Distribution of chestnut (Castanea sativa Mill.) forests in Spain: possible ecological criteria for quality and management (focusing on timber coppices)

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Abstract
The literature dealing with Spanish chestnut coppices from 1990 till 2001 is reviewed. Assuming that the basal area and Hart’s indexes are the best parameters to identify the optimal environmental conditions for chestnut trees, the best ecological conditions for sweet chestnuts are given according to Spanish districts.

It is concluded that it is possible to increase the surface of chestnut forests in western Spain. In northern districts, however, mean annual temperature and soil permeability are important limiting factors for chestnut reforestation. Evapotranspiration in summer and soil moisture storage are the limiting factors in southern Spain.

Keywords: coppices, chestnut, ecological parameters, quality, Spain

1 Introduction
Being able to predict the best sites for replanting with chestnut trees is important when considering the possible reforestation of marginal districts in Europe. This paper seeks to define the ecological criteria best suited for chestnut timber production and to find out how they are influenced by chestnut coppice management. The relationship between ecological characteristics and the production of chestnut coppice forests need to be understood so as to promote better sustainable management of these forests.

2 Methodology
Papers dealing with sweet chestnut coppices and orchards in different districts in Spain were reviewed. As a rule, basal area ($G$, m$^2$ ha$^{-1}$) or Hart’s indices ($Iq$, ha stool$^{1/2}$; SCHÜTZ 1990) were selected for defining the optimum quality of these coppices, and hence to find the relationships between these and the environmental and soil characteristics. Correlations between these proposed chestnut-quality indices and environmental and edaphic variables of the Spanish chestnut forests were made when selecting the values that correlated with best chestnut production. In most cases, more than 20 chestnut-forest sites were selected from each district. Regressions and Tukey test were used to find significant differences.

3 Results and discussion
Data were taken from the Spanish literature: RUBIO (1993), RUBIO and GANDULLO (1993), RUBIO and GANDULLO (1994a, 1994b), BLANCO et al. (1997), RUBIO (1997), RUBIO et al. (1997), MORENO et al. (1998), RUBIO et al. (1999), BLANCO et al. (2000). The best ecological parameters in each district (based on $G$ and $Iq$ parameters) that provided the best growing conditions for sweet chestnut were then sought. Tables 1 and 2 show the information obtained from these papers about both the environmental and edaphic characteristics of the Spanish sweet-chestnut forests. Other statistical methods used are described by the authors referred to above.

The review of these papers shows that many types of soils are suitable for chestnut, including humic and district Cambisols, haplic and district Luvisols and haplic Alisols (soil
types according to the F.A.O.'s soil system). Nevertheless, in some districts, such as Asturias, Catalunya, and Extremadura, the dominant soils with chestnut coppices are humic Cambisols. This indicates that the best soil conditions for producing chestnut forests vary according to the different Spanish districts. Even these differ from the recommended criteria for France, which mainly refer to soil texture and water balance (BOURGEOIS 1992). In all districts, however, soil suitable for chestnut should: 1. have fair to high pluviometry with no soil dryness during summer; 2. be deep with not too high a content of stones and/or clays; 3. have good soil permeability; 4. be acid, but not too acid; and 5. contain a fair amount of soil organic matter (BERROCAL et al. 1998).

Table 1 shows that the mean values of both environmental and soil characteristics of sweet-chestnut sites (forests, coppices or orchards) are different in different regions, in some cases significantly. The characteristics of sites from Extremadura differ markedly from those of the chestnut sites from northern Spain. With respect to: altitude, complexity index, annual and summer rainfall, mean annual and July temperatures, potential and actual evapotranspirations, winter water drainage, length of drought (in Navarra this period is almost null), soil moisture storage, soil organic matter content, and C/N ratio.

Table 2 compares characteristics between coppices from Asturias (northern Spain) and Extremadura (central Spain), because in both regions coppices are dominant (in Galicia orchards are predominant). Significant differences in altitude, slope, both winter and summer rainfalls, mean annual and July temperatures, thermal amplitude, potential and actual evapotranspiration, summer water deficit, dryness (both length and intensity), soil texture, water-holding capacity of soil, permeability, annual moisture deficit, and soil pH were found. Obviously, these resulted in different production values, ranging from 5 to 18 m³ ha⁻¹ a⁻¹ depending on the coppice management implemented (CABRERA and OCHOA 1997, GALLARDO et al. 2000, GALLARDO, submitted).

Lastly, as regards the distribution of chestnut forests, it should be pointed out that coppices are maintained in Asturias, Catalunya, and Extremadura (GALLARDO 2001), but are disappearing in Navarra because, unless there is no summer water deficit, some pine species grow faster and earn more money than chestnut. On the other hand, there continues to be a decrease in the production of chestnut fruit in orchards from Galicia (Gallardo, submitted), where nut production is concentrated, and contributions of nuts from Asturias and the provinces of Leon and Salamanca are also decreasing.

From the existing data, it seems it could be possible to increase the surface of chestnut forests because they can occupy mostly the climax areas where Quercus pyrenaica Wild., Q. robur L., and Q. suber L. grow. One limiting factor, however, is the increasing mean age of the people living in rural, mountainous areas (MORENO et al. 1998). Only some developing districts, close to the Portuguese border (western Spain) that still have a small young population (e.g. in the Aliste district, province of Zamora), are making efforts to improve the remaining chestnut orchards and to reforest the area with chestnut forests. They are seeking financial support for this from the European Union. Nevertheless, the current situation is that chestnut forests are disappearing from the best timber areas (e.g. in Navarra and Galicia) in favour of other tree species. The orchards are tending to be abandoned in areas where the Spanish economy has improved as a result of tourism, becoming peri-urban areas with industrial zones, or modern, intensive agriculture has been implemented. Some of the old orchards are being converted to coppices and, in this way, the surface of chestnut coppices has been almost maintained in Spain.

Forests have nowadays increased their importance as a sink for sequestering atmospheric CO₂ (Kyoto agreement). Therefore areas with chestnut may be extended if they are managed as coppice. Because chestnut orchards have a limited economical yield in post-industrial societies, a decrease in nut production in the European Union is foreseeable.
<table>
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Table 2. Environmental characteristics of the chestnut coppices from Extremadura and Asturias. (N.d.: No data available; significance: No: No significant difference; * p < 0.05; ** p < 0.01; *** p < 0.001).

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4 Conclusions

In spite of the limited number of parameters that can be useful as criteria for characterising the best chestnut area (see Tables 1 and 2), every district has optimum values, which are correlated with the more productive chestnut coppices. In northern Spain, mean annual temperature, last frost, and soil permeability can be good criteria for chestnut reforestation, but in the southern districts these criteria can be dramatically changed by such factors as altitude, summer evapotranspiration, length of drought, and soil moisture storage. If the results are to be extrapolated to Central Europe, only the selected criteria for Galicia and Asturias (perhaps also those for Navarra) should be included.

5 References


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