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CERTIFICATION SYSTEM FOR SUSTAINABLE FOREST MANAGEMENT OF CORK TREE (*QUERCUS SUBER* L.) FORESTS

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ABSTRACT

Sustainable Forest Management (SFM) seeks to make sure a performance of forest ecosystems environmental and socioeconomically just. The cork oak forest management presents a complex problem because silvicultural peculiarities. The aim of the SFM, to guarantee a functioning of forest ecosystems environmental and socioeconomically adequate, is difficult to achieve in the Mediterranean forests, because they have a limited capacity to reply to the systematic changes, human impacts, wide climatic, edaphic, and biological variability, and a complicated socioeconomic environment. Given its heterogeneity, the management of these ecosystems represents a multifaceted problem, being particularly significant in the cork oaks because of their silvicultural features. The key aspect of the cork oak silviculture is the production of cork, which is separated regularly without cutting down the trees. Cork oak stands need a SFM to resolve their major problems: scarce natural regeneration, ageing of stands, quality loss, severe pruning, and cork oak decline ("seca"). Cork is the outer bark of the cork oak (*Quercus suber* L.), an evergreen tree species belonging to the *Fagaceae* family. Its chemical composition is different from other lignocellulosic raw materials. It is light, squeezable, and impermeable; it has low thermal conductivity, energy-absorbing capacity, and high friction resistance. The best sheets are used for manufacturing natural stoppers, vital in the aging process of "great" wines. The cork oak is a Mediterranean species covering a global area of about 2,2 million hectares; Portugal and Spain being the countries where it occupies a larger area. Our goal was to consider possible options for carrying out a forest certification system in small stands of cork oak with a lower area of 25 hectares. These forests are essential agents of sustainability and a driving force for sustainable rural development. They play a crucial role in the world's ecological balance, fighting climate change and desertification and maintaining biodiversity.

Keywords: *Mediterranean western, Quercus suber L., Cork oak stands, Properties.*

INTRODUCTION

Cork is a secondary protection layer of cork oaks (*Quercus suber* L.) and from viewpoint anatomical is a part of the periderm (Pereira, 2007). It can be obtained for the first time after the 20-25 years of growth of the cork oaks; this bark is known as "bornizo" or "virgem" cork in Spain and Portugal, respectively. It is broken, cracked and of low quality, so it is intended for crushing. Between nine and twelve years after the first uncorking, the "segundero" or "secundeiro" cork have a better quality, nevertheless still deficient. Cork sheets do not reach optimum quality until the next uncork, about 9-12 years later (3rd uncorking), when the cork tree is approximately 60 years old. The best cork sheets are mostly used for the manufacture of stoppers (Paulo *et al*., 2015). Thereafter, the cork produced every 9-15 years is well-known as reproduction cork. Uncorking is a sustainable process that does not harm the tree (Faias *et al*., 2018). Cork is composed of suberin, lignin, holocellulose, and extractives. Suberin is the principal component, accounting for 30-50% of cork's cell walls, and it is stored on the secondary walls. The lignin percentage has been found to range between 20-25%, and the polysaccharide concentration is relatively small (Song *et al*., 2017). Given the structure of the cell wall, the chemical composition and the lignocellulosic materials, cork performance it is outstanding compared to other materials. It is light and impermeable and has many exceptional properties including of little thermal conductivity, energy-absorbing aptitude, extraordinary friction resistance, and excellent sound insulation, between other (Pereira, 2007; Shiqian *et al*., 2018).

Cork is a 100% natural, sustainable, and recyclable material. Cork oaks have a unique ability to absorb CO_2 from the atmosphere. It is estimated that the cork oak forests can absorb up to 14 million tons of CO_2 per year. Their relationship over three centuries with wine guarantees its privileged position as a cultural reference. The natural cork stopper is the closure chosen for the best quality aging wines (Gil, 2014; APCOR, 2015). Wineries pay a high price for them and require a guaranteed tightness and absence of defects aroma, increasing demand for quality controls for the cork industry (Diaz-Maroto and Sylvain, 2016). This must have rapid and efficient analysis systems that allow it to select cork in the forest and monitor their evolution until obtaining the stoppers, following a strict traceability program (PEFC, 2012).

The annual world wine production is about 275 million hectolitres (292 Mhl in 2018) (OIV, 2019), and 90% of bottle wines are stopped by corks. In the manufacture (about 300 thousand tons of cork are used per year), and the cork waste is 25% of the raw material. Different cork wastes can be found depending on their characteristics, density, moisture, granulometry, size, ash content, and tannin concentration (Reis *et al*., 2019). The cork is also employed for a wide variety of products, including sealing materials and gaskets, heat and sound insulating materials, construction materials, and all types of ornaments. Among the bio-based materials that give satisfactory results in sound protection we can find black agglomerated cork with composite panels (APCOR, 2016) (Figure 1).

Figure 1. "Saca" –uncorking– of the cork oak [Source: Las Provincias, July 20th, 2012]

The present work was developed to assess the opportunity for applying a certification system for small cork oak stands, area under 25 hectares. The process must be leaded by the Regional Groups of Forest Certification and Chain of Custody. The certification system used is mostly the Programme for the Endorsement of Forest Certification (PEFC). As specified by the multifunctional forestry employed in these ecosystems, its main use is the production of natural cork stoppers for the best quality aging wines.

MATERIAL AND METHODS

Study framework and kind of cork oak forests

Cork oak forests are located along the occidental Mediterranean basin, focusing on the Iberian Peninsula. *Quercus suber* is the dominant tree species, in many stands unique, being an evergreen tree belonging to the *Fagaceae* family. The cork oak woodlands cover a worldwide area of 2,139,942 ha (Gil, 2014, APCOR, 2016). In Spain occupy more than half a million hectares and are set in the southwest (Extremadura and Andalucía) and west (Cataluña). The annual output is 340,000 tons of natural cork. Spain is the second largest world producer with 30%,

surpassed only by Portugal with 61%. In both countries they are around 300 companies linked to the cork, highlighting the stopper industry, 85% of the turnover of the sector (MAPA, 2019). These forests are vital ambassadors of environmental and socioeconomic sustainability and a powerful force for sustainable development. They play a crucial role in the ecological balance, fighting climate change and desertification, and maintaining biodiversity. *Quercus suber* is normally found in forests or open woodlands as the main tree species (Houston *et al*., 2016) (Figure 2).

Figure 2. Cork forests and open cork woodlands [Source: El Mundo, March 8th, 2009].

Cork oak woodlands in Spain and Portugal can be differentiated into cork oak forests (higher density) according to environmental, silvicultural, and socioeconomic characteristics and open cork oak forests (low tree density, "dehesas" and "montados", respectively) (Torres and Montero, 2000; Pereira, 2007) (Figure 2). Cork oak forests have a higher tree density and an understory of shrubs such as *Arbutus unedo* L., *Juniperus* spp., *Ulex* spp., *Cistus* spp., and aromatic species, among other (Torres and Montero, 2000). Open cork oak forests have a canopy cover of 10 to 60% and well-developed annual grasslands in the understory; the main production is cork extraction, but also provide grazing for domestic and wild livestock. In addition, the variety of productions linked to the species, such as: cork, firewood, acorns, biodiversity, and landscape diversity, give cork tree a privileged position among forest species in the Iberian Peninsula (Montero and Cañellas, 2003).

Open cork oak forests: growth patterns and competition with understory

Growth patterns can provide to the forest management decision making process so long as give stand development forecasts. Interspecific competition between trees and understory may affect stand growth patterns, along with intraspecific competition and forest structure, depending on the species, environment, and forest management. The understory may be positive for some soil process as it

contributes to the nutrient concentration and increase natural regeneration development (Faias *et al*., 2018). Specially, the growth models for dominant trees are highly suitable in the management of open cork oak forests (Sánchez-González *et al*., 2005). However, ecological factors, silvicultural treatments, and productive characteristics of these woodlands are not the same in Spanish and Portugal, "dehesas" and "montados", so growth behaviour could also be different.

RESULTS AND DISCUSSION

Structure of Regional Model of Forest Certification

In Spain have been certified around 125,000 hectares of cork oak forests and 20 companies in the sector have received certification of the Chain of Custody, 2015 data, through the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification Systems (PEFC). This process must be leaded by the Regional Groups of Forest Certification and Chain of Custody, main regional certification organisms (Figure 3). The certification system managed by those is mostly the Programme for the Endorsement of Forest Certification (PEFC). As specified by the multifunctional forestry applied in the *Quercus suber* forests, its main use is the production of cork stoppers for the best quality aging wines. PEFC is a non-profit, non-governmental organization dedicated to promoting SFM by independent third-party certification (PEFC, 2012).

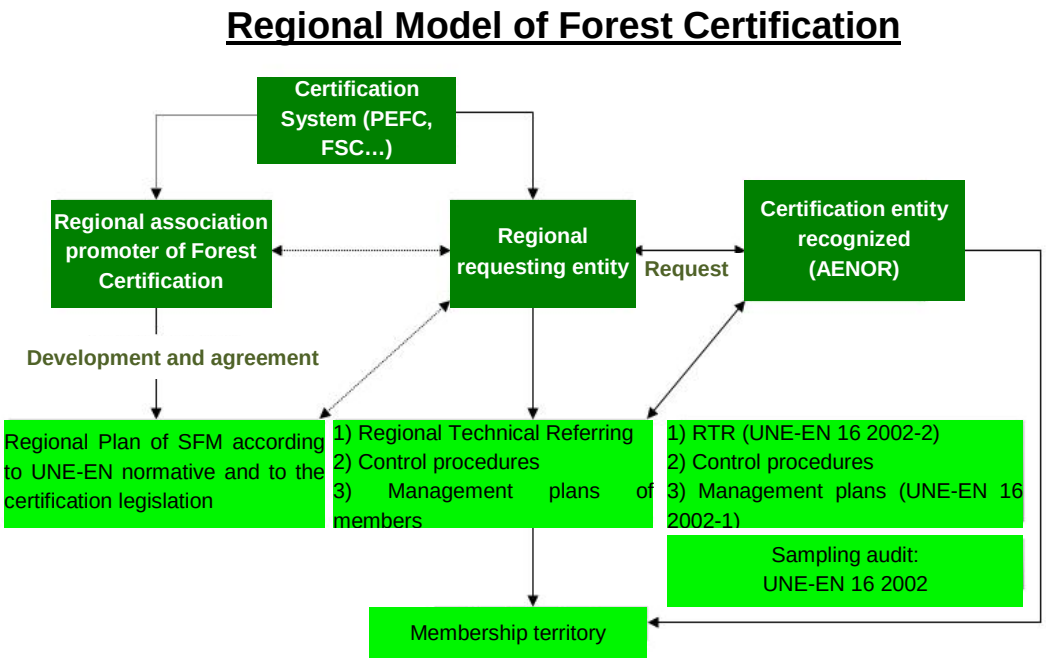

Figure 3. General scheme of Regional Model of Forest Certification
[*RTR: Regional Technical Referring].

Variability of bark, sapwood and heartwood depending on age

All members of the system plots (plots that have received acceptance notification and the membership reference code), the "saca" should be done considering the following (PEFC, 2012; Robak et al. 2012):

1) No delivery orders will be issued for certified cork oak plots whose date of registration in the application for license of "saca" is before the date of been membership of the system.

2) It's needed to submit a request for authorization by cadastral reference and properly complete all fields of the form. In addition to reflect all relevant observations, it is important to note the following data: i) complete cadastral reference; ii) total area of the plot to be uncorked (ha), wooded total area (ha), and forest total area (ha); iii) species to profit different to cork oak (if any); iv) number of trees; v) tons of cork to be extract (m^3).

3) Joined to the authorization of the Forestry Service, the uncorking must have all other legally required permits that would be applicable (water, patrimony, environment, etc.).

4) Companies engaged to the uncorking plots must comply with the provisions in this regard in the Manual of Good Practice of the Regional Groups of Forest Certification and Chain of Custody. Therefore, they must have sent the form entitled "Commitment Compliance of the Good Practices Manual", signed, and sealed before carrying out the first uncorking of a certified plot.

CONCLUSIONS

Sustainable Forest Management developed quickly. However, the implementation of its strategic framework has been delayed and some significant components progressing slowly. Greater time and effort obtaining transparency of roles and support from all stakeholders at the SFM stages, slowing the early stages, could have led to more progress. Meanwhile, the forestry industry suffered increasing pressure from the markets and public opinion to show that it had implemented sustainable practices. However, the private forest sector, which is moving in this way despite the difficulties caused by the small exploitations and fragmented ownership, has begun to understand that the SFM implementation, including the widespread application of forest certification systems, could reduce some of forest sector problems. Since some positive outcomes linked with administration's strategy have been achieved by private initiatives in a brief period of time, there are reasons to be optimistic.

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