

1 Weeds, Nature, and Empire

The salient characteristics of imperial phytosociology have drawn increasing attention from historians since the publication of Alfred Crosby's studies on the "Columbian Exchange" in the 1970s.¹ The subsequent growth of environmental history has made it possible to establish some general features of the kind of botanical communities and relations that empires create. It seems that empires tend to reduce the isolation of regional floras, and to cause, or accelerate, mixtures of plants, both on purpose and unwittingly. Furthermore, the economic exploitations empires sponsor have important effects on the conditions in which vegetation lives, or does not live.

A comparative imperial botany is a useful backdrop against which to set the weed history of the Carolingian empire. For the Carolingians' hegemony was an environmental fact as much as a political or cultural one. For more than a century, the Franks stimulated the agrarian economies of their heartland, and also of its peripheries, in the process increasing transregional movements and mixing together European plants. Therefore, after a foray into comparative imperial phytosociology, the second part of this chapter lays out how Carolingian economic integration and activity reformed growing conditions for plants, and particularly for weeds. A more complicated and more ecological account of the forces at work in the Carolingian sphere of influence enhances understanding of Europe's first postclassical empire. Plants, and specifically unwanted plants, were partners of the people who united much of Latin Christendom between the eighth and the ninth century.

Empires and Weeds

Weeds are opportunistic. Empires offer them one of their greatest opportunities for multiplication and propagation. The evidence for weeds' opportunistic dissemination is best for modern empires, of course, but

¹ A. Crosby, *The Columbian Exchange* (Westport, 1972) was not an immediate success.

it is hardly lacking for premodern ones, too. For, by their nature, empires tend to share the same cosmopolitan urges and policies, and seek to create similar transregional economic linkages.² These imperial linkages are in effect what weed scientists call “disturbance corridors,” pathways along which weeds move from one place to another.³ Exploiting these linkages, or corridors, the undesirable plants of one imperial region expand their range by trickling into others. Once they get there, free of pesky competitors from their native places, they increase their population, sometimes quite quickly. At least in the short term, their emigration is a triumph.

Some awareness of this botanical reality existed in ancient and early modern empires, but alarm over the spillage of spontaneous plants into new terrains, revealingly called by modern botanists “colonization” or “invasion,” or lately “bioinvasion,” really developed a fever pitch in the twentieth century. No doubt this heightened awareness depended on the scale and rapidity of the phenomenon in industrial and postindustrial times.⁴ For the “globalized” economies of the twentieth and twenty-first centuries, with their vastly increased production and consumption patterns and attendant quickened circulation of goods and services (which really means people), have witnessed an “explosion” in the number of weeds common to different parts of the earth.⁵ At the fountainhead of such explosive botany was the British empire, or so at least it seemed to some of its protagonists and to many later historians of imperial phytosociology.⁶ From the 1930s pioneering ecologists like Charles Elton hypothesized disastrous takeovers or “colonizations” by plants (and other organisms) that people unwitting introduced into previously “virgin” landscapes, and catastrophic mingling of weed species there.⁷

² S. Reynolds, “Empires: A Problem of Comparative History,” *Historical Research* 79 (2006), 152–62. Connectivity is the leitmotif of J. Burbank and F. Cooper, *Empires in World History* (Princeton, 2010).

³ L. Ziska and J. Dukes, *Weed Biology and Climate Change* (Ames, IA, 2011), 109.

⁴ On industrialization and empire, see Burbank and Cooper, *Empires*, 19. R. Zimdahl, *Fundamentals of Weed Science* (Amsterdam, 2013), 192 explains weed scientists’ distinction of “introduction” from “invasion.” B. Bennett, “A Global History of Species Introduction and Invasion,” in *Environments of Empire*, ed. U. Kirchberger and B. Bennett (Chapel Hill, 2020), 224–33 argues for a “key shift” in imperial biotic transfers AD 1600–1900.

⁵ F. Pearce, *The New Wild* (London, 2015), 35; E. Salisbury, *Weeds and Aliens* (London, 1961), 50–80; R. Mabey, *Weeds* (London, 2012), 136–7, 146–52.

⁶ U. Kirchberger, “Introduction,” in *Environments and Empires*, ed. Kirchberger and Bennett, 1–2, lamented the preponderance of British studies in environmental histories of empire.

⁷ C. Elton, *The Ecology of Invasions by Animals and Plants* (London, 1958); D. Simberloff, *Invasive Species: What Everyone Needs to Know* (Oxford, 2013), 8–11. See also P. Coates, *American Perceptions of Immigrant and Invasive Species* (Berkeley, 2007), 1–6; Bennett, “A Global History,” 233–4.

Elton eventually likened the effects of biological “invasions” to the 1945 detonations of two atom bombs, hugely destructive man-made events with incalculable ecological and moral repercussions. He considered that the unprecedented technological mastery of humans, especially north-western Europeans, was wreaking havoc on placid ecosystems, particularly colonial ones which had been separate and stable until then. The connectivity of twentieth-century empires made possible transmissions on a scale and at an intensity never seen before.

As so often, what seemed to twentieth- and twenty-first-century people unprecedented actually had deep roots in the early industrial age, in the early modern period, and even further back into European history.⁸ The British empire of the eighteenth and nineteenth centuries had already created the conditions for several botanical explosions, some ardently desired by the colonists: for though imperial agents often extolled the possibilities, and for example eighteenth-century courtiers at St. Petersburg were enthusiastic about the potential for plant adoption that Catherine the Great’s annexation of Crimea opened up, it was the English Victorians who were the greatest “acclimatizers” of foreign plants, a few of which got out of hand in the home country, or became “naturalized.”⁹ Even George Perkins Marsh, a hero of early environmental thinking who took a dim view of the ecological transformations caused by empires like Rome’s, was enough “of his times,” enough of a Victorian gentleman, to consider that the botanical introductions that occurred around the ancient Mediterranean were positive developments.¹⁰ Regardless, the relationship between Britain and the plant life of its colonies was not just a matter of some passionate gardeners and daffy lovers of unfamiliar vegetation. For, beyond managing the global circulation of “exotic” (tropical, northern Atlantic) plants in early modern times, imperial Britain also imposed its agronomical tastes on far-flung colonies. In all the unlikely places where British grains were sown, numerous companion plants that the sowers did not consciously introduce also arose, or “exploded.” Both knowledge and ignorance of plants, both control and the lack of it, enabled the colonizers to harness colonial nature to imperial British interests. Indeed, for Alfred Crosby, essential to all imperial success was the exportation of “portman-teau biota,” a fully developed agroecological package that had coevolved

⁸ Pearce, *The New Wild*, 40–51. The founding father of this type of analysis was A. Crosby, especially in *Ecological Imperialism* (Cambridge, 1986), on whose insights this chapter tries to build.

⁹ A. Schönle, “Garden of the Empire: Catherine’s Appropriation of the Crimea,” *Slavic Review* 60 (2001), 5–8.

¹⁰ G. Marsh, *Man and Nature* (New York, 1865), 56–74. See also M. Hall, “The Native, Naturalized, and Exotic,” *Landscape Research* 28 (2003), 5–9.

over long periods and grown entangled, self-sustaining. Crosby considered that by 1400 Europe's plants and animals, including humans, were a formidable coevolved unit, the components of which mutually reinforced each other, giving them competitive advantages when they left Europe, and especially in the Americas.¹¹

Perhaps the best example (and definitely the most beautifully rendered) of the botanical explosions set off unknowingly by British imperial agents comes from the south Pacific. In his marvelous observation of the changing landscape in northeastern New Zealand during the decades around 1900, Guthrie-Smith described the relentless encroachment of weeds introduced from Britain, as well as the adventures of his flock of sheep who favored them as food. In his memorable phrase, "the proverbial sun that never sets on" the imperial flag also "never sets on the chickweed, groundsel, dandelion, and veronicas that grow in every English garden and on every British garden-path" across the world.¹² He chronicled meticulously how sacks of grain, cattle hooves, sheep hair, the intestines of several vertebrates, wildfire, the gardens of intrepid Christian missionaries, pig snouts, people's clothes, floods, shepherds' packed lunches, and other unwitting participants in a grand movement of weed dissemination, conveyed the seeds of numerous European weeds across the New Zealand landscape.¹³ His account would have seemed familiar to the seventeenth-century New England Indians who called the meadow weed plantain (*Plantago maior*) "Englishman's foot" in recognition of its intimate association with the settlement and agricultural successes of British colonists.¹⁴ The British empire was one of weeds as much as of scientific agriculture, resource extraction, and transcontinental naval connection. In the 1940s, when Elton began to be alarmed by and to study his "explosions," it had been so for a long time.

Beyond the reasons of state, the great fomentor of weed dissemination in empires was trade. Premodern empires (like their modern successors) tended to forge enlarged commercial networks, systems of trade within

¹¹ B. Tobin, *Colonizing Nature* (Philadelphia, 2005), 9–10; P. Anker, *Imperial Ecologies* (Cambridge, MA, 2001), 1–3; J. Frawley and I. McCalman, "Invasion Ecologies: The Nature/Culture Challenge," in *Rethinking Invasion Ecologies from the Environmental Humanities*, ed. J. Frawley and I. McCalman (Abingdon, 2014), 4–5. A. Crosby, "Ecological Imperialism," *Texas Quarterly* 21 (1978), 117 defined Europe's "portman-teau biota" as "often mutually supportive plants, animals, and microlife which in its entirety can be accurately described as aggressive and opportunistic, an ecosystem simplified by ocean crossings and honed by thousands of years of competition in the unique environment created by the Old World Neolithic Revolution."

¹² H. Guthrie-Smith, *Tuivra: The Story of a New Zealand Sheep Station* (Seattle, 1999), 236. For lists of the invaders keyed to the time of their invasion, see 242–5.

¹³ *Ibid.*, 236–94. ¹⁴ W. Cronon, *Changes in the Land* (New Haven, 1983), 143.

which metropolis and peripheries exchanged goods, usually to the greater benefit of the hegemon.¹⁵ In these bigger, more-than-regional markets, unwanted plants circulated more readily, for just as markets are epidemiological communities, they are also botanical communities, and a more cosmopolitan flora is one inevitable outcome of a more interconnected economic system. Inevitably, the best evidence for the impact of market integration on phytosociology is fairly recent. A nice example of how an increasingly integrated imperial market facilitated the dissemination of weeds comes from the industrializing United States.¹⁶ In the nineteenth century the commercial seed trade permeated American markets with new species and new cultivars, and also new weeds able to insinuate themselves into the packages of cuttings, bulbs, and seeds that traveled by mail to remote destinations.¹⁷

But the nascent American market for domesticated plant seeds was not alone in driving weeds' success. Other kinds of markets were equally effective. Quite accurately Guthrie-Smith identified Napier, the provincial port and main market town of the Tutira area, "as the main centre of weed liberation."¹⁸ At roughly the same time as farmers spread into north America numerous new unwanted plants by buying desired ones, and Guthrie-Smith carefully tabulated the movements of weeds in northwestern New Zealand, the importation of raw wool from Australia and other corners of the British empire to Tweedside, the finished cloth from which was highly prized, introduced hundreds of species of alien plants to northern Britain, even quite far from the Tweed river. For the wool waste called grey shoddy was a highly regarded soil fertilizer among British gardeners, and despite the brutal treatment of the fibers in the course of cloth production, it contained viable seeds of plants that had attached themselves to sheep in pastures thousands of kilometers away.¹⁹ While enriching their flower beds and onion rows, gardeners were also providing new, promising refuges to tough foreign seeds and weeds.

Deeper in the past it is more difficult to discern evidence of the expansion of weed flora that accompanied the formation of imperial networks and their "disturbance corridors." But it is not impossible. The vast and dense connectivity of the Umayyad and Abbasid caliphates had demonstrable effects on the dissemination of plants, particularly from the tenth

¹⁵ Kirchberger, "Introduction," 3–6 suggests network as a better model of imperial trade relations as it allows agency to more actors.

¹⁶ Burbank and Cooper, *Empires*, 6 consider the nineteenth-century USA a territorial empire.

¹⁷ R. Mack, "The Commercial Seed Trade: An Early Dispenser of Weeds in the United States," *Economic Botany* 55 (2001), 257–73. See also Guthrie-Smith, *Tutira*, 268.

¹⁸ Guthrie-Smith, *Tutira*, 280. ¹⁹ Salisbury, *Weeds and Aliens*, 138–9.

century onward. The caliphs in effect brought botanically distinct zones into contact, in a united commonwealth. They facilitated the westward migration of numerous Indian and Persian plants. The most famous among them are the citrus fruits, sugar cane, spinach, and rice that were being grown in the western Mediterranean by the thirteenth century, though an argument could be advanced for clover being the most important, since this potent nitrogen fixer restored the chemical balance to fields exhausted by grain cultivation. But we should not doubt that numerous obligate weeds accompanied the respectable immigrants of Arab agronomy, adapted to their specialized cultivations, or that opportunistic native weeds of the Mediterranean also honed their strategies to the new conditions, often irrigated, that the new crops entailed.²⁰ Thistles, for example, had become so ubiquitous in the Islamic Mediterranean by 1000 that weeders gave up, domesticated them, and grew them as a crop called cardoon.²¹

Earlier still, the first and last unification of the Mediterranean, and the empire's integration of several regions contiguous to the Romans' Very Own Sea (Mare Nostrum), produced still more premodern botanical upheavals and big breaks for weeds. Fritz Heichelheim's *Ancient Economic History*, first published in 1938, already hypothesized that the consequences of empire for ancient Italy included a vast uncontrolled influx of foreign plants, a vegetable counterinvasion that was not designed and almost wholly uncontrolled by the Roman hegemon.²² Heichelheim's alarmed tone in describing this botanical counterthrust against Rome's legions was unwarranted, for most colonial powers generally are able to export their own systems of production and expectations, and end up bringing home far fewer weeds than they spread among their colonies along with the imperial agronomic order: this was certainly the case for the modern British and early modern Spanish empires, for instance.²³

In fact, an enduring puzzle in imperial botanical history is the imbalance that tends to arise between the metropole's plants and weeds, usually

²⁰ A. Watson, *Agricultural Innovation in the Early Islamic World* (Cambridge, 2008). See also P. Squariti, "Of Seeds, Seasons, and Seas," *Journal of Economic History* 74 (2014), 1205–20; T. Kjaergaard, "A Plant that Changed the World," *Landscape Research* 28 (2003), 43 (on clover, whose point of origin is not certain); and (on irrigation and weeds) Zimdahl, *Fundamentals*, 119.

²¹ G. Sonnante et al., "The Domestication of Artichoke and Cardoon," *Annals of Botany* 100 (2007), 1097. It is still possible that cultivated cardoons were a Roman invention.

²² F. Heichelheim, *Wirtschaftsgeschichte des Altertums* 1 (Leiden, 1938), 597–8, 742–3. See also W. Hondelmann, *Die Kulturpflanzen der griechisch-römischen Welt* (Berlin, 2002), 9.

²³ Salisbury, *Weeds and Aliens*, 86–8.

quite successful in the imperial peripheries, and the generally less assertive vegetation of the colonized regions.²⁴ Darwin himself liked to joke about how Old World plants had thoroughly outcompeted New World ones, and made themselves at home throughout the Americas, while few American plants established themselves in Europe.²⁵ The transfer of so many Mediterranean weeds to the Habsburg transatlantic colonies was an important component to Crosby's "Columbian Exchange," and a partial explanation for the European humans' triumph on the western coast of the Atlantic Ocean.²⁶ In this early modern case the wanted and the unwanted plants, combined, became imperial agents, enablers of the human colonization that took place at the same time.²⁷ The apparent botanical lopsidedness to the Columbian Exchange remains something of a mystery, and may depend most of all on the Eurocentric assumptions historians have made, yet there are no simple, singular explanations for it.²⁸ Weed scientists note several preconditions that heighten a locale's vulnerability to "alien" plants. Among them, the absence in the new habitat of specialized pests and predators of the immigrant plants, the less crowded and competitive ecosystems of the Americas, and their shorter history of human land use, must have had an impact. But the far greater success of European weeds outside Europe than other weeds within western Eurasia is certainly related to the fact that, as William Cronon put it lapidarily, "economic and ecological imperialisms reinforced each other."²⁹

There is no evidence that the rulers of the most famous European empire of all, the Roman one, had any inkling of how political, cultural, economic, and social supremacy shaped the flows of plants within imperial territories, nor that they were aware of the environmental conditions that eased the life of foreign vegetation in previously sheltered areas. Yet it appears that Roman thinkers did not worry much about biological "invasions," or specifically about botanical "explosions," though these

²⁴ Bennett, "A Global History," 228–34.

²⁵ W. Beinert and K. Middleton, "Plant Transfers in Historical Perspective," *Environment and History* 10 (2004), 6. Bennett, "A Global History," 227 points out that after centuries of exporting them, around 1850 Europe became a net importer of exotic species.

²⁶ Crosby, *The Columbian Exchange*, 150, 158.

²⁷ J. McNeill, "Europe's Place in the Global History of Biological Exchange," *Landscape Research* 28 (2003), 33 stresses how exceptional was this case.

²⁸ Reflecting contemporary academic sympathies, recent work emphasizes the impact and agency of colonial plants in Europe: see, for example, M. Norton, *Sacred Gifts, Profane Pleasures* (Ithaca, 2008); E. Test, *Sacred Seeds* (Lincoln, NE, 2019).

²⁹ Simberloff, *Invasive Species*, 29–33. Cronon, *Changes in the Land*, 162. Also A. Ricciardi et al., "Invasion Science," *Trends in Ecology and Evolution* 32.11 (2017), 809 acknowledged "socioeconomic conditions govern the susceptibility of a country to invasion and its potential as a source region."

certainly took place in the territories governed by Rome, and perhaps in the waters of the Mediterranean as well.³⁰ In this the Roman writers on vegetable matters followed Aristotle and Hellenistic theorists, for whom human-induced changes to the landscape and flora of their Mediterranean worlds were legitimate and beneficial. Indeed, they proved the ingenuity and power of the men (always men) who set them off, as the importation to the Mediterranean of cherries by Lucullus did. Successful botanical introductions reflected the introducer's subtle understanding of plant and place, an intrinsic compatibility that others had until then missed.

Though classical Latin literature has its fair share of hostile asides against "foreign" innovations, in the case of botanical introductions from afar writers like Varro, Pliny, and Columella seem not to have been worried, and to have cheerfully accepted into their backyard landscapes a wide array of plants unknown to their ancestors. Biological invasions were not feared as much as military ones also because botanists expected the local, familiar conditions to mollify the exotic species, which would adapt and thereby improve themselves, as well as the place where they grew. This expectation that plants could change their nature somewhat, with or without human blandishments, suggests that in Roman literate culture some instability in the essence or identity of vegetation was normal and even desirable, especially if it improved the land's agricultural productivity.³¹

For the achievement of disseminating previously unknown plants in Roman landscapes was celebrated especially if it somehow generated profits. In imperial Rome respect for wealth-creating introductions overcame any suspicion of "un-Roman" vegetation, even when the plant in question could be deemed luxurious and a threat to Roman virtue. Especially after Augustus's reign, it seems, any link between eastern Mediterranean despotism and manipulation of natural vegetation weakened, though good emperors should not soil their own hands with tasks like transplantation. But, more than the absence of strong ideas of

³⁰ P. Squatriti, "The Vegetative Mediterranean," in *A Companion to Mediterranean History*, ed. P. Horden and S. Kinoshita (Chichester, 2014), 32–6; B. Galil et al., "Mare Nostrum, Mare Quod Invasit: The History of Bioinvasion in the Mediterranean Sea," in *Histories of Bioinvasion in the Mediterranean*, ed. A. Queiroz and S. Pooley (Cham, 2018), 21–49.

³¹ J. Secord, "Overcoming Environmental Determinism. Introduced Species, Hybrid Plants and Animals, and Transformed Lands in the Hellenistic and Roman Worlds," in *The Routledge Handbook of Identity and the Environment in the Classical and Medieval Worlds*, ed. R. Futo Kennedy and M. Jones-Lewis (London, 2016), 210–20. Theophrastus, *Enquiry into Plants*, ed. A. Hort, 2 vols. (Cambridge, MA, 1916–26), v. 2, 8.8, 190 early on observed that "foreign" seeds take about three years to change into native types.

vegetational indigeneity, it was the Romans' admiration for the skill and know-how of those who refashioned the landscape and increased upon nature's productivity that determined an open attitude to biological invasions and the dissemination of plants far from their original ecological niches.³²

By and large, it seems, the easy-going Romans were right, or at least less wrong than the panicked botanists and weed scientists of the twentieth century, who observed the mounting success of cosmopolitan weeds with dismay. One contemporary response has been increasingly nativist botanies, which ultimately have influenced American and European legislation, with their Weed Acts and Invasive Species Lists, and highway medians populated by "native" plants.³³ Instead the more relaxed attitude of Rome to the appearance of new species of plant in imperial landscapes may have better ecological foundations. For despite the early successes of most "exotic" volunteers after their arrival in new areas, exceedingly few foreign weeds manage to establish themselves as more than marginal presences in the long run. Without repeated reintroductions (which, of course, empires are good at providing), and without the support of the "portmanteau biota" with which they have coevolved at home, the vast majority of volunteer transplants fail within decades of their initial appearance in new lands.³⁴ It usually takes a great deal of human care to induce plants to make new homes for themselves in new ecological settings. And though ecological matters are always very complex, based on many layers of interdependence, and therefore hard to evaluate fully, it is also unclear that the dissemination of those weeds that do make themselves at home abroad is environmentally destructive, in the sense of reducing biodiversity (and through biodiversity, ecological resilience).³⁵ Perhaps the wisest imperialists of all were those who did not condemn the botanical mixtures their empires brought about.

³² Secord, "Overcoming Environmental Determinism," 212–23; L. Totelin, "Botanizing Rulers and their Herbal Subjects," *Phoenix* 66 (2012), 131–40; E. Pollard, "Pliny's 'Natural History' and the Favian Templum Pacis," *Journal of World History* 20 (2009), 320–9. See C. Goodson, *Cultivating the City in Early Medieval Italy* (Cambridge, 2021), 157–9 on the Roman gardening ethos and the virtue of plant manipulation.

³³ M. Davis et al., "Don't Judge Species on Their Origins," *Nature* 474 (June 9, 2011), 153–4; Zimdahl, *Fundamentals*, 193; Mabey, *Weeds*, 122.

³⁴ E. Le Floch, "Invasive Plants of the Mediterranean Basin," in *Biogeography of Mediterranean Invasions*, ed. R. Groves and F. di Castro (Cambridge, 1991), 74–5 gives a nice example from Montpellier, 1686–1950. See Crosby, *Ecological Imperialism*, 89.

³⁵ E. Weber, *Invasive Plant Species of the World* (Wallingford, 2017), xi, omits twenty species (from the first edition's 450) because evidence of their "negative impacts is rather scarce." See also P. Hulme et al., "Evidence of Bias and Error in Understanding Plant Invasion Impact," *Trends in Ecology and Evolution* 28.4 (2013), 213. Resilience: L. Gunderson et al., "The Evolution of an Idea," in *Foundations of Ecological Resilience*, ed. L. Gunderson et al. (Washington, 2012), 435–40.

Weeds in the Carolingian Empire

A recent reassessment of the process by which humans came to prefer farming to other ways of making a living, namely of what used to be called the “Neolithic Revolution,” has stressed the gradualness of the transition from hunting and gathering to sowing and plowing.³⁶ The fact that people took their time to become agriculturalists and long engaged in occasional farming only, mixing it in with more mobile ways of making a living, suggests that tilling the soil was far from an obvious choice, an ineluctable great leap forward in human evolution or economics. On the contrary, it seems that five thousand years ago conditions had to be pretty dire before humans gave up on their old flexible, often migratory methods of finding things to eat and places to take shelter. An unusual conjuncture of climatic, demographic, and other factors drove people to gather in communities to sow seeds on the same soil, year after year, and to live alongside the resulting fixed fields. Among the other factors, state formation was decisive. Scott argues that fixed-field, arable farming and “grain states” necessarily go together, and that the combination was not in earliest history, and never has been since, advantageous to most of humanity.

Among the disadvantages of specialized agriculture as it came, slowly, to be practiced in western Asia between 9500 and 5000 BC, was that it deskilled versatile hunter-gatherers until all they knew how to do was cultivate grain. Furthermore, this cultivation was laborious, much harder on human bodies than hunting and gathering and part-time farming seems to have been. Plowing, especially, represented a big increment in people’s workload. Weeding was not far behind, but it was not as big a novelty, since prehistoric people had weeded their temporary fields and even stands of wild grasses whose seeds they intended to eat. But as Scott put it, sedentary communities farming the same fields created a “permanent feedlot” for parasites of different kinds, animal, microbial, and vegetable, all commensals of farmers. The result was poorer health, more malnutrition, and shorter human lifespans, as well as proliferating obligate weeds finely attuned to the vagaries of human manipulations of the soil. The result was also more social stratification and stronger central government.³⁷

The reason why people put up with the new ways is not perfectly pellucid, but the “grain states” and the elites that ran them after about

³⁶ J. Scott, *Against the Grain* (New Haven, 2017), 12, 71, 96–7.

³⁷ *Ibid.*, xiii, 45–55, 64–6, 71–4, 92–5, 107–9. Feedlot: 110, where Scott notes that “parasite” derives from the Greek for “beside the grain,” and suggests Neolithic farmers were parasites too.

3500 BC were certainly involved. Their choice of crops, and resulting systems of cultivation and labor allocation, seem to have prevailed. The grains of choice were plants whose domestication created very visible seeds that would ripen at the same time, could be separated from their ear relatively smoothly, and resisted deterioration over the medium term. “Grain states” depended on regular harvests of these eminently quantifiable, taxable, and storable sorts of grain. Grains like barley or emmer wheat were vastly superior, from the point of view of a “grain state,” to legumes (maturation of which is extremely uneven and spread out over the season), or tubers (hidden underground and thus of uncertain ripeness or quantity), or fruits (whose preservability is poor), or nuts (hard for humans to digest if eaten as a staple, with the noble exception of chestnuts, which, however, tend not to grow in the kinds of places agriculturalists and “grain states” like to live in).³⁸

Despite the inevitable plagues that living in sedentary settlements and working the same restricted area of soil engendered, grain agriculture produced fairly reliable surpluses that sustained governments. But Scott also duly noted that the end of effective, large-scale government (for example, that of the Roman empire) set agriculturalists free to try their hand at less specialized living styles. A pattern of boom and bust in the formation of “grain states” and their dissolution meant that until relatively recently growing grain alone was not the normal human strategy, and it only prevailed when a burgeoning “grain state” was at the peak of its power and able to demand taxes and tribute in the most measurable, transportable, and preservable form, in other words when governments and elites could treat grain as a commodity.³⁹

Scott’s scheme has considerable applicability to early medieval history. If the Roman empire was just another (particularly successful) “grain state,” then its decline and fall must have set off an array of improvements in the standard of living of the cultivators who happen to have survived the state’s collapse and the reduction in its extraction of their surplus. One consequence should have been an increasingly flexible, more varied style of land use, with less focus on growing grains in fixed fields, and more exploitation of the uncultivated margin, of swamps, woodlands, bracken, and steppe landscapes. This more “natural” silvo-pastoral strategy might well have produced smaller surpluses, but it also produced more reliable returns on the labor people invested in the land, and greater resilience.⁴⁰

³⁸ Ibid., 22, 113, 120–32.

³⁹ Ibid., 14–15, 184–6, 202–4, 209–13, and (in praise of dark ages) 213–19.

⁴⁰ Among several reconstructions that lean in this direction, see P. Squatriti, “Barbarizing the *Belpaese*,” in *A Companion to Ostrogothic Italy*, ed. J. Arnold et al. (Leiden, 2016), 390–421.

Scott associated the post-“grain state” landscapes with barbarians. At the end of empire, as is well known, barbarians swarm, uninterested in fixed-field farming and the spoils of sedentarism. Curiously, to Scott, barbarians are just like weeds, opportunistic exploiters of the monomaniacal fascination for grain-growing that “grain states” inculcate in their subjects.⁴¹ Yet in his account, weeds flourish when “grain states” do and barbarians when “grain states” don’t, so whatever metaphorical similarity exists in their dependence on the choices and strategies of agriculturalists, weeds and barbarians have different historical settings. Weeds do well when empires wax, not when they decline and fall.

The Carolingian empire was the first barbarian empire in Europe’s Middle Ages. It was also a kind of “grain state,” encouraging (through its great monasteries especially) the “cerealization” of the empire’s territories, or more growing of wheat, rye, and oats, and the regional circulation of grain surpluses from fields to various places of consumption. Therefore, the Carolingian empire was also a sponsor of weeds, of the obligate companions of the grains European peasants living under Carolingian authority increasingly sowed over the great estates of rulers, aristocrats, and ecclesiasts. Almost certainly Carolingian imperial hegemony was not as effective in propagating the best-adapted undesirable species of plant uniformly across its territory as had been the Roman empire, and definitely it lasted less long and covered less land. Yet the Carolingian empire was an aspirational “grain state” that launched “the caging of the peasantry” in Europe, with increases in peasants’ agriculturalism, subjection to lords, and workload.⁴² After the barbarian interlude of the sixth, seventh, and eighth centuries, when peasants were for the most part not taxed in grain by Rome’s successor states, the Carolingian empire was more than a haphazard amalgamation of the barbarian polities of the Lombards, Bavarians, Aquitainians, and Saxons; it was a quite competent organizer of landscapes and their inhabitants, even if its organization was idiosyncratic and less centralized than that of other empires, and in consequence it, too, was an empire of weeds and of more attentive weeding.

For the political, social, and economic ferment of the eighth and ninth centuries in northwestern Europe, and the enhanced movement of people and things that the “practice of empire” stimulated, did establish novel conditions in several regions.⁴³ Particularly in the new agricultural

⁴¹ Scott, *Against the Grain*, 221 (“weeds in the cultivated field are to domesticated crops as barbarians are to civilized life”), 223–9, 248–56.

⁴² “Caging” is C. Wickham’s metaphor for what happened to European agriculturalists in 800–1000: *The Inheritance of Rome* (London, 2009), 529–50.

⁴³ J. Davis, *Charlemagne’s Practice of Empire* (Cambridge, 2015).

patterns of the ninth century, weeds found spaces into which to insinuate themselves, and these will receive the bulk of our attention in what follows; but the transfer of surplus produce from estates to emporia, the wider travels of the rulers' *missi*, or of high-ranking clergymen and Frankish aristocrats (with accompanying entourages), the tramping of armies and their supply trains, the surprisingly ubiquitous practice of rural migration, the forced population transfers (such as of Saxons into the Rhineland in 805), and the transportation of Rhenish quernstones or Roman Forumware pots far from their places of production also built useful "disturbance corridors" in Carolingian Europe.⁴⁴ Some weeds adapted to so much new-found mobility and flourished, while others languished.

Probably more than increased movement of people and things associated with running an imperial polity, it was the dynamism of the European agrarian economy in the eighth and especially the ninth century that created the biggest opportunities for weeds in Carolingian times: in this the Frankish empire differed somewhat from its earlier and later peers.⁴⁵ The Carolingian period saw conspicuous changes in Frankish agroecosystems, with inevitable repercussions for weed populations. The intensification of agricultural production, the expansion in arable grain cultivation, and, in at least a few regions, of rural settlement all had effects on both volunteer plants and Carolingian cultivars.⁴⁶

Some general, necessarily tentative considerations will help to contextualize how shifts in farming practice during the Carolingian centuries affected weeds and were affected by them. Almost certainly the crop fields of Carolingian Europe, like most premodern fields, were far weedier than the fields of contemporary agribusiness, and possibly more than nineteenth-century American or European ones too, which tended to be sown in a manner that reduced weeds' spread (see below on broadcast

⁴⁴ Internal trade: O. Bruand, *Voyageurs et marchandises aux temps des carolingiens* (Brussels, 2002). Movement: M. Gravel, *Distances, rencontres, communications: réaliser l'empire sous Charlemagne et Louis le Pieux* (Turnhout, 2012), esp. 46–51, 71–92. Migration: J. Devroey, *La nature et le roi* (Paris, 2019), 351–8. Deportations: J. Nelson, *King and Emperor* (Berkeley, 2019), 405–7.

⁴⁵ Good synthesis in J. Devroey, *Économie rurale et société dans l'Europe franque (VIe–IXe siècles)* (Paris, 2003), 112–29. See also J. Quirós Castillo, "Agrarian Archaeology in Early Medieval Europe," *Quaternary International* 346 (2014), 1–6.

⁴⁶ Farming styles and weed populations: G. Jones et al., "Crops and Weeds," *Journal of Archaeological Science* 37 (2010), 70–7; C. Brun, "Biodiversity Changes in Highly Anthropogenic Environments (Cultivated and Ruderal) since the Neolithic in Eastern France," *The Holocene* 19.6 (2009), 867–8. Rural settlement in Berry and Saxony: N. Poirier, "La dynamique du peuplement et des espaces agraires médiévaux en Berry," *Archéologie médiévale* 40 (2010), 21–3; H. Nitz, "Feudal Woodland Colonization as a Strategy in the Carolingian Empire in the Conquest of Saxony," in *Villages, Fields, and Frontiers*, ed. B. Roberts and R. Glascock (Oxford, 1983), 171–84.

and drill sowing). Chemical fertilizers, cheap herbicides, the mechanization of seed-cleaning, and new systems of rotation have conspired against the ebullient society of weeds that had coevolved with European field crops in the *ancien régime*, limiting their numbers and variety.⁴⁷ And though higher weed populations likely prevailed in early medieval than in today's pastures as well, they probably did not in the more meticulous cultivations of gardens. For early medieval people lavished attention and work on gardens, either because of their privileged fiscal status or (in the case of monasteries) because manicuring them was thought to be a spiritual exercise, as good for the weeder as for the garden itself.⁴⁸ In many cultures, a "clean" field or garden is associated with positive outcomes and garners social capital to its tenders, even when the neatness is agronomically unnecessary or irrational.⁴⁹

In addition to these general considerations, it matters to the history of weeds that many Carolingian farmers were not motivated by calculations of yield, instead measuring productivity in terms of labor inputs in relation to household needs; thus, as discussed in more detail in Chapter 3, they could tolerate some weeds in some seasons, because the crops lost thereby were less significant than the work that eliminating them would require.⁵⁰ Nevertheless, as in modern agribusiness, on Frankish farms and in Frankish gardens the presence of certain plants was resisted because they were deemed detrimental to the growth of desired vegetation. Despite all the differences across Frankish Europe in types and styles of cultivation, and in regional levels of weediness, all weeds gobbled up labor and limited crop growth.

Among the changes in agrarian practice that various specialists have reconstructed, particularly in the northwestern European Carolingian heartlands, the ninth-century intensification of land exploitation to increase surplus stands out. This intensification often seems to have been associated with bipartite estate management, or with the type of farm Anglophone scholars call manors. And it appears that the people

⁴⁷ Brun, "Biodiversity Changes," 867–8. Archaeophytes (see the introduction above), specialized by a longer coevolution with humans and thus dependent on the old style of cultivation, have suffered the biggest reductions.

⁴⁸ M. Montanari, *L'alimentazione contadina nell'alto medioevo* (Naples, 1979), 309–71; *The Rule of St. Benedict* 66, 48 insists both that monasteries should have gardens and that monks must labor with their hands. M. Goulet, "L'imaginaire du jardin monastique," *Pris-Ma* 26 (2010), 47–8 on spiritual gardening. Goodson, *Cultivating the City* is a guide to postclassical gardening.

⁴⁹ P. Halstead, *Two Oxen Ahead* (Chichester, 2014), 336, citing Mediterranean and Trobriand islander superstitions.

⁵⁰ Yields: J. Devroey, "La politique annonaire carolingienne comme question économique, religieuse, et morale," in *Settimane del CISAM* 63 (Spoleto, 2016), 303–5. Household production: Devroey, *Économie rurale*, 117.

who owned manors sought to organize land use in such a way that less lay fallow at any given moment than had been the case with two-field rotations, without, however, exhausting the soil. The technique involved in this more intensive exploitation of the same amount of land required rotating three types of cultivation across the manor's arable soil. In those places where it is attested, Carolingian enthusiasm for three-field rotations and its result, more productive cerealiculture, created new conditions for weeds.⁵¹

All rotations "create" weeds because they leave behind in harvested fields crop seeds of which the germination the following year produces unwanted plants. More frequent rotations create more weeds in this way. On top of this, on Carolingian farms for which accounting documents (polyptychs) survive, most of which seem to be bipartite estates, less familiar cereals were grown in the new rotations.⁵² The greater dissemination of winter-sown rye and spring-sown oats helped obligate weeds that are associated with those crops to thrive, notably members of the Secalietia group and (though their remains are hard to distinguish from cultivated oats) wild oats (*Avena fatua*).⁵³ Where the oats were grown for animals, not humans, to consume, no weeding occurred, giving excellent opportunities for wild oats and, in northwestern Francia, also to rye brome (*Bromus secalinus*) and to a weed usually found in rye fields, cornflower (*Centaurea cyanus*).⁵⁴ Even grain fields sown to feed people, if overrun by such specialist weeds, might have

⁵¹ Three-field rotation: A. Verhulst, *The Carolingian Economy* (Cambridge, 2002), 60–4; Y. Morimoto, "L'assolement triennal au haut Moyen Âge," in *Économie rurale et économie urbaine au Moyen Âge*, ed. J. Devroey and Y. Morimoto (Ghent, 1994), 91–125 and, more skeptically on its prevalence, J. Devroey and A. Nissen, "Early Middle Ages, 500–1000," in *Struggling with the Environment*, ed. E. Thoen and T. Soens (Turnhout, 2015), 43–4.

⁵² Rotations and weeds: M. Ruas, "La parole des grains," in *Plantes exploitées, plantes cultivées*, ed. A. Durand (Aix, 2007), 159; Halstead, *Two Oxen*, 56, 68, 200–7. On rye and oats, G. Comet, "Les céréales du bas-empire au Moyen Âge," in *The Making Feudal Agricultures?*, ed. M. Barceló and F. Sigaut (Leiden, 2004), 147–9, 162–4.

⁵³ Secalietia (also in inauspicious landscapes): D. Etienne et al., "Searching for Ancient Forests," *The Holocene* 23.5 (2013), 685; C. Bakels, "Crops Produced in the Southern Netherlands and Northern France during the Early Medieval Period," *Vegetation History and Archaeobotany* 14 (2005), 395–7; M. Ruas, "Alimentation végétale, pratiques agricoles et environnement du VIIe au Xe siècle," in *Un village au temps de Charlemagne* (Paris, 1988), 209–10. Wild oats: Salisbury, *Weeds and Aliens* 154–5; A. Kreuz, "Frühgermanische Landwirtschaft und Ernährung," in *Germanen*, ed. G. Uelsberg and M. Wemhoff (Berlin, 2020), 126; U. Willerding, *Zur Geschichte der Unkräuter Mitteleuropas* (Neumünster, 1986), 52–4; K. Knörzer, *Geschichte der synanthropen Flora im Niederrheingebiet* (Mainz, 2007), 454. How crop variety influences weed diversity: C. Bakels, "Archaeobotanical Investigations in the Aisne Valley, Northern France, from the Neolithic to the Early Middle Ages," *Vegetation History and Archaeobotany* 8 (1999), 76.

⁵⁴ F. Sigaut, "L'évolution des techniques," in *The Making*, ed. Barceló and Sigaut, 23. Early medieval oat cultivation in the Frankish northwest, and brome, esp. at

their crops repurposed as fodder.⁵⁵ Indeed, on bipartite estates, the fallow land integral to rotations had to be carefully tended, sometimes tilled, and its complex plant associations managed (or weeded) for the benefit of cattle. The less laborious “long fallows” of early modern times are attested only in a document from Nanteuil-la-Forêt dating to 900, and the various kinds of temporary or shifting cultivation that endured in Carolingian Francia also redoubled the opportunities for weeds and the obligations of weeders.⁵⁶ Certainly many details of eighth- and ninth-century manorial botany remain obscure, since few excavations of sites of production and of crop processing have been carried out (as opposed to those of storage sites). But there is no doubt that the more productive farming of the Carolingian period entailed much added labor, including more weeding and winnowing.

Three-field rotation also required more fences, to keep animals out of sown fields during the crops’ vegetative cycle and restrict them to the fallow ones. Wandalbert of Prüm thought fences would be built in March and April, and reinforced with ditches in the latter month; ruderal weeds will have found more refuge along these impediments that kept hoes and plows away.⁵⁷ While we might imagine cattle and goats tethered to the fences, acting as living lawn mowers by clearing the spontaneous vegetation the growth of which this additional fencing facilitated, even their munching cannot have eliminated the weeds altogether. Rather, in the diverse regions stretched across Carolingian Europe where three-field rotations and small-scale animal husbandry went together, fences and ruminants selected those species of weeds that could flourish under the novel evolutionary pressures, limited by the prevailing climatic and geological conditions.

Technology was another important aspect of the early medieval intensification of production and consumption associated with the Carolingian

Vieux-les-Gaudines (south of Caen): M. Ruas et al., “Les avoines dans les productions agro-pastorales du nord-ouest de la France,” in *Des hommes aux champs*, ed. V. Carpentier and C. Marcigny (Rennes, 2012), 334–5, 346–7, 355–6. Centaurea: A. Ferdière et al., *Histoire de l’agriculture en Gaule, 500 av. JC–1000 apr. JC* (Paris, 2006), 185.

⁵⁵ Halstead, *Two Oxen*, 192.

⁵⁶ Ruas, “La parole,” 159–60; F. Sigaut, “Le labour, qu’est-ce que c’est?” in *Nous labourons* (Nantes, 2008), 24–6; Halstead, *Two Oxen*, 200–7; J. Devroey, “Mise en valeur du sol et cycles de culture dans le système domanial (VIIIe–Xe siècle) entre Seine et Rhin,” in *Cultures temporaires et féodalité*, ed. R. Viader and C. Rendu (Toulouse, 2014), 33–57.

⁵⁷ Wandalbert, “De mensium duodecim,” ed. E. Dümmler, *MGH Poetae 2* (Berlin, 1884), 606–7; J. Henning, “Did the ‘Agricultural Revolution’ Go East with the Carolingian Conquest?” in *The Bajuvarii and Thuringii*, ed. J. Fries-Knoblauch (Woodbridge, 2014), 337–8. Drainage ditches still serve as reservoirs for weeds because farmers do not weed them: G. Zanin, “Definizione e classificazione delle malerbe,” in *Malerbologia*, ed. P. Catizone and G. Zanin (Bologna, 2001), 50.

ascendancy.⁵⁸ Several machines gained a new prominence on Carolingian manors, investments or inputs that made sense to the estate lords who pursued expanded production and profits, particularly in the ninth century when the rewards of conquest and plunder were harder to come by.⁵⁹ One example is the scythe, which François Sigaut believes to have obtained new prominence in northwestern Europe after about AD 700, and to have spread in parallel to spring-sown oats as fodder for horses in Carolingian times.⁶⁰ In Roman Gaul the introduction of bigger iron scythes virtually conjured up a new vegetable formation, the meadow, and had a deep effect on vegetable sociology by selecting the kinds of plant that could endure repeated cuts at the height of the growing season while still offering farmers adequate fodder for their beasts.⁶¹ The Carolingian dissemination of such technologies will have had parallel effects on the meadow community's desirable vegetation, but also of course on the undesirable one: weeds that clung to the ground and did not get in the way of the scythe had an advantage over tall ones, and over weeds the scythers sought to eliminate because they rendered the hay unpalatable to animals.

Though the "heavy plow" is not today considered to have had a history quite as linear or as revolutionary as Lynn White Jr. imagined, relevant innovations in plowing equipment certainly took place during the early Middle Ages, particularly in northwestern Europe.⁶² In the ninth century, written records suggest, deep-digging iron plowshares and coulter cut open, mixed up, aerated, and drained more soil than hitherto, and the Frankish heartland in the old kingdoms of Neustria and Austrasia, and its manors, were at the forefront of these changes in the land. Indeed, the enormous (68 cm long) high-quality seventh-century steel coulter recently unearthed at Lyminge in Kent, which weighed more than five

⁵⁸ Sigaut, "L'évolution des techniques," 23–9.

⁵⁹ T. Reuter, "Plunder and Tribute in the Carolingian Empire," *Transactions of the Royal Historical Society* 35 (1985), 75–94, with comments by Nelson, *King and Emperor*, 461–2.

⁶⁰ F. Sigaut, "Crops and Agricultural Development in Western Europe," in *Plants and People: Choices and Diversity through Time*, ed. A. Chevalier et al. (Oxford, 2014), 109. See also P. Reigniez, "Histoire et techniques: l'outil agricole dans la période du haut Moyen Âge," in *The Making*, ed. Barceló and Sigaut, (2004), 57, 91–6.

⁶¹ L. Foxhall et al., "Human Ecology in the Classical Landscape," in *Classical Archaeology*, ed. S. Alcock and R. Osborne (Oxford, 2012), 112.

⁶² Postclassical plowing history: A. Verhulst, "The 'Agricultural Revolution' of the Middle Ages Reconsidered," in *Law, Custom, and the Social Fabric in Medieval Europe*, ed. B. S. Bachrach and D. Nicholas (Kalamazoo, 1990), 17–24; J. Henning, "Germanisch-romanisch Agrarkontinuität und -diskontinuität in nordalpinen Kontinentaleuropa," in *Akkulturation*, ed. D. Hägermann et al., (Berlin, 2009), 401–15; G. Forni, "Innovazione e progresso nel mondo romano: il caso dell'agricoltura," in *Innovazione tecnica e progresso economico nel mondo romano*, ed. E. Lo Cascio (Bari, 2006), 145–79.

and a half kilograms, is thought to be a high-status gift to an English ruler from Francia, where such technologies were better established than in the British Isles.⁶³

Throughout early medieval Europe soil-stirring machines equipped with such long steel coulter were surely an exception, almost exclusively reserved to large estates and surplus production, yet their mere existence suggests that postclassical plowing was a dynamic area of experimentation and adaptation of technologies. And whatever the details of their introduction and distribution in Carolingian Europe, various forms of “heavy plow” used in more and more fields made a difference to weeds because they transformed soil structure and field ecology. By affecting soil temperatures and composition (longer coulters brought to the surface minerals and other nutrients that shallower plows did not reach), the bigger, heavier plows gave new species of field weeds opportunities they lacked earlier when simple wooden ards scratched barely the top ten centimeters of soil: plants whose seeds were able to remain dormant for longer periods (generally, plants with bigger seeds) did best, like stinking chamomille (*Anthemis cotula*) and wild mustard (*Synapis arvensis*). By crushing roots, rhizomes, stolons, and tubers that had lain hidden from shallower-plowing machines, or by bringing them to the surface where atmospheric agents could finish them off, they also robbed previously dominant weed species of their edge: perennials and biennials were at a disadvantage where heavy plows dug the ground up.⁶⁴

The popularization of the “heavy” plow refashioned the conditions of plant life also because bigger, heavier, deeper-gouging plows rendered cultivation viable in areas where clay soil discouraged farming with smaller and lighter equipment. In England, at roughly the same time as the Carolingian intensification took place, heavy clay soils came under cultivation, presumably thanks to new-style plows. Very promptly, stinking chamomille, a specialist in cultivated clay fields, sprang up in numbers, for the plows created a new landscape to which it was perfectly suited. But the improved drainage of the topsoil that the deeper furrows of Carolingian plows ensured also banished weeds that specialized in damp patches and were adapted to waterlogged soils.⁶⁵

“Heavy” plows required strong traction, best supplied by large oxen and horses. However, to work well these animals required good fodder, a need important enough to alter agricultural strategies. For the strength

⁶³ G. Thomas et al., “Technology, Ritual, and Anglo-Saxon Agriculture,” *Antiquity* 90.351 (2016), 742–58.

⁶⁴ Kreuz, “Frühgermanische Landwirtschaft und Ernährung,” 132 on how scanty first- to fourth-century plowing gave weeds opportunities.

⁶⁵ M. McKerracher, “Bread and Surpluses,” *Environmental Archaeology* 21 (2016), 97.

of a plow team determined how thorough was the tillage, which in turn affected how weedy a sown field could become: poorly tilled fields and untilled strips were the redoubt of weeds. Instead, perfectly tilled fields did not require subsequent manual clod-breaking prior to sowing, nor as much weeding after the crop had germinated. On the other hand, the new plowing methods created uneven surfaces that were hard for people to clear of unwanted plants once they had germinated: deep plowing piled up soil on the edge of the furrows, creating a ridge-and-furrow effect. Such ridged fields encouraged manual weed plucking, because the raised soil got in the way of scythes and hoes and slowed down weeding with tools, favoring weeds that were low and hard to handle because they were prickly or slender-stemmed and firm-rooted. Again, the spread of heavier plows shaped phytosociology, and Carolingian-era plowing techniques introduced new conditions for weed seeds and plants, which only some species could exploit.⁶⁶

A further cause of weeds' success was the customary method of crop sowing. Carolingian broadcast sowing meant most field crops did not grow in neat rows, which meant that traversing a crop field after germination was a delicate business. Broadcast sowing, whereby a swinging arm and semi-closed fist distributed the seed, also allowed more unexamined seed on to the field than did drill sowing, in which sowers manipulated individual seeds and could discard suspect ones before placing them in holes "drilled" into the ground, often in tidy rows. The broadcast sower could choose how thickly to sow a field, depending on soil conditions and maybe seed availability, but also on a calculation of how many weeds could be accepted in a given time and place. For this method of sowing could leave more space unoccupied by crop seeds, and thus available for weeds to colonize, or could so cover the tilled soil with seeds that crops smothered competitors once they germinated.⁶⁷ The choice was shaped by the size of the farm and the ultimate destination of the crop, whether domestic consumption or market.⁶⁸

⁶⁶ Tillage style and weeds: M. Jones, "Dormancy and the Plough," in *From Foragers to Farmers*, ed. A. Fairbairn and E. Weiss (Oxford, 2009), 60; Devroey and Nissen, "Early Middle Ages," 35–6; Zimdahl, *Fundamentals*, 264–7; A. Ferrero and P. Casini, "Mezzi meccanici," in *Malerbiologia*, ed. Catizone and Zanin, 253; Halstead, *Two Oxen*, 12–17, 44–55. See also G. Hillman, "Phytosociology and Ancient Weed Floras," in *Modeling Ecological Change*, ed. D. Harris and K. Thomas (London, 1991), 28–31, based on observation of moldboard plows' introduction to Syria and Turkey in the 1970s.

⁶⁷ Sowing styles: Salisbury, *Weeds and Aliens*, 31, 40, 144; G. Comet, *Le paysan et son outil* (Rome, 1992), 152–4, 167–8; P. Anderson and F. Sigaut, "Reasons for Variability in Harvesting Techniques and Tools," in *Explaining and Exploring Diversity in Agricultural Technology*, ed. A. van Gijn et al. (Oxford, 2014), 86.

⁶⁸ Halstead, *Two Oxen*, 11–12, 28–9 on sowers' calculus.

Partly to encourage crops' root and stem growth, limit lodging (the toppling of grain stalks), and improve yields, heavily plowed or not, early medieval fields were by modern standards sparsely sown. This technique left more ground bare, greedily colonized by spontaneous plants, but the resulting fields were easier to move through without treading on the seedlings of the crop.⁶⁹ Still, wielding a hoe or other long tool in them required careful calibration of the worker's movements, and interventions had to fall in line with the growth cycles of the crops and of the targeted species of weed, in such a way as to diminish the damage inflicted on the former and maximize that inflicted on the latter. The late Roman agronomist Palladius, whose book on agricultural tasks enjoyed some fortune in Carolingian libraries, suggested a thoughtfully modulated calendar of hoeing to his readers, depending on the type of crop and its maturation rates (which he recognized would not be the same in every place). The tenth-century Byzantine *Geoponika* considered the hoe best against dog-tooth grass (*Cynodon dactylon*) in June, evidently because the weed's warmth-dependent (and thus slow to germinate) growth cycle left it vulnerable in fields of quicker-maturing grain. But the point here is that whether in late ancient Rome, Macedonian Byzantium, or Carolingian Europe, the added power and speed of weeding with a tool did not magically free wielders of it from all constraints. Even the most balanced, lightest, sharpest-edged hoe obliged people to pay attention, bend their backs, stoop, and sweat.⁷⁰

At the end of the cropping cycle Carolingian harvesters faced many of the same constraints all pre-industrial harvesters faced.⁷¹ But where deep plowing took place, sickle-wielding reapers, slowed by the uneven terrain formed by the deeper incisions of heavier plowshares, could notice and avoid more weeds. This attentiveness might save some labor during crop processing and reduce the number of weed seeds that found their way into granaries and silos alongside oat, rye, or wheat seeds, where they might enjoy protection until the next sowing season.⁷² But fear of unfavorable weather created urgency, so a harvest team might remove the cut grains

⁶⁹ Devroey and Nissen, "Early Middle Ages," 52–3.

⁷⁰ Hoeing left the weed in the field as "green manure," so was done before the weed set seed. Estimates of premodern sowing density: J. Sadoks, *Crop Protection in Medieval Agriculture* (Leiden, 2013), 131, 134; P. Steen Henriksen, "Rye Cultivation in the Danish Iron Age," *Vegetation History and Archaeobotany* 12 (2003), 179–80. Many excellent observations on hoeing are in J. David, *L'outil* (Turnhout, 1997), 54, 101, 128, 145 and (as on most topics) in Comet, *Le paysan*, 167–70. Palladius, *Opus Agriculturae* 2.9–10, 2.14, 3.24, 4.3, 4.9, 5.1, 10.1. *Geoponika* 3.5, 3.10, tr. A. Dalby (Totnes, 2011), 106, 108. Gregory the Great (*Commentarii in Librum I Regum* 3.31) described hoes and their work subtly.

⁷¹ On the premodern harvest, see the very compelling B. Shaw, *Bringing in the Sheaves* (Toronto, 2013). Also useful is Anderson and Sigaut, "Reasons," 85–92.

⁷² Hillman, "Phytosociology," 30.

from the fields without too much fuss or sorting. And meteorology was not the only constraint, for on large estates with large plow teams the need for fodder obliged harvesters to stoop lower to cut the entire stalk off; this naturally affected the weeds, too, giving an advantage to ground-hugging plants able to elude the sickle.⁷³

After harvest, farmers had to store crops safely, threshed or unthreshed, for further use. There was some room for innovation even in this timeless activity. In the 800s bigger grain stores appeared in several Carolingian settlements.⁷⁴ Though small underground silos continued to be popular, a new design for granaries also gained favor. The larger granaries, often raised, that archaeologists associate with Carolingian-sponsored intensifications and rural reorganizations, offered opportunities to weeds that mimic grain crops and “bank” their seeds in human reserves rather than in the ground, as is the custom of most weeds. Their contents were less scrupulously threshed and winnowed than those of the silos associated with domestic consumption. For such storage chambers served a more tightly integrated economy in which exchanges, even of bulky commodities like grain, played a bigger role, and enabled weeds that imitated well the seeds of stored and transported crops to hide in comfort in the granaries, or to hitch rides and move across space more effectively. The seeds of these weeds could now await re-sowing in safe conditions, or even colonize new terrains if they entered commercial circuits.⁷⁵

Other Carolingian economic patterns also changed the odds of survival for weeds. The removal of arboreal cover appears to have accelerated during the Carolingian heyday, sometimes organized by monastic owners of great estates who left written traces of their endeavors.⁷⁶ Deforestation to create pasture or arable opened to light-dependent annual plants landscapes hitherto precluded to them, and if the loggers’ intention was to favor some selected edible members of that category, namely crops,

⁷³ Halstead, *Two Oxen*, 117.

⁷⁴ S. Jesset, “Les formes de l’exploitation rurale du IXe au XIe siècle,” in *Lumières de l’an mil en Orléanais* (Turnhout, 2004), 91; E. Peytremann, *Archéologie de l’habitat rural dans le nord de la France du IVe au XIIe siècle* (Saint-Germain-en-Laye, 2003), 337, 356–7; G. Bianchi and S. Grassi, “Sistemi di stoccaggio nelle campagne italiane (sec. VII–XIII),” in *Horrea, Barns, and Silos: Storage and Incomes in Early Medieval Europe*, ed. A. Vigil-Escalera Guirado et al. (Bilbao, 2013), 85–6, 90–1; H. Zug Tucci, “Le derrate agricole,” in *Settimane del CISAM* 37 (1990), 884–902.

⁷⁵ Trade and traffic: Bruand, *Voyageurs*; W. van Zeist et al., “Plant Husbandry and Vegetation of Early Medieval Douai,” *Vegetation History and Archaeobotany* 3 (1994), 216; P. Crabtree et al., “Environmental Evidence from Early Medieval Antwerp,” *Quaternary International* 460 (2017), 120.

⁷⁶ C. Grainge, “Assarting and the Dynamics of Rhineland Economies in the Ninth Century,” *Agricultural History Review* 54 (2006), 10–13. Still worthwhile is the pioneering H. Nitz, “The Church as Colonist,” *Journal of Historical Geography* 9 (1983), 105–26.

inevitably some hangers-on also benefited. The archaeobotanical evidence of this is reviewed more thoroughly in Chapter 2, but for now we should note how in the Eifel hills of eastern Belgium, during the eighth and ninth centuries, alder woodlands were cleared to make way for pastures in which flourished oxeye daisy (*Chrysanthemum leucanthemum*), ragged robin (*Lychnis flos-cuculi*), and brownwort (*Prunella vulgaris*).⁷⁷ Meanwhile, the extension of animal raising that accompanied the rise of the Carolingian dynasty in most of Europe required bigger pastures and, in the same areas, inaugurated a glorious period of increases in the populations of certain wild plants in the Poaceae (grasses) family.⁷⁸ The best adapted were weeds that could tolerate the harsh living conditions of pasture land, usually by being so brittle that when broken off by tooth or hoof (or plowing) they might regenerate from the remaining fragments, and by being able to germinate quickly and equally quickly produce many seeds that dispersed widely before the next phase in farmers' cultivation strategies redesigned conditions. Any plant that sought to flourish in Carolingian pastures also had to know how to cope with the novel soil chemistry that grazing animals' inadvertent and farmers' more conscious manuring created.⁷⁹ Where cattle and sheep raising declined in the ninth and tenth centuries, as in mainland Italy, phytosociological change also took place, though in an opposite direction.⁸⁰ Shadier, wooded pig pasture permitted weeds to prevail that were resistant to rutting snouts and tolerant of exposure to less light.

The weeds that found eighth- and ninth-century economic activities most congenial, that adapted best and evolved fastest, were not everywhere the same, of course. But the point here is that a valid generalization can be made, namely that the doings of Carolingian lords and farmers had an impact on the phytosociology of the empire's fields, just as the agricultural strategies of early modern English or Spanish colonists did in the New World, as Arab farmers did in western Eurasia, or Roman veterans did across the Mediterranean basin. Carolingian agropastoral economies

⁷⁷ C. Herbig and C. Sirocko, "Palaeobotanical Evidence of Agricultural Activities in the Eifel Region during the Holocene," *Vegetation History and Archaeobotany* 22 (2013), 460.

⁷⁸ Pastures: Jesset, "Les formes," 91. Poaceae: Herbig and Sirocko, "Palaeobotanical Evidence," 459. Animal husbandry patterns: P. Crabtree, "Agricultural Innovation and Socio-Economic Change in Early Medieval Europe," *World Archaeology* 42.1 (2010), 129–33.

⁷⁹ Candidates whose ecological curricula match these requirements include creeping buttercup (*Ranunculus repens*), quackgrass (*Agropyron repens*), and silverweed (*Potentilla anserina*): Hillman, "Phytosociology," 29. On the difference manure made: R. Jones, "Manure and the Medieval Social Order," in *Land and People*, ed. M. Allen et al. (Oxford, 2009), 216–17.

⁸⁰ Synthesis of archaeozoological data: F. Salvadori, "The Transition from Late Antiquity to the Early Middle Ages in Italy," *Quaternary International* 499 (2019), 38–9.

formed novel ecosystems in which specific kinds of weeds grew well, while others struggled.

Yet we should not imagine that Carolingian landlords and peasants had all the agency, and weeds quietly and passively adapted to the agricultural conditions of empire. Sometimes weeds struck back and created conditions to which humans had to adjust their strategies for profit maximization or survival. In a thrilling study of tumbleweed in 1930s Montana, Fiege developed the concept of “mobile nature.” To Fiege the mechanics of wild plants’ seed dispersal in windy steppe conditions remained an ineluctable ecological fact that commercial alfalfa farming, rugged individualism, and private property rights were unequipped to control. Tumbleweeds were a category of wild plant perfectly adjusted to local conditions, able to use the wind to spin large balls of fiber laden with seeds; since these balls were light enough to be blown considerable distances across the relatively open local landscapes, they conferred on tumbleweeds a peculiar mobility, an ability to pop up where they had not been before and to colonize virgin soils. Montanan farmers’ increasingly desperate efforts to prevent the windborne spread of weeds whose tough stem structure impeded mowing, and whose vigorous growth deprived the lucerne crop of vital resources, including water, introduced social change. The weeds drove farmers in Montana to pool labor in weed-control cooperatives, to solicit and then welcome state interventions, and to limit the exclusive rights of landowners too lazy or negligent to take care of tumbleweed in their own fields.⁸¹ In other words humble tumbleweeds subverted some of the loftiest social and cultural assumptions of capitalist westerners.

Little of Carolingian Europe appears to have been quite as arid as Dust Bowl Montana, and few of the various species of plant that rely on large, dry, rolling diaspores are native to western Europe.⁸² In addition, few early medieval landscapes can have been quite as monotonous as the monocropped alfalfa fields of twentieth-century Montana. However, in some parts of central Europe, more structured forms of landholding became established under Carolingian rule, and throughout the empire property rights over land were strengthened. In Carolingian Europe, what Peytremann has called a “more trenchant assertion of property in land” came along with larger settlements, more definite limits to the built space

⁸¹ M. Fiege, “The Weedy West,” *Western Historical Quarterly* 36 (2005), 23–47.

⁸² In Montana the bugbear was Russian thistle (*Kali tragus*), introduced to the American west in the 1870s in contaminated flaxseed: Fiege, “The Weedy West,” 30. Aldo Leopold’s essay “Cheat Takes Over,” republished in *A Sand County Almanac* (New York, 1949), 154–8, tells a similar story of western pastures overrun by invasive species, particularly *Bromus tectorum*.

of villages (set off from the cultivated space), stricter delimitation of people's living quarters (vs. storage space, for instance), bigger churches, longer use of cemeteries, and greater stability all around.⁸³ The empire, as we have seen, became increasingly cerealicultural over the course of its life, and the large estates revealed by ninth-century polyptychs seem prevalently given over to wheat, rye, barley, and oats. Moreover, the intensified rotations of Carolingian farming, with attendant increases in fencing, ditches, and other physical impediments to movement, in some areas created conditions not unlike those the Montanan settlers created for tumbleweed.⁸⁴

Weeds as usual darted across the new landscape, even if Carolingian Europe did not resemble 1930s Montana. The eighth- and ninth-century "mobile nature," in the form of creeping stolons or rhizomes or blowing pappi (the featherlike bristles that carry some seeds) may not have been as spectacular as meter-high balls of tumbleweed. But in its utter lack of respect for human conventions, and opportunistic exploitation for its own purposes of the conditions those conventions created on the ground, Carolingian "mobile nature," too, exerted pressure on people. Carolingian peasants, certainly, and maybe also Carolingian landowners, were incited to think of their landscapes as an integrated whole. The mobile weeds reminded everyone of "the shared experience of ecological connections."⁸⁵ Farming strategies, theories of ownership, commercial routes, neighborly connections, and weed ecology were interwoven. Fixed boundaries, customary dues, and labor calendars had to consider environmental facts like weeds' seasonal rhythms, their techniques of dispersal, and their irrepressible movement across space. Weeds distilled nature's mobility and thereby destabilized the sedentary assumptions of Carolingian agriculturalists.

Conclusion

Empires cannot help it: they fashion new conditions for vegetation. In their modern and premodern territories crop plants move by design, becoming a trace element of the imperial economic project and its homogenizing power. The diffusion of citrus cultivation (in the early Middle Ages, principally lemons and bitter oranges) from south Asia to Andalusia in the caliphate is only one example. But within imperial space some plants circulate by mistake, without humans intending them to. Several

⁸³ Peytremann, *Archéologie* 356–7: "une affirmation plus nette de la propriété foncière."

⁸⁴ Henning, "Did the 'Agricultural Revolution' Go East?", 336–8.

⁸⁵ Fiege, "The Weedy West," 25.

of these volunteer travelers are the weeds which have adapted to the field conditions necessary for the growth of popular crops. Others are weeds that flourish on the edges of imperial landscapes, on the borders of fields, along roadways and canals, in the shadow of walls, alongside middens near houses. Each weed is keenly honed to the environmental conditions that the economic activity of imperial people creates. Their propagation is a side effect of the larger free-trade zones and common markets of empire.

In the Carolingian case an increase in economic activity, meaning more intensive and extensive agriculture, also stimulated weeds. But this happened in a peculiarly Carolingian way, affected by the particularities of the Franks' empire. Amidst these, its short duration, and the preceding integration the Romans had brought about over the western portions of Frankish Europe, certainly matter.⁸⁶ Another important characteristic of the Carolingian polity was that despite the increased movement of people and goods it facilitated, it did not cause mass migration of peasants who completely reconfigured landscapes, unlike ancient or early modern imperial systems based on "settler colonialism."⁸⁷ But probably the most relevant idiosyncrasy of the Carolingian empire in this context was its Lilliputian scale, among empires. This was usefully underlined some years ago by Richard Hodges: however enormous by early medieval European standards, the empire Charlemagne laboriously assembled was miniscule compared to the Habsburg, British, or Ottoman empires of early modern times, or to its contemporary Tang empire in China or the caliphate.⁸⁸ In part because of its relatively modest scale, Carolingian Europe was also more geographically homogeneous than most empires, giving weeds fewer chances to prove their mettle and mobility. Its impact on phytosociology was correspondingly slighter.

That, of course, does not mean the impact was inconsequential. Increases in the cultivation of oats, rye, and wheat, discernible in the

⁸⁶ If Rome's control of the Mediterranean had collapsed with the Gracchi, its impact on the area's vegetation would have been slight: the pace of plant colonizations is slower than that of human ones. See Le Floch, "Invasive Plants." For the botanical impoverishment Rome's demise brought to northwestern Europe, see A. Livarda, "Spicing up Life in Northwestern Europe," *Vegetation History and Archaeobotany* 20 (2011), 146–7, 158–9; M. van der Veen et al., "New Food Plants in Roman Britain," *Environmental Archaeology* 13 (2008), 21–4.

⁸⁷ Bennett, "A Global History," 228 on "first phase settler colonialism" and its ecological impact before the 1800s. A case of new settlement and colonization: Nitz, "Feudal Woodland Colonization," 171–84.

⁸⁸ R. Hodges, *Dark Age Economics* (London, 2012), 117–20. J. Moreland, "The Carolingian Empire," in *Empires*, ed. S. Alcock (Cambridge, 2002), 415–18 nicely locates the Frankish one within broader imperial histories.

pollen and macrofossil records of several eighth- and ninth-century sites, probably reflect the tastes and demand of a new imperial elite. Membership in the Carolingian community, or “ecclesia,” was after all a liturgical fact, and participation required distinctive kinds of grain, able to produce very pale and “shiny” hosts.⁸⁹ Yet Crosby’s “portmanteau biota” do not appear to have been exported from a Frankish core area to the conquered peripheries of Europe, and the hard task of governing, from Aquitaine to Bavaria, from Saxony to Tuscany, was not obviously facilitated by the transfer of a Carolingian agroecological package into those regions. In fact, the new cultivations mostly extended and expanded older shifts and trends in land use, without many signs of large-scale botanical transfer accompanying the diffusion of the distinctive economic patterns of northwestern Europe.

In a sense, failure to replicate the ecological transformations of other empires actually enhances the significance of the Carolingians’ looser, smaller hegemony. The Carolingian case underscores how various was the exercise of premodern imperial power. Even if no palaeobotanical evidence for “explosions” of the sort that worried empire-watchers in the twentieth century currently exists for Carolingian Europe, and if much eighth- and ninth-century land use remained mixed and silvopastoral, nevertheless the ecological and phytosociological ramifications of more cereal cultivation, more market integration, and more thoroughgoing land exploitation were important. Some weeds lost ground, while others took advantage of the technologies and techniques of agrarian intensification, of the wine and grain trade, and became nuisances. That, for any agrarian population, including imperial ones, always meant more work, and sometimes different work. Given the dynamism of the Carolingian agrarian world, cultivators had to be flexible and adjust their management strategies, fundamentally their toil, to a fast-evolving weedy landscape. While the Carolingian empire did not sponsor a “Carolingian Exchange” or shape a homogeneous landscape of a few species of weeds from the north to the Ionian Sea, it did create novel conditions in various regional agroecosystems. However short-lived and Lilliputian it was, the Carolingian empire shifted the dialectic of relations between humans and plants in Europe

⁸⁹ M. de Jong, “The Empire as Ecclesia,” in *The Uses of the Past in the Early Middle Ages*, ed. Y. Hen and M. Innes (Cambridge, 2009); R. Kramer, *Rethinking Authority in the Carolingian Empire* (Amsterdam, 2019), 37–8; P. Squatriti, “The Material Eucharist in the Early Middle Ages,” forthcoming.