Conservation of forest genetic resources and sustainable forest management in Europe

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Abstract

Considerable efforts have been made to enhance conservation of forest genetic resources and to promote sustainable forest management in Europe over the past decade. The need to enhance of genetic conservation emerged from a concern on the impacts of environmental pollution and genetic erosion on forest ecosystems in the late 1980's. The concept of sustainable forest management, in a broader sense, gained ground in Europe after the United Nations Conference on Environment and Development in 1992 paid special attention to the role of forest ecosystems in maintaining and conserving biological diversity. Several Ministerial Conferences on the Protection of Forests in Europe were organised in the 1990's and this was a major political process pushing forward improvements in these two areas. In 1994, the European Forest Genetic Resources Programme was set up as an implementation mechanism of the Strasbourg Resolution (1990) on conservation of forest genetic resources. In the same year, Pan-European Criteria and Indicators for Sustainable Forest Management were also adopted following the Helsinki Resolution (1993) on sustainable forest management.

In many European countries, however, more resources have been channelled to habitat and species conservation while fewer resources have been allocated to the development of national programmes on forest genetic resources. Less than 30 per cent of the European countries have such programmes, which are necessary for implementing gene conservation in practical forestry. Subsequently, these programmes should be better linked with the overall national forest programmes, which are developing policies for the whole forest sector and also allocating resources for implementing sustainable forest management. The pan-European criteria and indicators include genetic indicators in rather operational way but there is a need to improve monitoring of genetic sustainability by developing commonly agreed technical terminology. This would facilitate collection of relevant data and making the data comparable internationally.

Keywords: Forest genetic resources, gene conservation, forest management, criteria and indicators

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Introduction

The continent of Europe is characterised by three main types of forest ecosystems, ranging from the relatively open Mediterranean woodlands to more dense temperate and boreal forests. In 2000, the total forest area of Europe was 1,039 million ha of which Mediterranean, temperate and boreal forest types accounted for 5, 22 and 73 per cent, respectively (FAO 2003). On average, the European forests cover around 46 per cent of the continent's land area (FAO 2003). However, the FAO statistics includes the whole territory of Russian Federation to Europe which gives slightly biased picture of the European forest resources. The actual forest cover is considerably lower than 46 per cent in many European countries.

After the last glaciation, which ended some 10,000 years ago, European tree species have experienced episodes of climatic changes that have likely dominated evolution of local populations (Namkoong 1998). Natural selection has influenced among-population differentiation through adaptive traits while long-distance gene flow has been rather efficient in increasing genetic variation within populations in many European tree species. Thus the natural populations of many widely occurring species demonstrate low genetic differentiation in terms of biochemical markers but large variation in adaptive traits (e.g. Eriksson 1998, Oleksyn et al. 1998).

Without doubt, human influence has also played a major role in the evolutionary history of European forests. Large-scale utilisation of forests and trees has continued for several thousands of years, especially in the Mediterranean region. Today, large areas of continuous forests occur mainly in the less populated areas of northern and eastern Europe while fragmented landscapes dominate the rest of the continent. Silvicultural practices have been applied for centuries in many European countries (Bürgi and Schuler 2003, Vallance 2001) and common traditions in forest management are now wide-spread throughout the continent.

In the late 1980's, increasing concern on the impacts of environmental pollution and genetic erosion on forest ecosystems emerged in Europe. Throughout Europe, scientists, managers, policy-makers and others were involved in public debate regarding the future of the forests while scientific knowledge available at that time was unable to provide clear and sound answers for several important questions. European countries recognised soon that the problems occurred across the continent regardless of national borders and subsequently, the countries organised the first Ministerial Conference on the Protection of Forest in Europe (MCPFE) in Strasburg in December 1990. In this Conference, the participating European countries adopted six resolutions to initiate immediate action to improve the state of the forests without waiting research to provide all the scientific answers.

One resolution was specifically developed for enhancing conservation of forest genetic resources and after the Strasburg Conference, intensive consultation process took place to make this resolution operational. A group of experts from four countries was assigned to develop operational recommendations in collaboration with the FAO Forestry Department, the International Plant Genetic Resources Institute (IPGRI) and the European Commission (EC). During this process, it was agreed that a voluntary instrument is needed to promote and to coordinate the implementation of the resolution and regional collaboration on conservation of forest genetic resources. To solve obvious operational problems, it was suggested that activities should be carried out within species-oriented networks focusing on only limited number of species which should represent different geographical and ecological conditions in

Europe. These operational recommendations and a proposal by IPGRI and FAO for the European Forest Genetic Resources Programme (EUFORGEN) were then endorsed by the Second Ministerial Conference in Helsinki in June 1993 and EUFORGEN became operational in October 1994.

In addition to highlighting the importance of biodiversity conservation in European forests (Resolution H2), the Helsinki Ministerial Conference also adopted general guidelines for the sustainable forest management in Europe (Resolution H1). Development of these non-legally but politically-binding European initiatives were supported by the adoption of the Convention on Biological Diversity (CBD) during the United Nations Conference on the Environment and Development (UNCED) in Brazil in 1992. The Helsinki Resolution H2 accepted the CBD definition on *biological diversity* and noted that conservation of biodiversity should be an essential operational component in sustainable forest management.

The political agreement on conservation of forest biological diversity as part of sustainable forest management was further strengthened and developed towards a more operational form during the third Ministerial Conference held in Lisbon in 1998. Lisbon Resolution 2 on *Pan-European Criteria, Indicators and Operational Level Guidelines for Sustainable Forest Management* provided a voluntary framework for developing and promoting sustainable forest management practices at the sub-national level. Later, the Pan-European Forest Certification (PEFC) scheme was developed based on these criteria and indicators to assess the implementation of sustainable forest management in Europe.

Conservation of forest biological diversity and promotion of sustainable forest management have remained high levels in the political agenda among European countries. In April 2003, the fourth Ministerial Conference in Vienna, Austria again endorsed several resolutions that are highly relevant for continued efforts in this regard. More detailed information on the outputs of the Ministerial Conferences can be found at www.mcpfe.org.

In this paper, we provide highlights of the European collaboration and activities on conservation of forest genetic resources. We also discuss the role of gene conservation in sustainable forest management and how conservation of forest genetic resources is implemented in European countries.

European Forest Genetic Resources Programme

EUFORGEN is financed by participating countries and its Steering Committee is composed of National Coordinators from each country. The role of National Coordinators is to act as a link between the EUFORGEN Secretariat and national institutions involved in the activities. The Secretariat is hosted by IPGRI, which also takes care of the overall management of the Programme in technical collaboration with the FAO Forestry Department. The Programme operates through networks in which mainly scientists and managers exchange relevant information and develop conservation methods and strategies for selected species. Participating countries implement activities with their own resources and to some extent, policy-makers have also participated directly in the work.

During the first five-year phase of EUFORGEN (1 January 1995 to 31 December 1999), the operational work was based on five pilot networks for specific species or groups of species, i.e. *Picea abies*, *Quercus suber*, Noble Hardwoods, *Populus nigra* and Social

Broadleaves. For the second phase of the Programme (1 January 2000 to 31 December 2004) the scopes of the networks were broadened and some names were changed during the phase. Currently the five networks are called Conifers, Mediterranean Oaks, Noble Hardwoods, *Populus nigra*, and Temperate Oaks and Beech, respectively. In February 2003, a total of 31 countries were officially participating the EUFORGEN Programme and its activities.

In addition to promoting international collaboration in Europe, EUFORGEN has also contributed to the development of national programmes or strategies on conservation of forest genetic resources at national level. National programmes on forest genetic resources are needed not only for meaningful international collaboration but also for implementing gene conservation in practical forestry. It has been recognised that integration of genetic considerations into national forest policies, involvement of relevant stakeholders and efficient coordination of activities are major challenges for the national programmes on forest genetic resources (see Turok and Geburek 2000).

EUFORGEN Networks

The Conifers Network has identified 52 species as important for gene conservation in Europe. Many of the native conifers in Europe are dominant elements in boreal, Atlantic, alpine and Mediterranean forest ecosystems while several exotic conifer species are also widely used in a few European countries. Several species, such as *Abies alba*, *Juniperus communis*, *Larix decidua*, *Picea abies*, *Pinus nigra*, *Pinus sylvestris* and *Taxus baccata* are widely occurring in the continent and 15 or more countries have been identified these species as important for gene conservation. Many conifer species are also economically very important and some of them have been utilised extensively in Europe during its long human settlement.

In 1997, the Conifers Network developed its first guidelines for *in situ* and *ex situ* gene conservation of *Picea abies* (Koski et al. 1997). Currently, the Network is developing more concise six-page technical guidelines for genetic conservation and use that are aimed at practical forest managers. The guidelines will be developed for 12 important species and these have already been published for *Pinus pinaster*, *Pinus halepensis*, *Pinus brutia* and *Picea abies* (Alía and Martin 2003, Fady et al. 2003, Skrøppa 2003). The Network has also initiated the mapping of *in situ* conservation areas for *Picea abies* to create a Europe-wide map. This effort serves as a pilot study and can be used as model for further monitoring the state of forest tree gene conservation in Europe.

The Mediterranean Oaks Network promotes gene conservation of *Quercus ilex*, *Q. pubescens* and *Q. suber*. These oaks dominate the Mediterranean forests and woodlands, which have been exposed to unsustainable utilisation for thousands of years. Historically, their timber was used to build houses and ships, and the wood was essential for charcoal production and as firewood. Today, the Mediterranean forests are no longer an important timber source but they are still heavily exploited for clearing arable use and harvesting of acorns to feed valuable breeding livestock. Plantations of *Q. suber* have been established to supply the well-established cork industries but a large part of the demand is still fulfilled with cork extracted from the natural forests and woodlands.

The Mediterranean Oaks Network has facilitated the establishment of international provenance trials for *Q. suber* as little genetic and breeding research has been conducted

earlier on this species. There is also a lack of basic information on adaptive traits and their geographical distribution patterns. Acorns were collected from seven countries (Algeria, France, Italy, Morocco, Portugal, Spain and Tunisia) as part of a EU-funded project and subsequently the trials were established in all these countries (except Algeria) during 1997 and 1998. This network of trials holds a unique collection of cork oak genetic material throughout the species' natural range in the Mediterranean basin. The Network is also preparing a technical bulletin and technical guidelines for gene conservation of *Q. suber*. As compared to the EUFORGEN Technical Guidelines, the Technical Bulletins are a broader presentation of the topic and targeted to both scientists and managers.

The Noble Hardwoods Network focuses on broad-leaved species which have only minor importance in traditional forestry. However, noble hardwoods are important multipurpose trees, which also produce valuable timber and they are often used in landscaping or other environmental purposes. Many of these species grow scattered in mixed species forests and have low capacity to compete with other tree species. Many European countries lack silvicultural tradition for these species and thus they tend to be neglected in forest management although recently they have received more attention. Noble hardwoods are also threatened by uncontrolled seed transfers, illegal cuttings and reduced population size. Furthermore, *Ulmus* spp. are severely threatened by Dutch elm disease.

The Noble Hardwoods Network has identified 32 tree species which are considered important for gene conservation in Europe and developed long-term gene conservation strategies for many of them (i.e. *Acer platanoides*, *A. pseudoplatanus*, *Alnus* spp., *Castanea sativa*, *Fraxinus* spp., *Juglans regia*, *Malus sylvestris*, *Prunus avium*, *Pyrus pyraster*, *Tilia* spp., *Ulmus* spp. and *Sorbus* spp.). These strategies have been published as part of the Network meeting reports (see Turok et al. 1998, 1999, 2002) and they are also available through the EUFORGEN web site (www.euforgen.org). The Network has also promoted *in situ* conservation in managed forests by producing silvicultural management strategies for noble hardwoods (Rotach 1999). Similarly to other EUFORGEN Networks, the Noble Hardwoods Network is also developing technical guidelines for several species. These have now been published for five species, i.e. *Acer pseudoplatanus*, *Alnus glutinosa*, *Fraxinus excelsior*, *Prunus avium* and *Sorbus domestica* (Rusanen and Myking 2003, Kajba and Gračan 2003, Pliûra and Heuertz 2003, Russell 2003, Rotach 2003).

The *Populus nigra* Network has mainly focused its efforts on the species concerned and only in 1999 another poplar species, *P. alba*, was included into the Network activities. *P. nigra* is a typical pioneer species, which is mainly growing in riparian mixed forests along European and West Asian rivers. It is threatened by extinction in large parts of the distribution range as a result of habitat destruction and hydraulic engineering practises, replacement by and interspecific hybridization with Euramerican poplars. The direct commercial value of *P. nigra* is low but it is used as a parental pool in many breeding programmes around the world. More importantly, it has high ecological value in riparian floodplain forests maintaining biological diversity.

Twenty-six European countries have actively participated in the *Populus nigra* Network which has established *ex situ* collections holding nearly three thousands accessions and made available the related databases (www.populus.it). The Network is also planning to establish an international collection of *P. nigra* provenances based on the material that was recently collected within the EU-funded EUROPOP project (see van Dam and Bordács 2002 for details). The development of a core collection and a database for *P. alba* has also been

initiated. Other Network outputs include a standardised list of clone descriptors and the dissemination of a set of 15 reference clones from unique stool-beds to participating countries. A standardized list of descriptors for inventories of *P. nigra* stands has also been created as well as an identification sheet in English, French, German, Hungarian, Spanish, Russian and Dutch. The Network has also produced a Technical Bulletin on *in situ* conservation of *P. nigra* (Lefèvre et al. 2001) and Technical Guidelines for the same species (Vanden Broeck, in print). Recently, the Network has initiated the development of a Europe-wide conservation strategy for *P. nigra* or so called 'common action plan'.

The Temperate Oaks and Beech Network has been working with three species, i.e. *Quercus robur*, *Q. petraea* and *Fagus sylvatica*. These tree species represent the major component of the European broadleaved forests. They have high economic and ecological importance and their genetic resources have suffered from drought, air pollution, defoliators, diseases and improper silvicultural techniques. The lack of natural regeneration is a major constraint for *in situ* conservation of the oaks in many European countries while beech does not face the same problem. In addition to assessing the status of gene conservation of the species concerned in various European countries, the Temperate Oaks and Beech Network has facilitated the development and implementation of several EU-funded research projects. The projects have generated a vast amount of new information and the Network is currently preparing a Technical Bulletin on the genetic conservation of the oaks and Technical Guidelines for all three species.

All EUFORGEN Networks have also contributed to the development of 'grey literature' database, which includes unpublished reports, theses and other similar documents on forest genetic resources in European countries. Currently this database contains nearly 2,000 records and is accessible through the EUFORGEN web site. The Networks have also produced public awareness material, such as brochures, photo collections and posters.

Promotion of sustainable forest management in Europe

After the Ministerial Conference in Helsinki (1993) made a resolution to promote sustainable forest management (SFM) in Europe, a series of expert level meetings was held to develop pan-European criteria and indicators for SFM. During this process, criteria and quantitative indicators were adopted by the first follow-up meeting of the Helsinki Conference in Geneva in June 1994 and later descriptive indicators were adopted by the second follow-up meeting in Antalaya in January 1995. In June 1998, the third Ministerial Conference in Lisbon decided to improve the first set of indicators and subsequently four workshops were organised in 2001 and 2002 to consult experts in different parts of Europe. The improved pan-European indicators for SFM were then adopted at the expert level meeting in Vienna in October 2002. Box 1 shows the criteria and more details on the improved indicators and the operational guidelines can be found at www.mcpfe.org.

Criteria and indicators are tools for assessing national and regional trends in the state of forest resources and their management. After the Pan-European criteria and indicators were adopted, several countries initiated the development and implementation of national level criteria and indicators by modifying the Pan-European criteria and indicators to their specific conditions. Simultaneously, customers buying timber, paper and other wood-based products demanded information on whether the raw material had been obtained from sustainably managed forests. This demand led to the development of national forest certification schemes

in many European countries and in 1999, the Pan-European Forest Certification Scheme (PEFC) was launched to act as a framework for the mutual recognition of credible national or regional forest certification schemes. Currently, national forest certification schemes in Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Latvia, Norway, Spain, Sweden, Switzerland and United Kingdom have been endorsed by the PEFC Council (see www.pefc.org). By August 2003, a total of 48,155,793 hectares had been certified by PEFC in 12 European countries (see www.pefc.org). As a comparison, the competing global forest certification scheme, i.e. the Forest Stewardship Council (FSC), had certified 25,032,514 hectares in 25 European countries under its own principles and criteria by the same point of time (see www.fscoax.org).

Box 1: Pan-European Criteria for Sustainable Forest Management

Criterion 1:	Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles
Criterion 2:	Maintenance of forest ecosystem health and vitality
Criterion 3:	Maintenance and encouragement of productive functions of forests (wood and non-wood)
Criterion 4:	Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems
Criterion 5:	Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)
Criterion 6:	Maintenance of other socio-economic functions and conditions

The Pan-European Process for developing criteria and indicators for SFM is perhaps the only one among similar regional processes that has properly addressed the issue of genetic diversity (FAO 2002). However, it is still problematic to carry out a sound assessment of the genetic component of SFM mainly due to lack of commonly agreed terminology and the fact that standard national forest inventories do not readily provide relevant data for assessing and monitoring this component in all European countries.

The Criterion 4 of the Pan-European Criteria is of particular relevance to gene management as it promotes conservation of forest biological diversity at the ecosystem, species and genetic levels. The improved Indicator 4.6 refers specifically to genetic resources, i.e.

*4.6 Area managed for conservation and utilisation of forest tree genetic resources (*in situ *and* ex situ *gene conservation) and area managed for seed production.*

The FSC forest certification scheme refers to forest genetic diversity in the following principles and criteria:

Principle 6: Environmental Impact
6.3 Ecological functions and values shall be maintained intact, enhanced, or restored, including: b) Genetic, species, and ecosystem diversity.

Principle 10: Plantations

10.3 Diversity in the composition of plantations is preferred, so as to enhance economic, ecological and social stability. Such diversity may include the size and spatial distribution of management units within the landscape, number and genetic composition of species, age classes and structures.

However, FSC does not provide any specific indicators that are used for assessing whether forest management is sustainable under its other criteria.

In 2002, there was a total of 47,443 hectares in Europe that were reportedly managed for *ex situ* gene conservation of forest trees (MCPFE 2003). This figure is based on the information European countries have provided in their country reports and updates for various EUFORGEN Network meetings. It should be noted that this is likely to be only a rough estimate of the area managed for *ex situ* gene conservation as there is no comprehensive data available from all European countries. Furthermore, not all countries are systematically collecting up-to-date information on *ex situ* conservation areas.

Sound estimates are also difficult to produce for areas managed for *in situ* gene conservation or seed production. One reason for this is that the countries have not yet developed commonly agreed technical terminology that is mandatory to produce internationally comparable data. At national level, protected areas or natural parks are often declared as *in situ* gene conservation areas or 'forest gene reserves' although the protected areas are been commonly established for other purposes than active gene management. Similarly, forest stands are seldom managed solely for seed production purposes and it is common that seeds are collected from different sources, such as *in situ* and *ex situ* conservation areas, other protected areas and production forests, depending on the species-specific demand and the availability of seed.

Geburek and Müller (2000) listed several issues that need to be considered before declaring an area as forest gene reserve. From the overall management point of view, the most important issues are ownership, management goals and potential for natural regeneration. Secured long-term ownership of an area is necessary for *in situ* gene conservation as it is common that a change in ownership also alters management objectives. It is possible to manage a forest area for multiple conservation objectives, such as habitat, species and gene conservation. However, silvicultural interventions are often needed as part of active gene management to improve natural regeneration of a given tree species or to keep the existing populations viable, especially in case of rare tree species or if a species will become suppressed by others along successional development. The silvicultural interventions are rarely allowed as part of habitat conservation, thus making it difficult to combine these management objectives. Geburek and Müller (2000) further listed several issues related to genetic conditions that will set the requirements for declaring forest gene reserves even a higher level. For example, the reserves should be of autochthonous origin and harbour sufficient genetic variation with respect to both neutral and adaptive genetic markers in addition of being sufficient in terms of size. It is obvious that European countries need to pay more attention to harmonise terms and definitions before it can be objectively assessed whether forest management is sustainable from the genetic point of view. As Geburek and Müller (2000) pointed out, it makes little sense to declare all possible forest and conservation areas as gene reserves unless the genetic quality of the stands is investigated and documented.

Implementation of gene conservation as part of forest management

The European countries have made a lot of progress in promoting sustainable forest management in pan-European level, as we discussed above. However, the implementation of various recommendations and resolutions in practical forestry remains a national-level responsibility. In 2002, EUFORGEN carried out a survey among national coordinators in its member countries regarding forest management and conservation of forest genetic resources (IPGRI, unpublished). Below we highlight some results of this survey to which a total of 34 countries provided feedback.

The pan-European criteria and indicators were used for relevant policy formulation with a direct impact on conservation of forest genetic resources in six per cent of the countries while 61 per cent responded that they will be doing so in the near future. A clear set of guidelines on genetic requirements in forest management was applied in 21 per cent of the countries. Similar guidelines existed in 66 per cent of the countries but they were insufficiently applied. These results indicate that there has been a delay in many European countries to incorporate genetic considerations to their forest policy formulation. Also, although a fifth of the countries apply genetic guidelines in their forest management, there seems to be a need to enhance the implementation of the existing guidelines in most of the countries.

Existence of a formal national programme on forest genetic resources with well stated objectives and funding is a relatively good indicator on the level of gene conservation activities in a given country. In the survey, only 27 per cent of the countries indicated having such a programme and in 33 per cent of the countries, an informal programme existed with fairly good coordination of various activities. However, involvement of other relevant stakeholders in national coordination structure was low. Only three per cent of the countries replied that all major stakeholders (e.g. non-governmental organisations, scientists, professionals, forest owners, private sector etc) are adequately involved in the decision making on forest genetic resources at the national level. In 42 per cent of the countries, only major stakeholders were involved in the national coordination.

The survey in 2002 did not specifically ask how well the possible national programmes on forest genetic resources are linked to national forest programmes (NFPs), which is considered as the overall planning and implementation mechanism covering the whole forest sector. The concept of a NFP covers a range of approaches and is a framework for addressing forest sector issues in a holistic and multisectoral manner (FAO 1999). Thus from the implementation point of view, it would be useful if national programmes on forest genetic resources would be closely linked with NFPS and *vice versa*. Approximately two thirds of the European countries have a NFP (FAO 1999) but in many cases these programmes emphasize very little the importance and benefits of gene conservation efforts to the whole forest sector.

Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) have been active in developing and promoting sub-regional collaboration on genetic resources in agriculture (including crops, animals and forest trees) (NCM 2002). All of them except Iceland also have fairly well established national programmes on forest genetic resources (Yrjänä 2003). Similarly, all countries except Iceland have national forest programmes but it seems that the activities within the two types of programmes are not properly linked with each other. For example, Finland's national forest programme gives very little emphasis to genetic resources (MAF 1999). In 2001, Finland developed a separate national programme on genetic resources

in agriculture (including forest trees) (MAF 2001) and although this includes some reference to the national forest programme, it remains unclear how these two programmes will interact while implementing their agendas. The linkage between the two types of programmes is neither very close in other European countries. France has a very strong national programme on forest genetic resources but lacks a NFP (Teissier du Cros 2001, FAO 1999). Netherlands has a NFP but no formal programme on forest genetic resources while a strategy document for it has been prepared. In Hungary, the national strategy on forest genetic resources has been implemented since 1997 and the country also has a NFP but there too the genetic component is missing.

Conclusions and recommendations

During the past decade, European countries have achieved a great deal in promoting and implementing both conservation of forest genetic resources and sustainable forest management. However, it seems that these two efforts are being implemented in a rather separate manner in many countries. The most recent Ministerial Conference on the Protection of Forests in Europe addressed the need for continued international collaboration on forest genetic resources and closer integration of gene conservation to sustainable forest management. This demonstrates the commitment of the European countries for the international collaboration and their willingness to strengthen the practical implementation of sustainable forest management.

In many countries, biodiversity conservation has received a lot of attention but most of the resources have been channelled to habitat and species conservation while fewer resources have been directed to the national programmes on forest genetic resources or their development. It is obvious that implementation of genetic conservation cannot be effective unless there is a national programme with clear objectives and adequate long-term resources. As only less than 30 per cent of the European countries have formal and well-established national programmes on forest genetic resources, countries should continue their efforts in developing these programmes. Furthermore, since the policies and resources for implementing sustainable forest management at national level are increasingly discussed through NFPs, it would be important to increase the linkages and coordination between the two types of programmes.

At international level, the pan-European process on criteria and indicators for sustainable forest management has been able to include the genetic indicators in rather operational way as compared to similar processes in other regions (cf. FAO 2002). However, to improve the monitoring of genetic sustainability of forest management, a commonly agreed technical terminology needs to be developed to ease the collection of relevant data and making the data comparable internationally. In addition, it might be useful to define minimum requirements for declaring gene reserves or *in situ* conservation areas as this would also facilitate the development of a pan-European network of *in situ* conservation areas for various forest tree species.

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