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Agroforestry Systems for Temperate Climates

LESSONS FROM ROMAN ITALY

Mark A. Lelle and Michael A. Gold

While agroforestry has appeared in the scientific literature only recently, agricultural systems incorporating woody perennials are ancient.¹ During the past fifteen years many traditional tropical agroforestry systems, whose historical existence has been confirmed in the oral traditions of the indigenous people who practice them, have been identified and subjected to intensive research.² Most contemporary agroforestry systems are modifications of traditional practices used in tropical regions. In contrast to tropical agroforestry, little is known about indigenous agroforestry systems in temperate regions.³

One example of indigenous agroforestry is in the tree-based agricultural systems developed in the temperate regions of the Roman Empire. Many people in agrarian Italy and adjacent areas of the Mediterranean still rely on various agroforestry techniques for subsistence.⁴ Several Roman agriculturalists recorded descriptions of Roman agroforestry systems, and their writ-

ings provide a unique opportunity to understand ancient Roman agroforestry. The four most prominent have been translated into English and are the focus here: Marcus Porcius Cato (234–149 B.C.), Marcus Terentius Varro (116–17 B.C.), Lucius Junius Moderatus Columella (?–c. A.D. 70), and Pliny the Elder (A.D. 23–79).⁵ The translated texts of Cato, Varro, Columella, and Pliny have been of concern primarily to Latin scholars and agricultural historians; they have been of less interest to contemporary agroforesters studying temperate climates.⁶

Cato, Varro, Columella, and Pliny

While Pliny's goal was to "describe the entire world of nature," Cato, Varro, and Columella wrote to offer Roman landowners practical advice.⁷ Social, political, and economic conditions at the time each book was written created important differences both in style and intended audience.

Cato, a statesman and soldier who endured a severe upbringing on a small farm near Reate, eventually acquired large plantations that were worked by slaves.⁸ But in his writing Cato "was not thinking primarily of the peasant farmer with a holding of less than ten acres, nor of the very large ranches, but of medium-sized estates with substantial farm buildings and a variety of crops."⁹ Varro was perhaps the most learned Roman of his time. Like Cato, he was heavily involved in the affairs of war and government, as well as in the operation of his estates. Varro maintained large herds of sheep and horses in Apulia and at Reate, and he sustained a deep interest in his estates throughout his life. Varro traveled widely as a soldier and often took the opportunity to learn more about agriculture in the places he visited. Varro started his work on agriculture in 37 B.C., when he was eighty years old. Historian Russell Meiggs wrote of Varro:

In form his book was very different from Cato's. Cato had simply provided a practical handbook of recommendations based on experience, set down without any serious consideration of how his material could best be organized. Varro's book was a literary work in dialogue form, designed to interest as well as instruct. The book was divided into three sections—agriculture proper, sheep and cattle, birds, and other lesser animals. His material, he tells us, was drawn partly from other authors, partly from consultation with experts, and partly from his own experience.¹⁰

Columella, unlike Cato, Varro, and Pliny, was a professional agriculturalist who had little involvement in affairs of state. He was born in Spain, held a junior command in the army, and spent most of his life managing his estates in Italy. Columella's body of work constitutes the Roman writers' most comprehensive and systematic treatise on agriculture.¹¹

Pliny was born in Comum in northern Italy but spent most of his life in Rome or on imperial service in the provinces. Eventually Pliny commanded the main Roman naval base at Misenum, where he died in 79 A.D. while attempting to rescue refugees from the erupting Mt. Vesuvius. Pliny completed *Natural History*, thirty-seven books on a variety of subjects, in A.D. 77. He claimed to have consulted approximately two thousand other volumes while writing his work, and he listed one hundred twenty-three authors in his six books on trees. Pliny addressed trees before agricultural crops because he believed human beings first turned to trees for food.¹²

The Role of Trees in Roman Agriculture

Cato, Varro, Columella, and Pliny viewed trees as an integral part of agriculture, and they adapted agroforestry systems to temperate climates of the Mediterranean region. Although inadequate distribution of rainfall and summer drought hampered Roman farmers, the combination of cereal crops with olives, vines, and orchard trees allowed for an efficient agricultural system.¹³ The specific agroforestry techniques that Cato, Varro, Columella, and Pliny describe include

trees used as living trellises and fences, trees grown with annual food crops, and tree products used in livestock systems, fertilizers, farm chemicals, and medicine.

Arbustra

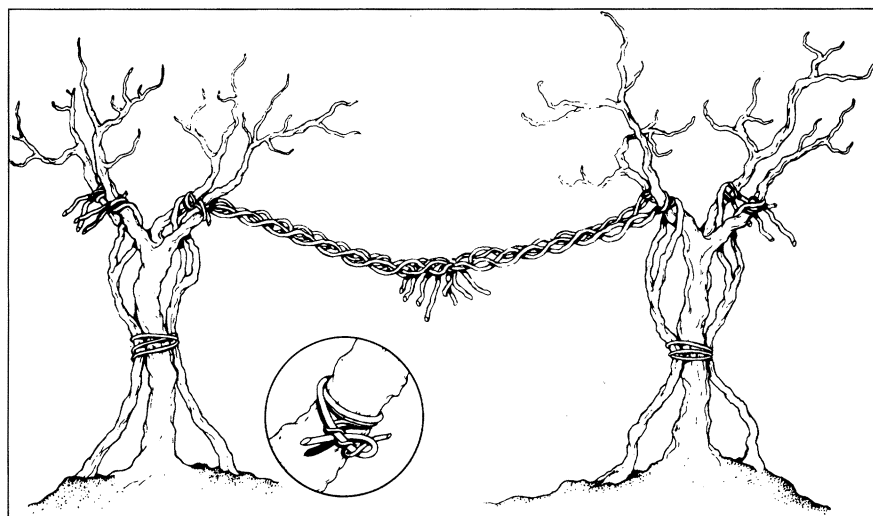
Arbustra were Roman vineyards that used trees as living trellises.¹⁴ They were formed by weaving grapevines into the branches of trees planted specifically for this purpose. Cato listed a productive arbustrum as one criterion for a good farm, advising farmers to trim trees carefully so the branches would spread out and not block sunlight.¹⁵ In trellising grapevines to trees, Cato instructed readers how best to prepare willow bark so it could be used as tape for tying vines to tree branches.¹⁶

Writing several decades after Cato, Varro emphasized the importance of tree arrangement in arbustra. His ideas for managing system components demonstrate an appreciation for manipulating the phenology of the agroforestry systems he studied. Varro claimed that trees planted in rows received more sun, thus increasing yields and shortening the time required for fruit to ripen.¹⁷ In addition, he explicitly stated that vines should be protected toward the north by the prop (whatever was used to hold up the vine, usually a tree acting as a living trellis).

Columella also emphasized the importance of site characteristics when locating arbustra. He wrote that "in a soil which is exposed to dew and mist the elms must be planted in such a way that their branches may be directed towards the east and west, in order that the middle of the trees, to which the vine is applied and fastened, may receive more sunlight."¹⁸ Furthermore, "[i]n very hot localities the plants should be attached to the tree on the north side, in cold places to the south side...so that they may not have to endure the sun or the shade all day."¹⁹ Columella also encouraged using leaves and woven palm-leaf mats to protect vines.²⁰

Varro mentioned that many tree species, especially maples and figs, were used in arbustra in other regions of the Mediterranean.²¹ Pliny wrote that "[i]n Campania they attach the vine to the poplar: embracing the tree to which it is thus wedded, the vine grasps the branches with its amorous arms, and as it climbs, holds on with its knotted trunk, till it has reached the very summit...." Pliny believed that vines grown on living trellises produced the finest wines:

The experience of ages, however, has sufficiently proved that the wines of the highest quality are only grown upon vines attached to trees, and that even then the choicest wines are produced by the upper part of the tree, the produce



Grapevines woven into the branches of trees planted specifically as living trellises. Diagram reprinted from The Red and the White, by Leo A. Loubère, by permission of the State University of New York Press © 1978 State University of New York. All rights reserved.

of the lower part being more abundant; such being the beneficial results of elevating the vine.²²

Columella preferred the poplar, elm, and ash (in that order), but also said “[t]here is another kind of plantation found in Gaul, which is called that of dwarf trees. It requires a low and not very leafy tree, and the guelder-rose tree seems to be the most suitable for this purpose, a tree which closely resembles the cornel-tree.”²³ Columella thought management techniques could be used to produce dwarf trellises:

The elm can also be adapted to this purpose by having its top cut off while it is still young, so that it does not exceed the height of fifteen feet; for I have noticed that the plantation dwarf tree is usually so ordered that the “stories” are arranged at the height of eight feet in dry, sloping places, and twelve feet on flat, marshy ground. But usually this tree is divided up into three branches, upon each of which several arms are allowed to grow on both sides; then almost all the rods are pared off at the time when the vines are pruned, so that they may not cause a shade.²⁴

Roman agriculturalists demonstrated their awareness of the danger of allelopathic effects of trees. Speaking of the use of cypress trees as props, Varro warned farmers to be “careful not to plant the vines near them, because they are hostile to each other.”²⁵ According to Columella, some trees, such as willows, could cause grapes to develop an undesirable taste.²⁶ Pliny warned that “[b]etween the quercus and the olive there exists a hatred so inveterate, that transplanted, either of them, to a site previously occupied by the other, they will die. The quercus too, if planted near the walnut, will perish.”²⁷

Intercropping

As in contemporary tropical agroforestry systems, Roman farmers intercropped trees with food crops.²⁸ Cato encouraged this practice especially on marginal land, saying “[w]herever there is a river bank or wet ground, plant poplar cuttings and a reed thicket.... Plant there also the wild asparagus; for a reed thicket goes well with asparagus, because it is worked and burned over, and furnishes a shade when shade is needed.”²⁹ Cato also

encouraged intercropping leeks with woody perennials so farmers could reap early profit from vineyards and orchards prior to their peak productivity.³⁰

Like Cato, Varro recognized the importance of increasing and diversifying crop yields:

Some places are suitable at the same time for the planting of other crops; thus in young orchards, when the seedlings have been planted and the young trees have been set in rows, during the early years before the roots have spread very far, some plant garden crops, and others plant other crops; but they do not do this after the trees have gained strength, for fear of injuring the roots.³¹



Old olive trees intercropped with durum wheat and ready for plowing in Greece's Macedonia Province. Intercropping was common in the Mediterranean until 1900. Photos accompanying this article appear courtesy of Christian Dupraz.

Columella recognized intercropping as a way of harvesting a crop annually from olive orchards, which often yielded decreased quantities every second year:

When the ground underneath has not been sown with a crop, the tree is putting forth its shoots; when the ground is full of sown crop, the tree is bearing fruit; the olive-grove, therefore, being thus divided, gives an equal return every year.³²

Columella not only recommended intercropping, he also gave specific instructions about methods. Concerning dwarf arbutus he wrote, “If no cereal is sown amongst the dwarf trees, spaces of twenty feet are left on either side; but if one indulges in crops, forty feet are left on one side and twenty on the other.”³³ For olive

tree/corn intercropping he stated, “On ground which is rich and fit for growing corn the space between the rows ought to be sixty feet in one direction and forty in the other: if the soil is poor and not suitable for crops, twenty-five feet.”³⁴

Roman farmers used various kinds of fences to delineate property boundaries, one of which was a living fence or hedge.³⁵ Varro gave a detailed description of living fences:

The first type, the natural, is a hedge, usually planted with brush or thorn, having roots and being alive, and so with nothing to fear from the flaming torch of a mischievous passer-by....

Furthermore, if there are no enclosures, the boundaries of the estate are made more secure by the planting of trees, which prevent the servants from quarrelling with the neighbors, and make it unnecessary to fix the boundaries by lawsuits. Some plant pines around the edges, as my wife has done on her Sabine farms; others plant cypresses, as I did on my place on Vesuvius; and still others plant elms, as many have done near Crustumeria. Where that is possible, as it is there because it is a plain, there is no better tree for planting; it is extremely profitable, as it often supports and gathers many a basket of grapes, yields a most agreeable foliage for sheep and cattle, and furnishes rails for fencing, and wood for hearth and furnace.³⁶

Multi-purpose Usage

Varro's last sentence demonstrates that the Romans were concerned with multi-purposes for trees. While the use of trees for construction appears to have been of minor importance to Roman farmers, Cato believed farmers should plant elms and poplars around the borders of farms and along roads so they would have timber for building, but more importantly so they would have leaves for feeding livestock. Trees were also used for fuel. Cato emphasized that "both wood and small trimmings" could be sold for firewood, and that extra wood could be used to make charcoal.³⁷ Pliny emphasized that many trees yielded more than one product.³⁸ As with trees in arbustra, the location of trees in living fences was important. Varro believed trees on northern boundaries were especially important because they did not block the sun.³⁹

Fodder

Roman agriculturalists used periods of low labor demand for cutting and storing poplar, elm, and oak leaves for use as sheep fodder. They also used fresh leaves and other products, such as acorns and grape husks, from woody perennials.⁴⁰ Varro encouraged using acorns as feed for swine: "As this animal feeds chiefly on mast, and next on beans, barley, and other grains, this food produces not only fat but a pleasant flavour in the

flesh."⁴¹ He also suggested planting mast groves to provide swine with nuts and leaves.

Columella recommended cultivating the legume shrub-trefoil as a fodder crop because "it is most useful for chickens, bees, sheep, goats, oxen and cattle of every kind, which quickly grow fat upon it and make ewes yield a very large quantity of milk; moreover you could also use it for eight months of the year as green fodder and afterwards as dry."⁴² Shrub-trefoil was especially useful since it grew in poor soils and could withstand considerable abuse from the elements. Columella also recommended planting fodder trees, especially elms because "[i]n this way we shall always have a mixture of foliage for use and the cattle, attracted by this kind of seasoning for their food, will finish off with greater heartiness the full ration allotted to them."⁴³

Ash was particularly well-suited as a fodder tree because it could be planted in rough and mountainous places and was acceptable to goats, sheep, and oxen. Columella thought planting fodder trees on marginal land was a wise use of resources, and he claimed that most people preferred using the elm because "it both accommodates itself very well to the vine and provides food most acceptable to oxen and flourishes in various kinds of soil."⁴⁴ Pliny recommended the willow because it could be planted in moist soil and yielded stakes and bindings.⁴⁵

Apiaries

Roman farmers often maintained extensive apiaries. Hives were commonly formed in hollowed-out trees or manufactured from wood. According to Varro, the best hives were those made of bark; the worst were made of earthenware because they were severely affected by hot and cold temperature extremes. Trees also provided food for bees. Varro believed that bees should be provided with food so they would not have to travel great distances. He instructed farmers to boil ripe figs in water and to roll the figs into lumps that could be placed near the hive.⁴⁶ According to Varro, some farmers pounded raisins and figs together, soaked them in boiled wine, and made pellets from the mixture.

Chemicals, Medicines, and Fertilizers

Roman agriculturalists made extensive use of tree products in manufacturing farm chemicals. One chemical that Cato, Varro, Columella, and Pliny discussed and praised is amurca, a byproduct of olive dregs. Cato recommended it as a moth repellent, as a feed additive for horses, and as a pesticide for weevils and other pests in threshing rooms.⁴⁷ He advised farmers to "[m]ake a plaster of earth and oil dregs....With this thick plaster go over the whole granary. Later sprinkle with oil dregs all the plaster you have put on. When it is dry, store the grain in it after it is well cooled. The worm will not harm it."⁴⁸

Cato recommended making plaster from marble and quicklime, or from clay mixed with grain chaff and oil dregs. According to Cato, this mixture "does not allow mice and worms to be there and makes the grain solidier and harder."⁴⁹ He also described a pest repellent used for preserving lentils. The liquid was made by mixing vinegar, a solvent, with *laserpicium*, a gum resin with an acrid, bitter taste and strong odor.⁵⁰ Cato mentioned several ways that tree products could be used in human medicine. He recommended crushing juniper berries and mixing them with wine "if urine is passed with difficulty." He also suggested using boiled juniper wood for lumbago, myrtle for indigestion and



Widely spaced oaks in a pasture, Portugal. The tree canopy is pruned (debris beneath trees) to stimulate pasture growth and acorn production (for sheep and pigs).

colic, and ground pomegranates for dysentery and diarrhea. Pomegranate buds, harvested prior to flowering, were used to purge tapeworms.⁵¹

Pliny's *Natural History* included one hundred twenty chapters devoted to trees that yielded medicines and chemicals. Within these chapters he wrote:

Not even are the forests and the spots in which the aspect of Nature is most rugged, destitute of their peculiar remedies; for so universally has that divine parent of all things distributed her succours for the benefit of man, as to implant for him medicinal virtues in the trees of the desert even, while at every step she presents us with most wonderful illustrations of those antipathies and sympathies which exist in the vegetable world.⁵²

Roman farmers also used tree products as a source of organic fertilizer to enrich the soil. Cato suggested that olive dregs be carried into the fields in donkeys' packsaddles or placed in trenches dug around olive trees. He further recommended using leaves in compost piles, especially the leaves of evergreen and deciduous oaks, which he did not value as an animal forage to the extent he valued the leaves of other trees.⁵³

Columella emphatically endorsed the production and use of fertilizer:

Wherefore if it is, as it would seem to be, the thing of the greatest value to the farmer, I consider that it should be studied with the greatest care, especially since the ancient authors, while they have not altogether neglected it, have nevertheless discussed it with too little elaboration.... I appreciate that there are certain kinds of farms on which it is impossible to keep either livestock or birds, yet even in such places it is a lazy farmer who lacks manure: for he can collect leaves, rubbish from the hedge rows....⁵⁴

The Decline of Roman Agroforestry

Throughout Roman history, a large percentage of the Roman population engaged in some branch of agriculture. Agricultural historian Kenneth D. White, who claimed that the Roman Empire's entire administrative structure rested on the foundation of an agricultural surplus, noted:

The earliest evidence we have concerning early settlement in and around Rome points to a fairly large population, most of whom were engaged in subsistence farming on small plots of land. The predominant features of soil and climate in this region, and the size of farm units, tended to promote the growth of an intensive smallholding farm economy, such as may still be found in many parts of Italy today. The variety of crops, the limited size of farm units, and the need to maximize productivity have combined to spur on the husbandman to conserve the precious topsoil, to replenish its fertility, and to work with speed and ingenuity in face of a climate that is more than ordinarily capricious.⁵⁵

While small farms survived throughout Roman history, agricultural systems changed dramatically over the span of time that Cato, Varro, Columella, and Pliny lived.⁵⁶ Most notable was the emergence of vast plantations or *latifundia*, which were owned by absentee landlords and worked by tenant farmers and slaves. *Latifundia* were carved out of public lands, especially in the case of livestock plantations, but also emerged from the ruins of smaller farms where the conservation farming and agroforestry described by Roman writers had previously been practiced. The destruction of land resources and reduced agricultural yields resulting from plantation agriculture caused Pliny to declare that plantations were ruining Rome and its provinces.⁵⁷ Seneca, one of Rome's richest landowners, asked "How far will you

extend the bounds of your possessions? A large tract of land, sufficient heretofore for a whole nation, is scarce wide enough for a single lord."⁵⁸

Columella was distressed by the wasteful farming practices found on *latifundia*, but he challenged landowners' assumptions that lower yields were the result of reduced soil fertility. Instead he asserted that absentee landlords' improper farming techniques were to blame, and he lamented the lack of agricultural education in the Roman Empire. The decline of Roman agroforestry and perhaps of the empire itself, while linked to the depletion of soil and other resources, was a socio-political phenomenon and not a physical one.⁵⁹

Linking Roman Agriculture with the Present

Over the past two thousand years, interest in the works of Cato, Varro, Columella, and Pliny has surfaced and resurfaced among agriculturalists, naturalists, and Latin scholars.⁶⁰ Varro quotes Cato frequently, and Columella refers often both to Cato and Varro. In the fourth century, Palladius "supplied the hornbook used by the agricultural monks throughout the Dark Ages," apparently basing much of it on the Roman agriculturalists.⁶¹ In the first half of the sixth century, Isidore of Seville wrote a voluminous encyclopedia that was partially attributed to Varro's earlier work, and St. Augustine made frequent reference to



Intercropping of vineyards and olive trees, Alpes-de-Haute-Provence, France.



An old, isolated walnut tree in a wheat field in the Drôme Valley in France's Dauphiné Province. Before 1850, isolated trees in fields comprised most of Europe's agroforestry systems. The move to line planting of trees permitted mechanized agroforestry practices, where the main branches of trees were felled to allow harvesting under the crown. This particular tree was not shaped for mechanized harvesting.

Varro in his work *De Civitate Dei*.⁶² While it is difficult to measure the impact Cato, Varro, Columella, and Pliny have had on Italian, other European, and North American agriculture over the past two thousand years, their treatises have probably been more widely read than widely used. Writing in 1725, the Englishman Richard Bradley noted:

It is no less surprising than unfortunate, that the Husbandry of the Ancients has not hitherto been made familiar to our English Gardeners and Husbandmen; since every one who has maturely considered the Works of Columella, Varro, Cato, Paladius, etc. must have discovered many extraordinary Things...unpractised in our Days; tho' in the ancient Times, they were of great Profit to the Lords of the Soil.⁶³

Much agricultural knowledge thought to have been discovered during the past hundred years can be found in the works of these Roman authors. A Virginia farmer writing in 1913 commented that "[t]he Romans had learned many things which we are now learning again, such as green manuring with legumes, soiling, seed selection...intensive cultivation of a fallow as well as of a crop, conservation rotation...the preservation of the chemical content of manure and the composting of the rubbish of a farm...."⁶⁴

The remnants of Roman agroforestry described by Cato, Varro, Columella, and Pliny led to interest in establishing comparable tree-based agricultural systems in the United States. In 1929 J. Russell Smith, in his book *Tree Crops: A Permanent Agriculture*, outlined the concept of agriculture based on trees and shrubs.⁶⁵ Many of Smith's views resulted from his travels and scientific observations in the Mediterranean while he was an economic geographer. Smith documented the destructive results of erosion following cultivation on hilly,



Traditional Mediterranean landscape in Agadir Province, Morocco. Almond, olive, and argan trees scattered throughout the area have multiple uses, but their main product is fruit. The trees are intercropped with cereals, mainly barley, or alfalfa.

marginal lands, and he illustrated scenarios in which tree crops could be used to help solve erosion problems, provide food for animals and humans, and serve as the foundation on which long-term ecological and social sustainability could be built.

Corsican chestnut farming is typical of that which covers many thousands of steep and rocky acres in central France...of Italy from end to end... Especially do I recall when crossing the Apennines from Bologna to Florence, the marked and sudden increase of population that occurred at about two thousand feet elevation. The slopes below two thousand feet were treeless and on them were few evidences of people. At two thousand feet, where the chestnut forests began, the villages were numerous, large and substantial.⁶⁶

During the 1940s, the concept of tree crops resurfaced in other temperate regions of the world. Botanist Constance Eardley discussed the suitability of carob, mesquite, and honeylocust as supplementary fodder for livestock in southern Australia. Several commentators described fodder trees useful as stock feed in South Africa, where large areas are often stricken with drought. A 1947 publication detailed uses of trees and shrubs as fodder, windbreaks, shade trees, and soil conditioners throughout the British Commonwealth. Italian observers described "coltura promiscua," a polyculture system in which pollarded

poplars are used as vine supports and also provide fuel and lumber. This contemporary Italian system, based on Roman agroforestry techniques, supports three to four-story cultures of poplars, grapes, and dwarf fruit trees, with an annual crop or forage species at the base.⁶⁷

The use of tree-based agricultural systems has been slow to gain acceptance in the United States despite concerns about conventional, high-input and highly mechanized approaches to managing agricultural and natural resources.⁶⁸ Trees on agricultural lands, where tolerated, are viewed as conservation measures and not income producers.⁶⁹

Conclusion

Cato, Varro, Columella, and Pliny recognized that trees are a fundamental component of a sustainable society. The treatises of these Roman authors provided specific advice to Roman agriculturalists about agroforestry techniques in the temperate Mediterranean climate. These authors suggested using trees for intercropping with food crops, as fences, as fodder, and in making fertilizers, other farm chemicals, and medicines.

As Roman landholders consolidated their property into large plantations, they were less inclined to follow the practices of conservation farming and agroforestry that the treatises recommended and smaller farmers had used. The resulting destruction of land resources and decline in yields in parts of the Roman Empire was therefore arguably more a consequence of social and political factors, which encouraged consolidation at the expense of conservation, than of depletion of soil and other resources.

Roman agroforestry principles have influenced Western views of agricultural practices over the past two millennia, particularly in temperate regions.⁷⁰ Some areas, such as modern Italy, have been highly receptive; others, such as the United States, have been less receptive.

Contemporary agroforestry techniques tend primarily to be adaptations of indigenous systems from tropical regions. While useful to tropi-

cal agroforestry practitioners, few of these techniques are directly applicable to agriculture in temperate regions.

The works of the Roman agriculturalists provide not only the first known written description of agroforestry techniques, they describe agricultural systems that can be implemented in temperate regions, whose often fragile soils are characterized by poor regenerative capacity and deforestation. The works of Cato, Varro, Columella, Pliny, and other Roman agriculturalists have much to offer contemporary agroforestry.

Notes

1. Agroforestry is a name for land use systems where woody perennials are deliberately grown on the same land management unit as agricultural crops and/or animals, either in spatial mixture or temporal sequence. The objective of agroforestry is to optimize positive interactions between woody and non-woody components in order to achieve a more ecologically and socially productive, sustainable, and diversified output from the land than is possible with conventional approaches. See Bjorn Lundgren, "Introduction," *Agroforestry Systems* 1 (1982): 3-6. In describing agroforestry systems, contemporary agroforesters use the phrase "woody perennials" instead of "trees" to acknowledge the important role of vines, shrubs, and other woody plants not commonly thought of as trees. Roman law also treated vines as trees. See Marcus Porcius Cato, *Cato the Censor on Farming*, trans. Ernest Brehaut (New York: Columbia University Press, 1933), p. 15. For an excellent overview of the history of tree-based farming systems, see K. F. S. King, "The History of Agroforestry," in H. A. Steppeler and P. K. R. Nair, eds., *Agroforestry: A Decade of Development* (Nairobi, Nigeria: International Council for Research in Agroforestry, 1987), pp. 3-5.
2. P. K. R. Nair, *Agroforestry Systems in the Tropics* (Dordrecht, The Netherlands: Kluwer Academic Publishers, 1989), pp. 21-24.
3. Michael A. Gold and James Hanover, "Agroforestry Systems for the Temperate Zone," *Agroforestry Systems* 5 (1987): 109, 110; Peter R. Schaefter, "Trees and Sustainable Agriculture," *American Journal of Alternative Agriculture* 5 (1989): 174. Agroforesters from the United States and Canada have recently established the Association For Temperate Agroforestry (AFTA), an organization focused on temperate zone agroforestry systems. Individuals interested in AFTA or its newsletter, *The Temperate Agroforester*, may write to AFTA c/o Michael A. Gold, Department of Forestry, Michigan State University, East Lansing, MI 48824, U.S.A.
4. For the best treatment of Roman agroforestry published to date see Russell Meiggs, "Farm Forestry in the Ancient Mediterranean," *Social Forestry Network* 8b (Summer 1989): 1-12; and Louis Huguet, "Symbiosis of Agriculture and Forestry," *Unasylva* 31 (1979): 25-29.
5. Due to the linguistic limitations of the authors, this article examines almost exclusively English translations of works written in Latin and Italian. Much has been written this century in Italian that would interest temperate-region agroforesters. Little is known about the personal history of Columella except that which can be gleaned from incidental references he makes in his writings. Based on information about his known contemporaries, Columella may have died around A.D. 70. See Lucius Junius Moderatus Columella, *De Re Rustica*, trans. Edward S. Forster and Edward H. Heffner (Cambridge, Massachusetts: Harvard University Press, 1954), 2:xiv; Palladius, who wrote his treatise on agriculture more than three centuries later than Columella, is not addressed in this article because, according to Kenneth D. White and Russell Meiggs, much of his work follows Columella closely. Meiggs believes the main contributions Palladius provided are his list of building timbers and his mention of the use of chestnut in building during the late Roman Empire. See Russell Meiggs, *Trees and Timber in the Ancient Mediterranean World* (Oxford, England: Clarendon Press, 1982), p. 270; Kenneth D. White, *Roman Farming* (Ithaca, New York: Cornell University Press, 1970), p. 30. Chestnut cultivation suffered a reverse at the end of the Roman Empire, but its use in building may have had some effect on farming systems that relied on chestnuts for food. See Chris Wickham, "European Forests in the Early Middle Ages: Landscape and Land Clearance," in Chris Wickham, *L'Ambiente Vegetale Nell'Alto Medioevo* (Spoleto, Italy: Presso La Sede Del Centro, 1990), pp. 479-545.
6. Kenneth D. White claims that historians give Roman agriculture in general only cursory treatment. See Kenneth D. White, *Roman Farming*, pp. 10, 11. Cato's work, *De Re Rustica*, may be the oldest prose in the Latin language. See Cato, *De Re Rustica*, trans. William Davis Hooper and Harrison Boyd Ash (Cambridge, Massachusetts: Harvard University Press, 1934). William Davis Hooper and Harrison Boyd Ash also translated Marcus Terentius Varro's *De Re Rustica* in the same volume. See Cato, *Cato the Censor on Farming*, p. xiii. Roman agroforestry practices can be seen in many works of art from the Roman Empire, especially in frescoes at Pompeii and North Africa. Many of Kenneth D. White's books on Roman agriculture contain photographs of these frescoes.

- One anonymous reviewer of this article mentioned that statues at the Capitoline Museum in Rome include representations of coppiced and heavily pruned trees. This reviewer also noted that a long history of landscape paintings in Italy reveals, as background features, the historical continuity of many agroforestry practices developed during the Roman Empire.
7. Meiggs, *Trees and Timber*, p. 21.
 8. Cato, *De Re Rustica*, p. ix.
 9. Meiggs, "Farm Forestry," p. 4.
 10. Meiggs, "Farm Forestry," pp. 6, 7.
 11. Meiggs, "Farm Forestry," p. 7. Columella, *De Re Rustica*, p. xvii.
 12. Meiggs, *Trees and Timber*, pp. 19-22.
 13. Kenneth D. White, *A Bibliography of Roman Agriculture* (Reading, England: University of Reading Institute of Agricultural History, 1970); Kenneth D. White, *Roman Farming*, p. 47. J. Russell Smith also recognized the important role trees played in the long-term sustainability of the agricultural and social systems of Italy, France, and Corsica. Between 1914 and the early 1950s Smith promoted the use of similar tree-based land use systems in North America as a way of minimizing soil erosion, mitigating environmental damage, and stabilizing rural communities. See J. Russell Smith, *Tree Crops: A Permanent Agriculture*, rev. ed. (New York: Harper & Row, 1950), pp. 9, 10, 131-35.
 14. Leo Loubère describes arbustra in some detail and mentions that they are still used in parts of Italy. He believes arbustra produce inferior grapes and lower yields but fails to mention the benefits of arbustra, such as multiple yields of diverse crops, protection for grapes from too much sun, and erosion control. See Leo A. Loubère, *The Red and the White: A History of Wine in France and Italy in the Nineteenth Century* (Albany: State University of New York Press, 1978), pp. 89-90. Based on information in Varro's *De Re Rustica*, Fairfax Harrison claimed that Roman arbustra produced more than twice the amount of wine than did the Burgundy region in 1913. See Fairfax Harrison, *Roman Farm Management: The Treatises of Cato and Varro* (New York: The Macmillan Company, 1913), p. 61.
 15. Cato, *De Re Rustica*, p. 49.
 16. Cato, *De Re Rustica*, p. 51. Willows and reeds for binding vines to props (used to hold up a vine, usually tree limbs acting as a living trellis) were considered so important to Roman vineyards that Columella said a farmer who could not grow his own had better get out of farming. See Cato, *Cato the Censor on Farming*, pp. xxv, xxvi.
 17. Varro, *De Re Rustica*, p. 195.
 18. Columella, *De Re Rustica*, 2:49, 51.
 19. Columella, *De Re Rustica*, 2:57.
 20. Columella, *De Re Rustica*, 2:39.
 21. Varro, *De Re Rustica*, p. 199. Leo Loubère says that during the first half of the twentieth century mulberry trees were used in Venetian arbustra because the leaves could be used as food in the silkworm industry.
- See Loubère, *The Red and the White*, pp. 89-90. Because botanical names for tree species were not central to the purpose of this article, and because of the difficulties involved in accurately identifying tree species mentioned in Roman writings, the authors have not included botanical names of tree species mentioned by Cato, Varro, Columella, and Pliny the Elder. This decision is supported by Russell Meiggs, who noted that "even if the claims of precision were considered paramount it would not often be possible to give the botanical name, because our sources rarely distinguish between the various species of oak and pine and when they do their judgement is not always sound." See Meiggs, *Trees and Timber*, p. 6.
22. Pliny, *Natural History*, trans. John Bostock and H. T. Riley (London, England: Henry G. Bohn, 1761), 5:218, 3:512.
 23. Columella, *De Re Rustica*, 2:67, 69.
 24. Columella, *De Re Rustica*, 2:69.
 25. Varro, *De Re Rustica*, p. 247. Allelopathic effects are harmful interactions between woody perennials and agricultural crops that can cause reduced yields or even the complete destruction of a crop.
 26. Columella, *De Re Rustica*, 2:69.
 27. Pliny, *Natural History*, 5:1.
 28. Kenneth D. White claims that the intercultivation of wheat with vines and olives was normal practice in the Roman Empire. See White, *Roman Farming*.
 29. Cato, *De Re Rustica*, p. 19.
 30. Cato, *De Re Rustica*, p. 65.
 31. Varro, *De Re Rustica*, pp. 243, 245.
 32. Columella, *De Re Rustica*, 2:63; Fairfax Harrison mentions in his 1913 work on Roman agriculture that arbustra were common in Italy at the time, and that they yielded several crops from the same ground: "...everyone who has been in Italy will recall the endless procession of small fields of maize and rye and alfalfa through which serried ranks of mulberry or feathery elm trees, linked with the charming drop and garland of the vines, seem to dance toward one in the brilliant sunlight, like so many Greek maidens on a frieze." Harrison, *Roman Farm Management*, p. 30.
 33. Columella, *De Re Rustica*, 2:51, 69.
 34. Columella, *De Re Rustica*, 2:79. Clearly, Columella is not referring to maize. "Frumentario" is the Latin word in Columella's text from which "corn" is translated. Frumentario has been used to signify maize only during the past several centuries. Its ancient translation refers to wheat or other cereal plants important to a particular region. See *Oxford Latin Dictionary*, s.v. "frumentarius."
 35. "The practical farmer, as well as the lover of rural scenery, has cause for regret that American agricultural practice has not yet had the patience to enclose the land within live hedges and ditches." Harrison, *Roman Farm Management*, p. 101.
 36. Varro, *De Re Rustica*, pp. 217, 219.
 37. Cato, *De Re Rustica*, p. 19, and *Cato the Censor on Farming*, p. 65. According to Brehaut, who translated the second work, fuelwood was in short supply during Cato's time.
 38. Pliny, *Natural History*, 3:390.
 39. Varro, *De Re Rustica*, pp. 245, 247.
 40. Cato, *De Re Rustica*, p. 17. "The extravagant American farmer has not yet learned to feed the leaves of trees, but in older and more economical civilizations the practice is still observed." Harrison, *Roman Farm Management*, p. 44. In his translation of *Cato the Censor on Farming*, pp. xxviii, 4, 69, Brehaut notes that fodder trees were important because of southern Italy's lack of natural pasture. According to Brehaut, fodder was so important that timber from fodder trees was considered only a by-product.
 41. Varro, *De Re Rustica*, p. 355.
 42. Columella, *De Re Rustica*, 2:113.
 43. Columella, *De Re Rustica*, 2:45, 113.
 44. Columella, *De Re Rustica*, 2:45, 47.
 45. Pliny, *Natural History*, 3:492-93.
 46. Varro, *De Re Rustica*, pp. 507, 509, 515.
 47. See Harrison, *Roman Farm Management*, p. 46.
 48. Cato, *Cato the Censor on Farming*, p. 97.
 49. Cato, *Cato the Censor on Farming*, p. 97.
 50. See Cato, *Cato the Censor on Farming*, p. 107.
 51. See Cato, *Cato the Censor on Farming*, pp. 109, 110. Brehaut said that "[t]his recipe may be regarded as of value since the common juniper is official in the British pharmacopoeia and in that of the United States, yielding the oil of juniper, a powerful diuretic, distilled from the unripe fruits." Brehaut based his statement on an article on juniper found in *Encyclopedia Britannica*, s.v. "juniper." Speaking of the pomegranate, Brehaut wrote "Modern medicine uses the bark of the root and the rind." See Cato, *Cato the Censor on Farming*, p. 110.
 52. Pliny, *Natural History*, 5:1.
 53. See Cato, *Cato the Censor on Farming*, pp. 26, 60, 61.
 54. Harrison, *Roman Farm Management*, pp. 40, 41.
 55. See Kenneth D. White, *Agricultural Implements of the Roman World* (Cambridge, England: Cambridge University Press, 1967), p. 1.
 56. Kenneth D. White, *Farm Equipment of the Roman World* (Cambridge, England: Cambridge University Press, 1975), p. 216. Timothy Potter suggests that the agricultural systems described by Cato, Varro, and Columella were confined to a portion of west-central Italy and were not found throughout Italy. See Timothy W. Potter, *Roman Italy* (Berkeley: University of California Press, 1987), p. 98.
 57. Norman Scott Brien Gras, *A History of Agriculture in Europe and America* (New York: F.S. Crofts, 1946), pp. 56, 57.
 58. Seneca lived between 4? B.C. and A.D. 65. According to a statement Cicero (106-43 B.C.) attributed to his contemporary Phillipus, there were fewer than two thousand prop-

- erty owners in the entire Roman Empire. See Vladimir G. Simkhovitch, *Rome's Fall Reconsidered* (New York: Ginn & Company, 1916), p. 201. Simkhovitch was a colleague of J. Russell Smith at Columbia University. Although the two men shared similar agricultural and geographic interests, there is no record that Simkhovitch and Smith collaborated.
59. As Simkhovitch pointed out in his 1916 work that examined the relationship between the degradation of Rome's physical resources and the fall of the empire, "[t]hat factor—the exhaustion of Roman soil and the devastation of Roman provinces—sheds enough light for us to behold the dread outlines of its doom." Simkhovitch, *Rome's Fall Reconsidered*, p. 243. See also Donald R. Dudley, *The Romans: 850 B.C.—A.D. 337*, a volume of *The History of Human Society*, ed. J. H. Plumb (New York: Alfred A. Knopf, 1970), p. 212.
60. Bertha Tilly, speaking of Varro's impact, said "[w]riters of his own age and many that came after drew upon his works.... Varro's books and doctrine pervaded all learning after his time: his great merit is to be found in the vast mass of facts and data which he preserved from sources of every kind. Without what we know and possess of him...our knowledge of Roman antiquity would be greatly impoverished." See Bertha Tilly, *Varro the Farmer: A Selection from the Rae Rusticae* (London, England: University Tutorial Press, 1973), p. 13.
61. Harrison, *Roman Farm Management*, pp. 4, 5. According to Norman Gras, Palladius copied or paraphrased "those who had gone before." See Gras, *A History of Agriculture in Europe and America*, p. 33.
62. Ernest Brehaut, *An Encyclopedist of the Dark Ages: Isidore of Seville* (New York: Columbia University Press, 1912), p. 16. Introduction to Cato's and Varro's *De Re Rustica*, trans. William Davis Hooper and Harrison Boyd Ash, p. xix.
63. Richard Bradley, *A Survey of the Ancient Husbandry and Gardening* (London, England: B. Motte, 1725).
64. Harrison, *Roman Farm Management*, p. 2.
65. Smith, *Tree Crops*. Harrison briefly discussed the role of trees in Roman agriculture in *Roman Farm Management*, published in the United States in 1913. There is no record indicating that Smith was familiar with Harrison's translation of Cato and Varro. Smith makes no reference to Cato or Varro in his book.
66. Smith, *Tree Crops*, p. 132.
67. See Constance M. Eardley, "Tree Legumes for Fodder," *Journal of the Department of Agriculture of South Australia* 48 (1945): 342-45; E. E. M. Looock, "Three Useful Leguminous Fodder Trees," *Farming in South Africa* 22 (1947): 7-12; J. Sholto Douglas, "3-D Forestry," *World Crops* 19 (1967): 20-24; A. Jurriaanse, *Are They Fodder Trees?*, Pamphlet No. 116 (Pretoria, South Africa: Department of Forestry, 1947), pp. 1-3; Imperial Forestry Bureau, "The Use and Misuse of Shrubs and Trees as Fodder," *Joint Publication* 10 (1947); E. J. Schreiner, "Poplars in Forestry and Land Use," *FAO Forestry and Forest Products Studies* 12 (1958): 290, 291; and Louis Huguet, "Symbiosis of Agriculture and Forestry," *Unasylva* 31 (1979): 28.
68. L. H. MacDaniels and Arthur S. Lieberman, "Tree Crops: A Neglected Source of Food and Forage from Marginal Lands," *BioScience* 29 (1979): 173-75; Gold and Hanover, "Agroforestry Systems for the Temperate Zone," pp. 109-110.
69. In an effort to counter misperceptions, broaden current thinking about tree-based agriculture, and promote temperate agroforestry in North America, a series of biennial North American agroforestry conferences began in 1989. See *Proceedings of the First Conference on Agroforestry in North America*, ed. Peter Williams (Guelph, Ontario: University of Guelph, 1991). For information, contact Peter Williams, Department of Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1, Canada. Also see *Proceedings of The Second Conference on Agroforestry in North America*, ed. Harold E. Garrett (Springfield: School of Natural Resources, University of Missouri, 1991). For information contact Gene Garrett, School of Natural Resources, University of Missouri, Columbia, Missouri 65211. AFTA co-sponsored the Third North American Agroforestry Conference in Ames, Iowa, August 1993. The proceedings of the conference are now available. See *Opportunities for Agroforestry in the Temperate Zone Worldwide*, ed. Richard C. Schultz and Joe P. Colletti (Ames: Department of Forestry, Iowa State University, 1993).
70. J. Russell Smith noted that chestnut groves on Corsica, first introduced by Roman soldiers, have survived for more than two thousand years. Chestnut trees in Corsica produce food for human consumption, leaves for animal fodder, branches for fuel, and tannin for processing leather. See Smith, *Tree Crops*, p. 131.