	Geographic and climatic range	Ns
Global/ Regional/ National	Species distribution pattern of selected species	S	Distributional pattern within the latter, where appropriate	Geographic, climatic and eco-geographic distribution of populations	Ns

⁷ Selection, drift or gene flow. Ns = not specific; Na = not applicable.

Scale	Operational indicator	Type of indicator (SPRB)	Verifiable indicator	Verifiable measure (direct or proxy)	Genetic process ⁷ /indicator and threat addressed
Regional/ national	Trends in knowledge of geneecology	R,S	Number of species with mapped geneecological variation	Same	Ns
Regional/ national	Trends in knowledge of among-population genetic diversity	R,S	Among population genetic diversity (of selected species)	Parameters of genetic differentiation among populations	Ns
Regional/ national	Metapopulation abundance (size)	S, P	Representation within the natural range	Number of populations relative to their potential geneecological distribution	Ns
Regional/ national	Metapopulation abundance (size)	S	Number of populations, their area and density (abundance)	Area and density of populations	Ns
Regional/ national	Size of plantation programmes	B	Hectares planted by species/provenance either locally or as an exotic	Same	Na (artificial regeneration), Ns (natural regeneration)
Regional/ national	Status of genetic improvement	B,R	Number and type of improved seed sources traded	Same Certification scheme in place	Selection
Regional/ national Local	Status of <i>in situ</i> and <i>ex situ</i> conservation measures in place	R,B	Conservation action taken for species/populations at risk	Existence of a national strategy/programme Number and area of conservation units	Selection, drift
Regional/ national Local	Use of adapted seed sources	B,R	Guidelines/regulations in place for matching seed source and planting site (ecological conditions)	Seed source performance (growth and survival) Certification scheme in place	Selection
Regional/ National Local	Use of diverse seed sources	R,B	Guidelines/regulations for composition and harvest of seed sources (number of mother trees)	Seed source performance (growth and survival)	Drift

Scale	Operational indicator	Type of indicator (SPRB)	Verifiable indicator	Verifiable measure (direct or proxy)	Genetic process ⁷ /indicator and threat addressed
Local (management unit/landscape)	Plantation resilience, option values and improved production	B	Profit from breeding vs. loss from ill-adapted plantations	Seed source performance (growth and survival), realized gain and profit)	Selection
Local (management unit/landscape)	Population condition	S, P	Demographic condition of selected populations (diversity in adaptive traits/genes)	Age/size class distribution Number of reproducing trees Abundance of regeneration Environmental heterogeneity Number of filled seeds Percentage of germination	Selection
Local (management unit/landscape)	Population condition	S, P	Genetic condition of selected populations (population genetic structure where appropriate)	Genetic parameters: Effective population size (N_e) Allelic richness Outcrossing/inbreeding rate Spatial genetic structure, Hybridization/introgression	Geneflow, drift