Cork oak

Quercus suber

Luis Gil[1] and Maria Carolina Varela[2]
[1] *Technical University of Madrid, Spain*
[2] *National Agronomy and Fishing Investigation Institute, National Forest Research Station, Lisbon, Portugal*

These Technical Guidelines are intended to assist those who cherish the valuable cork oak 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

Cork oak (*Quercus suber* L.) is an evergreen broad-leaved tree. The species is long lived (200–250 years), commonly growing to a height of 15–20 m but it can reach 25 m under ideal conditions.

Stem diameter at breast height can reach more than 200 cm. The bark is up to 20 cm thick, porous and furrowed, with deep longitudinal fissures. The thick dermal system protects the trees from forest fires.

Leaves are alternate, simple and with the margin entire or with 4–7 pairs of acute teeth. They fall during the second year (13–23 months after leaf flush).

Cork oak is wind pollinated and has predominantly separate male and female flowers on the same plant. Male inflorescences are long, pedunculate and arise from the axillary buds of the previous year's branches. Female

flowers appear on vigorous new growth. The seed matures either during the year of set or the following year. Annual maturation is more common in the southern cork oak woodlands, whereas biennial maturation is more common in northern populations, but individual trees may display both patterns simultaneously. Within each population, precocious individuals show a higher percentage of annual acorns, while late-flowering individuals have a higher percentage of biennial acorns. Acorns from southern or low-altitude populations are usually longer, wider and heavier than those from northern latitudes or higher altitudes.

Distribution

Cork oak requires an annual mean temperature of 13–18°C and will not tolerate temperatures below –10°C. As a result, its natural range includes the coastal regions of the western Mediterranean Basin, including Algeria, France, Italy, Morocco, Portugal, Spain and Tunisia, the islands of Corsica, Sardinia and Sicily and very limited areas on the islands of Majorca and Minorca. The most extensive forests are on the Atlantic coast of the Iberian Peninsula. The easternmost extent of the species is the Adriatic coast of Apulia in Italy.

Cork oak grows mainly on non-calcareous substrates, preferring sandy and lightly structured soils, but is occasionally found on decarbonated soils. It is found under a wide range of annual rainfall, ranging from 479 mm in Mamora (Morocco) to 2400 mm in some north-western areas of Portugal and southern Spain.

Cork oak is commonly grown in agroforestry systems, known as *montado* in Portugal and *dehesa* in Spain. These are open woods with low tree density (50–300 trees/ha). In these systems, forage species are commonly grown under the trees and grazed by cattle during the summer.

Importance and use

The primary use of cork oak is as a source of cork. Cork is obtained by peeling the bark away from the trunk, leaving a thin layer of new cork still covering the functional secondary phloem on the trunk. The first harvest (virgin cork) is made when the tree is approximately 25 years old. Subsequent harvests can be made every 9–12 years. Cork yield is determined by the circumference of the tree trunk the harvesting frequency and the length of bole and main branches that can be stripped.

Cork oak was a neglected species before the systematic use of cork as the raw material for stoppers to seal bottles started. For more than three centuries production of stoppers has been the driving force for sustainable management of cork oak forests. Stopper production uses about 20% of the cork while generating more than 80% of the added value.

The cork left after stoppers have been made is used to make a wide range of products, including insulation panels, floor and wall tiles and sound-proofing in the car industry, as well as for handicrafts and artistic uses.

A number of high-value, low-volume ‘niche’ products are also made from cork, such as ‘cork paper’, a thin slice of cork obtained from cork board. Cork

paper is used in printing, book covering, clothing manufacture, cork 'maroquinerie' and other products. Cork is also used in making badminton shuttlecocks, handles of fishing rods and special devices for the space industry.

Genetic knowledge

Neutral markers, such as isozymes, show large genetic variation within populations and small differences between them. Highest levels of diversity have been found in southern and Central Spain. This suggests that the Iberian Peninsula is a centre of diversity and was a glacial refugium for the species. Marginal areas provide a significant component of the total diversity, mainly owing to their divergence from the mean genetic composition. In addition to the analysis of nuclear genetic variation, several independent and complementary studies using chloroplast markers also indicate that cork oak originated in the western Mediterranean. They also indicate that human activity has not altered the original genetic structure of cork oak. Chloroplast DNA variants, belonging to two very distant lineages, have been identified. Lineage 'suber' is the most widely distributed and it is composed of four to eight chlorotypes depending on the technique used. Conversely, 19 chlorotypes belong to a very different lineage called 'ilex-coccifera.' A large majority of Holm oaks (*Quercus ilex*) and of Kermes oak (*Quercus coccifera*) from Morocco, Iberia, the Balearic Islands, and southern France are also characterized by haplotypes of this lineage, hence its name..

Cork oak is highly variable in its adaptation, morphology and phenology. Phenological characteristics such as flower receptivity, pollen shedding, fruit production and seed maturation vary widely among individuals within the same population. These and characteristics related to drought tolerance have high plasticity. Leaf morphology and acorn size vary widely. Cork quality also varies between stands and between trees.

Cork oak populations differ in their adaptation to drought and low temperatures. Thermophilic provenances are more sensitive to frost and stop growing during cold winter months. Provenances from dry sites have better water-use efficiency than those from wetter sites. Another feature related to strategies to face drought and cold is vegetative phenology. Apical and basal bud flushing showed significant differences between provenances.

Threats to genetic diversity

Cork oak is not endangered, and no threats are foreseen at the species level as long as cork has economic value. However, marginal populations, often growing in small and scattered stands and in restricted habitats, are at risk of disappearing. In such populations the effective population size (in effect, the number of reproducing trees) may be too small to maintain enough genetic diversity for future generations. Furthermore, the trees rarely produce large amounts of seed. Hybridisation with other oaks, mainly Holm oak (*Quercus ilex* L.), may play a major role in the evolution of these populations.

Acting together, these factors limit natural regeneration in small populations. The threat becomes critical when such populations are grazed.

Even when the population size is large enough to maintain viable genetic progenies, regeneration may be insufficient to sustain the population. Acorns are extremely attractive to many animals, resulting in a large proportion of the seeds being eaten, especially if the population is far from stands of other species bearing attractive forage seeds.

Guidelines for genetic conservation and use

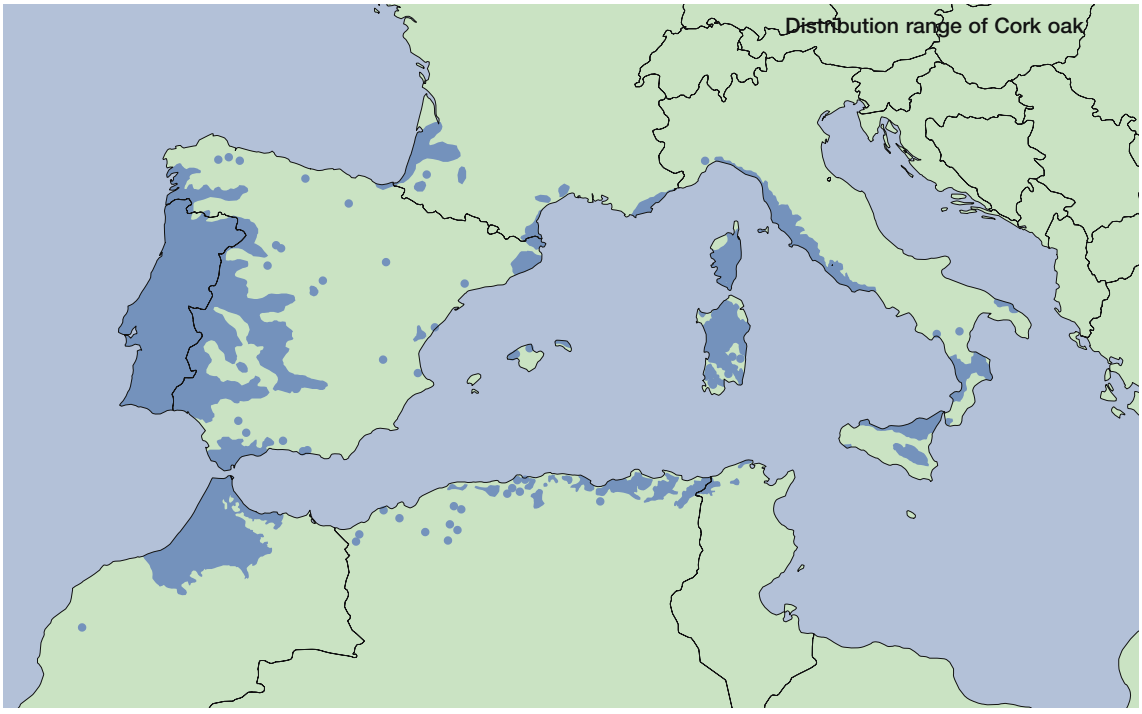
Genetic resources of cork oak should be conserved in several *in situ* populations representing the ecogeographic range of the tree. Each population should consist of at least 250 trees to ensure at least 50 reproductive trees.

The seed used to artificially regenerate large populations or to establish new ones should be collected from local populations or populations growing under similar edaphoclimatic conditions. However, seeds should not be collected for this purpose in years of low seed production.

In small and marginal populations, conservation activities should aim to promote regeneration to increase the population size. Where seed set is good, the main approach may be to protect the seed and seedlings from grazing and browsing animals. However, if the seed set is low, as a result of too few reproductive trees for example, seeds should be collected and seedlings raised in nurseries before being planted out in the location from which the seed was obtained.

Quercus suber

Cork oak *Quercus suber* **Cork oak** *Quercus suber* **Cork oak** *Quercus suber* **Cork oak** *Qu*



Quercus suber Cork oak Quercus suber Cork oak Quercus suber C

EUFORGEN

The series of these Technical Guidelines and the distribution maps were produced by members of the EUFORGEN Networks. The objective 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.

*Citation: Gil L, Varela MC. 2008. EUFORGEN Technical Guidelines for genetic conservation and use for cork oak (*Quercus suber*). Bioversity International, Rome, Italy. 6 pages.*

Drawings: Quercus suber*, Giovanna Bernetti.*

ISBN 978-92-9043-790-1

Selected bibliography

Aronson, J., J.S. Pereira and J.G. Pausas editors 2009. Cork oak woodlands in transition. Island Press, Washington. In press.

Díaz, P., P. Jiménez, G. Catalán, S. Martín and L. Gil 1995. Regiones de procedencia de *Quercus suber* L. MAPA–ICONA/ETSIM, Madrid, Spain.

López de Heredia, U., P. Jiménez, C. Collada, M.C. Simeone, R. Bellarosa, B. Schirone, M.T. Cervera and Gil L. 2007. Multi-marker phylogeny of three evergreen oaks reveals vicariant patterns in the Western Mediterranean. Taxon 56(4): 1209-1220..

Lumaret, R., M. Tryphon-Dionnet, H. Michaud, A. Sanuy, I. Ipotesi, C. Born and C. Mir 2005. Phylogeographical variation of chloroplast DNA in Cork oak (*Quercus suber*). Annals of Botany 96(5): 853-861.

Natividade, J.V. 1950. Subericultura. Min. Agricultura, Pescas e Alimentação. Dir. Geral das Florestas, 1st edn. (Reprinted in 1990) (in Portuguese, translated to Spanish and French).

Toumi, L. and R. Lumaret 1998. Allozyme variation in cork oak: the role of phylogeography and genetic introgression by other Mediterranean oak species and human activities. Theoretical and Applied Genetics 97:647–656.

Varela, M.C. editor 2003. Handbook of the EU concerted action on cork oak FAIR 1 CT 95 0202. INIA, Estação Florestal Nacional, Lisbon, Portugal.

Varela, M.C., G. Eriksson, R. Lumaret, L. Gil, P. Díaz and J. Turok. Gene conservation and management of *Quercus suber*. EUFORGEN Technical Bulletin. Bioversity International, Rome, Italy. (in prep)

Bioversity International

EUFORGEN Secretariat
c/o Bioversity International
Via dei Tre Denari, 472/a
00057 Maccarese (Fiumicino)
Rome, Italy
Tel. (+39)066118251
Fax: (+39)0661979661
euf_secretariat@cgiar.org

More information

www.euforgen.org