Anglo-Saxon Crops and Weeds

A Case Study in Quantitative Archaeobotany

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To Mr Snow
who taught me history and maths
and told me to roar.

Two out of three isn't bad.

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Abbreviations and notes

EHD	*English Historical Documents* (Whitelock 1979)
HE	Bede, *Historia Ecclesiastica Gentis Anglorum*
VCB	Bede, *Vita Sancti Cuthberti*
HER	Historic Environment Record
NCA	National Character Area
NGR	National Grid Reference
SFB	sunken-featured building
Beds	Bedfordshire
Berks	Berkshire
Bucks	Buckinghamshire
Cambs	Cambridgeshire
Glos	Gloucestershire
Oxon	Oxfordshire
Wilts	Wiltshire

All dates are AD unless stated otherwise.

Numbers are rounded to one decimal place unless stated otherwise.

The terms *Grubenhaus* (plural *Grubenhäuser*) and sunken-featured building are considered to be synonymous.

The maps in this book have been produced using two free resources: the QGIS package (http://www.qgis.org, accessed April 2017) and Ordnance Survey Open Data made available under the Open Government Licence (https://www.ordnancesurvey.co.uk/business-and-government/products/opendata-products.html, accessed April 2017).

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Chapter 1: Seeds of Change

Between the 7th and 9th centuries AD, much of Europe and the Mediterranean world experienced a step-change in agricultural productivity. Farmlands in the Germanic north-west witnessed the laying-out of new field systems, the introduction of intensive turf-manuring, and a growth in grain storage spaces, which implies the growth of surplus production (Hamerow 2002: 139–147). Cereal cultivation was expanding, with a particular emphasis on rye and oats (Behre 1992: 148–150; Hamerow 2002: 134–137; Henning 2014: 335–336). In contemporary Carolingian Francia, documentary evidence for a profusion of mills, breweries and bakeries – especially on monastic estates – similarly points to a significant upturn in the production of cereal goods (Lebecq 2000: 134). More generally, a range of geoarchaeological and palaeoenvironmental surveys demonstrate that scrub and woodland were cleared to open up new farmland in southern France, Byzantine Italy and the Iberian peninsula around the 8th century (Arthur *et al.* 2012: 445–449; Puy and Balbo 2013: 46–51; Ruas 2005: 401). Regarding pastoral farming, the evidence of excavated animal bones suggests a new emphasis on sheep husbandry in northern France around the same period (Crabtree 2010: 129). Within and around the Carolingian world, farming was in flux.

Similar, contemporary developments may likewise be traced in the archaeology of Anglo-Saxon England, where this period is known to archaeologists as the Mid Saxon period (*c.* 650–850). Excavated Mid Saxon rural settlements begin to show more regularity in plan than their Early Saxon precursors (*c.* 450–650). In particular, they increasingly incorporate ditched systems of paddocks and droveways for the closer management of livestock (Hamerow 2012: 72–73). Zooarchaeological evidence shows that the animals themselves were kept alive for longer, and therefore yielded more secondary products such as milk, plough-traction and wool (Crabtree 2010; Holmes 2014). Palaeoenvironmental evidence from numerous pollen cores, as well as sedimentary sequences, point to an expansion of arable land and cereal cultivation, once again between the 7th and 9th centuries (Rippon 2010). The growth of cereal surpluses in this period is further indicated by the reappearance in Britain, for the first time since the Roman period, of watermills, granaries and large stone-built grain ovens (Gardiner 2012; Hamerow 2012: 151–152; McKerracher 2014b).

In this way, it is increasingly being recognized that farming practices changed and became more productive in Mid Saxon England, as part of a wider process of agricultural development across the post-Roman world. To date, however, most studies of agrarian change in early medieval England have focused largely upon the broad outlines of change – such as the growth of crop husbandry at the expense of pastoralism – without considering the closer, more practical details of innovation, such as how cultivation practices developed to support the expansion of arable farming. A more fine-grained perspective can now be achieved, however, thanks to the massive growth of development-led archaeology in England over the past three decades and the concomitant increase in palaeoenvironmental sampling at these excavations (Bradley 2006).

The result of these twin trends is a rich but relatively little utilised national dataset of charred plant remains, chiefly characterised by cereal grains, cereal chaff and the seeds of arable weeds that were accidentally harvested with the crops (van der Veen *et al.* 2013). Over the same period, a combination of ethnographic, ecological and statistical research has been deployed by prehistorians to develop sensitive, quantitative archaeobotanical methods for the reconstruction of past crop husbandry regimes (Jones *et al.* 2010). These methods and models, being based upon functional ecological observations and the inherent characteristics of charred crop deposits, are as applicable to early medieval assemblages as they are to the Neolithic and Bronze Age material to which they have hitherto mostly been applied.

With that in mind, this monograph applies a range of quantitative methods to archaeobotanical data from Anglo-Saxon England, in order to shed more light on the agricultural innovations of the Mid Saxon period. This quantitative approach provides a complement to the more qualitative studies of the same topic which I have published elsewhere, and also fleshes out the statistical background to the dataset used in those publications (McKerracher 2016; 2018). In so doing, this book also proposes a standardised, repeatable set of protocols for the application of previously-developed, tried-and-tested quantitative methods, to facilitate their use in comparable future research projects. Procedures, variables, assumptions, decisions and data are therefore exposed as fully as possible in this book. Where appropriate, certain variables are also parameterised: defined as changeable values – parameters – that act as settings or configuration options for the various methodologies. For instance, in certain analyses I have required that samples contain at least 30 seeds; but the analysis could be repeated with a higher quorum for this parameter – say, 50 seeds – for a more rigorous approach. These key parameters are summarised in Appendix 1. In addition, several of my working assumptions are encapsulated in key bodies of metadata, such as the standardised terminology that I have applied to particular feature types. It would be possible to repeat the analyses undertaken here with different sets of metadata, resulting from different judgements or research aims. I have presented my sets of key metadata in Appendix 2, for reference and for repeatability's sake.

This kind of exposition is intended not only to support replication of the work, with the potential to tweak key variables, but also to admit a rigorous degree of critical assessment by the reader, which is seldom possible with heavily summarised methodologies.

Why crops and weeds?

Prior archaeobotanical work by the author has begun to illustrate the details of arable growth in terms of cereal crop choices. Charred plant remains from the Upper Thames valley and East Anglia, I have argued, demonstrate a diversification in cereals from the 7th century onwards, with cereal-cropping decisions adjusted to best suit local environmental conditions, such that drought-resistant rye was increasingly favoured on sandier soils, for instance, while salt-tolerant barley was preferred in saline regions (McKerracher 2016, and see Chapter 5 of this volume). Such work has, however, only scratched the surface of agricultural ecology in the Mid Saxon period. It assumes that certain cereals were favoured in certain regions because of their general suitability for different terrains, but it sheds little light on how those crops were cultivated in their respective regions.

A far more sensitive proxy for arable growing conditions, and thus for crop husbandry strategies, is offered by the accidentally harvested and charred seeds of arable weeds preserved amongst the cereal grains, since weed floras respond in distinctive ways to environmental variables, and these responses can be studied in modern farmlands managed in traditional ways. It is possible that the characteristics of individual weed species have subtly changed over time and between regions, such that modern ecological observations of a single weed taxon may be a misleading guide to past arable environments. However, this potential difficulty can be overcome by considering a variety of species at once, since it is unlikely that entire weed floras have changed in exactly the same ways since antiquity (Jones 1992: 136–137).

Before analysing the relative economic and ecological significance of different crops and weeds in the archaeobotanical record, however, we must grapple with the complexity of charred crop deposits. Put simply, we must treat deposits of charred botanical remains as artefacts – their charred nature indicating their origins in human activity – and thus assess their taphonomy before analysing their contents. Again, these kinds of assessments can be performed through the application of standardised, repeatable, quantitative methods: for instance, the determination of which stage in the cereal processing sequence is represented by a particular deposit, from the proportions of grain, chaff and weed seed in its contents (see Chapter 4).

Setting the scene

It is not sufficient, of course, simply to lay out a set of methods and present quantitative results. The analyst needs to interpret these results within a heuristic framework based, in this case, around the concept of agricultural development, with clearly defined terminology to avoid inter-disciplinary confusion and ambiguity. Equally, however, agricultural innovations cannot operate in a social vacuum. Before outlining the heuristic framework of this study, therefore, I will first sketch out brief environmental, social and economic narratives of Early and Mid Saxon history, as they pertain to the development of farming practices.

It is long since the Early Saxon period was thought to have witnessed the fruitful genesis of English agriculture. Gone are the days when historians envisaged the heroic salvation of a post-Roman wilderness: forsaken farmland, riven with swathes of regenerating woodland, awaiting the steady hand of the early English yeoman to carve out a new landscape of open fields. Palynological studies have suggested that much of the British landscape was already open farmland by the end of the Roman period, and that in many areas (especially lowland regions) this open farmland persisted throughout the Early and Mid Saxon periods without any large-scale woodland regeneration (Dark 2000: 150–154). The extensive palynological synthesis conducted in the *Fields of Britannia* project identified 'relatively little overall change during the first millennium AD', with no abrupt dislocation at the end of the Roman period (Rippon *et al.* 2015: 312).

The identification of localised woodland regeneration in some more northerly and upland pollen sequences, particularly those in the region around Hadrian's Wall, has however lent support to a new model of agricultural change in the 5th and 6th centuries, in which the most influential factor was not the arrival of Germanic settlers but the collapse of Romano-British economic and administrative infrastructures. Neither the means (villa estates), nor the markets (urban centres and military garrisons), nor the exchange mechanisms (coinage, taxation, state-sponsored transport by land and sea) survived to maintain the large-scale agrarian output that had been required and sustained in Roman Britain. As a result, the post-Roman agricultural economy entered a period of 'abatement', characterised by a shift away from high levels of arable productivity in favour of a greater emphasis on pastoralism (Faith 2009: 24–26).

This is not to suggest that Early Saxon agricultural practices were stagnating and entirely devoid of innovation. Indeed, the apparent shift in emphasis towards pastoralism could be considered an active adaptation to changing circumstances, albeit one which did not entail enhanced productivity *sensu stricto*, since pastoral farming generally produces lower calorific returns per land-unit, in comparison with arable farming (Spedding *et al.* 1981: 355). There are also likely to have been various minor modifications in farming practices throughout this period, the inevitable 'micro-inventions' discussed by van der Veen, implemented by individual farmers as needs and opportunities arose (van der Veen 2010: 7).

It is only from around the 7th century onwards that evidence begins to indicate plausible conditions for, and possible causes of, increasing agricultural productivity. Climatic change may be significant in this regard, but it is not currently understood in sufficient detail to be cited as a factor in – still less a determinant of – agricultural change in this period. A range of evidence, including historical sources, ice cores and tree rings, suggests that cooler, wetter conditions prevailed from around the 5th century onwards, with warmer and drier conditions returning in the last quarter of the millennium, continuing (with much geographical and chronological variability) towards the so-called 'Medieval Warm Period' (Dark 2000: 19–28; Hughes and Diaz 1994). It has further been suggested that the rapidity of climatic change in the 5th and 6th centuries would have been so disruptive as to have had adverse effects on agricultural production (Büntgen *et al.* 2011: 578–582). However, since such climatic studies lack close chronological and geographical precision, it would be unwise to presuppose any specific, direct relationship between macroclimatic changes and agricultural conditions at a given place and time.

Demographic pressure has long been posited as a basic (though not necessarily sufficient) causal factor behind agricultural development and, although difficult to demonstrate conclusively, could be inferred from a general expansion of settlement patterns in the Mid Saxon period (Hamerow 1999: 417; Morrison 1994: 118–124). Besides a growing population, demands for greater agricultural surpluses could also have come from élites, demanding tribute or renders, and markets, requiring goods for trade and craft-production (Morrison 1994: 125). Both of these can be identified as potential stimuli in the Mid Saxon period. The rise of a new élite in the late 6th and early 7th centuries, with evident command over labour and raw materials, is suggested by the occurrence of rich 'princely' burials and high-status settlements with large timber halls at around this time (Ulmschneider 2011: 159–160; Welch 2011: 269–275). Specific demand for agricultural produce in the form of food-renders, associated with the stabilisation of political structures, is further attested by documentary sources such as the late seventh-century laws of Ine of Wessex (EHD no.32, 70.1). It has been suggested that monastic landlords, documented from the late 7th century onwards in surviving charters, may have exerted particularly strong pressure on Mid Saxon agricultural land in order to produce or procure special ecclesiastical goods, such as vellum for monastic scriptoria (Blair 2005: 251–261).

Another potential stimulus that could be identified in Mid Saxon England – namely, demand for marketable surpluses to support specialist craft and trade activity – is represented principally by the so-called wics or emporia: large, organized settlements such as Ipswich (Suffolk), with populations participating in long-distance exchange and craft production (Cowie 2001: 17). The non-agrarian populations of such settlements are thought to have depended upon surplus goods from rural producers, received via royal food-renders and/or goods-exchange. The possibility that farming communities utilised greater surpluses in order to participate in wider trade networks is raised by the widespread rural distribution of artefacts such as silver sceatta coinage, Rhenish lava querns and Ipswich Ware pottery throughout much of Mid Saxon England, extending beyond the immediate hinterlands of the wics (Blinkhorn 2012: 87–99; Hamerow 2007: 225–226). The so-called 'productive sites', concentrations of coinage and other metalwork, often identified by metal-detectorists, may represent rural markets within this Mid Saxon exchange network (Ulmschneider 2000: 100–104).

The impact of these new markets and élites upon Mid Saxon farming may have extended beyond their demands for greater surpluses: they might also have been directly conducive to agricultural development. For instance, the evidence for long-distance exchange implies intensified inter-regional contacts both within and beyond Mid Saxon England, suggesting a plausible historical context for the diffusion of new technologies, agricultural or otherwise (Ruttan 1998: 158–159). The implementation of new technologies might also have depended upon the existence of supporting institutions (Ruttan 1998: 161–162), represented in Mid Saxon England by the growing power of secular and ecclesiastical landlords. The stimulating influence of strong landlords may have been further enhanced by the introduction of 'bookland': estates held in perpetuity and recorded as such in charters. Monastic examples survive from the late 7th century onwards, secular cases from the late 8th century onwards. The formal longevity of these landholdings could well have encouraged long-term investments in productivity, although it should be noted that, by definition, we are poorly informed as to how bookland differed from other, undocumented forms of landholdings (Blair 2005: 85, 129; Faith 1997: 159–161).

The apparent reorganization of landholdings in Mid Saxon England is a controversial subject. One influential interpretation has been offered by Brown and Foard, who argue from field surveys and excavated evidence in Northamptonshire that settlement nucleation had occurred by *c.* 850, as part of a process of 'manorialization' whereby peasant cultivators lost their freedom to increasingly powerful landlords (Brown and Foard 1998: 91). Although it is not the main subject of their discussion, they thus imply a model of agricultural development in which landowning élites were directly, purposefully instrumental in the reorganization of the productive landscape. The idea that the nucleated village may ultimately have Mid Saxon origins is reinforced by Reynolds' observation that rectilinear features – 'suggestive of imposed spatial regulation' – appear to be an innovation at Anglo-Saxon rural settlements from the late 6th or early 7th century onwards, and by Hamerow's related argument that Mid and Late Saxon settlements were often more stable than their more mobile, dispersed, and unenclosed Early Saxon predecessors (Hamerow 2012: 67–73; Reynolds 2003: 10–119). The nucleation and stabilisation of rural settlements can be seen as directly conducive to agricultural development, since agricultural labour and technologies may be more effectively deployed if stable and centralised (Williamson 2003: 67–68, 157).

Building a framework

Such is the historical context, in brief, within which agricultural development is understood to have progressed. We must now return to the question of a heuristic framework for exploring the transformation of farming practices, a framework that may ideally be applied to questions of agricultural development regardless of historical context.

Agricultural development exists as a distinct field in economics, in which guise it is concerned primarily with models for the enhancement of modern agrarian productivity in developing countries. A detailed exploration of this field is beyond the scope of this book, but certain concepts may usefully be borrowed to help frame new and existing archaeological hypotheses. So, for a working definition of the term 'agricultural development', I have followed Norton and Alwang's (1993: 170) description of it as the process whereby agrarian productivity can be increased through the stimulation of 'the basic sources of growth (labour, natural resources, capital, increases in scale or specialisation, improved efficiency, and technological progress)'.

Agricultural development, following Norton and Alwang, comprises a series of enhancements which stimulate growth. These enhancements I will gloss as agricultural innovations, each of which entails the transformation of techniques, practices, tools and materials. Evenson (1974: 52) has classified these entities in terms of five technologies – closely interrelated and sometimes overlapping – which form a useful framework for discussing innovations in Anglo-Saxon crop husbandry:

i. crop-biological,
ii. animal-biological,
iii. chemical,
iv. mechanical, and
v. managerial.

Under these headings, I will now summarise current ideas about Mid Saxon developments in arable farming which are apt to be investigated by archaeobotanical means. This book's specific focus on arable farming means perforce that animal-biological innovations will be omitted here, but these have been subject to extensive expert consideration in other recent volumes (Crabtree 2012; Holmes 2014).

Crop-biological innovations

Crop-biological innovations are concerned with the range and relative importance of the crop species cultivated. The introduction or reintroduction of certain crop species can be considered a productive innovation if the crops in question are potentially higher-yielding, and/or of greater cultural or economic value, than those previously cultivated. Similarly, there might be shifts in emphasis within the existing crop spectrum, towards crop taxa of greater cultural or economic value.

Archaeobotanical data have been drawn upon in studies of Anglo-Saxon arable farming for many years now, but extensive, data-rich, specialist syntheses have been slow to emerge, and misunderstandings sometimes appear in non-specialist discussions: for instance, *Triticum aestivum* (i.e. bread wheat) being dubbed 'einkorn' (Fowler 1999: 22), or charred henbane seeds being mistaken for pollen (Oosthuizen 2013: 66). Such misunderstandings are of course forgivable but nonetheless significant: the differences between einkorn and bread wheat, and between pollen and charred seeds, are critical in bioarchaeology.

A statistical review led by van der Veen in 2013 has highlighted the strong potential, and vital need, for more intensive specialist research on British plant remains from across the medieval period (van der Veen *et al.* 2013). Nonetheless, several crop-biological innovations have already been identified by those researching the history and archaeology of agricultural change in Early and Mid Saxon England. The most important of these models concern the role of free-threshing wheat, normally understood to be bread wheat (*Triticum aestivum* L.), destined to become the dominant cereal crop of modern Britain. According to most studies, free-threshing wheat supplanted first spelt as the most important wheat crop of Anglo-Saxon England, and then hulled barley as the most important cereal crop overall (Banham 2010: 179; Hamerow 2012: 146; Moffett 2011: 348–351).

It is widely accepted that, whereas spelt (*Triticum spelta* L.) was the predominant wheat crop of Roman Britain, free-threshing wheat came to replace it in the Anglo-Saxon period, but it remains an open question as to when, where, why, and how rapidly this change occurred (Green 1981: 133; Moffett 2011: 349). Some have dated this shift to around the 8th century (Astill 1997: 199; Oosthuizen 2013: 64) but it is more often suggested, more or less implicitly, that the demise of spelt occurred fairly rapidly around the 5th century. Hence, spelt remains found within Early or Mid Saxon contexts are often taken to represent residual prehistoric or Roman activity (e.g. Fryer in Atkins and Connor 2010: 102;

cf. Pelling 2003: 103). An alternative interpretation of spelt remains preserved in post-Roman contexts where residuality or disturbance is considered unlikely, is that spelt may have persisted as a self-seeding volunteer – or, at best, a very minor crop – in fields continuously cultivated since the Roman period (Murphy 1994: 37).

Emmer wheat (*Triticum dicoccum* Schübl.) existed as a minor crop in Roman Britain, and like spelt it has seldom been considered a significant member of the Anglo-Saxon crop spectrum. However, Pelling and Robinson have argued that emmer was reintroduced between the 5th and 9th centuries, locally to the Upper and Middle Thames valley, as part of an agricultural tradition imported by Anglo-Saxon colonists. Their principal supporting evidence comprises glume bases from Dorney (Bucks), radiocarbon-dated to cal. AD 435–663, and from Yarnton (Oxon), radiocarbon-dated to cal. AD 670–900. Without such radiocarbon determinations, a post-Roman date for these emmer macrofossils might have been seriously questioned, given the widespread assumption that Anglo-Saxons did not grow this crop (Pelling and Robinson 2000).

In a later study, drawing extensively upon archaeobotanical evidence from the Upper and Middle Thames valley in general and Yarnton in particular, emmer has been cited along with rye, lentil, grape and plum as newly reintroduced crops of the Mid Saxon period. According to this model, these crop-biological innovations were part of a process of 'agricultural recovery' in the Mid Saxon period, entailing the cultivation of a wider range of crops, agricultural and horticultural, than that evidenced for the Early Saxon period. The authors thus posit innovation through diversification (Booth *et al.* 2007: 329–336), an idea that recurs in other studies. The cultivation of rye (*Secale cereale* L.) and oats (*Avena sativa* L.), in particular, is often thought to have grown in importance over the course of the Anglo-Saxon period (Banham 2010: 179; Hamerow 2012: 150). Diversification may also have embraced fibre crops such as flax and hemp, although views on the role of these crops in Anglo-Saxon farming have varied. For Oosthuizen, their production 'on an industrial scale' was a Mid Saxon innovation; whereas the authors of *Thames Through Time* simply state that flax 'remained common in waterlogged deposits' in both periods (Booth *et al.* 2007: 330; Oosthuizen 2013: 64).

In another model, developed primarily by Banham but with wider currency in Anglo-Saxon scholarship, one specific crop-biological innovation is held to characterise Anglo-Saxon agricultural development: the rise of bread wheat to become the dominant cereal crop in place of hulled barley (*Hordeum vulgare* L.). This model I have elsewhere termed the 'bread wheat thesis' (McKerracher 2016). It is related to, but distinct from, the observed demise of spelt wheat in favour of free-threshing varieties. It focuses upon the relationship between barley and bread wheat, and argues that barley was the most important cereal crop of the Early Saxon period, but that bread wheat rose to dominance from the Mid Saxon period onwards (Banham 2004: 13–14; Fowler 1981: 279; Hagen 2006: 33–35; Hamerow 2007: 225; Oosthuizen 2013: 64).

This model has its origins in Jessen and Helbaek's landmark study of ceramic grain impressions (Jessen and Helbaek 1944), and found renewed relevance with the blossoming of British archaeobotany in the late 1970s. The findings of Monk, in particular, lent weight to the idea of a bread wheat ascendancy (Monk 1977: 332–340). Working with an even larger archaeobotanical dataset, of national scope, Banham found that barley was more common than wheat in the Early Saxon period, but that wheat was more common that barley by the Mid Saxon period – trends which echoed those previously observed by Monk (Banham 1990: 38). Since most of this wheat was positively identified as free-threshing, bread-type wheat, Banham suggested that a dietary preference for wheat bread over barley bread was ultimately responsible for the rise of the former over the latter. Indeed, there are persuasive indications of wheaten bread's higher esteem in the slim documentary record for the period (Banham 2010: 179). Other possible advantages of bread wheat include ease of processing (it is a free-threshing cereal and therefore does not demand the heavy additional labour of dehusking), its winter-hardiness, and the potentially great yields achievable with intensive manuring. However, as Moffett has argued, none of these factors is incontrovertible or necessarily exclusive to bread wheat; and none alone would necessarily explain why free-threshing wheats, although known in Britain since the Neolithic, only achieved predominance from the Anglo-Saxon period onwards (Moffett 2011: 349–350). Thus, as Banham argues, dietary preferences may have been a more decisive factor than purely practical considerations in shaping the crop-biological innovations of this period.

Chemical innovations

Chemical innovations concern the edaphic conditions of arable production, and could have entailed such techniques as crop rotation, fallowing, and the use of heavier, more fertile soils. A Mid Saxon shift in settlement patterns, involving the reoccupation of heavy clay soils for the first time since the Roman period, has long been recognized from both excavated evidence and field surveys, for example in the Sandlings area of Suffolk (Arnold and Wardle 1981; Hodges 1989: 62; Newman 1992: 30–35). That these soils were also tilled rather than just settled and grazed has been inferred from the increased occurrence, at sites such as Yarnton, of stinking chamomile seeds (*Anthemis cotula* L.) amongst Mid Saxon crop remains, since this is a weed characteristic of heavy clay soils (Stevens in Hey 2004: 362).

Zooarchaeological studies, meanwhile, have shown that cattle and sheep were increasingly being kept to a greater age in the Mid Saxon period (Crabtree 2012). This could have made available increasing amounts of animal manure for the intensified enrichment of arable soils. In addition, indirect evidence of Mid Saxon middening can be found in the occurrence of weed species such as henbane (*Hyoscyamus niger* L.), which is characteristic of middens, again in crop assemblages at Yarnton (Hey 2004: 48–49). It should be noted, however, that henbane does not grow exclusively around middens: it is a nitrophilous species that might equally thrive in other 'disturbed and enriched' soils, such as those alongside bridleways or droveways (Cappers and Neef 2012: 111).

Weed ecology therefore provides a sensitive way of exploring chemical innovations but, with a few exceptions such as the work at Yarnton, this approach has yet to be applied to many archaeobotanical assemblages of Anglo-Saxon date. In addition, it is preferable to consider weed floras in their entirety, rather than relying upon individual species as indicators of environmental characteristics, since the latter approach is more vulnerable to bias through chance occurrences and diachronic changes in individual species' ecological attributes (Jones 1992: 136–137).

Mechanical innovations

Chronologically speaking, Anglo-Saxon agriculture falls well within the era of so-called 'pre-mechanised' farming, but there is one particular mechanical innovation that has long been central in the historiography of early medieval arable: the heavy plough. The heavy mouldboard plough is distinguished from the lighter 'ard', or scratch plough, by the addition of a coulter to slice the soil vertically and a mouldboard to turn the sod (Bowen 1961: 7–11).

Artistic, documentary, artefactual and plough-mark evidence for heavy ploughing has long been known from the Late Saxon period, and a form of heavy plough, if not a true mouldboard plough, seems to have existed in Roman Britain (Booth *et al.* 2007: 288; Fowler 2002: 152–153; Hill 2000: 11–13; Williamson 2003: 120). An iron coulter from a swivel plough, a variety of mouldboard plough, has been discovered in an early seventh-century context at the royal complex of Lyminge, showing at least that the technology was available to Kentish kings at this early date (Thomas *et al.* 2016). What remains unclear is how widespread and significant this mechanical innovation was in arable farming at large in Mid Saxon England. The reoccupation of heavy clay soils from the 7th century onwards, as noted above, could be taken to imply the adoption of mouldboard ploughing, since according to Williamson these soils could not have been extensively tilled without a heavy plough (Williamson 2003: 121). On the other hand, with the growth of early medieval settlement archaeology, the picture of a Mid Saxon shift towards the occupation of heavy soils is by no means as clear as it was in the 1980s (McKerracher 2018: 34–37); and in any case the location of a settlement is not in itself a definitive guide to its patterns of land-use.

The weed spectra in the charred crop assemblages at Yarnton have been used as a more direct proxy for heavy ploughing, since species which are more tolerant of soil-disturbance (mostly annuals) are seen to become more prevalent in the Mid Saxon period, while those which are less tolerant of disturbance (mostly perennials) decline (Stevens in Hey 2004: 363–364). More specifically, Martin Jones has argued that a Mid Saxon decline in common chickweed (*Stellaria media* (L.) Vill.) and bromes (*Bromus* L.) in the archaeobotanical record, and a concomitant rise in stinking chamomile (*Anthemis cotula* L.) and cornflower (*Centaurea cyanus* L.) might reflect a shift from 'shallow' to 'deep' cultivation and so, by implication, from ards to heavy ploughs at Pennyland (Bucks). This interpretation is based partly upon the longer seed-dormancy of stinking chamomile and cornflower, and the particular capability of their seeds to germinate in disturbed soils (Jones in Williams 1993: 173–174; Jones 2009).

Managerial innovations

Managerial innovation can embrace a variety of changes concerned with the overall planning and rationale of agricultural production, and one example that has been postulated for the Mid Saxon period is the expansion of arable production at the expense of pastoral farming, as suggested by the appearance of larger-scale facilities for the processing and storage of crops. Specialist grain storage facilities do seem to be an innovation of this period, likewise watermills and grain ovens (Hamerow 2012: 151–152; McKerracher 2014b; Watts 2002: 72–82).

Arable expansion has otherwise been deduced from palaeoenvironmental evidence, especially from pollen sequences in which proportions of cereal pollen increase notably from the Mid Saxon period onwards; and also, at Yarnton, from the greater abundance of cereal remains among charred macrofossils (Booth *et al.* 2007: 333; Rippon 2010: 58). Palaeohydrological evidence is also suggestive of arable expansion beginning in the later Mid Saxon period: alluviation, presumed to reflect soil-erosion consequent on the extension of ploughed land, is seen to increase from around the 9th century onwards in the Nene and Upper Thames valleys (Booth *et al.* 2007: 19–20; Brown and Foard 1998: 81–82; Robinson 1992: 205–206).

Most fundamentally, whole new agricultural systems may have been instituted in this period. For example, a regime known as 'convertible husbandry', which entailed long-term rotations between cereal and grass crops, has been identified as an innovation of the 7th to 9th centuries in a palynological study in Devon (Rippon *et al.* 2006: 55). Oosthuizen meanwhile, through a seminal study of landscape archaeology, documentary sources, and the wider historical context, has dated a 'proto-open-field' arrangement in the Bourn Valley (Cambs) to the Mid Saxon period (Oosthuizen 2005: 176–188).

Additionally, Banham's bread wheat thesis might have further implications in terms of managerial innovation. Banham proposes that bread-type wheat would largely have been autumn-sown, whereas barley would have been spring-sown, as in regimes documented later in the medieval period. In this case, an increase in bread wheat cultivation in the Mid Saxon period could have entailed a shift in the seasonality of sowing regimes, with a greater importance being attached to autumn sowing: 'If changing from barley to wheat meant growing winter corn for the first time, improved drainage might be vital to prevent the young plants standing with their feet in water over the winter, even on soils which were not particularly wet in the spring and summer' (Banham 2010: 183). In order to facilitate the survival and success of bread wheat in those wet winter soils, better drainage could have been afforded by heavy ploughing and its resultant ridge-and-furrow patterns, perhaps culminating in the development of open field systems (Banham 2010: 182–187).

Summary

Such are the innovations that have been thought, in various recent studies, to characterise Mid Saxon farming. More specifically, I have described those possible innovations whose impact may be detectable in the archaeobotanical record. The various ideas discussed above can be distilled into three broader themes, around which the remainder of this study is based. Hence, the objective of this book is to determine how, when and where:

- i. crop surpluses grew,
- ii. crop spectra shifted, and
- iii. crop husbandry regimes changed, in Early and Mid Saxon England.

The following five chapters will provide worked examples of how descriptive, quantitative and semi-quantitative archaeobotanical analyses can produce results directly relevant to these themes. Chapter 2 provides a technical and descriptive account of the dataset that underlies this book's analyses, and Chapter 3 discusses the plant taxa which constitute that dataset, and how they are treated in this study. Chapter 4 addresses the question of crop surpluses, by considering the character, distribution, abundance and density of charred crop deposits in the project dataset. Chapter 5 investigates changes in crop spectra through the combined application of semi-quantitative and fully quantitative analyses of charred cereal remains. Chapter 6 turns to the evidence of charred weed seeds, a powerful proxy for changes in crop husbandry strategies and arable environmental conditions. Finally, in the closing chapter I will revisit the themes and theories discussed above, and consider what the findings of this study may contribute to those debates.