



EUFORGEN

FOCUS ON FOREST GENETIC DIVERSITY

PRODUCING AND USING FOREST REPRODUCTIVE MATERIALS



THEME 2

FOREST REPRODUCTIVE MATERIAL AND FOREST BASIC MATERIALS

Management of categories
and types to face future uncertainties



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The European Forest Genetic Resources Programme (EUFORGEN) is an international cooperation programme that promotes the conservation and sustainable use of forest genetic resources in Europe as an integral part of sustainable forest management. Experts from member countries come together within EUFORGEN to exchange information and experience, analyse policies and practice, and develop science-based strategies, tools and methods to improve the management of forest genetic resources. EUFORGEN is hosted by the European Forest Institute and is funded by its member countries.

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FOREST REPRODUCTIVE MATERIAL AND FOREST BASIC MATERIALS

Management of categories and types
to face future uncertainties

Forest ecosystems are critical components of the global carbon cycle, helping to remove carbon dioxide from the atmosphere and store it for the long term. This helps offset continued carbon emissions from human activity, slowing or reducing climate change. They are also a natural shelter for the world's terrestrial biodiversity. However, forests globally are threatened by logging, deforestation, change of land use, and fragmentation. They are also challenged by climate change and its effects, such as extreme weather events including droughts, floods, and heatwaves, as well as changes in occurrence of pests and diseases. This is threatening the long-term survival and productivity of forests.

It is essential that forest managers adopt appropriate management strategies and practices to mitigate these threats. A key measure is to choose high-quality forest reproductive material (FRM) that is adapted to current and future climates.

These FRM are subject to various international regulations. FRM production, use, and trade in Europe is regulated by the European Union (EU) while international trade in FRM is facilitated at the global level by the Organisation for Economic Cooperation and Development (OECD).

To facilitate regulation, FRM is organized into categories and is made up of forest basic material which is also categorized into various types.

In 2026, the European Union adopted a new Regulation on the production and marketing of forest reproductive material (Regulation (EU) 2026/1392¹), replacing the previous Directive 1999/105/EC. The new Regulation maintains the established framework for the production, certification and marketing of FRM while strengthening traceability. It also supports the availability, and use of high-quality reproductive material adapted to changing environmental conditions, contributing to the conservation and sustainable use of forest genetic resources. The scientific principles and practical guidance in this handbook, developed under the previous Directive, remain fully applicable and are further reinforced by the new Regulation.

The EUFORGEN community offers these guidelines to support practitioners through this maze of regulation and categorisation. Based on a scientific knowledge of forest tree population genetics, this handbook is written for anyone choosing or planting seeds or seedlings for forest management purposes.

GLOSSARY

Term	Definition
Forest reproductive material	Reproductive material of those tree species and artificial hybrids thereof which are important for forestry purposes.
Seed units	Cones, infructescences, fruits and seeds intended for the production of planting stock.
Parts of plants	Stem cuttings, leaf cuttings and root cuttings, explants or embryos for micropropagation, buds, layers, roots, scions, sets and any parts of a plant intended for the production of planting stock.
Plants	Plants raised from seed units, from parts of plants, or from plants from natural regeneration.
Forest basic material	Trees from which reproductive material is obtained.
Seed source	Trees within an area from which seed is collected.
Stand	A delineated population of trees possessing sufficient uniformity in composition.
Autochthonous stand	A stand or seed source which has normally been continuously regenerated by natural regeneration. It may have been artificially regenerated from reproductive material collected from the same stand or seed source, or from autochthonous stands or seed sources within close proximity.
Indigenous stand	An autochthonous stand or seed source or a stand or seed source artificially raised from seed, the origin of which is situated in the same region of provenance.
Seed orchard	A plantation of selected clones or families which is isolated or managed, so as to avoid or reduce pollination from outside sources, and managed to produce frequent, abundant and easily harvested crops of seed.
Parents of family/families	Trees used to obtain progeny by controlled or open pollination of one identified parent used as a female, with the pollen of one parent (full sibling) or a number of identified or unidentified parents (half sibling).
Clone	Group of individuals (ramets) originally derived from a single individual (ortet) via vegetative propagation, for example, via cuttings, micropropagation, grafts, layers or divisions.
Clonal mixture	A mixture of identified clones in defined proportions.
Origin	For an autochthonous stand or seed source, the place in which the trees are growing. For a non-autochthonous stand or seed source, the origin is the place from which the seed or plants were originally introduced. The origin of a stand or seed source may be unknown.
Provenance	The place in which any stand of trees is growing.
Region of provenance	For a species or sub-species, the area or group of areas subject to sufficiently uniform ecological conditions in which stands or seed sources showing similar phenotypic or genetic characters are found, taking into account altitudinal boundaries where appropriate.
Official body	An authority established or designated by the EU Member State under the supervision of the national government. It is responsible for questions concerning the control of marketing and/or the quality of forest reproductive material; the authority designated by, and responsible to, the Government of a country participating in the OECD Scheme; or an EU Member State for the purpose of implementing the OECD rules on its behalf.

Table 1. Definitions of terms related to forest reproductive material (European Union Council Directive 1999/105/EC).

01 DEFINING FOREST REPRODUCTIVE MATERIAL AND FOREST BASIC MATERIAL



Forest reproductive material (FRM) is the “reproductive material of tree species and artificial hybrids thereof which are important for forestry purposes in all or part of the Community,” and includes seed units – cones, fruits, and seeds – parts of plants, and planting stock.

European Union (EU) Council Directive 1999/105/EC²

FRM is the “reproductive material of genera and species of forest trees and shrubs”, which can include seeds, parts of plants, and plants.

OECD Scheme for the Certification of the Forest Reproductive Material Moving in International Trade³

Forest basic material (FBM) refers to trees or vegetative material from which reproductive material is obtained. The *EU Directive* identifies six types of FBM: seed source, stand (autochthonous stand and indigenous stand), seed orchard, parents of family, clone, and clonal mixture ([Table 1](#)).

02 REGULATION

The *European Union (EU) Council Directive 1999/105/EC*, henceforth *EU Directive*, regulates production, use, and trade in FRM in Europe. The *EU Directive* has been incorporated in national legislation in all Member States to ensure that FRM supplied for any site within the EU is suitable for the geographic location of that site.

International trade in FRM is facilitated at the global level by the *Organisation for Economic Cooperation and Development (OECD) Scheme for the Certification of the Forest Reproductive Material Moving in International Trade*.⁴

Both the *EU Directive* and the *OECD Regulation* require that FRM placed on the market must come from officially

registered FBM. The Directive also states that each EU Member State has a national register of different types of approved basic material.

In 2026, the EU Directive was replaced by Regulation (EU) 2026/1392 on the production and marketing of forest reproductive material. Unlike the Directive, the Regulation applies directly in all EU Member States, providing a harmonized legal framework for the production, certification and marketing of FRM. The categories of FRM and the approved types of basic material remain the foundation of the regulatory system.

03 CATEGORISING FOREST REPRODUCTIVE MATERIAL

FRM intended mainly for forestry and agroforestry is divided into four broad categories: a) source-identified; b) selected; c) qualified; and d) tested (Figure 1). These categories refer to which forest basic material (FBM) is used and how it is used.

Source-identified

This is the minimum standard permitted. FBM may be either a seed source or a stand located within a single region of provenance. The location and altitude of the place(s) from which FRM has been collected must be recorded. Little or no phenotypic selection has taken place.

Selected

FBM consisting of a stand located within a single region of provenance that has been phenotypically selected at the population level.

Qualified

FBM consisting of seed orchards, parents of families, clones, or clonal mixtures, the components of which have been phenotypically selected at the individual level. Testing is not required.

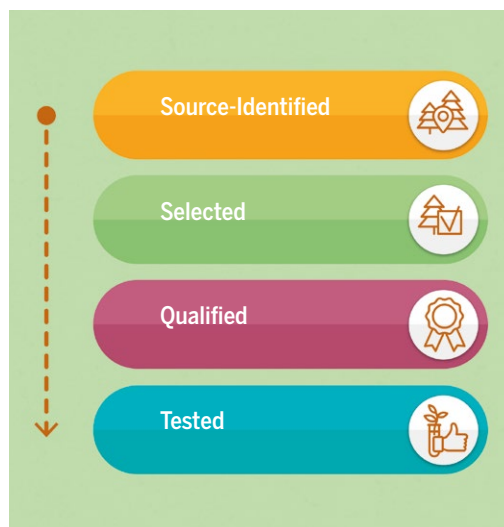


Fig. 1: Categories of Forest Reproductive Material as established under Council Directive 1999/105/EC and the OECD certification scheme..

Tested

FBM consisting of stands, seed orchards, parents of families, clones, or clonal mixtures. The superiority of the reproductive material must have been demonstrated by comparative testing, or an estimate of the superiority of the reproductive material must have been calculated from genetic evaluation of the components of the basic material.

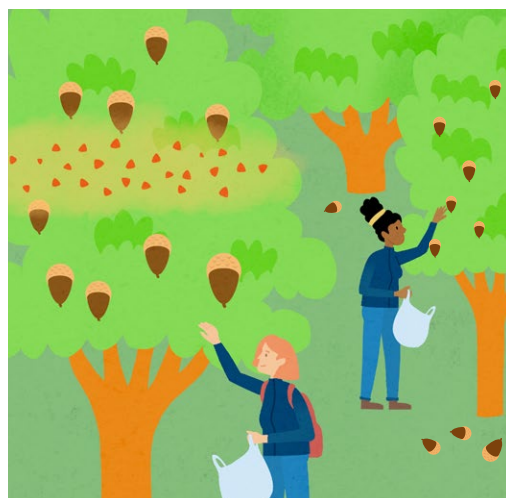
04 COLLECTING FOREST REPRODUCTIVE MATERIAL FROM FOREST BASIC MATERIALS

Source-identified: seed sources and stands

The seeds of some economically important tree species, such as Norway spruce (*Picea abies*), pines (*Pinus* spp.), oaks (*Quercus* spp.), and beech (*Fagus sylvatica*), are commonly collected locally from stands registered as “source-identified” rather than from higher categories that have stricter minimum stand-management requirements. Cones of conifer species are often collected from trees that have been felled for clear cutting during a mast year, while seed of broadleaved trees is usually collected several times during their lifetime and finally when mature trees are felled.

Where seed is collected from locally-adapted stands, only a minimal level of information is required to fit the “source-identified” category, i.e., the tree species and the geographical location of the stands, thus offering advantages over FRM from other regions. While “source-identified” FRM may be produced in all EU countries, 11 Member States impose additional legal restrictions for its use.

“Source-identified” FRM may be collected from areas other than forests and seed orchards (e.g., from urban areas, roadside plantations, and parks). Such seed sources may be preferred in the case of rare or endangered species, for which there may be no basic materials available



from more traditional seed sources such as seed orchards, parents of families, clones, or clonal mixtures. Many species do not occur in large stands (e.g., wild species from the genera *Pyrus*, *Malus*, and *Sorbus*) and are thus often harvested from non-traditional sources.

For scattered or rare tree species, mixing seeds collected from individual trees or groups of trees from the whole region of provenance helps ensure wider genetic diversity in the FRM. Ideally, seed should be collected from a minimum of 25–50 fruit-bearing trees to ensure a sufficient level of genetic diversity is maintained. The resulting additional genetic diversity can ensure better adaptability and stability for forestation. However, lack of information about quality traits and genetic composition of basic material is disadvantageous in multifunctional forestry where wood quality is of importance.

Some countries define management rules for commercial seed stands that have been approved for production of FBM. These are usually aimed at improving the genetic quality and structure of the stands and are similar to those for stands categorised as “selected”. Such sources are highlighted in forest management plans.

Use

“Source-identified” FRM is often used for afforestation of large clear-cut areas or where large numbers of trees have been killed by forest fires, pests, or such like because it is cheaper to produce than other categories of FRM. FRM seed lots from “source-identified” stands also have the

advantage of being more genetically diverse than seed from clonal seed orchards.

Selected: seed stands

“Selected” FRM includes seed material, plant parts, and plant material from forest trees in seed stands within a given provenance region. The stands must be phenotypically different to populations in other provenance regions and superior to other forest stands within the region.

Approval criteria

The minimum requirements listed in Annex III of the *EU Directive* are quite general; detailed criteria are left to Member States to determine.

The general criteria include commercially important heritable properties, such as volume production, wood quality and form, and growth habit. Uniformity in these traits is desirable and should be noted when basic materials are approved. Ideally, phenotypically inferior trees should be removed from the stand.

Stands must also be old enough to allow the quality of the trees to be reliably assessed and for necessary management measures to be implemented. Stands proposed for approval should be adapted to the prevailing environmental conditions in the region of provenance, as demonstrated by their long-term persistence. Important information includes whether the trees flower and fruit regularly, whether the seeds germinate, and whether the seedlings/saplings are able to survive.



Fig. 2: Seed source quality depends on population origin, adequate population size and isolation from inappropriate pollen sources.

The stands should also be in good health: there should be no signs of pest infestation or diseases, and signs of tolerance of natural stress factors should be noted as an exceptional positive trait.

The final group of criteria focuses on genetics: the origin of the population, isolation from potential inappropriate pollination sources (poor stands, related species able to hybridize with the desired species, non-autochthonous stands surrounding an indigenous seed stand, etc.), and population size.

These criteria ensure sufficient genetic diversity in the seed crop and the adaptability of the offspring to future environmental fluctuations.

Seed stand management

Neither the *EU Directive* nor national forestry legislations give instructions concerning the management of seed

stands. However, there are some general practices for seed-stand management that are widely applied across Europe.

- As seed stands are mostly intended to produce FRM over a long period, the rotation period tends to be longer than normal.
- Superior trees are intentionally favoured in silvicultural treatments, such as crown thinning to promote fructification.
- For tree species whose seeds are collected from the forest floor, forest managers should establish appropriate ground cover that reduces natural regeneration and weed development and facilitates seed collection.
- Trees that exhibit heritable adverse traits, such as forking and spiral grain, are removed as soon as they are identified, as are trees affected by pests and diseases. Such trees may also be removed from surrounding stands.

- Final fellings, especially in coniferous stands, are planned for mast years to maximize the amount of seed that can be collected from the felled trees.
- Felling based on target trunk diameter should be avoided because it may result in fast-growing trees being felled before they mature and produce seed.
- Thinning is often used to favour growth of superior trees, or so-called “future trees”. However, this must be done carefully to avoid removing rare genetic types. While not all rare genetic types are beneficial, especially immediately, they may hold the key to adaptation to future environmental stresses and it is generally desirable to conserve as much of the genetic spectrum as possible.

Specific rules apply to seed stands located in gene reserves or dynamic gene conservation units. Silvicultural systems based on natural regeneration are preferred in these stands to ensure the conservation of the existing genetic diversity. When artificial regeneration is necessary, FRM originating from the same genetic conservation unit or from nearby autochthonous stands should be used.

For more information on how management practices can affect or influence genetic diversity of FRM, refer to **Theme 5 : Seed harvesting, treatment, storage, and nursery practices**.

Qualified: seed orchards, parents of families, clones, or clonal mixtures

“Qualified” FRM use FBM from **plus trees**, outstanding trees that have been selected for desirable characteristics and that are superior to other trees on comparable sites in terms of traits of interest (typically growth rate, stem quality, health, etc.). Plus trees are used in seed orchards and for clones or clonal mixtures. Unlike “parents of families”, their genetic value has generally not been proved via progeny tests. However, they can serve as parents of families during the initiation phase of a breeding programme.

Seed orchards

Plus trees are planted together in seed orchards to facilitate crosses between them. The trees may be vegetative copies of plus trees obtained by grafting (clonal seed orchards) or, less frequently, the offspring of plus trees grown from seed (seedling seed orchards). Seed orchards are important tools for forest tree improvement:

- They are expected to yield seeds that produce trees with superior quality
- They can be used for further breeding activities (e.g., artificial crossing and collection of material for progeny testing).

In addition, seed orchards can also be used to produce seed of scattered and endangered species that do not reproduce well in forest stands. As such, they are often treated as gene conservation seed orchards.



Fig. 3: A seed orchard should be well isolated from nearby pollen sources.

For more information on seed orchards, refer to **Theme 3: Seed orchards – why do we need them?**

Parents of families

A legally recognized type of FBM, parents of families are defined as trees with known breeding value and are used to obtain progeny via controlled or open pollination of one identified parent (used as a female) with the pollen from one or more identified or unidentified male parents. This definition implies that, in most cases, producing FRM from parents of families is time-consuming and expensive and thus only makes sense when the genetic value of the maternal tree is known. In most European countries, parents of families are only used as FBM in the “tested” category.

Clones and clonal mixtures

Though the *EU Directive* and national legislation in many European countries allows the use of plus trees in their original locations as parents of (open-pollinated) families, this option is rarely used in

practice. Progenies are mostly produced by artificial pollination from plus-tree clones located in seed orchards or specific clonal collections or clonal archives. In this case, the *EU Directive* requires that the objective, crossing design, pollination system, components, isolation, and location be approved and registered with the official body. This is implemented in most national legislations.

Selection of plus trees

Plus trees can be selected using several different approaches, the choice of which is influenced both by the genetic information available and the time and cost involved.

Phenotypic selection is the oldest method of selection: the best individuals are selected on the basis of their appearance without knowledge of the genetic background of the traits of interest. This method is simple, fast, and effective, but relies on the (not necessarily realistic) assumption that a good phenotype is associated with good genes.

Phenotypic selection can be performed using one of several methods. The simplest is based on the personal judgment of the breeder, commonly focusing on quality traits such as height or bark straightness.

An alternative is the tree-comparison method, in which trees are compared with a specified number of neighbouring trees. Some countries have developed selection indices for the main commercial species based on growth and stem-form

functions. These are derived from age, height, and trunk diameter; subjectively assessed crown form is also considered.

The selection criteria for most plus trees are general (e.g., growth, quality, and health), but the target traits can be modified and adapted to the objective of a particular breeding programme. The prerequisite is that the trait of interest is heritable.

Further considerations include, but are not limited to, the following:

- Tree crown development is an important trait but can sometimes overshadow consideration of stem quality which may be of equal or greater importance.
- Where species or local populations are facing strong environmental pressures, such as heat or drought stress or pest infestation, resistance

to stress becomes the main (or even the sole) criterion for the choice of a plus tree. Examples of this include the selection of conifer plus trees for polluted areas or ash (*Fraxinus*) trees tolerant to the ash dieback fungus, *Hymenoscyphus fraxineus*.

- The quantity and quality of fruit produced may become the main target of selection in the case of fruit and nut trees.

Tested material

Seed stands, seed orchards, parents of families, clones, and clonal mixtures can be approved as basic material for producing FRM in the “tested” category after they have been tested, according to the *EU Directive*.

The description of the testing procedures in the Directive is quite general and Member States implement the rules



Fig. 4: Phenotypic selection of plus trees, whereby the best individuals are selected based on their appearance (e.g. height and stem straightness) in the absence of genetic information.

slightly differently according to their national legislation and, in practice, to their specific needs.

One common rule is that the whole procedure of evaluation and genetic calculation must be approved by an

official national body. The amount of basic material approved as “tested” varies considerably between Member States. Updated information on European countries is available on the Forest Reproductive Material Information System (FOREMATIS)⁵.

05 REGISTRATION

In the EU, all FRM must be registered by a nominated national official body, along with the FBM category from which it is derived (see Table 1). Basic material used for producing FRM must meet minimum requirements defined in the *EU Directive*, and countries are free to define additional requirements.

European countries are obligated by the *EU Directive* to produce and update a national list of FBM. However, forest

owners who purchase FRM originating from a given FBM usually have no knowledge of its genetic quality, which is also subject to annual fluctuations, as the genetic makeup of seed can differ markedly from one year to the next.

These fluctuations may result in FRM that is poorly adapted to afforestation sites and that may perform poorly. This is especially true in the case of seed orchards composed of a small number of genotypes.



Fig. 5: The genetic quality is also subject to annual fluctuations as the genetic makeup of seed can differ markedly from one year to the next. A mast year does not imply correlation with the adaptive potential of the FRM.

Additionally, it is important to consider several factors which may affect genetic quality.

- Climatic conditions affect the fertility of individual trees and their flowering time, which alters crossing patterns.
- Annual changes in pest populations can affect individual trees or clones differently.

- The number of trees flowering is likely to fluctuate from one crop year to another for a given seed source.

To avoid these problems, producers of FRM must ensure that their production sites have a high level of diversity and should inform purchasers of genetic quality of the FRM they produce in any given year.

06 STAND MANAGEMENT

In each country, management rules of approved FBM can be defined if the sources and stands are highlighted in forest management plans. In some countries, this applies only to stands for “selected” FRM where support for the species in question must consider stand stability. However, there are countries where management procedures are also applied to “source-identified” stands.

In preparing a stand for seed collection, forest managers should consider removing phenotypically inferior trees. The collection of FRM can also be planned to ensure its genetic diversity. This will require that seed is collected in years of heavy seed-set, or mast years, from an adequate number of trees that are well spaced to facilitate fertilization.

07 CERTIFICATION

Once collected, FRM is issued a master certificate by a nationally designated authority, certifying that it is derived from approved basic material. The certificate provides additional relevant information, such as the type of basic material, its origin, and its phenotypic and genetic quality.

All approved FBM is recorded in national registers, while information regarding all

existing FRM categories and types, as well as tree species of interest in each EU country, is held in the FOREMATIS database. Some countries have created additional state forest registers for species (usually rare and scattered ones) that are not included in the *EU Directive* (Annex I. List of tree species and artificial hybrids).

FRM certification issued by the national official body must comply with the exact procedures defined by the country. This ensures that the rights of owners of basic material are met and that the FRM can be traced from collection to market.

The *EU Directive* sets the minimum requirements for the approval of different types of basic material intended for

production and use at the European level. Individual Member States are free to set more-stringent requirements. Both the *EU Directive* and the OECD Regulation require countries to establish Regions of Provenance of registered basic material (also referred to as “seed zones”). Certification provides the basis for the trade of FRM within and into the EU.

08 TRADE

Trade within the EU

A master certificate issued in one EU Member State is valid in all other Member States. When FRM is transferred between Member States, the company or individual making the transfer must inform their designated authority of the transfer. The designated authority of the provider’s Member State must then inform the designated authority of the recipient’s Member State of the identity and amount of FRM being transferred.

Import into the EU

The import of “**source-identified**”, “**selected**”, and “**qualified**” FRM into the EU from non-EU countries is regulated by Decision 1104/2012/EU of the European Parliament and the Council.⁶

This requires that FRM imported from outside the EU should come with the same assurances as material produced within the EU. The Decision states that any FRM certified in Canada, Norway, Serbia, Switzerland, Türkiye, and the United States under OECD certification rules fulfil the equivalent EU requirements.

The import of “**tested**” FRM, and imports for some other third countries, are regulated by the Commission Implementing Decision (EU) 2015/321.⁷

Additional imports are allowed based on the decisions of the Working Group on FRM at DG SANTE/G1 Plant Health.

END NOTES

1. Regulation (EU) 2026/1392 of the European Parliament and of the Council on the production and marketing of forest reproductive material.
<https://eur-lex.europa.eu/eli/reg/2026/1392/oj/eng>
2. Council Directive 1999/105/EC of 22 December 1999 on the marketing of forest reproductive material.
<https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A31999L0105>
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6. Decision No 1104/2012/EU of the European Parliament and of the Council of 21 November 2012 amending Council Decision 2008/971/EC as regards the inclusion of forest reproductive material of the category “qualified” and updating the names of the authorities responsible for approval and control of the production.
<https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32012D1104>
7. Commission Implementing Decision (EU) 2015/321 of 26 February 2015 amending Decision 2008/989/EC authorising Member States to take decisions under Council Directive 2008/72/EC.
<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015D0321>

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These guidelines and recommendations have been synthesized from:



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