Distribution and economic potential of the Sweet chestnut (*Castanea sativa* Mill.) in Europe

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Abstract

No official and coherent data on the distribution of the European chestnut exist despite its wide range of distribution and the important economic role it has played in many countries. In 1997, in the framework of the COST action G4 "Multidisciplinary Chestnut Research", quantitative and qualitative data on chestnut forests were collected, mostly from the National Forest Inventories, in order to provide as sound a picture as possible of this important European resource. A total of 2.25 million hectares of forest dominated by chestnut were recorded, with 1.78 million hectares (79.0 %) cultivated for wood and 0.43 million hectares (19.3 %) for fruit production. The remaining 0.04 million hectares (1.7 %) were classified as irregular structures or without any indication. A further 0.31 million hectares are thought to be mixed forest with chestnut. Three types of chestnut countries can be distinguished : (i) countries with a strong chestnut tradition (e.g. Italy, France, southern Switzerland, Spain, Portugal and Greece), where the chestnut stands are cultivated with intensive and characteristic silvicultural systems (coppices and orchards) ; (ii) countries with only a partially developed chestnut tradition due to the country's particular geography (e.g. England) or history (e.g. Croatia, Turkey, Georgia) ; (iii) countries where the chestnut only sporadically occurs (e.g. Hungary, Bulgaria, Belgium) or has been recently introduced (e.g. Slovakia, Netherlands). A comparison of the present distribution of traditional silvicultural systems and historical data on chestnut distribution supports the hypothesis that the large-scale chestnut forest plantations are of post-Roman origin. Chestnut cultivation is now at a turning point as the changed needs of society have changed as it has moved away from a rural-based to an industrial and urban-oriented organization. The evolution of the chestnut market in recent decades confirms the potential of this resource for both traditional products and new services and goods related to organic-food and environmentally friendly products.

Résumé

Il n'existe aucune donnée officielle et cohérente sur la distribution du châtaignier en Europe, en dépit de sa vaste aire de répartition et de l'important rôle économique que cette espèce a joué dans de nombreux pays. En 1997, dans le cadre de l'action COST G4 "Multidisciplinary Chestnut Research", des données quantitatives et qualitatives ont été collectées au sujet des châtaigneraies européennes, principalement à partir des inventaires forestiers nationaux. L'objectif était de fournir un état des lieux aussi précis que possible pour cette importante ressource économique. Un total de 2,25 millions d'hectares de boisements dominés par le châtaignier a été inventorié, avec 1,78 millions d'hectares (79,0 %) cultivé pour la production de bois et 0,43 million d'hectares (19,3 %) pour la production fruitière. Les 0,04 million d'hectares restants (1,7 %) ont été classés en structures irrégulières ou n'ont pas pu être classifiés. Plus de 0,31 million hectares sont classés en tant que boisements mixtes à châtaignier. Trois types de pays peuvent être distingués du point de vue de la castanéculture : (i) les pays dotés d'une forte tradition castanéicole (ex. Italie, France, sud de la Suisse, Espagne, Portugal et Grèce), où les châtaigneraies sont conduites en taillis ou futaies, grâce à des sylvicultures intensives et caractéristiques ; (ii) les pays où la tradition castanéicole n'est que partiellement développée en raison de contraintes écologiques (ex. Angleterre) ou historique (ex. Croatie, Turquie, Géorgie) ; (iii) les pays où la castanéculture n'est que sporadique (ex. Hongrie, Bulgarie, Belgique) ou a été récemment introduite (ex. Slovaquie, Pays-Bas). La confrontation de la distribution actuelle des pratiques traditionnelles et des données historiques sur la répartition du châtaignier supporte l'hypothèse d'une origine post-romaine pour les peuplements de châtaignier présents sur de vastes étendus. La castanéculture a été profondément bouleversée par les changements socio-économiques liés au passage d'une économie essentiellement rurale à une économie de type industriel. Toutefois, l'évolution du marché durant ces dernières décennies montre que le potentiel économique de cette ressource reste bien présent, à la fois pour des produits traditionnels mais aussi pour de nouveaux services et biens.

Distribution and economic potential of the Sweet chestnut (*Castanea sativa* Mill.) in Europe

*Distribution et potentiel économique du châtaignier (*Castanea sativa* Mill.) en Europe*

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Abstract

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A comparison of the present distribution of traditional silvicultural systems and historical data on chestnut distribution supports the hypothesis that the large-scale chestnut forest plantations are of post-Roman origin. Chestnut cultivation is now at a turning point as the changed needs of society have changed as it has moved away from a rural-based to an industrial and urban-oriented organization. The evolution of the chestnut market in recent decades confirms the potential of this resource for both traditional products and new

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Trois types de pays peuvent être distingués du point de vue de la castanéiculture : (i) les pays dotés d'une forte tradition castanéicole (ex. Italie, France, sud de la Suisse, Espagne, Portugal et Grèce), où les châtaigneraies sont conduites en taillis ou futaies, grâce à des sylvicultures intensives et caractéristiques ; (ii) les pays où la tradition castanéicole n'est que partiellement développée en raison de contraintes écologiques (ex. Angleterre) ou historique (ex. Croatie, Turquie, Géorgie) ; (iii) les pays où la castanéiculture n'est que sporadique (ex. Hongrie, Bulgarie, Belgique) ou a été récemment introduite (ex. Slovaquie, Pays-Bas).

La confrontation de la distribution actuelle des pratiques traditionnelles et des données historiques sur la répartition du châtaignier supporte l'hypothèse d'une origine post-romaine pour les peuplements de châtaignier présents sur de vastes étendus. La castanéiculture a été profondément bouleversée par les changements socio-économiques liés au passage d'une économie essentiellement rurale à une économique

INTRODUCTION

The Sweet chestnut (*Castanea sativa* Mill.) is the only native species of the genus in Europe. The main chestnut refugia are thought to be the Transcaucasian region, north-western Anatolia, the hinterland of the Tyrrhenian coast from Liguria to Lazio along the Apennine range, the region around Lago di Monticchio (Monte Vulture) in southern Italy, the Cantabrian coast on the Iberian peninsula, and probably also the Greek peninsula (Peloponnese and Thessaly) and north-eastern Italy (Colli Euganei, Monti Berici, Emilia-Romagna) (Krebs *et al.*, 2004).

Chestnut cultivation started early and has a long tradition in Europe, as it is a tree species that is suitable for both timber and fruit production. The first written evidence of chestnut management is found in Theophrastus' "Inquiry into plants", 3rd Century B.C. The Romans then introduced in most parts of Europe the idea of systematically cultivating and using the chestnut tree and, in certain cases, the tree itself (Conedera *et al.*, 2004). In Medieval Times, people in several parts of Europe became greatly interested in cultivating chestnut, mostly for fruit production. Chestnut cultivation was extended to the ecological limits of the species (Pitte, 1986).

Despite the historical and economic importance of the European chestnut, no official and coherent data exist on the distribution of the species. The only attempt to survey chestnut resources in Europe was made in the fifties within the framework of the Chestnut International Commission. The International Commission consisted of a group of experts from different chestnut countries (Spain, Portugal, France, Switzerland, Italy, Yugoslavia, Turkey, Greece) who were charged with the analysis of the effects on chestnut cultivation of the increasing abandonment of rural areas and the onset of pathologies such as *Cryphonectria parasitica* and *Phytophthora* spp. Creating a chestnut distribution map was listed as a priority (Groupe des Experts du Châtaignier 1951; Commission Internationale du Châtaignier 1953, 1955, 1958).

One of the most interesting products of the International Commission was the chestnut distribution map of Europe and the related quantitative data provided by the country reports presented during the

ern and eastern part of Europe were not considered in the survey.

Starting in the 1960s, new data on chestnut distribution became available as national forest inventories were carried out in several countries. But there were still problems with the classification of the different chestnut forest types as the surveying methods among the countries were only partially comparable. The search for accurate data on chestnut resources in Europe has intensified in recent decades, since the chestnut tree was recognised as a multipurpose species for landscape conservation in marginal areas. Responding to this need, some authors have tried to synthesise the existing data, providing an overview of chestnut resources in the main European countries (Bourgeois *et al.*, 1991).

In 1997, within the framework of the COST action G4 "Multidisciplinary Chestnut Research" experts from all European countries where chestnut is present, were regrouped for the first time. During this action, quantitative and qualitative data on chestnut forests were collected in order to provide as sound a picture as possible of this important European resource. In this paper we describe the project and discuss the collected data.

MATERIAL AND METHODS

Data collection

The experts (data contributors, see table 1) of the countries involved in the COST G4 action were asked to provide data about the area covered by chestnut forests according to the typologies reported in table 2. The data were made available as a national report for each country in which basic statistics were linked to other additional information about silvicultural management, products and research activities. The information so obtained was then compiled together with local and international literature on chestnut cultivation in Europe.

Defining chestnut silvicultural typologies

Country	Data contributor	Data sources
Albania	Maxhun Dida and Caush Elezi	Source not given
Andorra	Sebastià Semene Guiltart	National Forest Inventory 1997 IEA Centre de Biodiversitat 2003
Austria	Eva Wilhelm	Source not given
Azerbaijan	Vagid Gadjeiev	Source not given
Belgium	Hugues Lecomte and Klaartje van Loy	Flemish Forest Inventory (1996-99) Walloons: source not given
Bosnia-Herzegovina	Ahmet Lojo	Source not given
Bulgaria	Svetla Doncheva	Forest National Service
Czech Republic		Haltofová and Jankovsky (2004)
Croatia	Sanja Novak Agbaba	Croatian Forest Service
France	Eric Sevrin	National Forest Inventory (1999)
Germany	Volker André Bouffier	Seeman et al. (2001)
Georgia	Yuri Michailov	Source not given
Greece	Gregor Chatziphilippidis and Stephanos Diamandis	National Forest Inventory (1992), Diamandis (2002)
Hungary	Lazslo Radoz and Norbert Frank	National inventories and others
Italy	Maria Chiara Manetti	National Forest Inventory (1985) National Statistics Institute (1993) Regional Forest Inventories, <i>Ad hoc</i> questionnaires
Macedonia	Sotirovski Kiril and Sumarski Fakultet	Source not given
Netherlands	Anne Oosterbaan	Estimated by the referent
Portugal	Afonso Martins	National Forest Inventory (1998) National Statistics Institute (1987-1999)
Romania	Valentin Bolea and Danut Chira	Source not given
Russian Federation	Michhail Pridnya, Gennadyi Solntsev and Yuri Michailov	Source not given
Serbia-Monte Negro		Glisic (1975)
Slovakia	Milan Bolvansky and Ferdinand Tokar	Lesprojekt (General Directorate of State Forest) Institute of Forest Ecology, Nitra
Slovenia	Anita Solar, Dusan Jurc	Jurc (2002)
Spain	Juan Gaillard Lancho and Santiago Lorenzo Pereira	National Forest Inventory (1996)
Switzerland	Fulvio Giudici	National Forest Inventory (1985)
Turkey	Necdet Guler, Ümit Serdar	Agricultural statistics
United Kingdom	Nigel Braden and Karen Russell	National Forest Inventory (1995-99) Forestry Commission Census (1979-82)

Table 1. Participating countries and data contributors.

Chestnut forests (chestnut area)		Stands with more than 50 % chestnut
	Timber production	Stands where wood production is prevalent
	Coppices	Simple coppices. Coppices with standards
	High forests	« Natural » stands. Plantations Stands converted into high forests

with defined productive purposes (timber or fruit) and those without a codified management (irregular structure). The stands for timber production were subsequently divided into high forests and coppices and the stands for fruit production into orchards and high forests. Coppices are defined as pure chestnut forests regenerated from dormant or adventitious buds of the stump for wood production (mostly poles and firewood). Orchards (or groves, as some authors call them) are traditionally open stands composed of grafted chestnut trees (selected varieties) for fruit production with intercropping of cereals (silvo-arable system, usually wheat, oat or rye), hay or pasture (silvo-pastoral system). We classified as orchard also new plantations of chestnut trees of selected varieties for fruit production or row plantations of grafted chestnut trees. In contrast, high forest was defined as chestnut stands that originated directly from seedlings (*i.e.* without coppicing or grafting) and that were used for timber or fruit production.

Chestnut map

A GIS-based chestnut map was constructed using the original data from the International Chestnut Commission (Commission Internationale du Châtaignier 1958). The experts were asked to update the map for their own country or, for the countries with missing data in 1958, to provide a distribution map indicating the geographic location (polygons) of existing chestnut forest types. Where no forest type was indicated, the default classification of high forest was assumed. After scanning, the original chestnut maps were georeferenced and the polygons digitalised by hand with the best possible accuracy.

RESULTS AND DISCUSSION

Chestnut area

The reported chestnut area covers in total 2,53 million hectares in Europe, of which 2,25 million hectares are chestnut forests, *i.e.* forests where chestnut is the dominant tree species and the remaining 0,31 million hectares are mixed forests with chestnut (table 3). The distribution area ranges from southern Europe (*e.g.* Crete) to

are dispersed in the other countries (table 3). For certain countries, such as Albania, Austria, the Czech Republic and Serbia-Montenegro, little information is available. We know roughly where chestnut forests may be found (*e.g.* Glisic, 1975; Haltofová & Jankovsky, 2004), but no further details about stand type, distribution and management are provided. For the countries not included in table 3, we assume that chestnut does not occur. A comparison of the distribution map of current chestnut forests (fig. 1) with both the chestnut pollen map at the end of the Roman Period (ca. 570 AD, fig. 2a) and with that at the end of the Middle Ages (ca. 1460 AD, fig. 2b), shows that, especially in western Europe, the main chestnut areas coincide with the chestnut stands created since the Middle Age, as already reported by several authors (Pitte, 1986; Fernandez de Ana Magán, 2002).

The proportion of chestnut stands with respect to the total forest area is usually very low (< 1-3 %). Exceptions to this general picture are Georgia (16,1 %) and the two main West-European chestnut countries, Italy (7,7 %) and France (6,6 %). In some cases, the irregular distribution pattern of chestnut stands implies a contrast between the low percentages at the national level and the high concentration of the species at the regional level. This is, for instance, the case for Switzerland where the chestnut percentage is 1,2 % nationally and 12,9 % in the region south of the Alps, the main chestnut-growing area (EAFV 1988). In most countries, chestnut forests are cultivated along the mountain ranges, highlighting the orophilous (mountainous) character of the species.

Unfortunately, it is not possible to analyze reliably the evolution of the total chestnut area for the countries included in the FAO survey of the fifties as the methods of data collection are not comparable. The FAO-survey considered only the managed and productive chestnut areas (Commission internationale du châtaignier, 1958), a category not considered in the present study.

Chestnut forests for timber production

In Europe, chestnut-growing area devoted to timber production is 1,78 million hectares (table 3), corresponding to 79,0 % of the total chestnut growing area. The fur-

Fig. 1. Present distribution of the chestnut in Europe.

The traditional silvicultural method of timber production, the “coppice system”, is still widely applied in countries where chestnut cultivation was widespread in the past to satisfy the needs of rural populations located in marginal or mountainous areas and where the chestnut found suitable climate and soil conditions in Italy, France, Spain, Greece and Southern Switzerland (fig. 3 and 4; table 3).

There are several reasons for the large number of

that were abandoned at the beginning of the last century and then coppiced because of the high incidence of the chestnut blight and of the demand for chestnut wood for tannin, mining and – especially in Spain – for barrels (Pitte, 1986; Conedera *et al.*, 1997; Fernandez de Ana Magán, 2002). In these areas, there are now a number of atypical coppice stands, derived from orchards and characterized by very low stool density and poor quality shoots. According to Tani *et al.* (2003), two or three gen-

CHESTNUT FORESTS (chestnut > 50%)												
Total forest area 1)	TIMBER PRODUCTION			FRUIT PRODUCTION			Irregular structure	CHESTNUT AREA		chestnut forests vs total forest area	MIXED FORESTS (chestnut < 50%)	remarks
	Coppices	High forests	TOTAL	Orchards	High forests	TOTAL		ha	%			
km ²							ha	ha	ha	%	ha	
991								8600	8600	0.4	1800	
39									0	0.0	0.0	sporadic presence of chestnut in forest stands
9402												missing value
1094								1500	1500	0.1	700	high forests mostly for fruit production
620	750	300	1050					1050	0.0	0.2	4450	in mixed forests chestnut covers about 30% of the basal area.
2273	3057		3057						3057	0.1	4585	
3690	2000	100	2100		720		140	2960	0.1	0.1	480	distribution between coppice and high forest estimated.
1783	14580	420	15000					15000	0.7	0.8	22362	
2632												chestnut present as single tree or tree cohorts in more than 300 localities. No quantitative data available
15341	862500	58000	920500	100000		100000		1020500	45.3	6.7		coppice includes coppice with standards
298		48000	48000					48000	2.1	16.1		data source uncertain
10740	4400		4400					4400	0.2	0.0	1600	only total area available, including avenue and solitary trees; coppice stands are assumed to be prevalent
3599	33051		33051		600	600		33651	1.5	0.9		
1840	300	800	1100	900		900		2000	0.1	0.1	650	
10003	482751	15119	497870	235620		235620	32347	765837	34.0	7.7		irregular structure intended as forest without a codified management
906			0				5058	5058	0.2	0.6		irregular structure intended as forest without a codified management
375	50		50					50	0.0	0.0	250	
3666		33900	33900	19609		19609		53509	2.4	1.5	21400	coppice are included in the high forest area
6448		2890	2890	100		100		2990	0.1	0.0	200	
851392		40000	40000			0		40000	1.8	0.0	7000	
2887												chestnut presents in few spots. No quantitative data available
2177	16	1302	1318	92		92	95	1505	0.1	0.1	45	
1107		30000	30000	185		185		30185	1.3	2.7	202308	no detailed information on the special distribution of the different silvicultural systems
14370	49909	50039	99948	37679		37679		137627	6.1	1.0		confusion between high forests and orchards may exist; single or dispersed orchard trees are not included
1199	19000	4700	23700	3400		3400		27100	1.2	2.3	6800	mixed forests intended as chestnut presence less then 25% of the basal area
10225	3614		3614		25278	25278		28892	1.3	0.3	28000	confusion between high forests and orchards may exist
2794	7913	10875	18788					18788	0.8	0.7	10871	isolated woods < 2 ha are not included
961891	1483891	296445	1780336	397585	36698	434283	37640	2252259	100.0		313501	
	65.9	13.2	79.0	17.7	1.6	19.3	1.7	100.0				

economical structure of the rural areas and the crisis in the market for poles meant that different silvicultural treatments were needed to satisfy the new demand for larger size and higher quality products.

As a results of these developments, the silvicultural systems for chestnut timber production applied are now very diverse, both within and among chestnut-growing countries. In certain cases, the rotation period has been extended without any planned active silvicultural intervention and no well-defined long- or medium-term objectives. In some countries such as Italy, Spain and the United Kingdom, coppices have been converted into high forests or, in extreme cases, have just not been cut and have thus developed into high forest-like stands. Nevertheless, in some European countries, such as France, Greece, Italy, Portugal, Spain, Southern Switzerland and the United Kingdom, private chestnut coppices are still cultivated in a short rotation period (10-20 years) without thinnings (rarely 1, early and from below) to produce poles and small products, mainly in the private ownership. The application of long-rotation periods (30-60 years) and selective thinnings, however, are reported for Croatia, Bulgaria and Germany. Finally, there have been recent experiments in France, Italy and Spain in the face of the growing demand for chestnut wood products. Here the management policy has been to have rotation periods of 25-35 years and 1-2 thinnings from below, in order to produce timber of higher quality, especially with a low incidence of ring shake (table 4).

High forest stands, representing only 16,7 % (= approx. 296 500 ha) of the chestnut-growing area devoted to timber production, are prevalent in those countries that have recently introduced chestnut cultivation (Slovakia, Hungary), and in those where there is no specific chestnut silviculture (Romania, Russia), or where the adopted silvicultural practices early modified the forest structures, giving them the appearance of high forest-like stands (Portugal, Romania).

In mixed forests, the silvicultural treatment is generally uniform and the chestnut is managed in the same way as other species. In such stands, management generally follows a rotation period of 40-60 years, or, more rarely, of

The thinning type varies from selective to low thinning, probably according to the silvicultural tradition of the country concerned (table 4).

In summary, there appears to be variety in the silvicultural treatments (rotation period, type, frequency and intensity of thinnings) applied to chestnut coppice and high forest stands in Europe. Above all, it seems silviculture interventions are often applied without an exhaustive analysis of their ecological impact on the forest ecosystem, and without a preventive analysis of the relevant ecological parameters (which include site index, climatic characteristics, and soil type) or of the main structural parameters (*e.g.* silvicultural system, stand density, dominant height, degree of mixture).

Chestnut forests for fruit production

The chestnut-growing area devoted to fruit production covers 0,43 million hectares (table 3), corresponding to 19,3 % of the total chestnut-growing area. According to our survey, Italy and France are nowadays the countries with the largest orchard areas (together they account for 84,5 % of the total reported orchard area). Thus, similar to the coppice stands, orchards grown according to traditional silvicultural methods for fruit production are mostly found in countries with a long tradition of chestnut cultivation (fig. 5; table 3). During the Middle Ages, the chestnut was an essential source of food for many mountain regions of those countries and this resulted in a wide range of products and of cultivated varieties with different ripening periods (early, mid-season, late), types of use (fresh consumption, long-term storage, drying, flour, animal feed) and ranges of distribution (higher altitudes, lower slopes, ubiquitous, etc.). This gave rise to a very complex and highly structured chestnut culture with a considerable number of different chestnut varieties cultivated for different purposes (Conedera *et al.*, 1993).

The few regions where commercial transport routes already existed during the Middle Ages (*e.g.* Piedmont or Tuscany), where the only places where chestnut plantations with just one or few high-quality chestnut or

Fig. 2a. Chestnut pollen map 570 AD (source Conedera et al., 2004).

markets (Pitte, 1986). The marron varieties, then defined as elliptic-shaped fruits of medium to large size, with marked dark strips on the tegument, which are light to peel (no intrusion of the epispermatic pellicle in the cotyledons) and sweet in taste (Bassi, 1993), have traditionally been cultivated only in Italy and a few areas in France. In all other countries marron-cultivars do not exist or are of recent import (*e.g.* southern Switzerland, Conedera *et al.*, 1997). In France, the definition of marrons has been recently revised in order to better fit the market and com-

above ground level (Bourgeois *et al.*, 2004). This complex historical background makes it impossible to reliably estimate the number of chestnut cultivars or ecotypes existing in Europe, even if the inventories so far performed at the national level suggest that there are thousands more varieties (Pitte, 1986).

In chestnut-growing areas cultivated as orchards, the quantity of chestnut produced in the main chestnut-growing countries has dramatically decreased since the beginning of the 20ies Century although it begin to pick

recovered best where the high-quality marron and chestnut cultivars are cultivated (Italy and, to a lesser extent, France) or where the large-size chestnut varieties are grown (Spain, Portugal, Turkey and France) (Alvisi, 1994). In the Iberian Peninsula, intercropping with cereal is becoming rare, but the practice of soil tillage is used to increase nut production (Berrocal del Brio *et al.*, 1998; Portela *et al.*, 1999).

Since 1990s, people have become more aware of the value of chestnut orchards as a multifunctional landscape element. In many countries they have begun to revitalize chestnut orchards as they see them as having aesthetic and ecological value, acting as tourist attractions, and serving as fire-breaks (Bounous *et al.*, 1992, Conedera *et al.*, 1997). Besides the revitalisation of traditional orchards in marginal chestnut-growing areas, new plantations (or even re-grafted old orchards) with high-quality varieties (marrons and similar) or large-size Euro-Japanese varie-

ties have been cultivated in several countries (mostly in France, Spain and Italy).

High forests for fruit production are rare (covering approx. 36 700 ha in Europe, which corresponds to 8,5 % of the fruit production area). Most of them are located in Turkey. According to Soylu *et al.* (2002), the grafting of chestnut trees is not very common in the Black Sea region. In some unclear cases, such as the attribution to the “soto”-type (= orchard) of some fruit-producing stands in Spain, the corresponding area was classified as “orchard”.

Chestnut products

The increasing demand for natural and environmentally friendly products in Europe has led to more interest in the chestnut. Moreover, some recent technological improvements (laminated veneer boards, finger-jointed

	Timber production					
	Coppices			High Forests		
	rotation (years)	thinnings (number)	type of thinning	rotation (years)	thinnings (number)	type of thinnings
Belgium	No information			Generally in mixed stands		
Bosnia-Herzegovina	Clear cutting when blighted			No high forests		
Bulgaria	No information					
Croatia	40-60	yes	selective	Generally in mixed stands		
France	25-35	1 (9-12 yrs)	low	40-60	2-3 (every 10-15 yrs)	selective
Germany	20-30	No information		60-80	No information	
Greece	20-25	2 (7, 14 yrs)	low	No high forests		
Hungary	No coppice stands			No information		
Italy	12-18 / 25-30	no / 1-2	low	50-60	2-3 (every 10-15 yrs)	low
Netherlands	Generally in mixed forests			No high forests		
Portugal	15	1 (at 2 yrs)	low	40-45	5 (every 8-10 yrs)	low
Romania	No coppice stands			120	every 5-10 yrs	low
Russian Federation	No coppice stands			Generally in mixed forests		
Slovakia	No coppice stands			100-120	every 10-15 yrs	selective
Slovenia	No information					
Spain	5-8 // 18-25	no // 2 (5, 12)	low	40-60	2-3 (every 10-15 yrs)	selective
Switzerland	12-18	None		30-60	??	selective
Turkey	No information			No high forests		
United Kingdom	12-20	None		Generally in mixed forests		

Table 4. Main characteristics of the silvicultural management applied in the different countries for chestnut timber production.

beams and boards, thick sliced veneer, better use of industrial wood through joint production of tannin and panels, fruit conservation and processing techniques) have also positive driving forces influencing the chestnut market (Pettenella, 2001). As a consequence, traditional chestnut products have now more opportunities on the market (poles for land consolidation work or playgrounds, logs for flooring, chestnut flour for pasta production, certification of local cultivars, etc.) and new products (chestnut parquet, chestnut-laminated veneer boards, chestnut pasta, chestnut beer, etc.) have been launched. Some of these new products and new applications, such as finger-jointed beams, and shingles from the wood, and pasta, biscuits, beer from the fruit are particularly interesting because it is possible to produce them from

exemplary model of multifunctional forestry (figure 7), playing an important social and economic role in rural areas.

The recent development of the chestnut market has not been homogeneous. It is frequently affected by agricultural, economic, and social and cultural local factors (Hennion & Vernin, 2000). Pettenella (2001) provides examples of niche chestnut markets, but the evidence of these is largely anecdotal and there are no figures available. For example, chestnut sawnwood for solid wood furniture production is in great demand in Tuscany (Italy), logs for floorings are highly desirable in France, poles for land consolidation, torrent and avalanche control works are used in Switzerland, the production of chestnut laminated beams and panels is increasing in

Fig. 3. Present distribution of chestnut coppices in Europe.

	Fruit	Timber		
Country	chestnuts (tons)	Sawnwood (m³)	Poles (m³)	Tannin and industry (m³)
Croatia		2,000	1,000	20,000
France	13,000	115,000	310,000	500,000
Greece	12,000			
Germany			1,000	5,000
Italy	52,000	54,000	300,000	150,000
Portugal	33,000			
Slovenia	16,000			
Spain	10,000		8,000	12,000

Fig. 4. Percentage distribution of the two different timber-producing silvicultural systems coppices (grey) and high forests (black) in the surveyed countries.

livestock, etc.). For fruit, the official statistics provided by the FAO indicate that around 350 000 tons of chestnuts are produced a year all over Europe (table 5). No official statistics exist for chestnut timber production, and only a few countries were able to provide data within the framework of the G4 Cost Action (table 5). Although incomplete, the data clearly show the poor amount of chestnut timber products of high value (*i.e.* sawnwood). This is probably due to the general lack of tradition in applying silvicultural treatments to improve the wood quality of the wood in the chestnut coppices.

CONCLUSIONS

Chestnut cultivation has a long tradition and deep roots in many European countries. The European countries with chestnut histories and tradition, can be divided into three main categories: (i) countries with a strong chestnut tradition (*e.g.* Italy, France, southern Switzerland, Spain, Portugal and Greece), where chestnut stands have been cultivated since centuries with intensive and characteristic silvicultural methods (coppice and orchards); (ii) countries with a only partially developed chestnut tra-

dition due to their particular geography (*e.g.* England) or history (*e.g.* Slovenia, Croatia, Turkey, Georgia); (iii) countries where the chestnut only occurs sporadically (*e.g.* Hungary, Bulgaria, Belgium) or has been recently introduced (*e.g.* Slovakia, Netherlands).

Despite this historical background, chestnut cultivation is now at a turning point and is being confronted with changing needs of a society that has moved from being rural to becoming industrial and urban-oriented. The development of the chestnut market in recent decades confirms the potential of this resource for both traditional products and new services and goods related to organic food and environmentally friendly products. This is particularly important for the chestnut as it is widespread in the territory particularly cut off from the main industrial developments. Silvicultural management trends are already reacting to these developments. The cultivation of high-value chestnut products (fruit or timber) is being intensified in the best chestnut-growing areas, new plantations are being created in potentially good sites for the chestnut, and traditional old orchards are being restored as part of a multipurpose landscape. At the same time, chestnut cultivation is being abandoned in the very marginal areas, where the old chestnut stands will evolve into mixed stands.

Fig. 6. Evolution of chestnut fruit production (tons) in different European countries since 1960. Source: FAO (FAOSTAT Agriculture Data - Agricultural Production - Crops Primary; <http://apps.fao.org/>) and Commission Internationale du châtaignier (1958).

Fig. 7. Products and services provided by chestnut forests classified according to the management system (modified from Pettenella 2001).

Given this dynamic situation, new marketing instruments will have to be developed, such as the certifying and registering the place of origin and the system of cultivation (Pettenella, 2001). More research is also needed to develop sound silvicultural techniques to solve problems related to the correct management of chestnut stands to best take into account not only productive aspects, but also the historical value of the forests, the establishment of multifunctional stands, and the improvement of the ecological and environmental value of the landscape.

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