Chestnut

Castanea sativa

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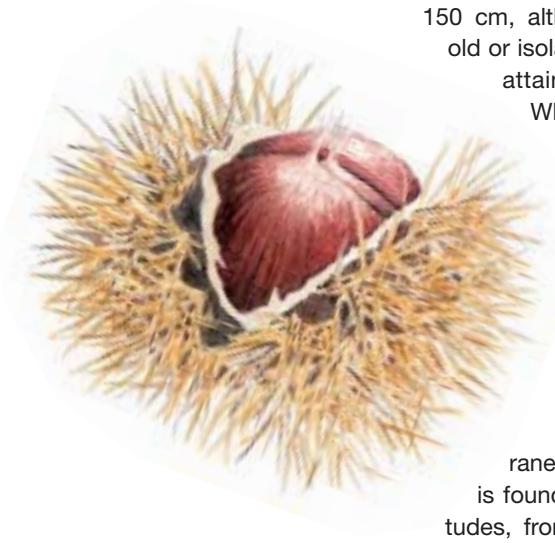
These Technical Guidelines are intended to assist those who cherish the valuable chestnut genepool and its inheritance, through conserving valuable seed sources or use in practical forestry. The focus is on conserving the genetic diversity of the species at the European scale. The recommendations provided in this module should be regarded as a commonly agreed basis to be complemented and further developed in local, national or regional conditions. The Guidelines are based on the available knowledge of the species and on widely accepted methods for the conservation of forest genetic resources.



Biology and ecology

Chestnut (*Castanea sativa L.)* is a large, deciduous tree, reaching a height of 40 m and a diameter of 150 cm, although exceptionally old or isolated individuals may attain a girth of 9 m. When grown for fruit, tree height does not normally exceed 18 m. Chestnut has an excellent ability to re-sprout from the stump and consequently produce coppice.

In the Mediterranean region, chestnut is found at a variety of altitudes, from sea level to over 1000 m (1500 m in Spain and in Sicily). It prefers a mean annual rainfall of over 600 mm with no dry season, or a very short dry season of up to three months. Good fruit production requires a mean monthly temperature above 10°C for at least six months of the year.

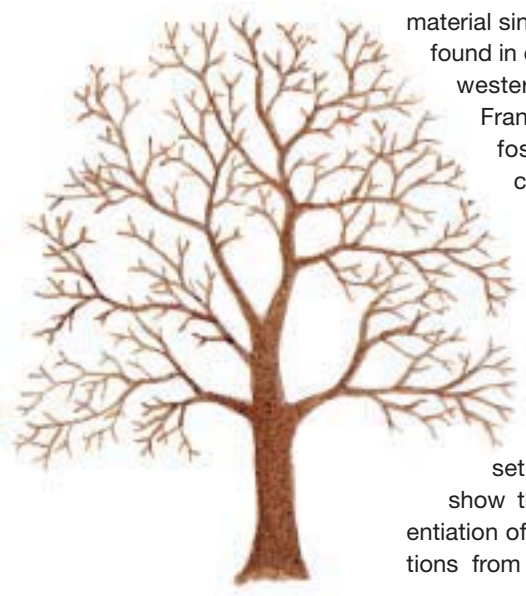
The buds burst relatively late, from April to June. Flowering occurs later in chestnut than in most other broadleaves: May-June in Mediterranean areas and June-July further North. The male catkins develop first, followed by the androgenous catkins at the upper end of the shoots. Male sterility of varying degrees is frequent in domesticated varieties and in some wild populations. Chestnut can be wind or insect pollinated, depending on the humidity. The small size of the chestnut pollen (14-18 microns) enables significant amounts to be transported up to 100 km. The spiky husks containing the edible brown nuts ripen at the end of October.

Chestnut roots are very prone to "ink" disease, caused by several species of *Phytophthora* sp., mainly *P. cinnamomii* and *P. cambivora.* The first incidence in Europe was reported in 1726 in Spain, and the disease can cause significant damage in mild, humid climates. *Chryphonectria parasitica*, the chestnut canker introduced in Europe

by 1950, greatly affects grafted populations. This fungus is an opportunist pathogen, infecting trees in a variety of ecological conditions, and the most successful control treatments are inoculations of hypo-virulent strains.

Distribution

Chestnut is distributed across the Mediterranean region, from the Caspian Sea to the Atlantic Ocean. It is thought that the species survived in several refuges during the last ice age in southern Europe, Northeast Turkey and the Caucasus. It then spread North and West throughout mainland Europe, and is thought to have arrived in Italy from Asia Minor with the Greeks. Chestnut currently occupies more than 1 700 000 ha in southern Europe in a discontinuous, scattered range, occupying hundreds of hectares in coppices and orchards on acid soils. It is found rarely, in mixed broadleaved forests stands (*i.e.* with *Quercus robur* as the principal species).



Genetic knowledge

There are a large number of old, grafted cultivars of chestnut. Tree breeding in Europe has focused on describing and selecting grafted varieties, as well as adding resistant genes to the genepool for major fungal diseases. This has been achieved by hybridization with the more resistant, Asiatic species *C. crenata* and *C. mollissima*. Despite this benefit of resistance and growing vigorously in humid climates, the earlier bud burst of these hybrids makes them more vulnerable to frost damage than *C. sativa,* and they are also less tolerant to drought.

Results of isoenzyme studies investigating intra-specific diversity of wild populations support the westward flow of genetic material since greater diversity is found in eastern Turkey than in western Turkey, Italy and France. Studies based on fossil records and chloroplast DNA, suggest that chestnut remained in several refuges in Southern Europe during the ice age. Studies of the variation in adaptive traits, such as bud burst, bud set, or growth, clearly show the geographic differentiation of populations. Populations from wet and cool areas

have a greater heat requirement for bud burst, have higher growth, and stop growing later than those found in dry conditions.

The genetic differences between domesticated and wild populations is longstanding. The lengthy domestication of chestnut, mainly for nut production, is thought to have caused genetic differentiation between the cultivated varieties and the wild populations.

Importance and use

Chestnut is an economically important species, covering large areas in France, Greece, Italy, Portugal, Spain, Turkey, and the United Kingdom. Tall forests for producing high quality timber are currently very scarce but are increasing in area. Chestnut timber is straight grained, and closely resembles oak in colour and texture. It is highly valued, and large trees, free of defects are especially prized. Chestnut wood is used extensively in rural areas, and the early formation of heartwood keeps it well preserved. Small pieces of wood were traditionally harvested from coppices and used in vineyards and mines.

In the Mediterranean region, chestnut is an important multipurpose tree used for both nut and wood production. The use of the species increased as the surface area and distribution range expanded, and grafted orchards and coppices are now found in vast, continuous areas. Many varieties have been grafted, mostly for nut and wood production. The chestnut fruit is extensively consumed by humans, and is an ingredient in many traditional recipes. Although nut prices are currently high, many orchards are being abandoned due to rural depopulation, particularly in the Mediterranean region.

Threats to genetic diversity

The adaptability of wild populations, in some areas, is under threat due to the reduced genetic base resulting from the incorporation of seedlings from a few grafted genotypes. The domestication of wild populations, by grafting wild trees with scions of varieties, is a significant threat to the genetic variability of some wild populations. Coppicing rotation of high density populations prevents regeneration and thus stops the natural selection processes – and is also considered a threat.

Domestication of chestnut is thought to have significantly influenced the genetic variability of the wild populations. Socio-economic developments in the Mediterranean have led to many chestnut orchards being abandoned, which are now slowly reverting back to the wild. Local grafted varieties represent an important genetic resource, and the loss of these orchards through neglect during the 20th century has resulted in the loss of genetic diversity of domesticated chestnut throughout Europe.

The introgression of the Asiatic chestnut species in the European wild chestnut

populations has frequently occurred in areas where both pure species and hybrids were planted, due to the overlapping flowering period. Hybridization affects both the adaptive potential and the phenotype of trees, and this must be considered when analysing the benefits and risks of hybrid plantations. In some cases, nuts from domesticated varieties are being used for forest plantations instead of that from wild populations, because of the lower prices.

Guidelines for genetic conservation and use

The first step to ensure the conservation and sustainable use of chestnut genetic resources in Europe is to assess, for each country, the present and past geographical distribution of the species, the conservation status, to identify threats and the prevailing or potential uses. Inventories should be undertaken in countries where the distribution of the species in the wild is unknown. Historical data may be required to distinguish the natural distribution range from the naturalized populations. Ecological gradients could be used to define ecogeographic zones or regions of provenance where the species is seed propagated.

For *in situ* conservation of populations, several managed stands should be designated from those selected for seed production (seed stands), with at least 100 trees that fruit regularly in each. These populations should then be sampled for provenance testing. If the populations are small (less than 20 trees), then seeds from several different populations within an ecogeographic zone should be collected and mixed, and the seedlings produced should be planted in the *in situ* gene conservation population to enhance their genetic diversity. If this is not possible, the number of trees in the population should be increased by planting material according to data from provenance trials where available, or by introducing individuals from similar ecological conditions. Different conservation populations should be established for nut and wood production.

A Multiple Population Breeding System (MPBS) is recommended to conserve the genetic diversity in wild populations (Ideally in MPBS, a breeding population is subdivided into subpopulations which are then grown over a wide range of site conditions. Each subpopulation may have the same or different breeding goal. In less intensive version of MPBS, subpopulations are selected from existing forests instead of establishing *ex situ* stands of the subpopulations). To create a European network of gene conservation stands, at least 30 ('undomesticated') stands should be selected throughout the distribution area, with greater numbers representing

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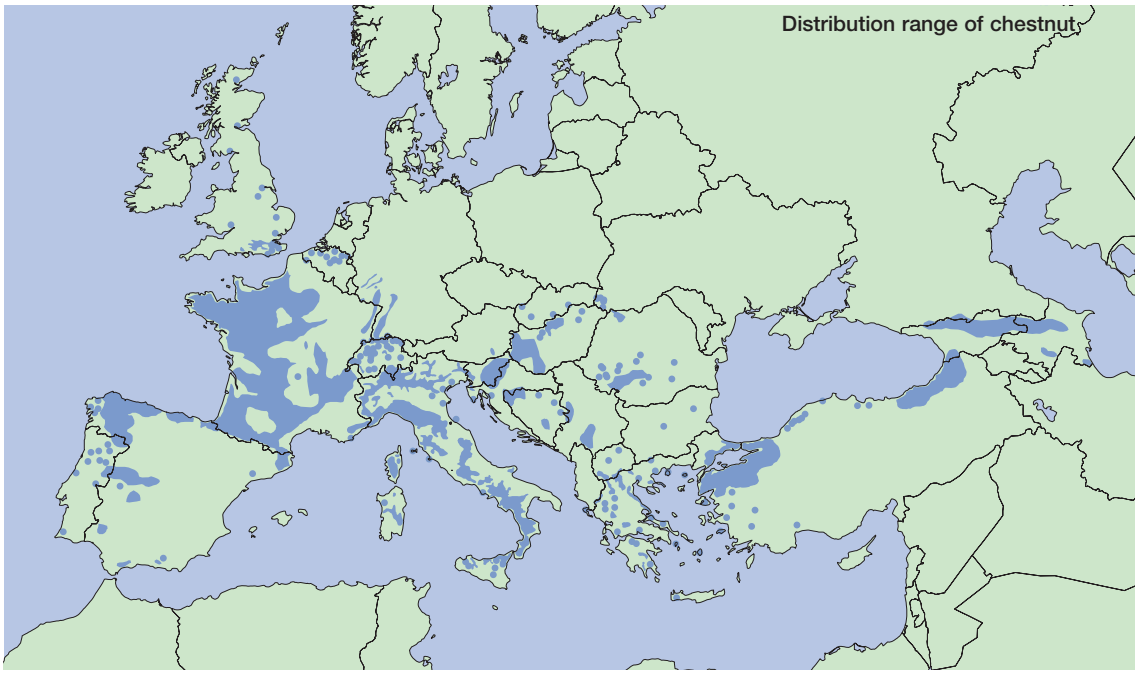

marginal populations. Sub-populations should be managed to promote nut production in trees with desirable phenotypes.

Cultivated varieties should be conserved in clonal archives. Clonal archives of plus trees and local fruit varieties can be considered as sub-populations within a Multiple Population Breeding System, with the main objectives of breeding and preserving the present composition of the chestnut forest stands and orchards. The aim is to prevent disappearance due to disease or dysgenic selection. Since two hybridizing species confer disease tolerance to *C. sativa*, it is recommended to include material from plus trees of *C. crenata* and *C. molissima* in clonal archives, located in areas without pronounced drought.

For *ex situ* conservation, provenance tests should be established in contrasting, disease free environments. Aiming firstly at studying the variability of the adaptive traits and then to conserve the material, progeny tests of selected plus trees from several populations should be set up on sites where a breeding programme will be implemented. One of the populations will serve as a control, to be tested in different environments, and the others will be included depending on the needs and priorities of every country.

EUFORGEN

These Technical Guidelines were produced by members of the EUFORGEN Noble Hardwoods Network. The objective of the Network is to identify minimum genetic conservation requirements in the long term in Europe, in order to reduce the overall conservation cost and to improve the quality of standards in each country.

*Fernández-López J. and R. Alía. 2003. EUFORGEN Technical Guidelines for genetic conservation and use for chestnut (*Castanea sativa*). International Plant Genetic Resources Institute, Rome, Italy. 6 pages.*

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The distribution map, including both natural and naturalized occurrence, was compiled by members of the EUFORGEN Noble Hardwoods Network based on an earlier map published by (i) Maurer, W.D.; Fernández-López, J. in 2001 (Establishing an international sweet chestnut (*Castanea sativa* Mill.) provenance test: preliminary steps - Forest Snow and Landscape Research. 76, 3: 482-486) and by (ii) Bounous G. in 2002 (Il Castagno: coltura, ambiente ed utilizzazione in Italia e nel mondo. Ed. Agricole – Bologna. Italy)

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