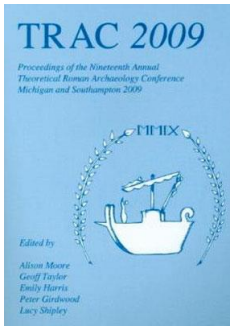

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Growing and Felling? Theory and Evidence Related to the Application of Silvicultural Systems in the Roman Period

Ronald M. Visser

> *'de omnibus agris optimoque loco iugera agri centum* […] *septimo silva caedua, octavo arbustum, nono glandaria silva'* (For the best kind of farms, I [Cato] would say that [...] in the seventh place comes a coppice wood, in the eighth an orchard and in the ninth a *silva glandari*) (Cato *a.c.* 1.7, transl. by author)

> *'Ut enim mulieres habent ad partum dies certos, sic arbores ac fruges'* (Just like women give birth after a certain number of days, so do trees carry fruit) (Varro *r.r.* I.XLIV.4, transl. by author)

Introduction

When discussing buildings or building activity in previous TRAC volumes, people have dealt with subjects such as monumentality (Aitchison 1999), ideology (Kerr 2002), the role of buildings when navigating in towns (Malmberg 2009), the (functional) classification of domestic space (Anderson 2005) or the unifying aspects of a legionary camp (Driessen 2005). Most of these papers were focussed on stone buildings, whereas timber has been the most important building material from the Neolithic onwards. It is also interesting to note that only a few theoretical papers have dealt with the basics, such as supply of resources (although a special TRAC volume dealing with food supply has recently been published (Stalibrass and Thomas 2008)). The famous and thorough study Meiggs (1982) wrote on timber and wood in the Mediterranean area mainly dealt with the use of this material, but also described some aspects of supply. However, he hardly ever mentioned the production of wood or the management of woodlands. This also holds true for Hanson (1978) in his well written paper on the Roman military timber supply in the north of England.

In this paper I will try to bridge this gap and summarize evidence for the production of wood and timber in the Roman period. This is not an all inclusive study of Roman forestry, but must be seen as a starting point. For my PhD on the Roman timber supply in the Lower Rhine area I will write more extensively on this subject (Visser in prep.). The main research question for the paper presented here is, then, what historical and dendrochronological evidence exists for the application of modern silvicultural systems during the Roman period? I am consciously using the word modern here, since the systems explained later in the text are those applied in modern forestry and not necessarily the systems applied and discerned as such during the Roman period. These modern systems are used as a theoretical framework to enhance our understanding of an important part of the Roman economy.

By looking for the application of modern systems in the ancient economy I do not *a priori* assume that the economy or the economic rationale (Mickwitz 1937) was modern. Several recent overviews of the Roman economy (e.g. Greene 2000; Woolf 2001) have shown that the Roman economy was not as primitive as suggested by Finley (1973), nor as modern as Rostovtzeff (1957) thought it was. I share the current and more balanced view of the ancient economy, in which we should understand the Roman economy as different, but not necessarily lacking modern aspects. This view enables us to consider whether rationalism applied in production systems, here in silvicultural systems.

Knowledge needed for forestry

Before looking into the evidence relating to ancient forestry, we first need to understand what a silvicultural system is. According to Matthews (1989: 3) it embodies three ideas:

> '1) The method of regeneration of the individual crops constituting the forest;
> 2) the form of crop produced; and
> 3) the orderly arrangement of the crops over the whole forest with special reference to silvicultural and protective considerations and efficient harvesting of produce.'

The last item, in particular, points out that specific knowledge is needed when a silvicultural system is applied. This knowledge is related to the processes and circumstances that influence the growth of trees. Several factors can affect the growth of plants in general and trees specifically, such as soil, climate, competition, slope, ground water level, etc. If knowledge of these factors did exist during the Roman period, we can proceed further in aiming to find out whether silvicultural systems were applied then. The knowledge needed for the application of silvicultural systems can be divided into three groups, namely knowledge related to reproduction, production and harvesting the produce. In the discussion of this knowledge below I have not distinguished between that which is needed for silviculture and that for arboriculture (production of tree crops), since techniques applied in arboriculture can also be applied in silviculture, while there is no difference in the knowledge. However, it should be noted that the processes can differ.

The first type of knowledge needed embodies the reproduction of trees. Trees can be propagated in two ways: sexual and asexual. Pliny (*n.h.* XVI.134) mentions a third method of propagation, namely spontaneous growth of trees, but this is biologically impossible. Sexual propagation embodies the growth of trees 'from the memory of a single seed' (Kainulainen 2009). Varro (*r.r,* I.IV.1) mentions that the casting of seed is the first step in all production. Many other Roman and Greek authors also mention the growth of trees from seed (e.g. Columella *r.r.* III.I.1; Pliny *n.h.* XVI.134; Theophrastus II.I.3, II.VI.1, VII.I.1–2; Varro *r.r.* I.XXIII.6, I.XL.1, I.XLI.6). Propagation from seed is widely mentioned in ancient sources and from this it can safely be concluded that trees were seeded in the Roman period. Asexual propagation is also known as vegetative reproduction. This can be achieved in several ways, the most common being the use of cuttings, layering and suckering. Reproduction of trees or shrubs by cuttings is widely mentioned in ancient sources (e.g. Cato *a.c.* VI.3, XXIII; Columella *r.r.* several places in book III & IV, e.g. IV.IV.2 (mallet cutting of vine) or IV.XXXIII.2 (chestnut); Pliny *n.h.* XVII.58; Varro *r.r.* I.XXXIX.3; Virgil *Georgica* II.23–25, 64–68), and is sometimes even seen as the preferred method of propagation (Varro *r.r.* I.XLI.6). Suckering, or basal shoots, is among others mentioned by Columella (*r.r.* IV.XXXIII.4), Pliny the Elder (*n.h.* XVI.134) and Virgil (*Georgica* II.17). Propagation of trees by layering was also practised in the ancient world (Cato *a.c.* LI; Columella *d.a*, VII; Pliny *n.h.* XVII.58).

After knowledge on propagation, it is necessary to know how to enhance production when applying any silvicultural system. Columella (*r.r.* III.I.1) acknowledges that trees should be managed and that it is a very important part of farming. It was also known that some species grew faster than others (Varro *r.r.* I.XLI.4). In relation to management and tree growth, the words of Cato (*a.g.* LXI) on the growth of olives are very important: '*Quid est agrum bene colere? bene arare. Quid secundum? arare. Quid tertium? Stercorare*.' In other words, the most important things when growing plants are, according to Cato, manuring, manuring and

ploughing. The latter is also mentioned by Virgil (G. II.397–400) in relation to a vineyard, which often included trees to support the branches of the vine. Manuring or fertilizing trees was probably common practice, since it is mentioned by several other ancient authors (e.g. Cato *a.g.* V.8, VIII.1, XXIX, XXXIII; Columella *r.r.* I.VI.22, II.II.13, II.V, III.XI.9; Pliny *n.h.* XVII.50–53; Virgil G. II.347). Thinning, pruning and the orderly placement of trees in a stand are also very important for enhancing production in modern plantations. Examples regarding the orderly placement of trees can be found in writings of Varro (*r.r.* I.XXIII.6), who mentions that young trees should be placed in rows. Theophrastus (II.V.1,5–6) and Pliny (n.h. XVII.59) both describe the preferred planting distance between trees. Thinning was also widely practised in the ancient world and is mentioned by Cato (*a.g.* CXXXIX), in relation to thinning of a grove, and Virgil (*G.* II.400–401), who describes how a vineyard is thinned. Columella (r.r. IV.XXXIII.2–3) gives us a description of the orderly placement of chestnut trees, the thinning process and the care taken while growing them.

Special measures to enhance production, or at least protect the current production, were taken by Hadrian around A.D. 138. Over a hundred inscriptions have been found in Lebanon covering a large area, the most common text being '*IMP.HAD.AUG.ARBORUM GENERA IV CETERA PRIVATA D(E)F(INITIO) S(ILVARUM)'*. This can be freely translated as: In the woods of the emperor Hadrianus four species have been demarcated; the rest can be used by private people (Honigmann 1926: 5–7; Meiggs 1982: 85–87). Thus the emperor had clearly taken protective measures to prevent illegal felling in his woods in Lebanon. Unfortunately, it is not known which species he wanted to protect, nor are the reasons for protection mentioned.

The third type of knowledge needed for the application of silvicultural systems is related to harvesting the crop and its effects on the remaining trees and the landscape. Although authors such as Vitruvius (II.9.1.) and Cato (*a.g.* XXXI.2) seem to agree that felling should be done during the autumn or winter, not many sources describe what should happen with the land after felling trees. Virgil (*G.* II.207) is the only author who speaks directly of the felling of a forest, and tells us that the land now finally yields crop after many years of no gain. He also states that the land should be ploughed after felling the trees. Since the ancients clearly knew that manuring the land enhanced production, it seems likely that this was also done after woodland was cleared.

Silvicultural systems in the Roman period

Clear cutting

The clear cutting system is the most basic silvicultural system (Fig. 1). When this system is applied a large area of a woodland is felled completely. After the felling of all the trees, the cleared area is left to regenerate by itself or new seedlings are planted in. In the ideal situation some sections would be cleared each year, as was the case in some pine-forests in Germany during the eighteenth century. However, it was soon realized there that trees did not grow as regularly as expected, and during the early nineteenth century trees were felled less frequently (Matthews 1989: 65–66). Protective measures are often taken, such as retaining the outer trees to protect the young trees from strong winds or removing other competing plants (more examples can be found in (Matthews 1989: 66–76)).

Since this system is described as 'the simplest of all high forest systems' (Matthews 1989: 87), it is likely that such a system was applied in the ancient world. Several sources describe the clear felling of an area, such as Caesar (*Bello Civili* 2.15.1) describing all the trees in the area around Massillia being felled during the war efforts. The felling of a complete woodland

could also be punishment after an enemy was conquered (Nenninger 2001: 111*ff.*), but the reverse could also happen. After the Romans had defeated Phillip V of Macedonia in 198 B.C., he was forced to replant the forests (*silvae*) and sacred groves (*luci*) he had cleared during his war efforts (Livius 32.34.10). Although these textual sources seem to indicate clear felling, the question remains whether this is evidence for the application of a silvicultural system or just systematic destruction.

Figure 1: Modern clear cutting in the Sauerland (Germany). A felled patch is seen on the left side of the slope, in the middle older clear cutting is recognizable and on the right the woodland is nearly fully regenerated after clear cutting longer ago (photo by author).

It is important to look at other sources than just the written ones to find out whether the clear cutting system could have been applied in the Roman period. At the end of the first century a road was built along the *limes* in the Lower Rhine area. In the Netherlands, this road has been excavated at Valkenburg (Zuid-Holland). The wood that was used for the road came from trees that probably grew in the nearby coastal peat area, since the material shows strong correlation with the timbers used for an indigenous settlement at Nieuwenhoorn and the wood used in an early Roman fort at Velsen. However, when this road was rebuilt at the same location twenty five years later, wood with a different provenance was used (Visser and Jansma 2009). This seems to suggest that, when the road was first built, all the available trees were felled, so that no trees of the right size could be found in the same area twenty five years later. Clear felling had clearly taken place here, but it can not be said whether this was part of a silvicultural system or if it was just military clear cutting without any considerations for future use of the area. However, the latter would be strange for an area that was meant to be part of the Roman empire for a longer period, as implied by the reorganization of the region into the provinces Germania Inferior and Germania Superior around A.D. 85 (Carroll 2001: 41). Furthermore, the elevation of the civilian settlement near Xanten to Colonia Ulpia Traiana (Rüger 1968: 85–87), and Nijmegen to Ulpia Noviamagus Batavodurum (van Enckevort *et al*. 2000: 92) around A.D. 100, also shows that this area was seen as a permanent part of the

Imperium Romanum. If the Roman state or local government considered the area as a stable part of the empire, one would expect the executives of this policy, the army, to take more responsibility than to simply clear the landscape without replanting some trees. However, it might be the case that the commanders or soldiers building these roads were not concerned with these issues or could not see the long term effects of their actions (see Groenman-van Waateringe 1983; van der Leeuw and de Vries 2003 for a discussion on unintentional effects of Roman occupation and colonization).

Clear cutting obviously took place during the Roman period, but it remains unclear whether any silvicultural considerations were taken into account. The examples mentioned here are mostly related to military practices and seem to point toward systematic clear felling, but no hard evidence can be presented for systematic replanting after these (military) clearings.

Selection

If the selection system is applied, a selection is made of trees that will be felled within a forest. Felling and regeneration are not confined to certain areas in the forest, but are distributed throughout the stand. The application of this system results in a forest with trees of different ages, and sizes, geographically widely spread throughout the forest. After felling natural regeneration springs up in the gaps that are created in the forest. In the most primitive form all trees of a certain diameter or size are felled, but in a real selection system, the mixture of species, age-classes, sizes and regeneration of the forest should all be considered when felling a selection. The major advantages of this system are that saplings and younger trees are constantly protected by older trees and that the forested area is better protected from erosion than when, for example, the clear-cutting system is applied (Matthews 1989: 163–169).

An indication of the application of the selection system in the Roman period can be derived from the existence of the *saltuarii*. The distribution of inscriptions of these found in the Roman empire (Fig. 2) shows that they were present in several provinces. *Saltuarii* worked on the imperial domains, which were known under the term *saltus* (Sprater 1929: 62). These men were either slaves or freedmen and were led by a *villicus* (Meiggs 1982: 330), whose function was to guard the borders of the estate and to protect the crops on the estate (Rostowzew 1904: 299). As well as these functions, their role as foresters has also been mentioned (Sprater 1950). The different functions of this group of people is also reflected in the distribution on the map in Fig. 2, since evidence for *saltuarii* is not restricted to densely wooded areas.

Their function as foresters is nevertheless underlined by the depiction of a *saltuarius* on a grave stone that has been found in the Heidelsburg at Waldfischbach (Germany). On this stone, Titus Publicus Tertius is depicted with his wife, and he is carrying an axe that represents, according to Roller (1986: 61), a *securis* (Fig. 3). The same kind of axe has also been found during excavations at the same location (Sprater 1950: 425). Roller (1986: 61–63) has shown that a *securis* shows strong resemblance to the so-called *Loogaxt*, an axe that was used from the early Middle Ages until the eighteenth century to mark trees that should be felled. This *Loogaxt* not only had a functional use, but was also a status symbol. The use as a marking axe seems quite possible for the *securis* and, if this was the case, it might be an indication of the application of the selection system during the Roman period. The use of the *securis* as a symbol of status is suggested by its use on the grave stone of Titus Publicus Tertius and his wife. Since it is the only object he holds, and he or his relatives obviously wanted him to be depicted with it, the *securis* must clearly have had a strong meaning for him or his heirs.

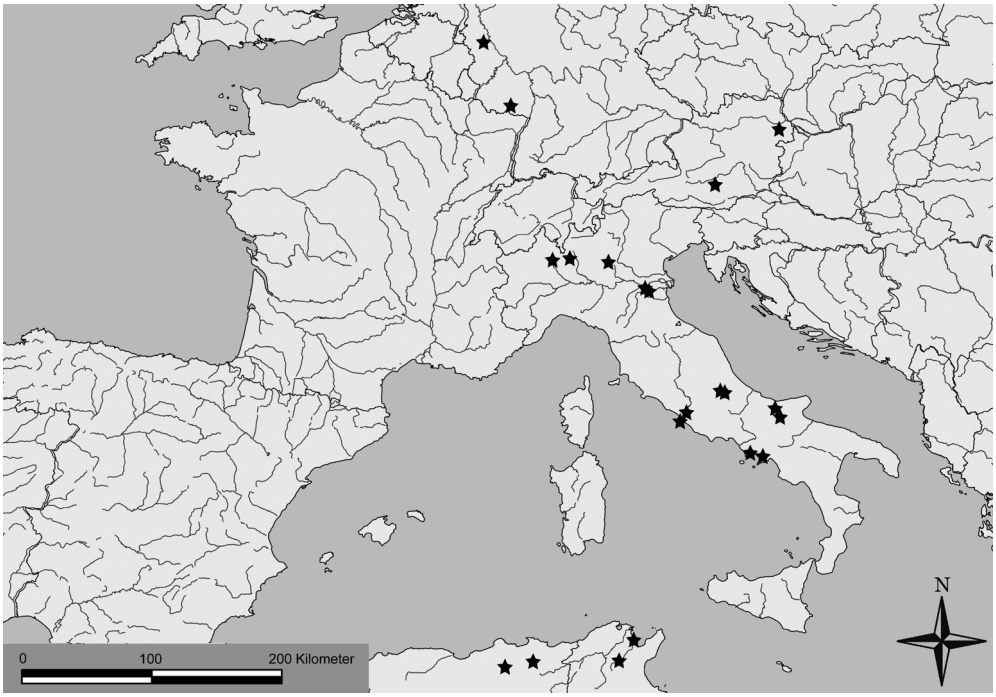

Figure 2: The distribution of the twenty four inscriptions of the saltuarii (map by author).

Figure 3: The relief from Waldfischbach showing a saltuarius (Sprater 1929: 64) (left). The excavated securis from the same location is shown on the upper right, with a Loogaxt below (drawings by author).

Selection of trees within a forest can also be derived from dendrochronological material. During the late Roman period, water wells in a native settlement near Gennep (Heidinga and Offenberg 1992) and a Roman bridge at Cuijk (Goudswaard *et al.* 2001) were built in the eastern River area in the Netherlands. The bridge was constructed between 347–349, renovated in 368 and between 388–398 it underwent the last large scale restoration, whilst the wells were constructed in the late fourth or early fifth century. The correlation between the dendrochronological material from these two sites is remarkable, pointing to the fact that the trees used there during different periods probably grew in the same forest (see also Jansma 1995: 65). It is interesting to note that, after the first felling of trees to build the bridge around 347–349, enough older trees must have been left standing to enable a second felling in 368. The trees used in 368 were older than twenty years and were already growing in 347, so it can be deduced that in 347 some selection took place. The same is true for the trees used in 388–398; some were even a hundred years old by this time. Several trees used for the wells were over a century old and were therefore growing while the bridge was built around 347–349, when it was renovated twenty years later and also when it was restored at the end of the fourth century. This shows that selection took place in the woods of the Lower Rhine area during the fourth century A.D. However, we must be cautious, since selection of trees in a forest could just be a selection based on the demand for wood with specific dimensions and not a selection which has been made after (careful) silvicultural considerations. Furthermore, the selection here could also have been possible because more woodland was available, so that the builders of the bridge had more to choose from. The population declined strongly during the second half of the third century (van Enckevort 2001). This led to less pressure on the landscape and probably expansion of the woodland (see Groenman-van Waateringe 1983: 147–148 for some pollen evidence). However, an argument in favour of selection is the relatively short distance between Cuijk and Gennep, which suggests that both the builders of the bridge and the wells were using the same woodland.

Coppicing

The coppice system is based on the regenerative properties of several tree species (Fig. 4). When most broad-leafed species, up to a certain age, are felled near the ground, they will form new shoots. These new shoots can be felled when they have reached the preferred size (either diameter or length). The mean maximum age at which the first felling should take place is around forty years, but with chestnut the first cut to create shoots can even be done after the tree has been growing normally for over a hundred years. The coppicing system can be combined with the selection system, in which case it is called a coppice selection system. Coppicing is particularly suitable for production of fire wood or of smaller constructional timbers. Larger timbers can be produced by leaving some trees to grow longer, when we speak of coppice with standards (Matthews 1989, 190–193, 213–224). Pollarding is related to coppicing, the only difference being that the trees are not cut at ground level but between two to five meters above ground (Rackham 1977: 65).

Evidence for coppicing in the Roman period can be found in several ancient sources. The term that was used for coppice woodland was *silva caedua* according to Meiggs (1982: 263). Makkonen (1967: 40) defines this term more broadly, when he states that a *silva caedua* ‘comprised all utility forests, whose main function was to supply wood’. Nenninger (2001: 45–47), however, mentions a juridical text that states that a *silva caedua* is a forest where trees are felled, but in such a way that the stems sprout again. Hence, the term *silva caedua* is used for coppiced woodland. Independently from this debate on the ancient Latin terms for these

woodlands, it is undeniable that coppicing took place during the Roman period, since several sources describe it. A very clear description of a five year coppice cycle comes from Columella (r.r. IV. XXXIII.1):

> 'Its nut, too, when planted in prepared ground, quickly springs up; and when cut down, after five years, it renews itself in the manner of the willow, and when made into a stake it lasts usually to the next cutting'

Columella (IV.XXI.2–3) also mentions the practice of pollarding, and Pliny (XVI.141–142) writes on the basics of coppicing, describing how a cypress will grow again from the roots after it is felled.

Figure 4: A coppiced oak stand at the Laarzenberg near Rhenen in the Netherlands (photo by author).

Archaeological evidence for coppicing dates back to the Neolithic. Based on the shape of the wood and its rapid early growth, Rackham (1977) concludes that coppiced hazel was used in the construction of several Neolithic trackways in Somerset. In contrast with the later medieval practice of clear felling the coppice stools, the Neolithic coppiced wood shows that coppicing was combined with selection on the basis of size. During the Roman period the application of coppice can also be proved archaeologically. It will suffice here to mention examples from two regions in the Roman West; Picardy and Flanders.

In the Picardy region, in north western France, many pieces of wood have been researched dendrochronologically and archaeologically by Bernard (2003). He has concluded that areas of

approximately fifty square kilometres around the larger Roman settlements were used to supply them with wood and timber. His dendrochronological and morphological research on the shape, size and age of the wood points towards standardization after the end of the first century A.D. According to Bernard, this was the result of a forty year coppice cycle. Wood used for two wells in the late Roman settlement of Oudenburg (Belgium) was analysed dendrochronologically by Haneca *et al.* (2005). They compared the growth patterns, and more specifically the growth rate, of this archaeological wood with the growth rate of (natural and managed) high forests and coppiced stands. Based on this comparison the conclusion was drawn that this wood from the Roman period came from a coppiced woodland. Although the results of this study are very promising, I feel that we must be careful when concluding a linear relation between one modern coppice stand and archaeological material. However, when these results are combined with the written evidence mentioned earlier, the use of coppiced wood seems very probable at Oudenburg (and other locations) during the Roman period.

Based on historical sources it can be concluded that the theory behind coppicing was known and that it was probably applied. This is corroborated by the archaeological evidence, which shows that coppicing was practised in the Roman period.

Agro-forestry

This widespread practice is a combination of growing timber trees, fruit trees and/or shrubs in combination with agricultural crops and/or animals. When combined with crops, the trees protect the plants from strong winds and the branches or stems can be used to build fences or used as poles to grow, for example, beans. Coppicing the woodland is especially suitable for producing small timbers for these purposes. Woodlands can also be used as pasture. In this case the animals remove the undergrowth and their dung fertilizes the soil. If trees are coppiced or pollarded, the leaves can be used as fodder for the animals. Pastoral use of woodlands can be combined with clear-cutting. If the young trees are sufficiently protected, the livestock can eat away the competing weeds or shrubs giving the young trees more light (Matthews 1989: 240–243).

The Latin term for the combination of agriculture and forestry is *silva glandaria*. The term was originally used for woods with oak (*glans* = acorn) but, according to Meiggs (1982: 263), it can also be used for beech-forest. The nuts from the trees were used to feed the pigs. This conclusion of Meiggs is clearly based on the passage from Pliny (*n.h.* XVI.15–34), where he describes how these nuts are fed to pigs and that these animals especially like the nuts from the beech. A *silva glandaria* was seen as a very good investment in Gallia during the Roman period, and pigs that were fattened in them supplied a large part of the meat consumption in the (western) Roman empire (Meiggs 1982: 263; Nenninger 2001: 46–47).

Another combination of forestry and agriculture is described by Varro (*r.r.* I.XV), when he mentions the planting of trees on a farm. Here he points out that trees on a farm are important to make the boundaries of the estate more secure and prevent any quarrels with neighbours. Furthermore, the young branches of the elm trees can be used to make baskets, the larger ones to build fences, the foliage used as fodder for sheep and cattle and, finally, that the wood can be used as fuel. The use of leaves of elm as well as oak and poplar as fodder is also mentioned by Cato (*a.g.* V.8).

Conclusion

In this paper I have shown that the knowledge that is needed for the application of silvicultural

systems existed during the Roman period. In a short survey of the historical sources and some dendrochronological publications and material, evidence has been presented for four silvicultural systems. For the clear cutting system, no irrefutable evidence could be found for its application in the Roman period, but some evidence of clear felling has been mentioned. It remains unclear whether measures were taken to ensure regeneration of the woodland after clear cutting. In relation to the selection system, the existence of the *saltuarii* is seen as an indication for the application of this system. Furthermore, the choice of certain trees to build a bridge in the fourth century seems to indicate selection, although selection for use does not necessarily imply the application of the selection system. Coppicing is certainly the system for which the most evidence has been found; both the historical sources and several dendrochronological studies point to the application of this system. Based on historical sources it can be argued that agro-forestry was applied during the Roman period.

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