CHAPTER 2

ARABLE FARMING, PLANT FOODS AND RESOURCES

By Lisa Lodwick
With contributions by Tom Brindle

INTRODUCTION

Arable farming was central to both the rural economy of Roman Britain and the entire Roman world (Bowman and Wilson 2013a; Erdkamp 2015). Cereals were the basic foodstuff of the rural population, and were required in large quantities by military and urban dwellers in Britain and beyond. In Roman Britain, arable farming was primarily based on the cultivation of spelt wheat and barley, with the introduction of corndryers, granaries, aisled barns, mills, new plant foods and hay meadow management, indicating the production of surplus for the market and the military (Van der Veen 2016). However, unlike pastoral farming, we have little understanding of how arable farming varied between regions and through time, which settlements were primarily involved in surplus production, the requirements of arable farming on labour and capital, or the scale of production. A number of syntheses have discussed the broad character of arable farming (Collingwood 1929; Applebaum 1958; 1963; 1972; Morris 1979), most being heavily influenced by Mediterranean-centred studies of Roman farming (White 1970). The rise of environmental archaeology in the 1970s had a major impact on our understanding of crops (Lambrick 1992; Robinson 1992), and large amounts of archaeobotanical data, that is identifications of cereal grain, chaff, arable weeds and other plant foods, are now available because of developer-funded archaeology (Van der Veen *et al.* 2007). A series of syntheses have drawn primarily on this archaeobotanical data (e.g. M. Jones 1981; 1982; 1989; Van der Veen and O'Connor 1998; Van der Veen 2016), although few studies have managed to undertake quantitative analysis (though see Parks 2012), with the lingering perception that archaeobotanical data are in short supply (Taylor 2012). Instead, emphasis has been placed on imported plant foods over the cultivated cereals (Van der Veen *et al.* 2008).

The current orthodox model of arable farming and production of other plant resources in rural Roman Britain can be summarised in four key points. First, a continuation in the choice of cereal crops and cultivation techniques from the Iron Age, drawing on late Iron Age innovations (Campbell and Hamilton 2000; M. Jones 1981). Second, an expansion of the area under cultivation, producing an increase in overall production, but not necessarily an increase in *per capita* production (Van der Veen and O'Connor 1998). Third, an increase in the scale of production, specifically in the mid-Roman period, with a surplus of cereals and other plant resources produced for the market (Parks 2012; Van der Veen 2016). Fourth, the production of specialised crops and products, namely fruits, herbs, vegetables, grapes (vineyards), malted beverages and hay (Van der Veen 2016). However, there has been relatively little advance in our understanding of these changes for several decades, and archaeobotanical evidence remains a relatively under-studied aspect of recent syntheses of farming (Fowler 2002) and farmers (McCarthy 2013).

A wide range of palaeoenvironmental and landscape analytical techniques has been used elsewhere to study arable farming (Dark 2000; Fowler 2002; Rippon *et al.* 2015), but in keeping with the scope of the project, emphasis is placed here on archaeobotanical data collected from excavations. In this chapter, evidence is presented for the various stages of arable farming and the management of other plant resources, drawing primarily on archaeobotanical data, but also using artefactual and architectural data, as well as insect remains. The current models for arable farming are evaluated, and more nuanced patterns of regional and chronological change are presented. The Appendix to this volume provides a list of archaeobotanical datasets consulted.

ESTABLISHING THE EXTENT OF ARABLE FARMING

Despite the long-standing division of Roman Britain into highland and lowland, or military and civilian zones, it is now clear that arable farming extended across the majority of the province (Smith *et al.* 2016). Considering crops in particular, there was a notion that agricultural changes taking place during the first millennium B.C. in central southern Britain were adopted later in the north (M. Jones 1981). The adoption of spelt wheat, and arable farming more broadly, is now understood to have occurred across the majority of Britain, but with substantial regional variation in the range

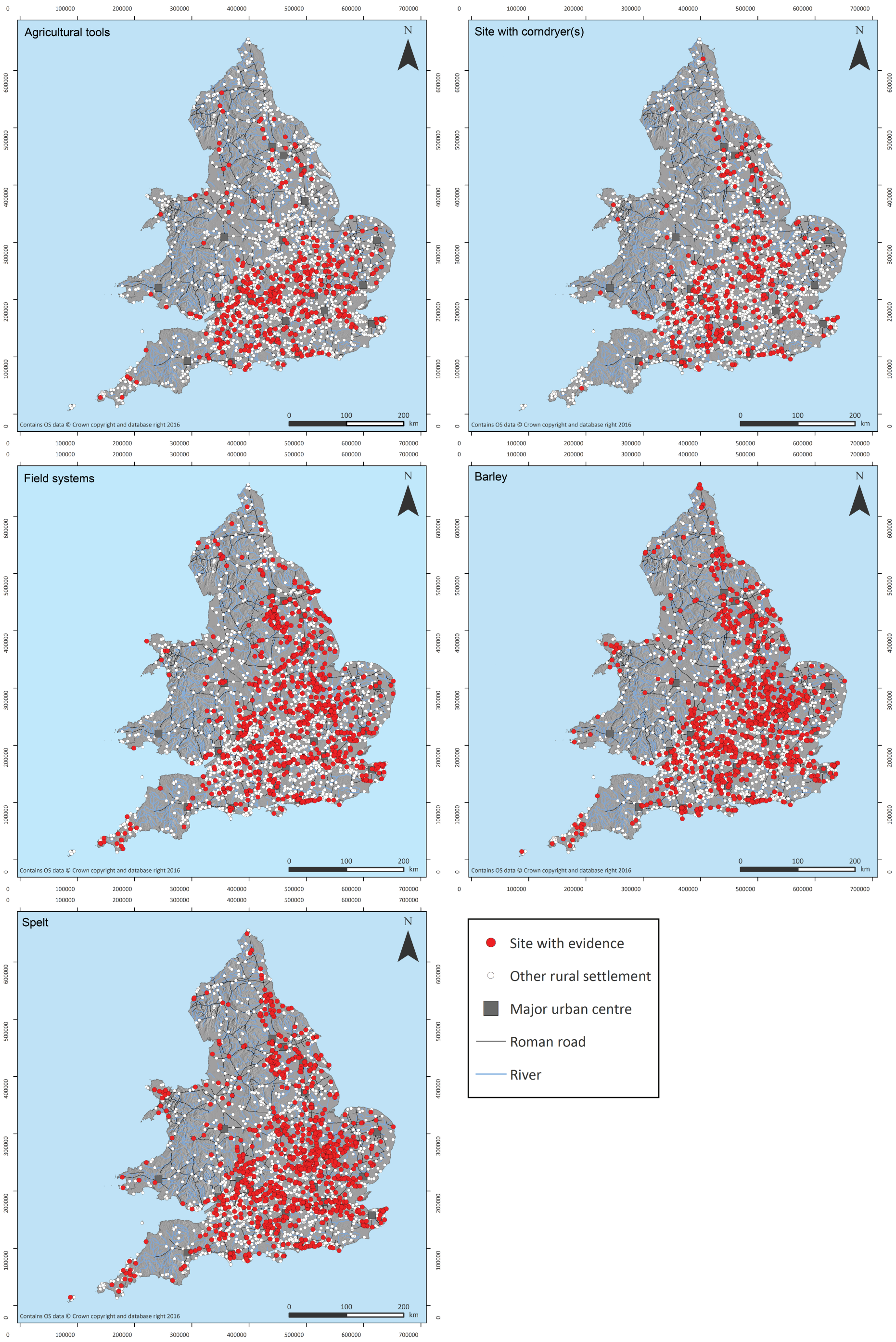

FIG. 2.1. Distribution of key indicators of arable farming

of crops that were being cultivated and in the intensity of cultivation (Van der Veen and O'Connor 1998; Van der Veen 1992). Volume 1 established parts of the Central Belt and South regions to be the major areas of intensive arable farming (Smith and Fulford 2016, 408), and a review of several proxies for arable farming demonstrates this point (FIG. 2.1). The distribution of agricultural tools clearly shows a concentration in the Central Belt and South regions, although poor preservation of iron further north and west and the recycling of tools may have influenced this pattern (see below, p. 42). Corndryers are also most prevalent in these regions, although the distribution of field systems, spelt wheat and barley are more widely spread. These different strands of evidence indicate that arable farming extended across the majority of Roman Britain, but that intensive production of cereals was focused upon the Central Belt and the South.

UTILISING ARCHAEOBOTANICAL DATA

The archaeobotanical component of this chapter draws on a combination of the data collected during the first stage of the Roman Rural Settlement Project (the national dataset; see Smith *et al.* 2016) and the supplementary collection of quantitative data on charred plant remains from regional case study areas. The national dataset consists of 1393 records of individual site phases, with major disparities in the distribution of these across the regions (TABLE 2.1). The Central Belt is the best represented region with 638 records, while the South-West and Upland Wales and the Marches each have only 28 records. The case study areas were selected with the intention of addressing regional variation within the Central Belt (Upper Thames Valley and margins, Trent Valley and Rises, West Anglian Plain north and south), and the South (Kent and Wessex), which contain the highest number of rich datasets and were the focus of arable farming, as well as to illustrate the diversity of arable farming within other areas of rural Roman Britain (South-West and North-East). These case study areas are shown in FIG. 2.2, and correspond with Natural England landscape zones (as discussed in Vol. 1; Fulford and Brindle 2016, 15–16) with alterations. The West Anglian Plain has been separated into the Nene Valley (north), with the addition of Rockingham Forest and the Midland Clay Pastures, and Ouse Valley (south) with the addition of the Bedfordshire Greensand Ridge. The Upper Thames area is focused on the Upper Thames Clay Vales and the Mid Vale Ridge, and includes the edges of the Cotswolds, Berkshire and Marlborough Downs, and the Chilterns. Wessex, in the South region, includes the landscape zones in calcareous regions; the South Wessex Downs, the Hampshire Downs, and the Berkshire and Marlborough Downs. The South-West region has been treated as one case study. Kent includes the landscape zones of the North Kent Plain, the Greater Thames Estuary, the North Downs, the Wealden Greensand, the Low Weald and the Romney Marshes. Data were collected from several landscape zones in the centre of the North-East region; the Southern Magnesian Limestone, Humberhead Levels, the Vale of York and Mowbray and the Coal Measures.

TABLE 2.1: SUMMARY OF ARCHAEOBOTANICAL RECORDS IN THE NATIONAL DATASET

Region	*No. of archaeobotanical records*
Central Belt	638
Central West	53
East	114
North	33
North-East	175
South	324
South-West	28
Upland Wales and the Marches	28
Total	**1393**

Full sample-by-sample data were collated from sites where fully quantified data on charred plant remains were available, both from full excavation reports and post-excavation assessments. Samples were included from all feature types. While the inclusion of samples from corndryers is likely to over-represent those crops processed in these structures, namely wheat (Rippon *et al.* 2015, 81), such samples have been included as many charred plant remains recovered elsewhere on the settlement may well have derived from these ovens, and corndryers often represent the major source of plant remains from archaeological sites. Data standardisation and analysis has been undertaken to produce categories of crop items that can be compared across sites and regions (TABLES 2.2 and 2.3). Crop choice at sites has been assessed using the sum of standardised grain counts per site. Given the proportion of rachis:grain in barley (1:3), the maximum number of barley grains has been calculated per sample on the basis of the highest number of grains, or rachis multiplied by three. These totals have been summed for all samples. This method of analysis may over-emphasise the importance of certain crops, but it is the simplest way to assess broad patterns in the data. The type of crop-processing activity has been assessed through assigning each sample to a crop-processing stage, based on the ratio of crop grain and chaff items and the physical characteristics of weed seeds (TABLE 2.4). Where these two results correspond, the samples have been classified as a single crop-processing stage. While potentially some of these samples are in fact a mixture of different crop-processing events, it is considered here that these samples can be taken as representing a single activity (Bogaard 2011, 151; Hillman 1984, 13). The interpretation of the presence and absence of certain crop-processing stages at different sites remains contentious (Stevens 2003; Van der Veen and Jones 2006). Here a combination of crop-processing stage assignment (fine-sieving product, fine-sieving by-product) and densities of spelt and emmer glume bases per litre of soil have been used in order to highlight chronological and regional patterns in the data. Soil conditions and cultivation practices have been investigated through considering the weed seeds present alongside the most commonly occurring crop-processing stage, glume wheat 'fine-sieve

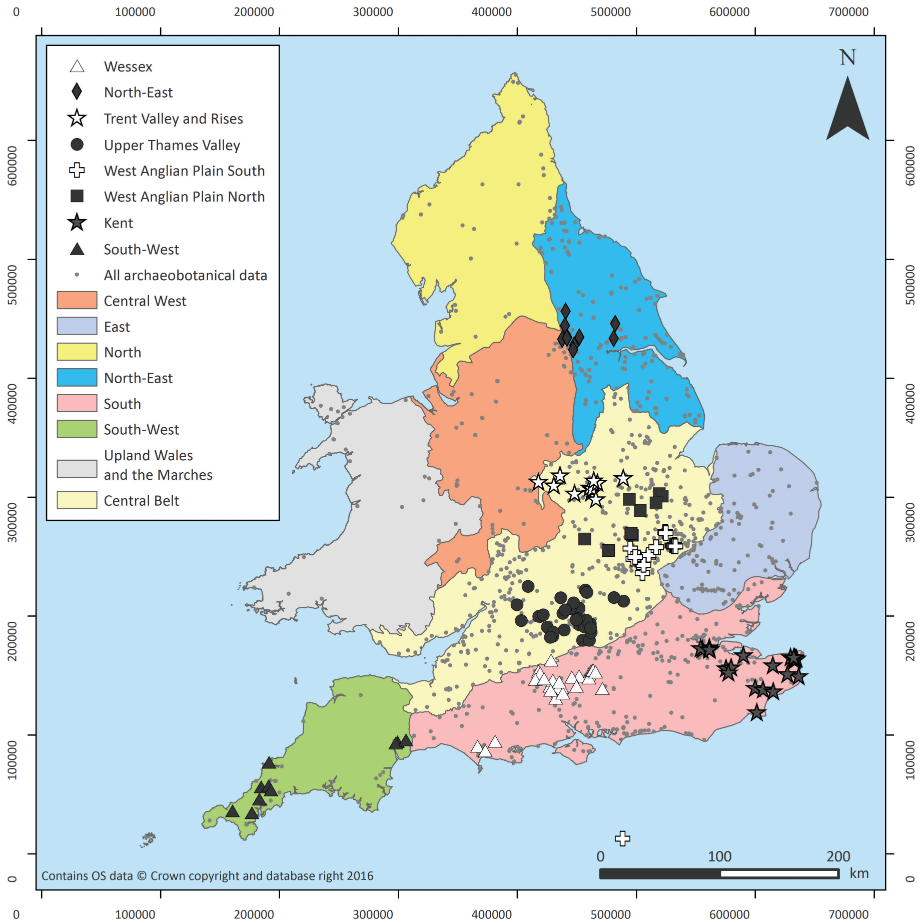

FIG. 2.2. The Roman Rural Settlement Project regions and case study areas

TABLE 2.2: SUMMARY OF THE STANDARDISATION OF THE MAJOR CEREAL CROPS

Nomenclature follows Zohary *et al.* 2012, table 3

Latin name	*Common name*	*Standardised categories*	*Inclusions*
Triticum spelta L.	Spelt wheat	Spelt grains and glume bases	All spelt and cf. spelt. Reallocated spelt/emmer
Triticum dicoccum L.	Emmer wheat	Emmer grains and glume bases	All emmer and cf. emmer. Reallocated spelt/emmer
Triticum spelta/dicoccum	Spelt/emmer wheat	Spelt/emmer grains and glume bases	All spelt/emmer and *Triticum* sp. glume bases
Triticum free-threshing	Free-threshing wheat	Free-threshing wheat grains and rachis internodes	All *T. aestivum*, *T. aestivo-compactim*, *T.* free-threshing. No tetraploid wheat was present in the dataset
Hordeum vulgare L.	Hulled barley	Barley grains and rachis internodes	All *Hordeum*
Avena sativa L.	Cultivated oat	Cultivated oat grains and floret bases	Only *Avena* sp. grains and floret bases specifically identified as cultivated type
Secale cereale L.	Rye	Rye grains and rachis internodes	All *S. cereale*
Arable weeds	–	All weed taxa considered likely to be arable weeds	Definite and cf. identifications. Reallocated genus and family level identifications per sample basis

TABLE 2.3: CRITERIA FOR SAMPLE INCLUSION WITHIN EACH STAGE OF DATA ANALYSIS

Stage of analysis	*Data standardisation and inclusion*	*Criteria*
Crop choice – site based	Crops standardised following TABLE 2.2, max. items of each crop type calculated on basis of grain and chaff, sum all sample counts	Samples with >30 standardised items
Crop choice – sample based	Crops standardised following TABLE 2.2, max. items of each crop type calculated on basis of grain and chaff, average percentages per sample	Samples with >30 standardised items
Crop-processing stage	Ratios calculated following TABLE 2.4 Discriminant analysis conducted following Jones 1984	Samples with >10 items per crop type (glume wheat) (barley) (free-threshing wheat)
Weed ecology analysis	Sample assigned to a single crop-processing stage. Weeds standardised following TABLE 2.2	Over 30 standardised weed taxa

TABLE 2.4: SUMMARY OF MAIN CROP-PROCESSING PRODUCTS AND BY-PRODUCTS REFERRED TO IN THE TEXT

Ratio	*Values*	*Origin*	*Description*
Barley grains/Barley rachis	>3	Fine sieve product	Barley grain and big-free-heavy weed seeds remaining after fine-sieving
	<3	Early stage by-product	Barley rachis
Glume wheat grains/ Glume wheat glume bases	>1.5	Fine sieve product	Spelt and emmer grains and big-free-heavy weed seeds remaining after fine-sieving
	0.8–1.5	Spikelets	Spelt and emmer spikelets (grains within glumes), with or without small-free-heavy weed seeds
	<0.8	Fine sieve by-product	Spelt and emmer glume bases and small-free-heavy weed seeds removed during fine-sieving

TABLE 2.5: SUMMARY OF THE DISTRIBUTION OF CHARRED PLANT REMAINS BY REGION, CASE STUDY AREA AND SITE TYPE

Number of sites/Number of samples

Region and case study area	*Enclosed farmstead*	*Open farmstead*	*Complex farmstead*	*Unclassified farmstead and other rural*	*Hillfort*	*Roadside settlement*	*Extramural*	*Field system*	*Village*	*Villa*
CENTRAL BELT										
Trent Valley and Rises	3/20		2/17	12/76	–	–	–	1/1	1/9	–
Upper Thames Valley	9/166	2/9	9/89	16/187	–	1/9	3/7		4/106	4/22
West Anglian Plain north	5/15	–	2/20	4/35	–	2/10	–	–	–	1/3
West Anglian Plain south	9/66	–	16/224	15/110	–	1/5	3/16			1/14
SOUTH-WEST	7/84	1/13	–	4/52	1/1	–	–	1/8	–	–
SOUTH										
Kent	4/24	–	1/3	11/93	–	3/65	–	1/1	2/21	3/44
Wessex	13/104	1/7	6/57	9/24	–	1/11	–	–	2/7	4/57
NORTH-EAST	3/17	1/15	3/24	5/43	–	–	–	2/2	–	1/9

by-products' (FSBPs) (TABLE 2.4). These samples have been isolated by conducting ratio analysis and discriminant analysis, so that the wild plants occurring alongside cereal remains can be considered as arable weeds. Glume wheats, spelt and emmer, also referred to as hulled wheats, are cereals where the grains are enclosed in tough glumes that require de-husking to produce clean grain. These samples represent weed seeds removed from cereal grains alongside glume wheat glume bases during fine-sieving.

There has also been a lengthy debate over how best to reconstruct past cultivation practices (M. Jones 1988; Van der Veen 1992), but with very few applied studies in Britain. Autecological values, classifications of specific weed taxa on a scale for tolerances to environmental conditions, provide a direct method of highlighting changes in soil status. Values were drawn from British Ellenberg numbers (Hill *et al.* 2004), which are a series of indicator values for several factors such as soil pH, soil wetness and soil nutrient status (Hill *et al.* 1999). Here presence/absence per sample of standardised weed taxa have been used in order to highlight broad chronological and regional patterns.

While initially a large quantity of data were collected (TABLE 2.5), many samples were removed owing to a lack of sufficient items and because they could not be assigned to a single crop-processing stage. It should also be noted here that many of the samples used were much smaller than the desired number of 400 crop and weed items per sample (Van der Veen and Fieller 1982), and the number of samples available per site are often much lower than the ideal number of 30 (Van der Veen *et al.* 2007), but these samples were deemed useful in attempting to gain a regional picture of crop cultivation.

CROP CHOICE

CEREAL CROPS IN ROMAN BRITAIN: LINES OF EVIDENCE

The choice by farmers of which cereals to grow is a decision based on economic, cultural and environmental factors. The late Iron Age has been seen as a period of expansion in the range of crops cultivated (M. Jones 1981), yet it is now clear that arable farming in rural Roman Britain was primarily based on the continued cultivation of spelt wheat and six-row hulled barley (Van der Veen 2016). Epigraphic evidence for crop choice in Roman Britain is restricted to occasional inscriptions on jars, such as an amphora sherd from Silchester inscribed AVIIN ('oats'; Boon 1974, 239), and the Vindolanda tablets listing food items required by soldiers on Hadrian's Wall. A wide range of cereal types and products are listed, including *hordeum* (barley), *cervesa* (Celtic beer), *bracis* (spelt?), *frumentum* (wheat), *siligo* (soft wheat) and *farina* (flour) (Bowman 2003; Pearce 2002, 934), but matching these names to types of cereals recorded in archaeobotanical samples is very difficult.

The bulk of our evidence comes from archaeobotanical data, primarily charred plant remains. The analysis in Volume 1, based on presence/absence data per site, showed relatively minor regional differences in the frequencies of spelt wheat and barley, but sub-regional variation was highlighted in the proportion of minor crops, with rye more common in the sandy regions of the London Basin and the Brecklands (Smith and Fulford 2016, 399–400). The reliance on presence/absence data can, however, exaggerate the presence of minor crops that may well have been weeds, and incorporate the biases of preservation inherent in different crop types. For instance, glume wheats (spelt and emmer) are much more likely to come into contact with fire during processing than free-threshing wheat, barley, oat and rye. Thus, subtle changes in crop choice can be over emphasised, although this problem can be countered by using abundance data as well (G. Jones 1991, 64). In order to refine these analyses, national patterns in presence/absence data are here contrasted with the results from fully quantified data collected from the regional case studies (see Appendix).

PROVINCE-WIDE PATTERNS IN CROP CHOICE

The presence/absence data on crops from excavated sites across England and Wales utilised in Volume 1 (Smith *et al.* 2016) highlighted several key patterns. First, chronologically (FIG. 2.3), from the late Iron Age to the late Roman period, the frequency of free-threshing wheat, pulses and rye increased by around 10 per cent, with flax increasing from 4 to just 7 per cent. The frequency of emmer decreases, from 47 per cent in the late Iron Age, sharply dropping to 28 per cent in the early Roman period with only a small increase to reach 30 per cent by the late Roman period. Spelt wheat and barley are much more frequent than these crops, occurring at between 75 per cent and 90 per cent of sites in all periods. Both crops show a slight decrease in the early Roman period, an increase in the mid-Roman period, and a decrease in the late Roman period.

The grouping of sites by regions shows several patterns (FIG. 2.4). The highest frequency of spelt wheat is found in the East, the South and Upland Wales and the Marches, which correspond with

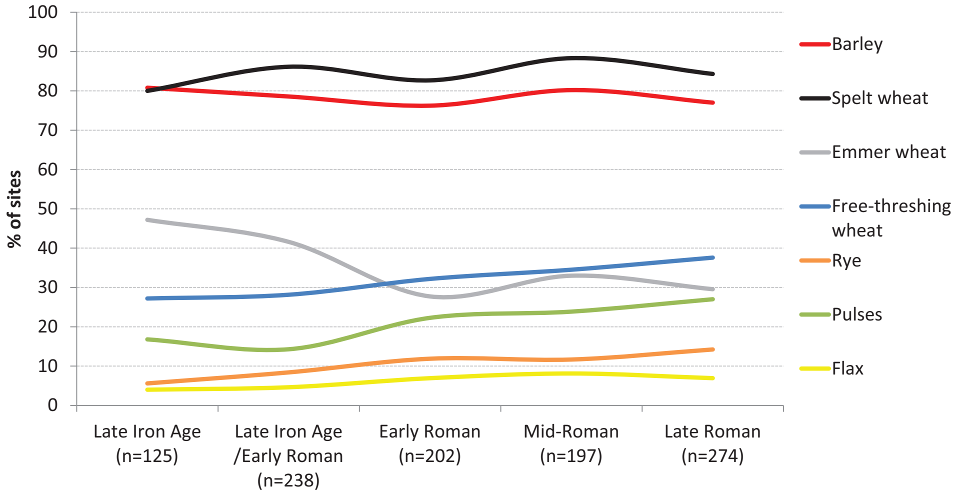

FIG. 2.3. Frequency of crops within the national dataset through time

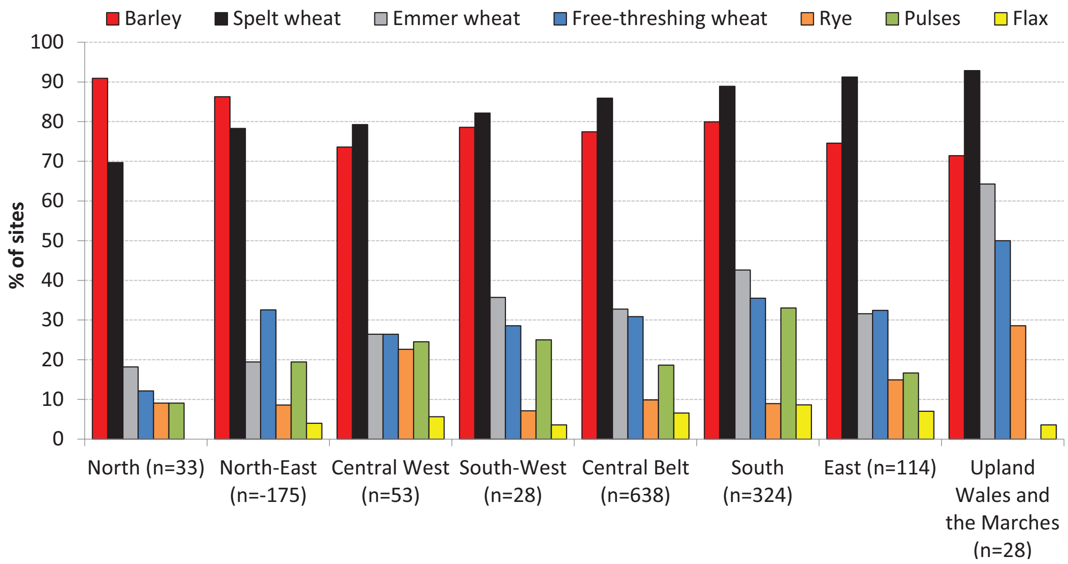

FIG. 2.4. Frequency of crops within the national dataset by region

lower frequencies of barley. In contrast, the North and North-East have the highest frequencies of barley and lowest frequencies of spelt wheat. The Central West and especially Upland Wales and the Marches both have higher frequencies of minor crops – rye, pulses, free-threshing wheat, and particularly emmer.

The major patterns displayed when sites are organised by site-type (FIG. 2.5) are related to the chronological trends, mainly the increasing frequency of emmer wheat, and decreasing frequency of free-threshing wheat, pulses, rye and flax at unenclosed and enclosed farmsteads which are, on average, earlier in date than villas and roadside settlements (Smith and Fulford 2016, 394–5). In contrast, complex farmsteads and villages have the highest frequencies of spelt wheat. The dominance of spelt wheat and decline in emmer wheat are a culmination of the switch from emmer to spelt wheat following the introduction of spelt wheat in the mid-Bronze Age (Campbell and Straker 2003; Lambrick and Robinson 2009, 251). Traditionally, spelt wheat has been seen as a hardy crop, better suited to being autumn sown on heavier soils (Percival 1921, 326; Van der Veen 1992, 145–6). In contrast, emmer has been characterised as a spring-sown crop of light soils (Applebaum 1958; M. Jones 1981). While these views are based on how these crops are cultivated in recent periods, and our ecological understanding of spelt and emmer is limited (Van der Veen 1992, 146), experiments have shown that spelt wheat increases in proportion to emmer under autumn sowing regimes (Lambrick and Robinson 2009, 258), and that spelt is higher yielding than emmer (Van der Veen and Palmer 1997). Archaeobotanical studies have shown spelt to be associated with weeds of lower fertility than emmer (Van der Veen

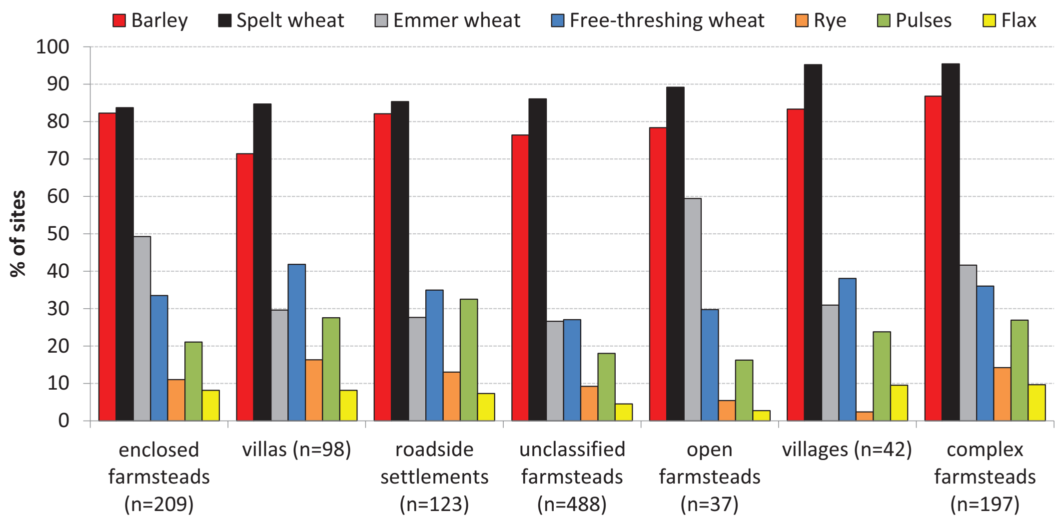

FIG. 2.5. Frequency of crops within the national dataset by site type

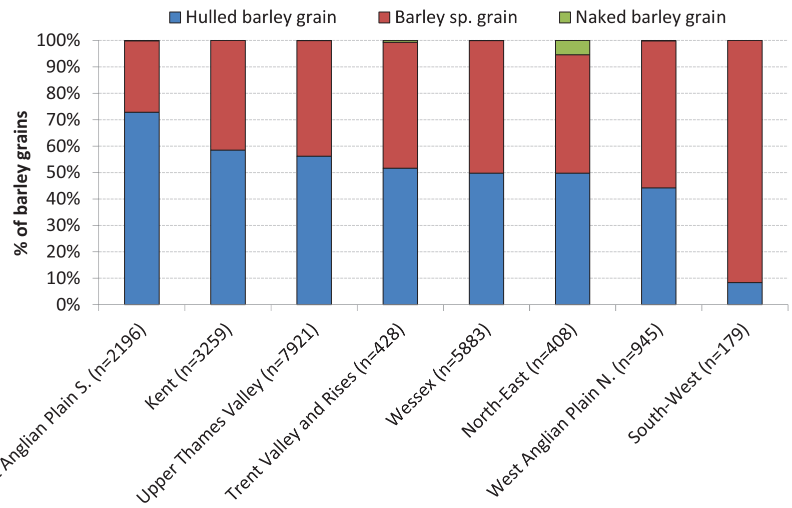

FIG. 2.6. Proportions of hulled, indeterminate and naked barley grains per case study area

1992). Given these factors, the shift to spelt wheat is understood as a move towards more extensive cultivation, with larger areas of land cultivated with lower inputs of labour and manure (Van der Veen and O'Connor 1998, 131–3).

Several key trends can also be investigated in particular crops utilising the regional case study data. The staple barley crop cultivated in Roman Britain is considered to be six-row hulled barley, where the paleas – membranous bracts – are fused with the grain (Zohary *et al.* 2012, 52). The comparison of the total sum of barley grains per region shows that hulled barley grains are dominant, with very minor proportions of naked grains in the Central Belt case study areas and in Wessex (FIG. 2.6). The only area where the proportion of naked barley grains is above 1 per cent is the North-East, where they make up 5 per cent of the total barley grain assemblage. These derive from a single sample from the late Roman villa at Dalton Parlours, West Yorkshire, which contained 25 hulled barley grains, 19 naked barley grains and 35 barley indeterminate grains (Murray 1990). Clearly, hulled barley was the only type of barley cultivated in Roman Britain. In traditional societies in the Mediterranean and south-west Asia, hulled barley is usually reserved for animal fodder or beer (Zohary *et al.* 2012, 52). Literary evidence (e.g. Polybius, *Histories* 6, 38) indicates that barley was considered as fodder or a punishment food in the Mediterranean Roman world, yet barley bran fragments were recorded in human faecal waste from both military and civilian settlements around Hadrian's Wall (Britton and Huntley 2011) and barley was clearly a common crop in Roman Britain (FIG. 2.3). Further work is required to establish whether it was intended primarily for human or animal feed.

The status of cultivated oat in Roman Britain has long been a subject of speculation. Martin Jones (1989, 133) argued that oats were cultivated by low-status farmers on shallow, nutrient-poor

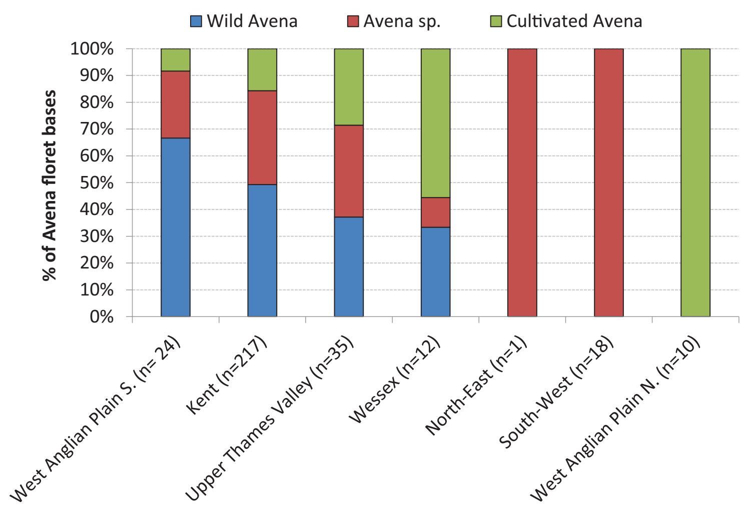

FIG. 2.7. Proportions of cultivated, wild and indeterminate *Avena* floret bases per case study area

soil, and oats are generally considered as a minor crop in this period (Van der Veen 2016). However, some have considered all *Avena* sp. seeds as crop items, and included these in proportional analysis of regional crop choice (Rippon *et al.* 2015, 70). The argument that a higher abundance of oats in one region indicates that more oats were being cultivated (Rippon *et al.* 2014, 211) overlooks the issue that different cultivation practices will also cause differing proportions of specific weeds.

The separation of cultivated (*Avena sativa*) and wild oat (*Avena fatua* and *strigosa*) is reliant upon identifying traits of the floret bases (Jacomet 2006; Zohary *et al.* 2012, 67). FIGURE 2.7 displays the proportion of wild, cultivated and indeterminate floret bases in each case study area. The total numbers of floret bases are unfortunately extremely low. While this itself indicates that oat was not a common crop, floret bases are removed at an early stage of crop processing and do not preserve well. In most areas the proportions of wild and indeterminate floret bases are greater than cultivated floret bases, with the exception of the West Anglian Plain north, where ten cultivated floret bases were identified from a single sample at a late Iron Age/early Roman enclosed farmstead at Grange Park Courteenhall, Northamptonshire (Ciaraldi 2006). In the Upper Thames Valley, the cultivated floret bases derive from two samples from the extensively analysed site of Cotswold Community, south of Cirencester, alongside much glume wheat and barley remains (W. Smith 2010), and from samples at Whitelands Farm, Bicester, Oxfordshire (Stevens 2011a). In Wessex, cultivated floret bases originate only from the late Iron Age site of Suddern Farm, Hampshire, in samples containing abundant glume wheat and barley chaff (Campbell 2000b). Conclusive evidence for the cultivation of oat must be based on the crop occurring frequently within a single assemblage, and sometimes in high abundance within single samples (Bogaard 2011, 86). For instance at Penhale Round, Cornwall, oat was suggested as a crop partly due to the presence of grains in substantial numbers in all samples (Scaife 1999). Hence cultivated oat was only a minor crop, possibly for fodder (Campbell 2000a, 50), or a contaminant of barley and glume wheat crops.

The introduction of free-threshing wheat, or bread wheat (*Triticum aestivum*), has long been associated with the late Iron Age and Roman periods (M. Jones 1981). A major difficulty in tracking the cultivation of free-threshing wheat is the difficulty of separating free-threshing and glume wheats (spelt and emmer) on the basis of grain morphology (Hillman *et al.* 1996), compounded by the presence of short-grained varieties of spelt and emmer wheat now known to have been grown in southern Britain (Campbell and Straker 2003). Free-threshing and glume wheats can, however, be separated on the basis of rachis internodes (Hillman *et al.* 1996). FIGURE 2.8 compares the number of cereal grains and rachis internodes identified as free-threshing wheat by case study area. This graph shows that, in most regions, the number of free-threshing wheat grains vastly outnumbers free-threshing wheat rachis items. While rachis is removed at an early stage in the processing of free-threshing cereals (Hillman 1981; G. Jones 1984), and hence may be under-represented in crop-processing debris derived from on-site activities, such a disparity between grain and rachis internodes suggests that the cultivation of free-threshing wheat has been exaggerated by potentially insecure grain identifications. For instance in Kent, samples with ten items of free-threshing wheat rachis internodes were only recovered from mid- and late

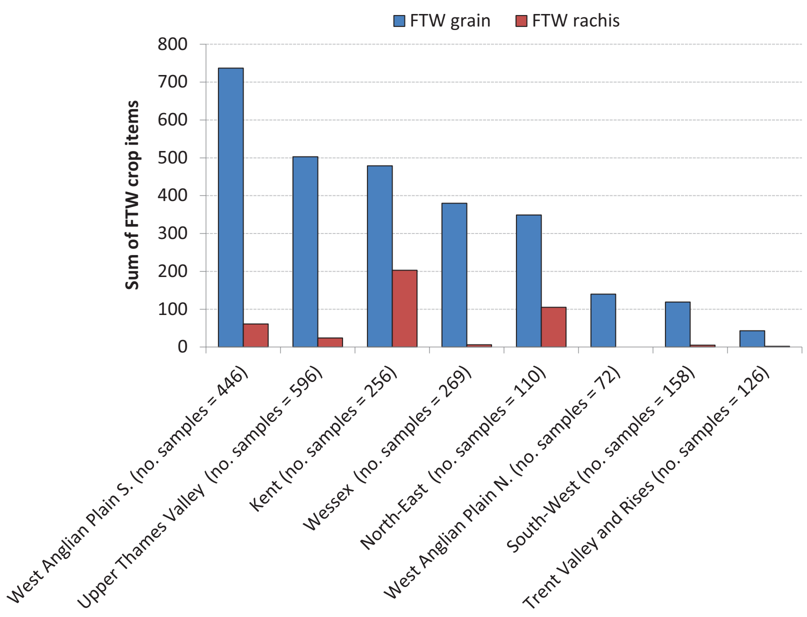

FIG. 2.8. Sum of free-threshing wheat (FTW) grain and rachis per case study area

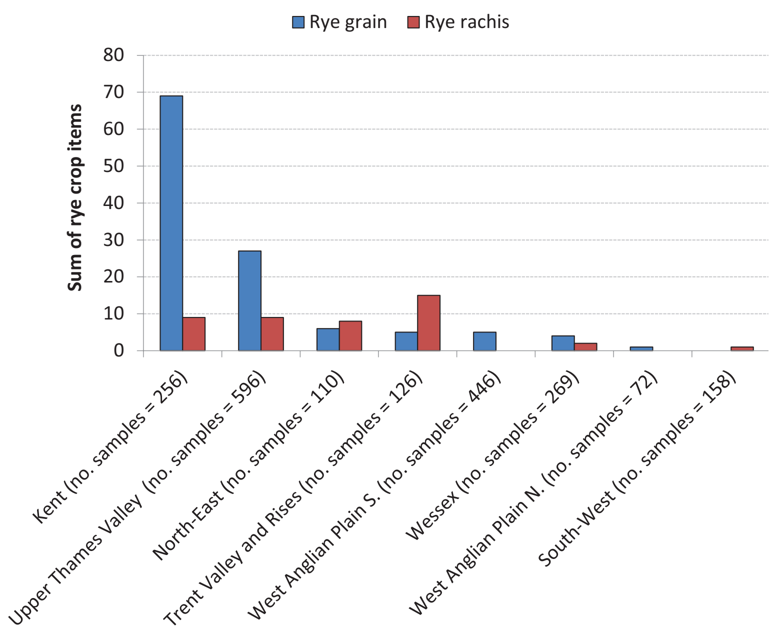

FIG. 2.9. Sum of rye grain and rachis per case study area

Roman Northfleet villa and Roman Monkton Mount Pleasant (Pelling 2008; W. Smith 2011). From the North-East, the free-threshing wheat rachis come from late Roman Dalton Parlours, West Yorkshire (Murray 1990). Beyond rural settlements, a substantial quantity of free-threshing wheat was recovered from the granary at South Shields, Tyne and Wear, 42 per cent of the total identified cereal grain. Previous suggestions that this grain was imported from the Continent due to the lack of free-threshing wheat cultivation in Britain seem increasingly likely, given the continued lack of evidence for free-threshing wheat cultivation in Roman Britain (Van der Veen 1988; 1994). In the analysis below, free-threshing wheat counts have been standardised from grain and rachis counts, but the issues raised here should be kept in mind when interpreting patterns in the data.

The final minor crop is rye, which has a limited archaeobotanical record in Europe, but is considered to have been cultivated in the Roman period (Behre 1992), with Martin Jones (1989, 133) arguing for an increase in rye cultivation associated with lower status farmers in Roman Britain. While rye does increase in frequency on a national basis (see FIG. 2.3), the numbers of rye grain and rachis present in the regional case study areas are very low (FIG. 2.9). For example, out of 596 samples in the Upper Thames Valley and margins, only 27 rye grains and 9 rye rachis internodes were present. The highest numbers come from Kent, deriving almost exclusively from large charred assemblages of malting waste at a late Iron Age/early Roman farmstead at Nonington (Helm and Carruthers 2011). Elsewhere, medieval contamination may be a contributing factor to rye records, as at Old Park House, Ashby de la Zouch, Leicestershire, where thirteen rye grains derived from a mid-Roman sample, with medieval ridge-and-furrow noted at the site (Ciaraldi 2002, 28). Rye has been identified in reasonable numbers (30 rachis fragments and 10 grains) in several samples from Ellesmere Road, Shrewsbury, an enclosed farmstead in the Central West region, where rye would have been well suited to the infertile, sandy soils (Robinson 1990). Substantial assemblages of rye are also known from military settlements and towns, albeit from grain stores considered to be imported based on the weed flora, such as York (Kenward and Williams 1979, 61–2) and tentative identifications at Caerleon in South Wales (Helbaek 1964). Rye was perhaps a minor crop in areas of marginal soils.

This analysis has shown that the status of cultivated oat, rye and free-threshing wheat remain very minor in the Roman period, while hulled barley, spelt and, to a lesser extent, emmer were the main cereal crops. Pulses are considered later on in this chapter alongside horticulture, and the cultivation of the oil crop flax is evaluated in Chapter 5.

CASE STUDY AREAS

Across the eight case study areas examined here, there are clear variations in the abundance of different crops. TABLE 2.6 summarises the average percentage of crop items within each site assemblage. The Central Belt and Kent case studies have higher percentages of spelt wheat, followed by emmer, then barley, and between 0 and 5 per cent free-threshing wheat. Wessex sites have the highest average percentages of barley (23 per cent), while the North-East and South-West have the highest percentages of emmer (12 and 23 per cent). Rye and pea/bean represent less than 1 per cent of the crops in all areas other than Kent, where it is on average 2 per cent. This initial analysis shows that arable farming in some regions was heavily focused on glume wheats, and that spelt wheat was being grown in larger quantities than emmer wheat. Spelt wheat and emmer wheat can be cultivated and processed together, and hence are considered together as a combined glume wheat category. The case study areas will now be addressed separately, with chronological and settlement-type patterns highlighted where sufficient data are available, based on the average percentages of crops per sample.

The South-West

The South-West can be considered to show a more subsistence-based level of arable farming, in contrast to the agricultural heartlands of the Central Belt, on the basis of the absence of corndryers (see FIG. 2.1), although there is much geographical variation (Brindle 2016d). Very limited archaeobotanical information is available from the only major town in the region, Exeter, with little indication of cereal crops (Straker *et al.* 1984). Fully quantified sample level data were available for ten sites, mainly in Cornwall with some sites around Exeter in Devon. FIGURE 2.10 displays the sum of crops per site where at least 30 standardised crops were present. Barley, spelt and emmer are the dominant crops, with all sites containing less than 10 per cent free-threshing wheat. The proportion of emmer wheat is often quite high, as at Reawla (Appleton-Fox 1992) and Lellizzick (Wessex Archaeology 2008) in Cornwall, and Blackhorse (Fitzpatrick *et al.* 1999) and Hayes Farm (Barber 2000) around Exeter, and these

TABLE 2.6: AVERAGE PERCENTAGE OF CROPS PER SITE WITHIN CASE STUDY AREAS

	CENTRAL BELT				*SOUTH*			
	Trent Valley and Rises	*Upper Thames Valley*	*West Anglian Plain north*	*West Anglian Plain south*	*Kent*	*Wessex*	*North-East*	*South-West*
Barley	19	22	13	5	11	23	17	14
Emmer	1	2	0	5	7	3	12	23
Spelt	67	66	85	81	77	33	48	47
Combined glume wheats	10	75	87	89	85	70	74	84
Free-threshing wheat	2	2	0	5	2	4	8	2
Rye	0	0	0	0	0	0	0	0
Pea/Bean	0	0	0	0	2	0	0	0

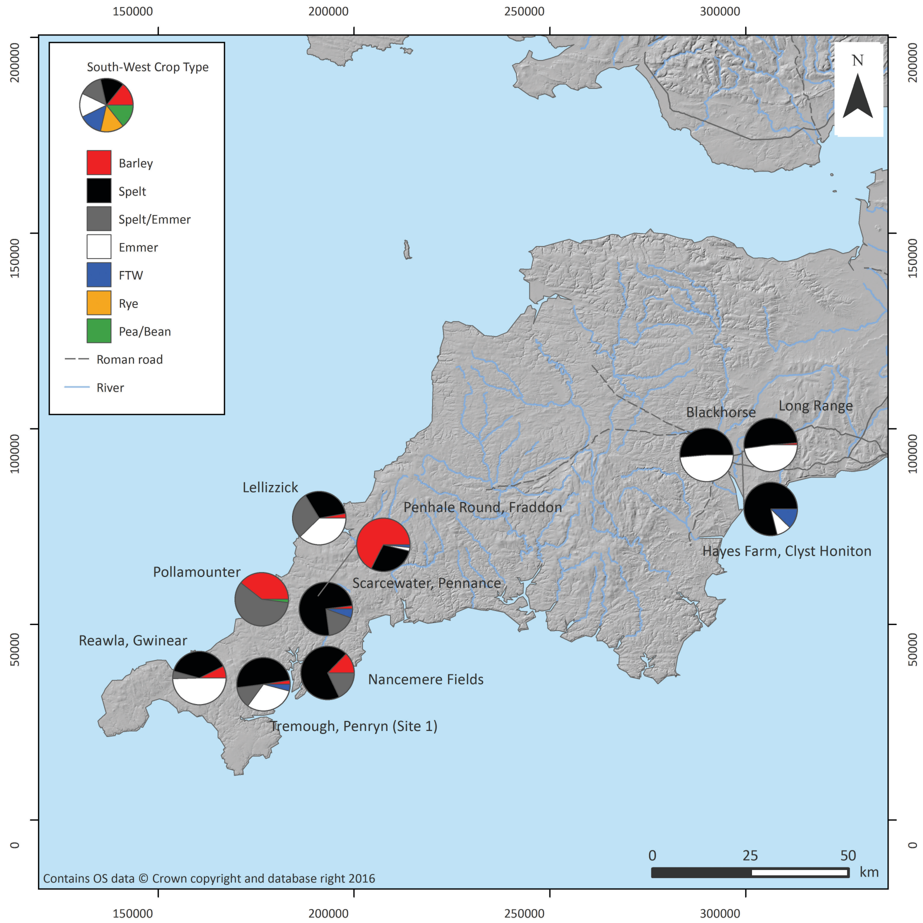

FIG. 2.10. Distribution of the sum of standardised crop items per site in the South-West

sites also have very low quantities of barley. Other sites, such as Scarcewater (A.M. Jones and Taylor 2010), Nancemere Fields (Higgins 2009) and Pollamounter (A.M. Jones and Taylor 2001), all in Cornwall, are dominated by spelt and barley. Assemblages dated to the late Iron Age are almost entirely composed of spelt and emmer wheat, these deriving from farmsteads at Long Range and Blackhorse, in the hinterland of Exeter (Fitzpatrick *et al.* 1999). The combined glume wheats in the late Iron Age average 99 per cent. The composition of mid-Roman and Roman samples are more varied, with more barley and free-threshing wheat from sites such as Penhale Round (Scaife 1999), Nancemere Fields, Hayes Farm and Lellizzick. The average percentage of combined glume wheats decreases to 78 per cent at this time, while barley increases to 20 per cent, and free-threshing wheat increases to 2 per cent (TABLE 2.7). Hence the key pattern from the South-West is a decrease in emmer and increase in barley and free-threshing wheat during the Roman period.

The South – Kent

Kent has a much richer archaeobotanical dataset owing to the recent large-scale excavations in advance of the East Kent Access road and High Speed 1 rail line (Hunter 2015; Stevens *et al.* 2011). No archaeobotanical evidence is currently available from the *civitas* capital at Canterbury. Fully quantified sample data were available from 25 sites, many of which are clustered around the Isle of Thanet and the Ebbsfleet Valley. Assemblages from most sites are spelt wheat dominated, with lower proportions of barley, emmer and free-threshing wheat (FIG. 2.11). Spatial patterning is limited; Little Stock Farm (HS1) near the south-east coast has higher proportions of barley and emmer, which may reflect its location on the edge

TABLE 2.7: AVERAGE PERCENTAGE OF CROPS PER SAMPLE PER PERIOD IN THE SOUTH-WEST

	Late Iron Age	*Roman*
Barley	0	20
Spelt	46	52
Emmer	53	13
Combined glume wheats	99	78
Free-threshing wheat	0	2

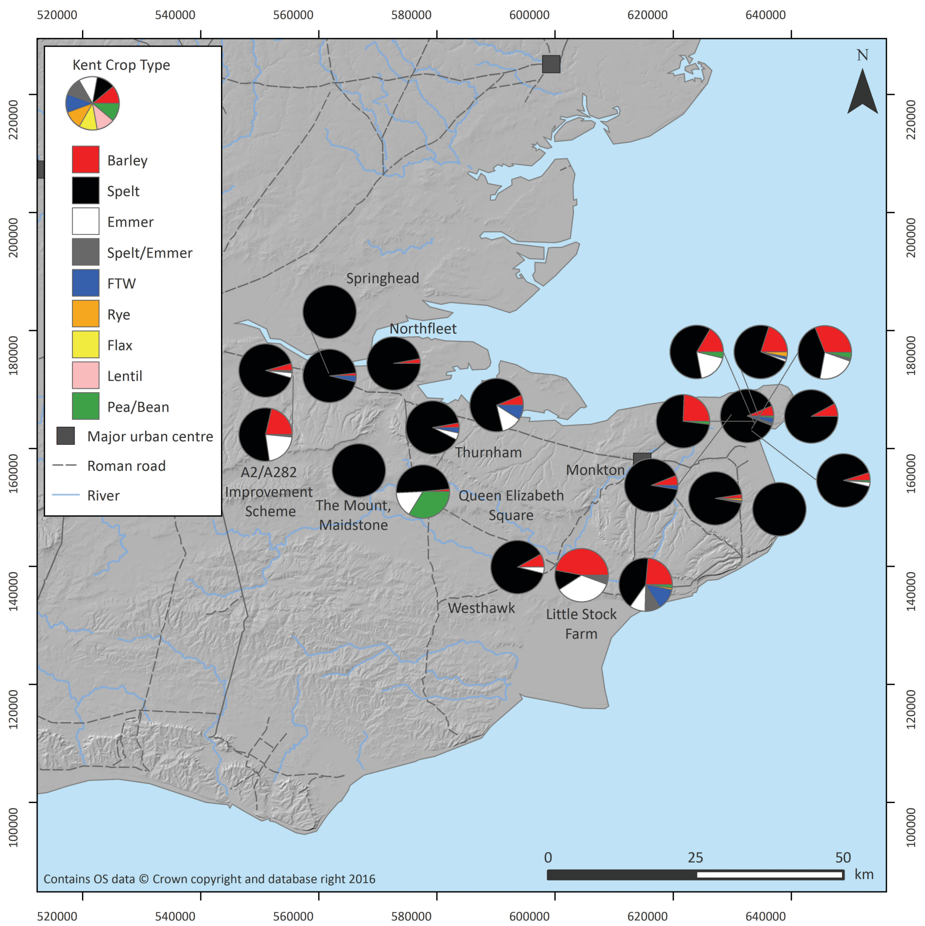

FIG. 2.11. Distribution of the sum of standardised crop items per site in Kent

TABLE 2.8: AVERAGE PERCENTAGE OF CROPS PER SAMPLE PER PERIOD IN KENT

	Late Iron Age	*Late Iron Age/ early Roman*	*Early Roman*	*Mid-Roman*	*Late Roman*
Barley	25	12	8	4	9
Spelt	43	69	86	91	80
Emmer	28	15	3	2	3
Combined glume wheats	74	87	90	94	89
Free-threshing wheat	1	2	2	2	2

of the Greensand. While still very low, the proportion of pea is higher than other regions, averaging 2 per cent of site assemblages (TABLE 2.6), with the notable site of Queen Elizabeth Square, Maidstone, consisting of 34 per cent pea (Pelling 2004), and other sites containing 0.5–3 per cent pea. *Lens culinaris* L. (lentil) was also recorded in eight samples from Springhead roadside settlement (Stevens 2011b). The main crops during the late Iron Age were spelt (45 per cent), barley (25 per cent) and emmer (28 per cent). The proportion of spelt wheat increases to 86 per cent in the early Roman period, and 91 per cent in the mid-Roman period, as the average proportion of barley decreases to 8 per cent and 4 per cent during these time frames (TABLE 2.8).

At all sites glume wheats represent over 70 per cent of the average sample proportion (FIG. 2.12). At farmsteads (A2/A282 Improvement Scheme; Simmonds *et al.* 2011), villages (Monkton; Pelling 2008) and roadside settlements (Springhead: Stevens 2011b; Westhawk: Booth *et al.* 2008), the average proportion of barley is generally between 10 and 20 per cent. In contrast, nearly all villas (The Mount: Houliston 1999; Northfleet: Andrews *et al.* 2011; Thurnham: Lawrence 2006) have an average percentage of barley below 10 per cent, and are focused on the production of glume wheats.

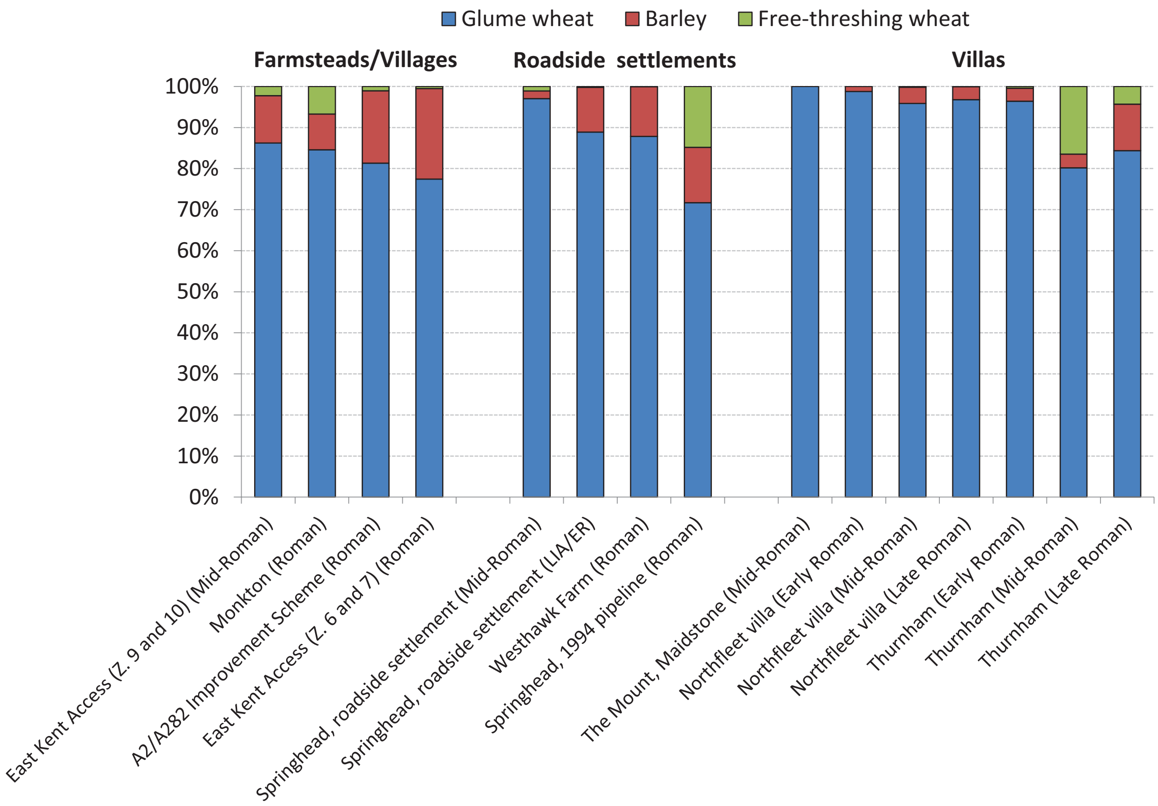

FIG. 2.12. Average percentage of glume wheats, barley and free-threshing wheat per site in Kent

TABLE 2.9: AVERAGE PERCENTAGE OF CROPS PER SAMPLE PER PERIOD IN WESSEX

	Late Iron Age	*Late Iron Age/ early Roman*	*Early Roman*	*Mid-Roman*	*Late Roman*
Barley	34	31	27	7	16
Spelt	39	46	40	85	71
Emmer	0	9	5	8	2
Combined glume wheats	66	68	68	93	81
Free-threshing wheat	0	2	6	0	3

The South – Wessex Chalk Downs

The chalk downlands of Hampshire and the Salisbury Plain have extensive evidence for Romano-British agricultural activity, in the form of corndryers, water mills and aisled barns (Allen 2016a, 135–9). Evidence is available for plant foods from the major towns on the periphery of this region – Winchester (Carruthers 2011), Silchester (Lodwick 2016) and Dorchester (Stevens 2008) – indicating small quantities of crop-processing waste of spelt and barley, and the presence of a range of pulses, imported fruits and flavourings.

Fully quantified archaeobotanical data were available from 31 sites clustered in the Test Valley as a result of the Danebury environs excavations (Campbell 2000a; 2008a), and around Basingstoke, Salisbury Plain and Dorchester. Spatial analysis (FIG. 2.13) shows that sites in the south-west of this case study area produced higher proportions of spelt and emmer, while those in the Test Valley produced higher proportions of barley, and settlements on the eastern Hampshire Downs produced more free-threshing wheat. However, some of these sites derive from older studies when positive identifications of minor crops were more common. Spelt wheat is present in similar quantities in the late Iron Age–early Roman period, between 39 and 46 per cent, but in the mid- and late Roman periods, the proportion of spelt wheat increases, with the combined glume wheats accounting for averages of 93 and 81 per cent (TABLE 2.9). In parallel, the proportion of barley decreases from 34 per cent in the late Iron Age to 7 per cent in the mid-Roman period. The proportion of free-threshing wheat remains low, peaking at an average of 6 per cent in the early Roman period.

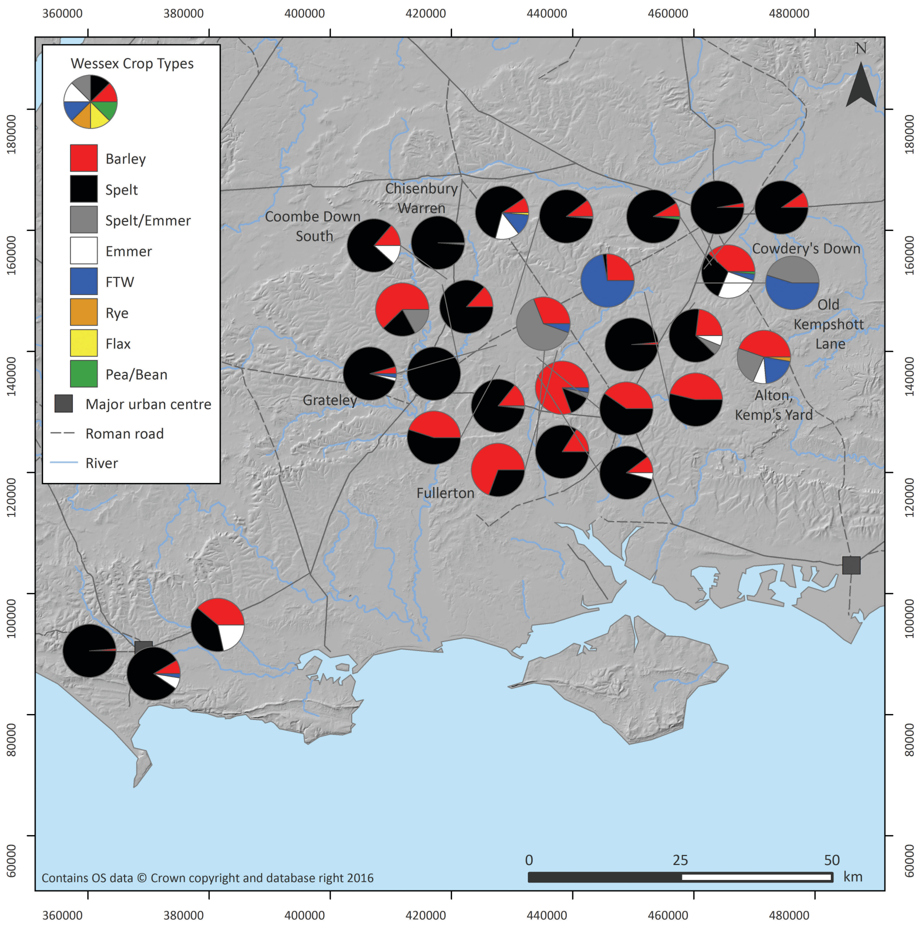

FIG. 2.13. Distribution of the sum of standardised crop items per site in Wessex

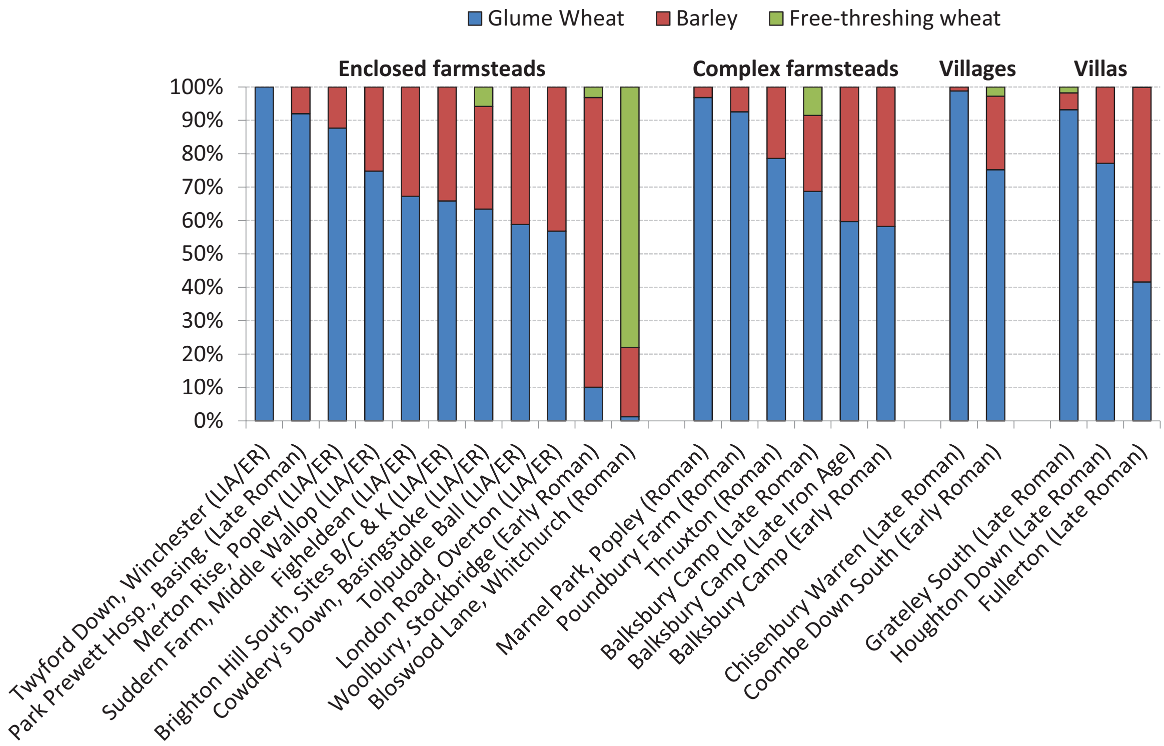

FIG. 2.14. Average percentage of glume wheats, barley and free-threshing wheat per site in Wessex

There are no major differences in the proportion of crops at different sites, with glume wheats always being dominant, followed by barley (FIG. 2.14). Free-threshing wheat is absent from enclosed farmsteads, but present in small quantities at complex farmsteads (Cowdery's Down: Millett and James 1983), villages (Coombe Down South and Chisenbury Warren on the Salisbury Plain: Fulford *et al.* 2006) and villas (late Roman Grateley: Campbell 2008c).

The Central Belt – West Anglian Plain (north and south)

The Central Belt region has been identified as the main centre of agricultural productivity in rural Roman Britain (Smith 2016a, 206). Here, several case study areas are examined in order to assess the intra-regional variation in crop choice, beginning with the northern section of the West Anglian Plain. No major towns lie within this study area or the southern West Anglian Plain, and little archaeobotanical evidence is available from the minor towns of Water Newton, Godmanchester, Irchester, Towcester and Cambridge. Fully quantified samples were available from thirteen sites (FIG. 2.15), of which eleven had sufficient crop items to investigate regional variation. The majority of sites are dominated by spelt wheat, such as Higham Ferrers in Northamptonshire (Lawrence and Smith 2009), and Parnwell, Peterborough (Webley 2007), with very low proportions of barley, emmer and free-threshing wheat. Only one site was dominated by barley, Wakerley, an enclosed farmstead in the Rockingham Forest, Northamptonshire, although the record consists of only a single quantified sample (Arthur 1978). There is little chronological variation in the average percentage of crops per sample, with spelt wheat always the most dominant crop and emmer already in very low proportions, just 1 per cent, in the late Iron Age (TABLE 2.10). Barley decreases from an average of 25 per cent in the late Iron Age to 16 per cent in the late Roman period.

The southern part of the West Anglian Plain, the Ouse Valley, shows a more varied crop spectrum. Fully quantified sample data were available from 42 sites. Spatial analysis (FIG. 2.16) demonstrates the strong dominance of spelt wheat, with generally low proportions of barley and emmer wheat. There are, however, sites with very

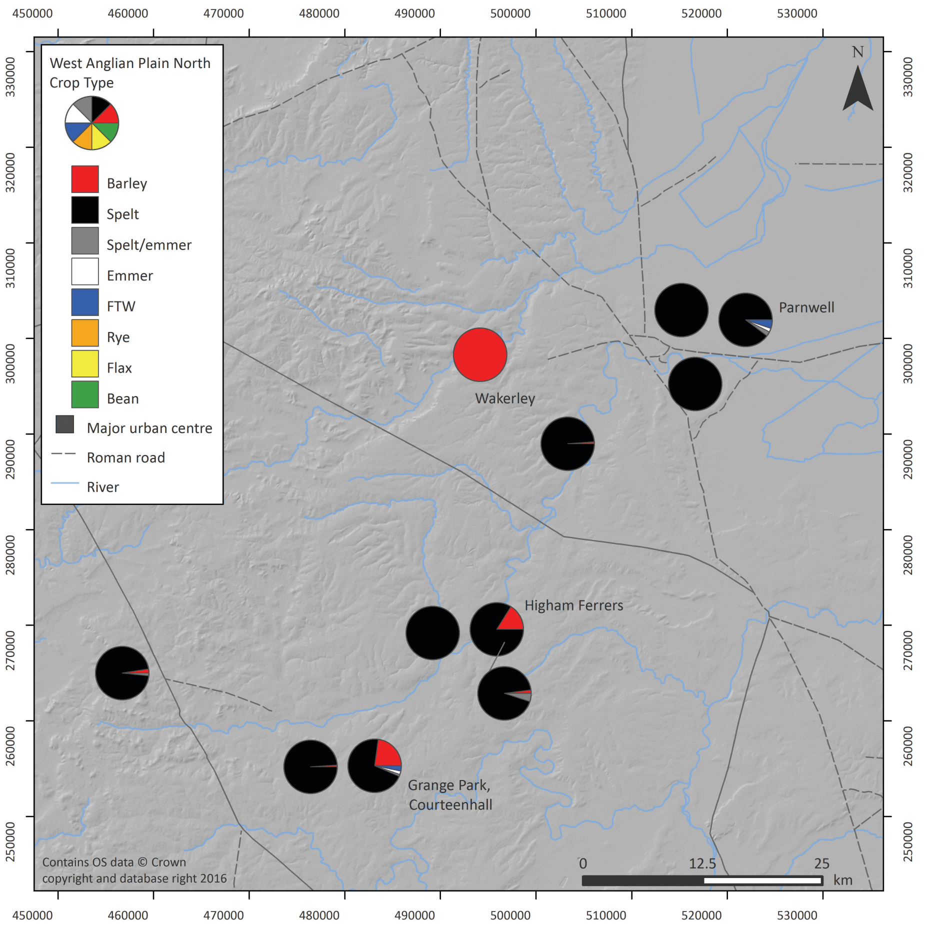

FIG. 2.15. Distribution of the sum of standardised crops per site in the West Anglian Plain north

little spelt but high proportions of free-threshing wheat and barley in the north-eastern part of the case study area, along the Fen edge. These sites include Harradine's Farm, Woodhurst (late Roman farmstead: Williams 2011), Godmanchester (walled 'small town': A. Jones 2003), and Little Paxton Quarry (late Iron Age and early Roman complex farmstead: A. Jones 2011), all in Cambridgeshire. The variation in the phasing of these sites shows that this is not a change linked to the supply of urban markets. There are also sites with reasonable quantities of flax: in the south-west, Renny Lodge, Newport Pagnell (Budd and Crockett 2009), and in the north-east, Harradine's Farm, Woodhurst. Chronologically, there is a substantial presence of emmer wheat in the late Iron Age (49 per cent), before a sudden decrease to 4 per cent in the late Iron Age/early Roman period, as spelt wheat becomes the dominant glume wheat (66 per cent). Spelt wheat continues to increase in abundance throughout the Roman period, averaging 86 per cent in the late Roman period. Barley decreases from 21 per cent in the late Iron Age before averaging just 4 per cent per site in the late Roman period (TABLE 2.11). Considering the West Anglian Plain as a whole, there is a clear difference between crop choice at different site types (FIG. 2.17). At complex

TABLE 2.10: AVERAGE PERCENTAGE OF CROPS PER SAMPLE PER PERIOD IN WEST ANGLIAN PLAIN NORTH

	Late Iron Age	*Late Iron Age/ early Roman*	*Mid-Roman*	*Late Roman*
Barley	25	20	1	16
Spelt	71	65	83	75
Emmer	1	2	4	4
Combined glume wheats	73	78	94	79
Free-threshing wheat	2	3	5	5

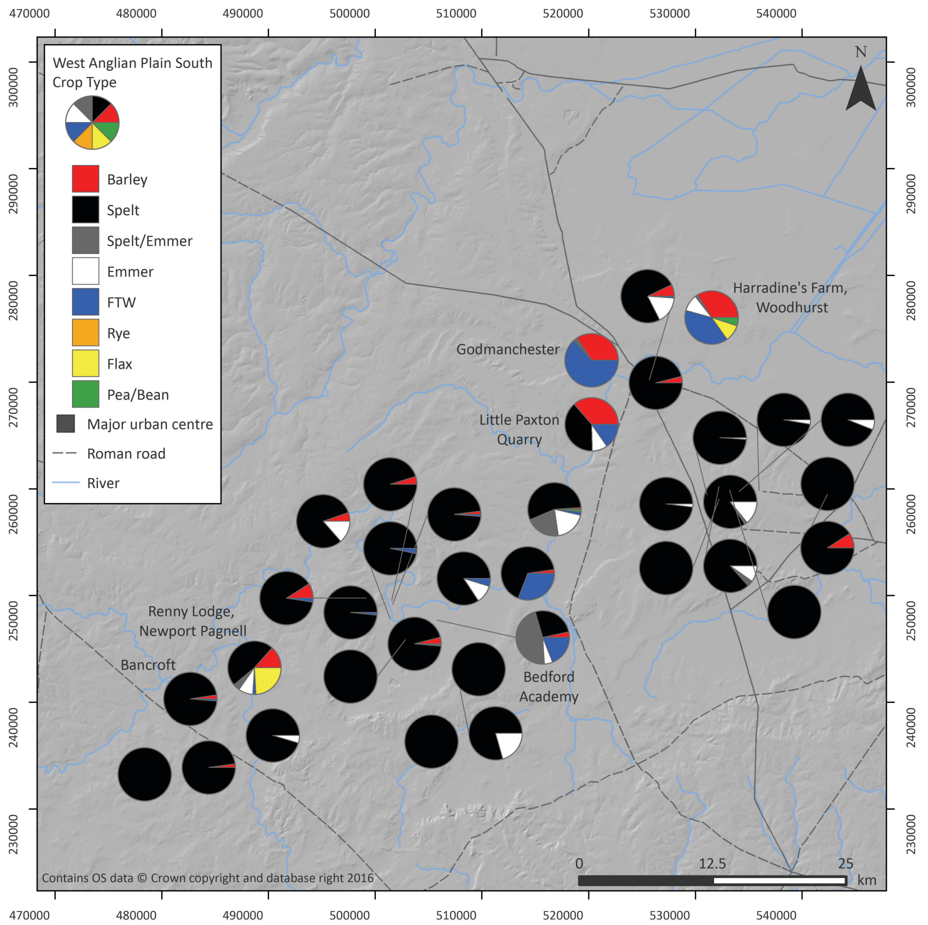

FIG. 2.16. Distribution of the sum of standardised crop items per site in the West Anglian Plain south

TABLE 2.11: AVERAGE PERCENTAGE OF CROPS PER SAMPLE PER PERIOD IN WEST ANGLIAN PLAIN SOUTH

	Late Iron Age	*Late Iron Age/ early Roman*	*Early Roman*	*Mid-Roman*	*Late Roman*
Barley	21	17	9	5	4
Spelt	20	66	75	83	86
Emmer	49	4	5	9	4
Combined glume wheats	76	79	86	92	92
Free-threshing wheat	3	4	5	3	4

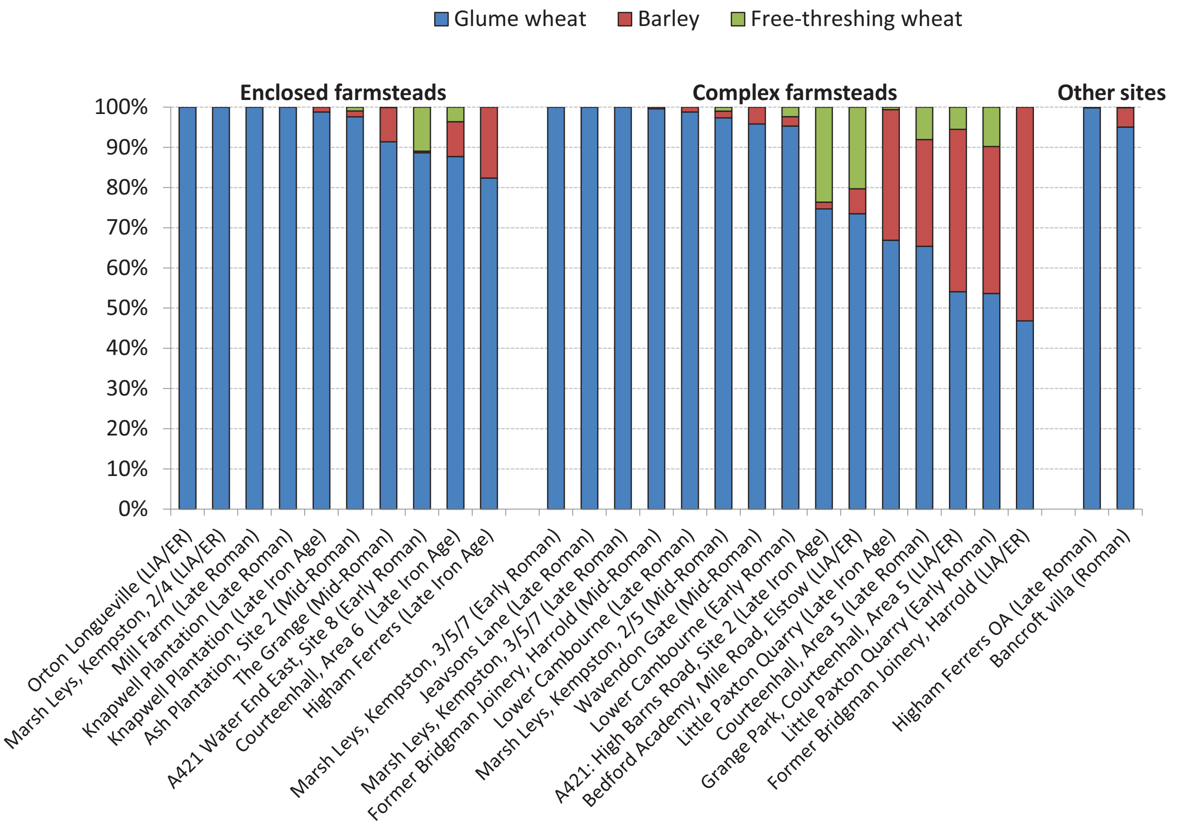

FIG. 2.17. Average percentage of glume wheats, barley and free-threshing wheats per site in the West Anglian Plain

farmsteads, such as Little Paxton Quarry and Bedford Academy (Ingham and Pilkinton 2012), there are substantial proportions of barley and free-threshing wheat in the late Iron Age and early Roman period. However, mid- and late Roman complex farmsteads are focused on glume wheats, averaging between 90 and 100 per cent, other than at Grange Park, Courteenhall, Northamptonshire (L. Jones *et al.* 2006). Enclosed farmsteads do not show the same shift in crop choice, but have relatively low proportions of barley and free-threshing wheat in all periods. The only assemblages from a roadside settlement (Higham Ferrers) and a villa (Bancroft, Buckinghamshire; Williams and Zeepvat 1994) comprise over 95 per cent spelt wheat, showing that these sites also concentrated on the processing of spelt wheat.

The Central Belt – Upper Thames Valley and margins

The Upper Thames Valley provides a similarly well-analysed landscape of gravel terraces and floodplains as the West Anglian Plain. The only major town, Cirencester, has a very limited archaeobotanical record (Carruthers 2008), as do the minor towns of Alchester and Dorchester-on-Thames. Fully quantified samples were available from 39 sites, and the distribution of these samples shows several interesting patterns (FIG. 2.18). Sites located on Akeman Street Roman road across the north of the Upper Thames Valley have high proportions of spelt wheat. These include sites such as Weedon Hill (Wakeham and Bradley 2013) and Aston Clinton Bypass Lower Icknield Way site B (Masefield 2008) in Buckinghamshire, and Wilcote (Hands 2004) and Whitelands Farm

TABLE 2.12: AVERAGE PERCENTAGE OF CROPS PER SAMPLE PER PERIOD IN THE UPPER THAMES VALLEY

	Late Iron Age	*Late Iron Age/ early Roman*	*Early Roman*	*Mid-Roman*	*Late Roman*
Barley	31	37	18	16	22
Spelt	56	52	59	58	53
Emmer	3	2	5	10	5
Combined glume wheats	67	58	79	80	70
Free-threshing wheat	2	5	3	4	8

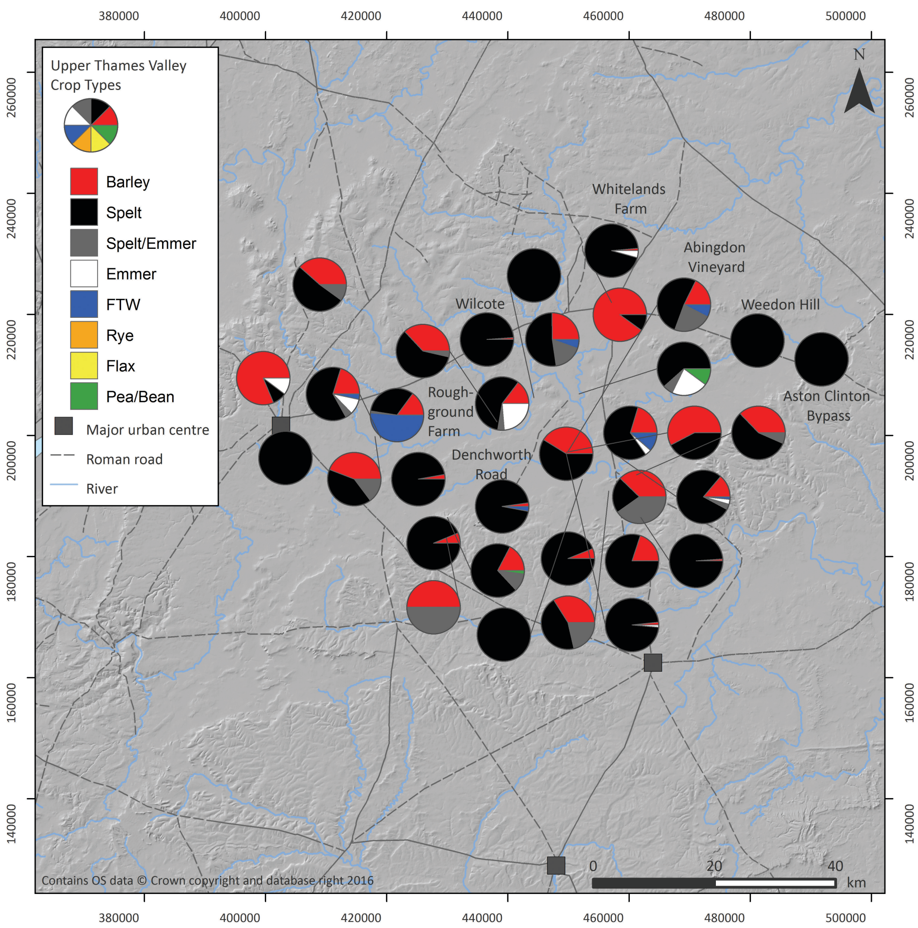

FIG. 2.18. Distribution of the sum of standardised crop items per site in the Upper Thames Valley and margins

(Martin 2011) in Oxfordshire. In contrast, sites in the centre of the valley have higher proportions of barley, such as Old Shifford Farm (Hey 1995) and Ashville (Parrington 1978), as do those on the limestone hills of the Cotswolds, as at Guiting Manor Farm (Vallender 2005) and The Ditches, North Cerney (Trow *et al.* 2009). Proportions of emmer are generally low, other than some sites in the central part of the Thames Valley around Oxford. Proportions of free-threshing wheat are also low, highest at Roughground Farm villa, Gloucestershire (Allen *et al.* 1993) and Abingdon vineyard, Oxfordshire (Allen 1993), which were both early studies and possibly unreliable.

Chronological patterns in the data (TABLE 2.12) show relative consistency between all periods, with barley always represented as a substantial proportion of the total crops; 31 per cent in the late Iron Age, 16 per cent in the mid-Roman period and 22 per cent in the late Roman period. After a small-scale presence in the late Iron Age, free-threshing wheat becomes more abundant in the mid-Roman period, reaching an average of 4 per cent, and emmer continues to be present in small proportions from the late Iron Age (3 per cent) until the late Roman period (5 per cent). The combined glume wheats are always the most dominant crop, although they are present in lower

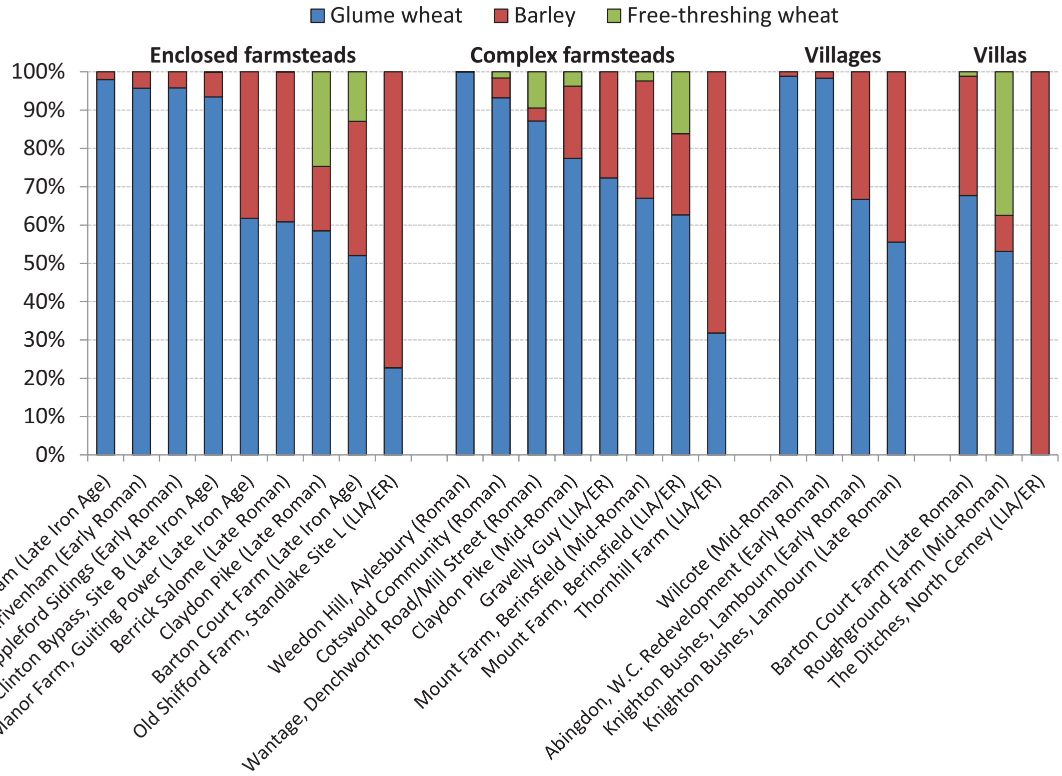

FIG. 2.19. Average percentage of glume wheats, barley and free-threshing wheats per site in the Upper Thames Valley and margins

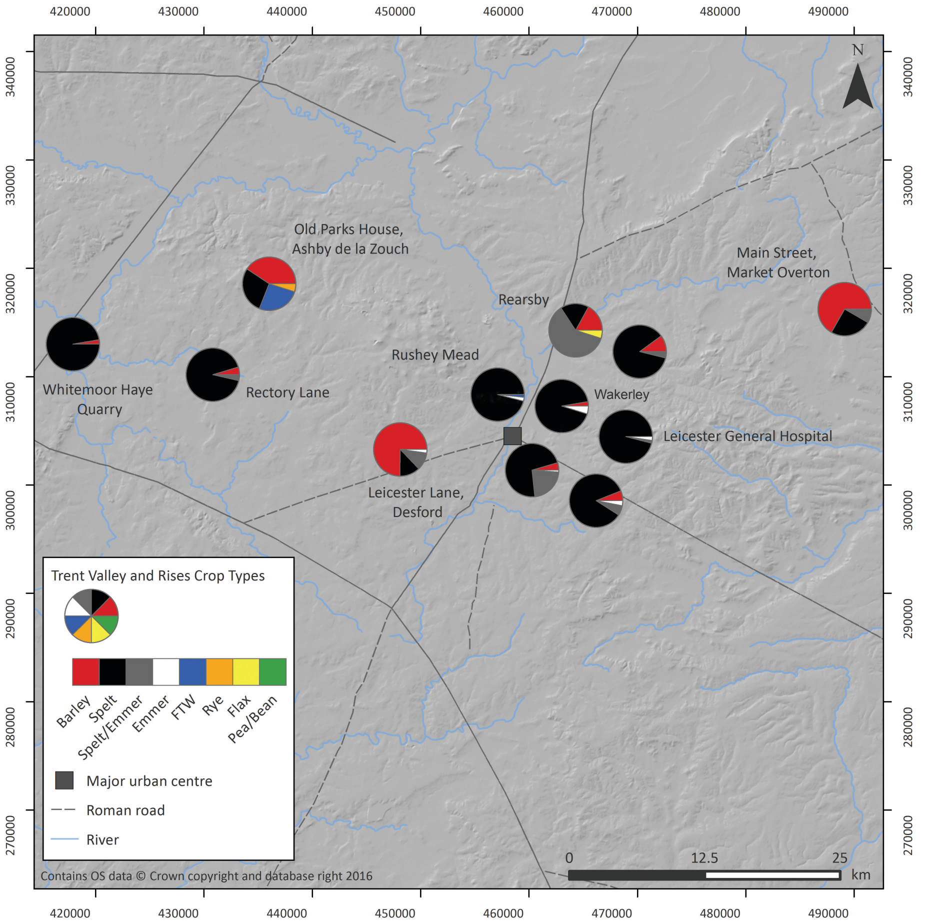

FIG. 2.20. Distribution of the sum of standardised crop items per site in the Trent Valley and Rises

TABLE 2.13: AVERAGE PERCENTAGE OF CROPS PER SAMPLE PER PERIOD IN THE TRENT VALLEY AND RISES

	Late Iron Age	*Early/mid-Roman*	*Late Roman*
Barley	21	24	6
Spelt	66	64	87
Emmer	1	1	2
Combined glume wheats	76	71	93
Free-threshing wheat	2	5	0

proportions than other case study areas, peaking at only 80 per cent in the mid-Roman period. There is no substantial variation between the quantities of different crops at different site types, in contrast to the West Anglian Plain (FIG. 2.19). The majority of enclosed and complex farmsteads produced predominantly glume wheats, although with at least 10 per cent barley, while the three villas (Barton Court Farm (Miles 1986), The Ditches and Roughground Farm) show a more diverse crop spectrum.

TABLE 2.14: AVERAGE PERCENTAGE OF CROPS PER SAMPLE PER PERIOD IN THE NORTH-EAST

	Late Iron Age/ early Roman	*mid-/late Roman*
Barley	19	21
Spelt	24	47
Emmer	55	7
Combined glume wheats	79	67
Free-threshing wheat	2	12

The Central Belt – Trent Valley and Rises

Fifteen sites with quantified data were available from the Trent Valley and Rises around Leicester (FIG. 2.20), a *civitas* capital that has good archaeobotanical evidence for the use of spelt wheat and barley (Monckton 1999). There are sites with high proportions of spelt wheat, and low proportions of barley, emmer and free-threshing wheat (Whitemoore Haye Quarry, Staffordshire; Rectory Lane, Rushey Mead, Leicestershire; Leicester General Hospital, Leicestershire), and sites with high proportions of barley and/or free-threshing wheat (Main Street, Market Overton, Rutland; Leicester Lane, Desford, Leicestershire; Old Park House, Ashby de la Zouch). Flax was present in higher amounts than typical at Rearsby, Leicestershire (R. Moore 2009). The key chronological change is the decrease in the average proportion of barley from 21 per cent in the late Iron Age to 6 per cent in the late Roman period (TABLE 2.13). Commensurate with this change is the increase in the dominance of combined glume wheats, from 76 per cent in the late Iron Age to 96 per cent in the late Roman period, a change driven by spelt wheat, since emmer was already a minor proportion (1 per cent) in the late Iron Age.

The North-East

While the central southern area of Roman Britain has traditionally been seen as the centre of arable production, farmsteads were also practicing arable cultivation in the North-East, with the distribution of corndryers extending into this region (FIG. 2.1). Numerous studies of the *colonia* at York have indicated the presence of stores of cereals, primarily spelt wheat and barley, within the town (Kenward and Williams 1979; Hall and Kenward 1990). The distribution of sites from selected parts of this region shows some, on the Southern Magnesian Limestone, with higher proportions of spelt wheat, and others, on the Coal Measures and Humberhead Levels, with higher proportions of barley (FIG. 2.21). Free-threshing wheat is present at several sites. Emmer wheat is a substantial crop at just two sites – Holmfield Interchange (Brown *et al*. 2007) and Swillington Common (Roberts *et al.* 2001), both in West Yorkshire. Although the number of samples available is limited, the key chronological pattern is a decrease in emmer wheat from an average of 55 per cent in late Iron Age/early Roman samples to 7 per cent in mid-/late Roman samples, an increase in spelt wheat from 24 to 47 per cent, and a small increase in barley from 19 to 21 per cent (TABLE 2.14).

CROP CHOICE: SUMMARY

This analysis has re-affirmed that spelt wheat became the dominant crop in the Roman period in all regions, based on the average proportions of crops represented in individual samples. The pattern arises from two aspects: the shift from emmer to spelt wheat as the dominant glume wheat crop, and the increased proportions of the combined glume wheats in comparison to barley. Crucially, these changes were not highlighted by simple presence/absence analysis (see above p. 17), which showed continuation in the occurrence of spelt and barley, and a much slower decrease in the importance of emmer. Barley, as a free-threshing cereal, is less likely to come into contact with heat

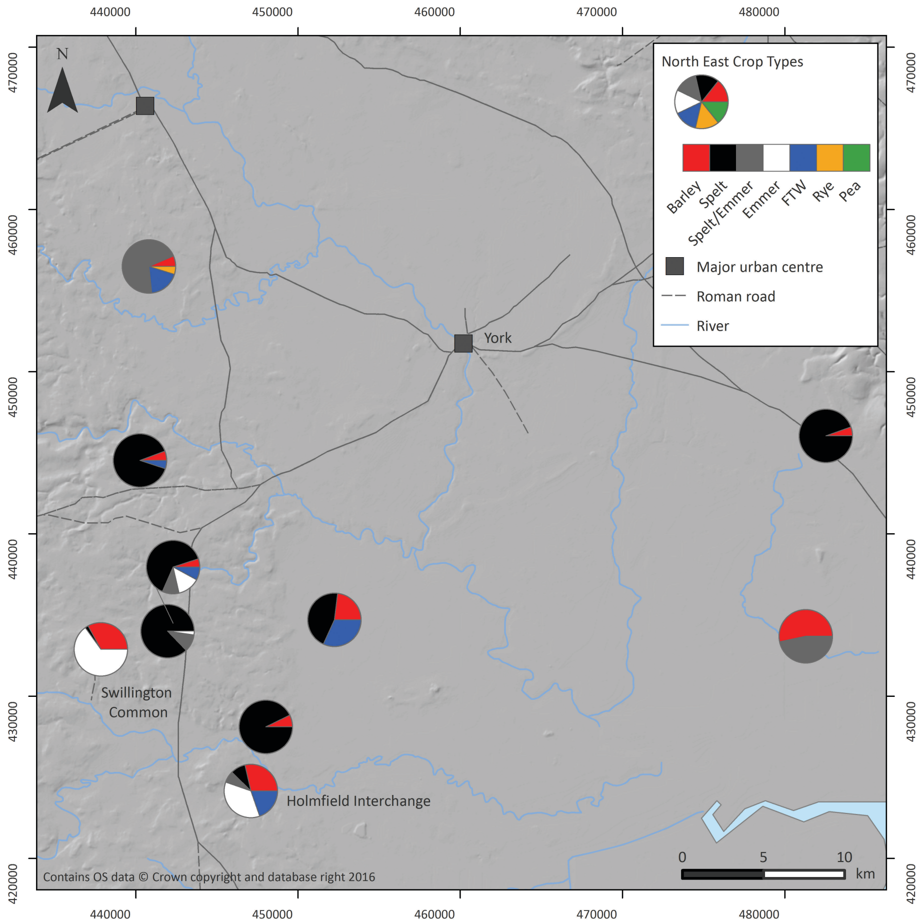

FIG. 2.21. Distribution of the sum of standardised crop items per site in the North-East

and become charred during processing than glume wheats. Hence, it may not have formed such a small percentage of the crops cultivated as the composition of charred cereal assemblages suggests. However, the shift in relative proportions of barley and glume wheats through time does indicate a change in their relative importance as cultivated crops. While much of the spelt wheat recorded in mid- and late Roman assemblages derives from fuel in corndryers, there is no reason why barley rachis could not also have been used if it was available in large quantities. These shifts in the proportion of glume wheats and barley occurred at different times in different regions. Emmer wheat was still present in substantial quantities during the late Iron Age in Kent, the West Anglian Plain south, the South-West and the North-East, although in all areas other than the South-West and the North-East, emmer had declined to 5 per cent or under by the early Roman period. This shift from emmer to spelt wheat can be considered as an indication of more extensive cultivation regimes, having larger areas cultivated with lower inputs of labour and resources (Van der Veen and O'Connor 1998, 131–3). In addition, the trend towards an increasing focus on producing glume wheats rather than barley suggests specialisation in one crop in order to create surplus for the market. In the West Anglian Plain and Kent, where we see a switch towards glume wheat-focused arable farming by the late Iron Age/early Roman period, there is also site-type variation. Roadside settlements and villas in both regions produced an average of over 80 per cent glume wheats, while enclosed farmsteads in the West Anglian Plain show a clear shift towards glume wheats in the early Roman period, to join the complex farmsteads that were already focused on glume wheats from the late Iron Age.

There was no substantial variation in crop choice by site type observed in the Upper Thames Valley or Wessex, while combined glume wheats do not reach over 80 per cent until the mid-Roman period in Wessex, and not at all in the Upper Thames Valley. Hence, we have a shift towards glume wheat-focused arable farming earlier in the East than the West. Free-threshing wheat increases in all periods in all regions, but samples dominated by free-threshing wheat are rare, and the status of the crop remains unclear. The proportions of cultivated oat, pulses and rye are very small, with no certainty that any settlements were cultivating these as crops. Millet has not been identified from any rural settlements in Britain, being recorded only at very few military and urban sites – Alchester (Sauer 2006), Carlisle (Huntley 1989) and London (Willcox 1977). This absence confirms that the observed shifts in carbon isotope ratios in humans cannot result from the consumption of millet cultivated in Britain, but rather because of the consumption of fish and shellfish (Müldner 2013).

Rippon has placed great emphasis on regional variations in crop choice in Roman Britain based on soil type – with bread wheat dominant on heavy soils, emmer on lighter soils, and barley on chalk soils (Rippon 2013, 132–3; Rippon *et al.* 2015), although the inclusion of oat, and merging of all wheats, obscures patterns in his analysis. Wessex, a calcareous region, has indeed shown the highest percentages of barley at an average of 23 per cent (TABLE 2.6), in comparison to the other more geologically mixed regions. This chapter's approach of analysing crop choice at a regional level may well have obscured more localised relationships between certain crops and soils. However, the common shifts towards spelt wheat indicate the significance of wider factors, namely the supply of food to the military and civilian population, in leading to a shift towards large-scale spelt production. It is likely that areas with higher percentages of barley in archaeobotanical samples, namely the Upper Thames Valley and the Wessex Downs, were cultivating higher proportions of barley than glume wheats (see above, pp. 24 and 28). This may represent local food choices, or a focus on producing barley for fodder, and a reduced emphasis on large-scale arable farming compared with Kent or the West Anglian Plain.

PULSES

In addition to spelt, emmer, barley and several minor cereal crops, two pulse crops, *Pisum sativum* L. (pea) and *Vicia faba* L. var. *minor* (Celtic bean), were already cultivated in Britain during the Iron Age (Campbell and Straker 2003), and continued to be throughout the Roman period, alongside a diverse range of new horticultural crops. *Vicia faba* var. *minor* is a small seeded variety of *Vicia faba* – broad or horse bean. The domestication process of *Vicia faba* is still unclear, but after originating in the pre-pottery Neolithic in the Near East, the current understanding is that only small-seeded varieties were cultivated in the prehistoric and Roman period (Zohary *et al.* 2012, 89–92). There is currently little evidence for pea in Neolithic and early Bronze Age Britain, but it commonly occurs from the Iron Age period onwards (Campbell and Straker 2003, 25).

Identifying the distribution and scale of pulse cultivation in Roman Britain is extremely difficult. Large legumes are rarely well enough preserved, i.e. with the hilum and testa intact, to allow identification to species or even genus, meaning that the category *Pisum/Vicia* is often reported rather than the species. In addition, as pulses do not require direct heating as part of food preparation, they are under-represented in charred assemblages and their remains also tend to fragment easily. Taking these considerations into account, regional and chronological patterns in pulse cultivation will now be explored.

NATIONAL DATASET

The presence of peas and beans in archaeobotanical assemblages was recorded combined within the 'pulses' category on the project database. While the mode of preservation was not consistently recorded, pulses occur very rarely in waterlogged assemblages, and therefore the vast majority of records are of charred pulses, with a small presence of mineralised peas and beans. As in the prehistoric period, most occurrences consist of just a few pulses, representing a small percentage of the total number of cultivated plants identified per site. Several high density deposits of pulses are also present, which can be interpreted as the accidental (or perhaps purposeful) destruction of pulses during cooking or storage. FIGURE 2.22 displays the proportions of peas, beans or pea/beans present in archaeobotanical assemblages across the eight main project regions. The highest proportion of pea is in the South, at 13 per cent, while the lowest is in Upland Wales and the Marches, where pea is present in only 3 per cent of assemblages. Pea-rich samples, or caches, are restricted to parts of southern and eastern England, having been recorded at late Iron Age Queen Elizabeth Square, Maidstone, Kent (Pelling 2004), The Grange, Cambourne, Cambridgeshire (C. Stevens 2009a), late Iron Age Suddern Farm (Campbell 2000b) and late Roman Chemistry Research Lab. site, Oxford (Pelling 2000) (FIG. 2.23).

Celtic bean has been recorded in all regions apart from the North and Upland Wales and the Marches (FIG. 2.22). It is usually less frequent than pea, present in 6–8 per cent of assemblages, other than in the South-West, where the proportion reaches 15 per cent. The distribution map (FIG. 2.23) emphasises the coastal distribution of Celtic bean, with several occurrences on the Sussex Plain and the south coasts of Dorset and Kent. There are currently more occurrences of Celtic bean in assemblages at the western end of the Central Belt, and more pea at the eastern end of this region. Bean-rich deposits have been recorded at early Roman Furfield Quarry, Boughton

Monchelsea in Kent (Mackinder 2006), late Iron Age Green Island, Poole Harbour, Dorset (Harding 2003a) and mid–late Iron Age Hamdon Hill, Montacute, Somerset, in 'special deposits' (Stevens 2006).

Beyond the continued cultivation of prehistoric pulse crops, there was also an increase in the oil crop flax in Roman Britain, this being only rarely found during the Iron Age (Campbell and Straker 2003). The status of flax as a textile or oil crop is

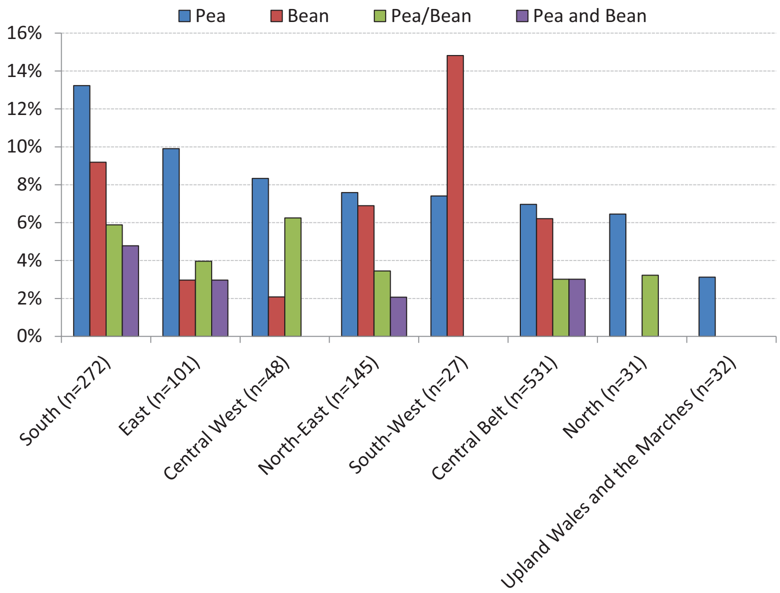

FIG. 2.22. Frequency of pulse crops in archaeobotanical assemblages by region

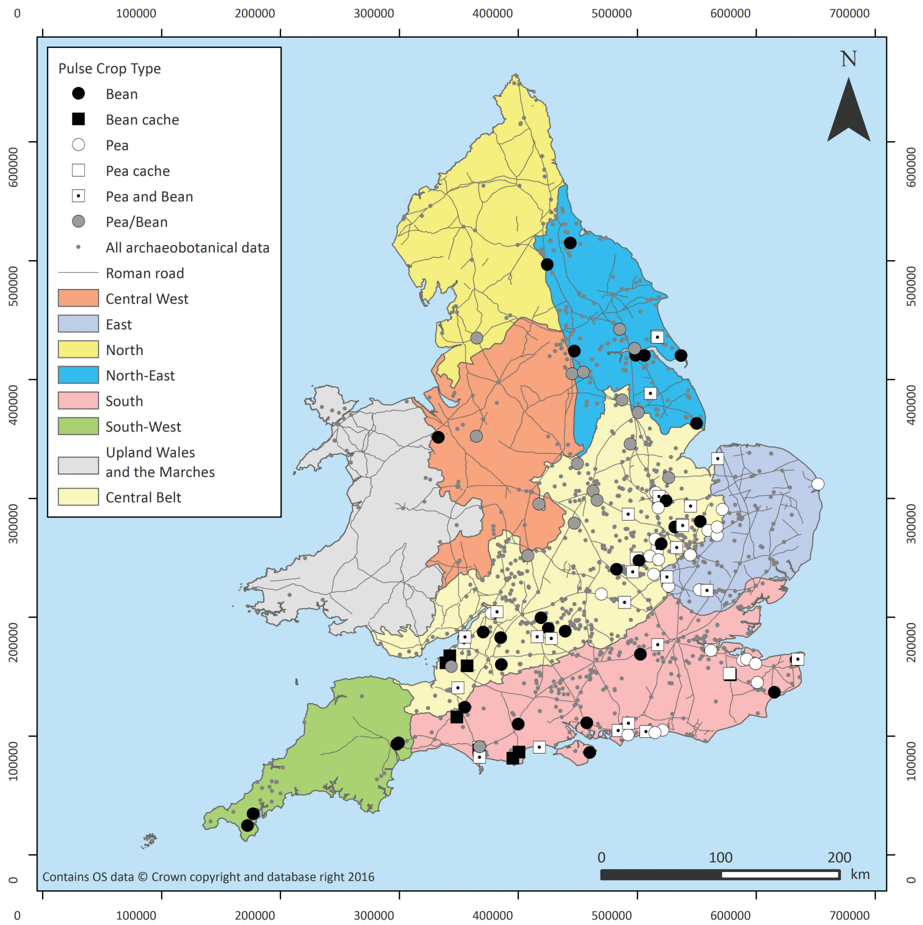

FIG. 2.23. Distribution of sites with pulse crops

evaluated in full in Chapter 5, although it is clear that it was consumed as a food, occurring, for example, in mineralised latrine deposits at mid-Roman Silchester (Robinson 2011).

CASE STUDY AREAS

Within the case study areas, there are certain landscapes where pulses have rarely been recorded. Within the Central Belt, pulses were absent from assemblages in the Trent Valley and Rises, possibly reflecting adverse preservation conditions typical of these soils. Pea was absent from the northern West Anglian Plain, but present at several sites in the southern West Anglian Plain and Upper Thames Valley (TABLE 2.15). All three areas had evidence for Celtic bean (TABLE 2.16). In the North-East, the only pulse recorded was pea, this being found in a few assemblages of late Roman date. In the South region, the calcareous landscape of Wessex has no records of Celtic bean, but several records of pea (present in 16 per cent of assemblages). In contrast, Kent has numerous sites with pea (32 per cent) and bean (24 per cent). The significance of pulse cultivation in Kent is also shown by pea/bean comprising 2 per cent of the average percentages of crops per site (see TABLE 2.6) and by the high frequency of pulses within individual sites. At Monkton, pea or pea/bean was present in seven out of eleven samples, and ten out of 28 samples at Northfleet villa. Pulses were especially common in the East Kent Access zone excavations, pea and pea/bean occurring in ten out of eleven samples in Zones 6 and 7 (a village), and seven out of eight samples in Zones 4 and 5 (a late Iron Age farmstead). Pea was interpreted as being an established crop at Monkton (Pelling 2008, 262), and, considering the frequency of pea and bean in Kent, it is possible that pulses were cultivated in rotation with cereals in order to maintain soil fertility (Zohary *et al.* 2012, 75).

TABLE 2.15: DISTRIBUTION OF PEA IN CASE STUDY AREAS OVER TIME
* indicates presence

	Late Iron Age	*Late Iron Age/ early Roman*	*Early Roman*	*Mid-Roman*	*Late Roman*	*Roman*	*Overall frequency (% presence)*
CENTRAL BELT							
Trent Valley and Rises (n=21)							0
West Anglian Plain north (n=14)							0
West Anglian Plain south (n=57)		*	*	*		*	9
Upper Thames Valley (n=60)	*		*		*	*	13
SOUTH							
Kent (n=38)	*	*	*	*	*	*	32
Wessex (n=43)	*	*			*	*	16
NORTH-EAST (n=18)					*	*	6
SOUTH-WEST (n=14)		*				*	7

TABLE 2.16: DISTRIBUTION OF CELTIC BEAN IN CASE STUDY AREAS OVER TIME
* indicates presence

	Late Iron Age	*Late Iron Age/ early Roman*	*Early Roman*	*Mid-Roman*	*Late Roman*	*Roman*	*Overall frequency (% presence)*
CENTRAL BELT							
Trent Valley and Rises (n=21)							0
Upper Thames Valley (n=60)	*	*		*	*	*	8
West Anglian Plain north (n=14)					*	*	7
West Anglian Plain south (n=57)			*	*	*	*	11
SOUTH							
Kent (n=38)	*		*	*		*	24
Wessex (n=43)							0
NORTH-EAST (n=18)							0
SOUTH-WEST (n=14)	*					*	14

PULSES: SUMMARY

While there are clear regional patterns in the use of pulses, identifying the role of Celtic bean and pea in the agricultural system is very difficult. It has been suggested that legumes form part of intensive crop husbandry regimes (Campbell and Straker 2003, 25), potentially featuring in crop rotation (Applebaum 1972, 115). The distribution of these crops does broadly match the areas of large-scale agricultural production – Kent, the Central Belt and Sussex Plain – although records from Cornwall show that pulses could also be part of small-scale intensive farming systems.

Pulses are nearly always present alongside much larger quantities of wheat and barley, but this could be due to the mixing of these items at any point during processing and storage. Pulses were definitely being consumed by some people, with pea and bean occurring in mineralised latrine deposits at mid-Roman Silchester (Robinson 2011) and Baldock (Hunn 1998) and pea only at Winchester Northgate House (Carruthers 2011). Charred assemblages from urban centres have also produced substantial quantities of pea and bean (Davis 2011; Helbaek 1952, 213). These occurrences do not preclude the possibility that many pulses were actually grown as fodder crops; indeed this is seen to be a widespread practice, recorded across the Roman world (White 1970, 189–90).

LAND PREPARATION AND HARVESTING

The annual tasks of soil preparation, sowing the seed-corn, tending the fields and harvesting crops, would have placed demands on labour throughout the year, being key activities through which social relationships were created, negotiated and reinforced (Taylor 2013). The lines of evidence for these processes in Roman Britain are almost entirely limited to archaeobotanical remains, although some items of material culture provide insights into the techniques of ploughing and harvesting. This section focuses on the type of arable weed seeds occurring alongside cereal remains, together with supporting archaeological evidence, in order to identify major trends in cereal cultivation practices.

SOIL PREPARATION

Field systems have generally received insufficient research focus, although recent cross-period (Fowler 2002, 127–60) and regional summaries (Taylor 2007, 55–72) have been published. Information on the layout of field systems derives from a combination of 'macro' approaches (aerial photography, LiDAR, GIS mapping) and the 'micro' approach of excavation (Chadwick 2013). Such detailed considerations of field size, layout and orientation, drawing on non-intrusive investigations and survey, are beyond the scope of this volume. An example of the potential for 'macro' scale analysis has been demonstrated through the EngLaID project, which has utilised GIS to investigate the alignment of field systems mapped through the NMP project, suggesting biases in orientation (Green 2016). The evidence for excavated field systems was addressed on a regional basis in Volume 1 (Smith *et al.* 2016), with the distribution of such landscape features shown in FIG. 2.1 above.

All types of land were utilised for cultivation in rural Roman Britain. Beyond the physical evidence for the fields themselves, the general range of cultivated landscapes can be considered through the arable weed seeds found alongside crops within archaeobotanical assemblages. Different weeds have different tolerances to soil conditions, with some taxa having particular preferences, and hence can be used as indicators for the type of soil being cultivated. In order to analyse these broad trends, the presence/absence of three indicator species has been assessed for all sites with charred plant remains in the Central Belt, a method first undertaken by Jones to examine Iron Age and Roman agriculture in the Upper Thames Valley (M. Jones 1981, 111). The three taxa are *Anthemis cotula* (stinking mayweed), a common annual herb of arable land, waste and rough ground, most commonly found on calcareous heavy clay and clay loam soils (Stace 2010, 75; Kay 1971), *Eleocharis palustris* (common spike rush), a perennial herb, found alongside or within ponds, marshes, ditches and riversides (Stace 2010, 946), and *Montia fontana* (blinks), an annual/perennial herb found in a range of damp places (*ibid.*, 507). While *Eleocharis palustris* is not known of as an arable weed today, it is considered to have been one in the past, associated with the expansion of cultivation onto marginal soils at the edge of gravel river terraces (M. Jones 1988), or perhaps puddles where arable soil has been compacted by ox hoof prints (Robinson pers. comm.).

The presence of these specific taxa shows two key chronological patterns (FIG. 2.24). First, *Anthemis cotula* increases in frequency over time, from being present at 14 per cent of late Iron Age sites, to 24 per cent of early Roman sites and 59 per cent of sites in the late Roman period. Second, the frequency of the wet-ground plants increases in the early Roman period, with *Montia fontana* being found at 41 per cent of sites and *Eleocharis palustris* at 53 per cent. These taxa decrease in frequency during the late Roman period. The initial increase in the cultivation of wet soils indicates agricultural expansion up to the edge of

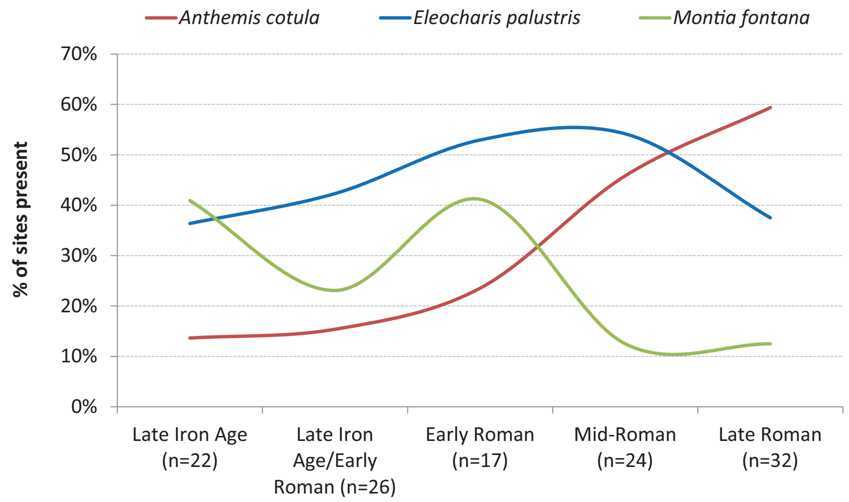

FIG. 2.24. Frequency of indicator weeds (*A. cotula, E. palustris, M. fontana*) at sites in the Central Belt

river floodplains, using all available land, while a late Roman decline shows that advances had been made in draining low-lying ground, or arable fields had shifted onto alternative soils, such as heavy clays. Alternatively, the late Roman decrease in wet-ground plants may reflect the decrease in settlement numbers in the third and fourth centuries A.D. (Smith and Fulford 2016), and a corresponding decrease in the cultivation of marginal land.

These patterns fit well with the accepted framework of late Iron Age and early Roman expansion onto marginal soils, before innovations in the mid-Roman period enabled the cultivation of clay soils (M. Jones 1981, 111–12). However, *Anthemis cotula* was only introduced to Britain during the late Iron Age (Preston *et al.* 2004; Robinson 1981, 275), and its absence from a site phase may be because the weed had not yet been introduced to the area rather than because of a lack of cultivation of heavy soils. Furthermore, much developer-funded work has shown that clay soils were intensively occupied and farmed much earlier. For instance, the claylands around Cambridge were first occupied from the mid-Iron Age (Smith 2016a, 195). Nevertheless, it remains the only indicator of clay commonly present in weed assemblages, and overall it is clear that a range of soil types were under cultivation, with expansion onto clay soils occurring over time.

MANURING

The application of manure to arable fields would have been an important practice to maintain or improve the yields of cereals and to avoid the risk of soil exhaustion. A wide range of soil-fertilising techniques is reported by the Roman agronomists, including animal manure (cattle, horse, poultry, sheep, etc.), green-manure, marling and seaweed (White 1970, 125–45). Excavated examples of chalk quarries have been recorded on 27 sites (see Ch. 5, p. 208), suggesting that chalk was also being used to produce agricultural lime to aid soil fertility (Dix 1979, 262). Evidence for manuring derives from ceramic scatters in fields, the type of weed seeds growing alongside cereals, and the isotopic composition of cereals themselves (Bogaard *et al.* 2016). Assemblages of waterlogged plant remains identified as fodder, bedding material and animal faeces, classified as so-called stable-flooring material (Kenward and Hall 1997), have been identified in samples from nucleated settlements and military centres from the late Iron Age and Roman periods (Lodwick 2016; see *Fodder* below, pp. 80–1), and show that there was ample material available for manuring. Ceramic scatters have long been the main dataset drawn upon as evidence for manuring across the Roman world (Friedman 2013; Witcher 2006); yet the reliability of ceramic scatters for identifying manuring is much debated (Bintliff and Snodgrass 1988; Alcock *et al.* 1994). A major issue is that the application of manure lacking ceramics would not be detectable (R. Jones 2004), leading to a circular argument that manuring can only be dated by ceramics (Gaffney and Tingle 1989). Iron Age ceramics are far less likely to survive in ploughsoil owing to their fragility, hence the presence of Roman ceramic spreads is likely to exaggerate the change in manuring practices (Lambrick 1992, 99). Another major constraint in terms of Roman Britain is that field survey data are poor when compared to those available in Roman Italy (Witcher 2006).

At Drayton, Oxfordshire, in the Upper Thames Valley, Roman fields were preserved beneath later alluvium. Present within the Roman ploughsoil was pottery in moderate to poor condition with a

FIG. 2.25. Plan of ceramic scatters and ard marks at Drayton, Oxfordshire (Lambrick 1992)

low average sherd weight of 5 g. The ceramic density varied from 1–3 sherds per 2 m square, within fields 1.5–4 ha in size (FIG. 2.25), and was interpreted as evidence for first to second-century A.D. manuring (Barclay *et al.* 2003, 104–16; Lambrick 1992). Nearby at Yarnton, fieldwalking was undertaken over an area of 182 ha, identifying three clusters of late Iron Age/early Roman ceramic scatters, again interpreted as intensive early Roman manuring of fields on the gravel terraces (Hey 2004). Manuring scatters have also been identified in the Nene Valley during the Raunds Area Survey. A detailed fieldwalking study showed that all settlements in the valley and on the Boulder Clay uplands had an associated manuring scatter, extending right to the edge of each farmstead's land. Overall, manuring is seen to have declined in this area from the late second/third century A.D. onwards (Parry 2006, 81). Later occurrences of manuring have been identified at Hunt's Hill, Greater London. Here an increase in Roman pottery sherds was recorded from *c.* A.D. 260 onwards, contemporary with the reorganisation of land into smaller fields (Howell *et al.* 2011, 82). Extensive ceramic scatters have also been reported in calcareous areas, such as around the villa at Maddle Farm on the Berkshire Downs (Gaffney and Tingle 1989), and within first to second century A.D. field systems at Overton Down site X/XI, Wiltshire (Fowler 2000, 92). Occasionally, smaller areas of manured horticultural soil have been identified during excavation, such as at Chisenbury Warren, Wiltshire, where fragmented and abraded bone and pottery were recorded within small plots (Fulford *et al.* 2006, 60–1). In contrast, fieldwalking at Burnby Lane, Hayton,

TABLE 2.17: FREQUENCY OF ARABLE WEEDS IN GLUME WHEAT FINE-SIEVE BY-PRODUCTS IN THE CASE STUDY AREAS

	CENTRAL BELT				*SOUTH*			
	TVR (n=8)	*UTV (n=89)*	*WAP N (n=19)*	*WAP S (n=61)*	*Kent (n=98)*	*Wessex (n=41)*	*NE (n=10)*	*SW (n=6)*
Agrostemma githago	0	10	21	5	14	5	0	0
Anagallis arvensis	0	3	11	0	7	7	0	0
Anthemis arvensis	0	0	0	0	0	17	0	0
Anthemis cotula	50	34	26	11	6	15	40	0
Aphanes arvensis	0	8	16	3	1	17	0	17
Atriplex sp.	0	56	26	46	40	54	40	83
Avena sp.	0	69	53	48	65	51	10	17
Bromus sect. *bromus*	75	56	84	66	54	61	90	17
Carex sp.	50	43	63	48	24	32	90	17
Centaurea sp.	13	11	0	10	7	15	10	0
Cerastium sp.	0	4	11	0	4	2	0	0
Chenopodium album type	63	49	26	34	31	39	70	0
Cirsium/Carduus	0	6	11	13	15	5	10	0
Eleocharis palustris	25	52	58	21	14	10	40	0
Fallopia convolvulus	38	33	21	25	44	39	10	0
Fumaria sp.	0	0	0	2	8	17	10	0
Galeopsis tetrahit	0	1	0	0	2	7	0	17
Galium aparine	0	43	47	23	38	59	60	0
Hyoscyamus niger	0	4	21	3	2	10	0	0
Isolepis setaceae	0	1	5	7	0	0	40	0
Juncus indet.	0	3	0	0	3	2	10	0
Lapsana communis	13	6	16	0	6	15	0	0
Leucanthemum vulgare	0	2	0	3	4	0	0	0
Lithospermum arvense	0	20	26	2	39	46	0	0
Malva sylvestris	0	8	0	5	10	2	0	17
Medicago/Trifolium	88	84	63	66	58	80	10	0
Montia fontana ssp.	25	11	42	23	10	2	10	0
Odontites verna	25	37	58	8	19	37	0	0
Papaver sp.	13	8	5	7	10	22	10	0
Persicaria maculosa/lapathifolia	50	9	11	10	9	5	30	50
Plantago lanceolata	25	15	42	31	35	41	50	0
Poaceae indet.	100	93	95	89	96	98	90	83
Polygonum aviculare	13	34	42	31	48	34	50	0
Potentilla sp.	13	9	0	5	1	7	20	0
Prunella vulgaris	0	8	5	8	7	12	20	17
Ranunculus a.r.b.	0	15	21	18	35	32	10	0
Rumex acetosella	38	25	32	38	28	17	30	0
Rumex sp.	100	82	100	85	93	88	90	0
Sherardia arvensis	0	3	16	7	19	32	0	0
Silene sp.	0	12	11	7	24	15	0	0
Spergula arvensis	13	1	0	3	5	7	0	17
Stellaria graminea	0	1	0	8	8	7	0	0
Stellaria media	0	29	21	23	23	27	0	0
Torilis sp.	0	10	5	0	9	10	0	0
Tripleurospermum inodorum	13	53	37	26	53	44	40	17
Urtica dioica	0	3	5	7	4	15	10	0
Urtica urens	0	11	11	3	3	7	0	0
Valerianella dentata	0	6	11	3	8	29	0	0
Vicia/Lathyrus	63	81	68	80	80	71	0	17

East Riding, recorded a low density of pottery sherds from an area of cropmarks, indicating a lack of manuring or a non-arable use of these enclosures (Halkon *et al.* 2015, 148).

Archaeobotanical data have the potential to provide much more specific information on the practice of manuring. Here, the British Ellenberg numbers are used for assessing the general preference of different plants for soil fertility, ranging from one (extremely infertile) to nine (extremely rich) (Hill *et al.* 2004, 16). Limitations to this approach are that soil fertility can be a product of various processes, from crop-rotation to manuring. Also, the range of weeds that have a preference for high fertility soils (members of the Chenopodietea class) tend to be associated with spring-sown cereals and also more intensive tillage practices (Bogaard *et al.* 2001). However, nitrogen (N) values are used here to consider broad trends in soil fertility. The frequency of standardised arable weed taxa have been calculated within samples assigned as glume wheat fine-sieve by-products (FSBPs) in all regional case study areas (TABLE 2.17), hence only the manuring of wheat crops is considered here. The frequency of weed taxa with high N values (*Chenopodium album* – fat hen, *Atriplex* sp. – oraches, *Stellaria media* – common chickweed and *Galium aparine* – cleavers) within glume wheat FSBP samples was assessed between case study areas (FIG. 2.26).

The Upper Thames Valley has higher frequencies of *Chenopodium album* (49 per cent) and *Stellaria media* (29 per cent) while Wessex has high frequencies of *Galium aparine* (59 per cent) and *Atriplex* sp. (54 per cent), indicating these are areas of higher soil fertility. The northern West Anglian Plain has comparatively lower frequencies of *Chenopodium album* (26 per cent) and *Atriplex* sp. (26 per cent), and the southern West Anglian Plain has low frequencies of *Stellaria media* and *Galium aparine*, both occurring in 23 per cent of samples. The North-East has the highest frequencies of *Chenopodium album* (70 per cent) and *Galium aparine* (60 per cent), although only ten samples were available. The overall picture is of consistency in the weed flora of different areas, with lower fertility soils in the West Anglian Plain and Kent, and higher fertility soils in the North-East.

In contrast, FIG. 2.27 shows the frequency of arable taxa with low N values, which are likely to occur in soil of low fertility (*Rumex acetosella* – sheep's sorrel, *Medicago*/*Trifolium* – medicks/clovers, *Vicia*/*Lathyrus* – vetches/peas and *Fallopia convolvulus* – black bindweed). *Medicago*/*Trifolium* and *Vicia*/*Lathyrus*, long associated with low soil fertility in the Upper Thames gravels (M. Jones 1981), are actually frequent in most case study areas – especially Kent and the Upper Thames Valley. These leguminous plants act as nitrogen fixers, owing to a bacterial association in their root nodes, and occur in soils with low nitrogen levels (Booth *et al.* 2007, 258–9). Corresponding to higher frequencies of high N value taxa, the North-East also has low frequencies of low N value taxa, with *Fallopia convolvulus* and *Rumex acetosella* present in only 10 per cent of samples. All other regions have at least one of the low N value taxa present in at least 60 per cent of glume wheat FSBP samples. The presence of weed taxa indicative of both fertile and unfertile soils in all areas indicates that cultivation took place on a variety of soils, representing changes over time, between farms, and perhaps within different fields, all of which require further investigation.

Chronological changes are considered in FIG. 2.28, with the Upper Thames Valley showing a peak in low soil fertility taxa during the early Roman period, *Vicia*/*Lathyrus* occurring in 92 per cent of samples and *Medicago*/*Trifolium* in 75 per cent of samples, followed mainly by a decrease in

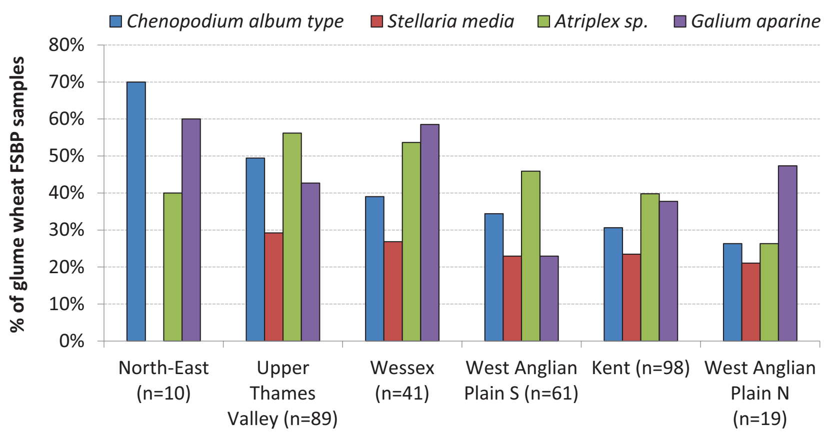

FIG. 2.26. Frequency of arable weeds indicative of high soil fertility in each case study area

the frequency of these taxa. In Kent, there is also a peak in low soil fertility taxa in the early Roman period, with *Medicago/Trifolium* in 75 per cent of samples, and the pattern also holds in the West Anglian Plain south, where there are early Roman peaks in *Fallopia convolvulus* (42 per cent) and *Medicago/Trifolium* (75 per cent). Overall, the patterns from these three areas are consistent in suggesting an early Roman decrease in soil fertility, followed by some form of recovery. This corresponds with the model of arable farming expanding in the early Roman period without a change in cultivation practices (Campbell 2008a; Taylor 2012, 190), thus leading to a decrease in soil fertility.

TILLAGE

The second crucial aspect of soil preparation is tillage – the mechanical disturbance of the soil to destroy weeds and produce a suitable soil texture for sowing seed-corn. Methods of tillage range from

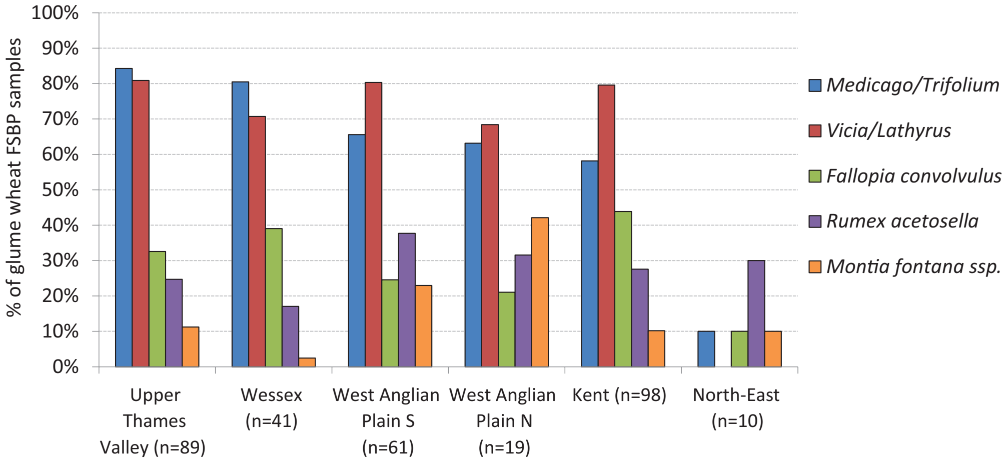

FIG. 2.27. Frequency of arable weeds indicative of low soil fertility within glume wheat FSBP samples in each case study area

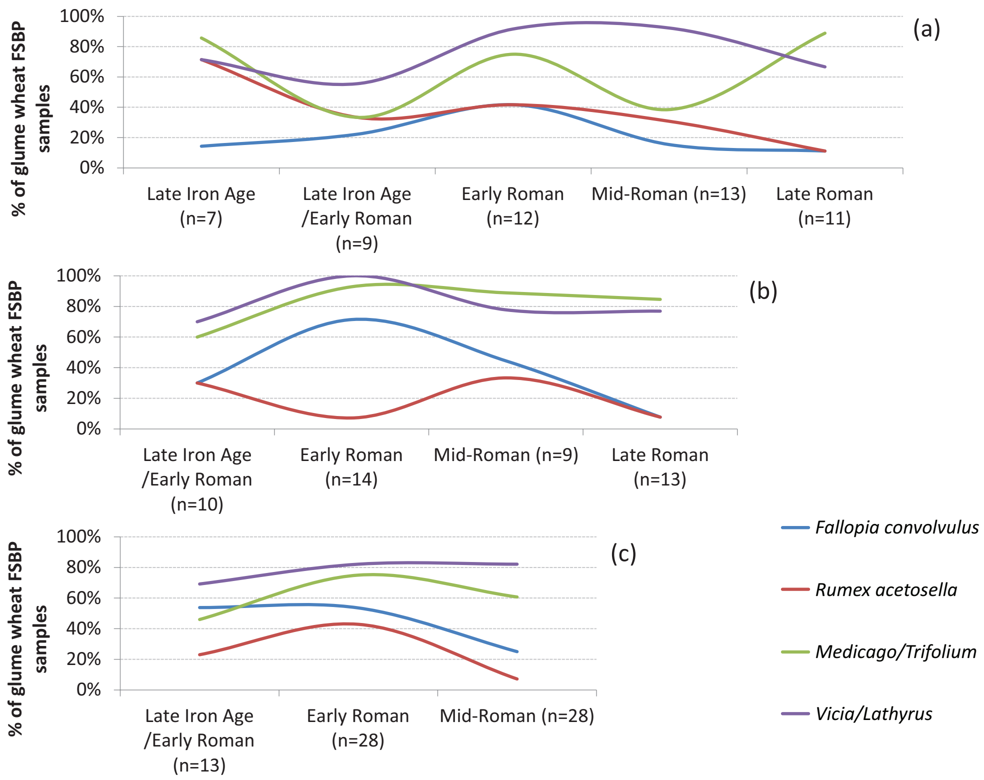

FIG. 2.28. Frequency of arable weeds indicative of low soil fertility within glume wheat FSBP samples in (a) the West Anglian Plain south, (b) the Upper Thames Valley and (c) Kent

intensive methods of digging and hoeing, to the use of animal traction in pulling an ard or a plough. Here, the evidence from artefacts, ard marks and weed ecology is addressed for identifying the type of tillage technology used in rural Roman Britain.

Ards or ploughs

By Tom Brindle

Despite being key agricultural objects, tillage implements are relatively uncommon finds from rural settlements, with elements of ploughs or ards identified at just 67 excavated sites (*c.* 2 per cent of sites in the project database). Most surviving elements are iron shares or iron share tips from wooden shares, along with a small number of coulters. The low number reflects poor preservation of iron as well as the likelihood that many iron objects would be recycled once worn out or damaged. Surviving wooden shares are rare but have been identified at Usk, Monmouthshire (Manning 1995), Walesland Rath, Pembrokeshire (Wainwright 1971a) and Abingdon, Oxfordshire (Parrington 1978).

As with many types of objects, there is a very uneven social distribution for tillage equipment, recovered from 6 per cent of roadside settlements, 5 per cent of villas and less than 2 per cent of farmsteads. The geographical distribution is also uneven, with a strong emphasis on the southern part of the province (see FIG. 2.1 for general distribution of agricultural tools). Taken in isolation, however, the distribution of extant ploughing equipment is probably little guide to the extent of arable agriculture. Whereas iron plough shares would be substantially more robust than those of wood, shares could be, and presumably at many sites usually were, made of wood, as the examples listed above illustrate. Iron share tips are among the more common finds, designed to provide a durable sheath for shares otherwise made of wood. However, in many areas fire-hardening wooden shares rather than sheathing them in iron may have formed an alternative way of increasing their durability, as on a first-century B.C. example from Walesland Rath (Rees 1979, 45; 2011, 91). The presence of iron plough shares may therefore say more about the wealth of the settlement from which they were recovered, as well as the general availability of iron objects made for particular technological purposes, than about the scale of tillage.

Where tillage implements have been identified, they are often listed in finds reports as plough share tips. In most cases these objects are technically more likely to relate to ards (light ploughs without a mouldboard for turning the cut sod) than heavy ploughs with mouldboards, and indeed the ard is likely to have been the principal tillage implement in use throughout most of Roman Britain (Fowler 2002). The two well-known models of ploughs from Roman Britain, from Piercebridge, Co. Durham, and an imprecisely provenanced example from Sussex, both appear quite clearly to represent ards rather than real ploughs (*ibid.*, 192). Ard share tips are well known from Iron Age sites (e.g. Balksbury Camp, Andover, Hampshire: Wainwright and Davies 1995; Gussage All Saints, Dorset: Wainwright 1979), and a rare survival of a wooden share from a secure third-century A.D. context at Abingdon, Oxfordshire, which was likely shod with an iron tip (Fowler 1978), demonstrates the continued use of wooden ard shares well into the mid-Roman period. Rees has noted a general chronological trend for iron share tips to increase in length during the early Roman period, which, she suggests, is perhaps more to do with the increasing availability and affordability of iron, rather than technological development (Rees 2011, 91–2).

In the later Roman period, ard shares were increasingly made entirely of iron, and the discovery of a number of iron foreshares and coulters indicates that by the late period ards were becoming heavier and increasingly sophisticated (Rees 2011, 93). Coulters, designed to cut the sod vertically in advance of the horizontally cutting share, appear to be a late Roman introduction. They are rare finds at rural settlements (identified at just ten sites on the database) and their association with villas and other sites that have unusually rich finds assemblages indicate that ards/ploughs fitted with these new features were expensive pieces of equipment, and not widely available. We do, however, need to be aware that iron could be and probably often was recycled, especially so at poorer settlements, and the distribution may not have been quite as restricted as our surviving evidence suggests. Further late changes in the types of share available indicate different types of tillage equipment, and the replacement of the ard at some sites with increasingly heavy ploughing equipment, designed for the tillage of heavy soils (Rees 1979, 94). While no mouldboards for turning the soil have been identified at rural sites, their presence in parts of Britain in the late Roman period is regarded as a distinct possibility (Rees 2011, 94), and some sophisticated ploughs may have been in operation. However, the overall dearth of all types of tillage implements from settlements, as well as their uneven social distribution, suggests that although new technology may have been adopted at some sites in the late Roman period, many Romano-British farmers continued to use wooden ard shares, which are difficult to identify archaeologically.

Ard marks

Ard marks can provide information on the type of ard or plough used, as well as the location of farming, field size and the frequency of cultivation. Ard marks are preserved if a recently arded furrow is covered by deposited material, or if a furrow penetrated below the sub-soil horizon and the land surface is covered by a range of materials (sand, peat growth, buildings) (Tegtmeier 1993).

The dating of these features is often problematic, relying on ceramics being deposited over the furrows, while origins other than cultivation could also be postulated for some sites, such as road construction (Fasham and Hamworth 1978). The presence of ard marks was not systematically recorded in the project database, though ten rural sites were noted as having these features, and evidence for cord rig and/or ard marks has been recorded at sixteen sites where the ground surface was sealed by the construction of Hadrian's Wall, Vallum and forts (Topping 1989; Symonds and Mason 2008, 8–9). The distribution of the ard mark sites in the project database, largely in the northern and south-western regions of Britain, is a product of local soil conditions and cannot inform upon agricultural practice in general. Unidirectional, V-shaped ard marks were recorded at the Cumbria Institute of the Arts Campus, Cumbria, dating to the pre- or early Roman period (Zant and Town 2013), while criss-cross ard marks were recorded within Iron Age and Romano-British fields at Stackpole Warren, Dyfed (Benson *et al.* 1990, 208). The most useful example, as with ceramic scatters, is at Drayton in Oxfordshire (see FIG. 2.25). Here criss-cross ard marks, spaced 0.5 m apart, with U or V-shaped furrows were recorded in several fields. Overlying these were distinctive marks created by a mouldboard plough, where soil layers had been sliced and inverted. These were dated to the late Saxon period on the basis of archaeomagnetic dating of the alluvium above (Barclay *et al.* 2003, 104–17).

Probable Roman plough marks have been recorded at Warren Villas, Bedfordshire. Iron Age or Roman criss-cross ard marks were sealed by second or third century A.D. ploughsoil, which contained unidirectional asymmetrical plough marks, considered to date to the Roman period. Furthermore, the ploughsoil contained waterlogged seeds of plants that grow in wet conditions, such as *Isolepis setacea*, indicating the use of a heavy plough on wet soils (Bedfordshire Archaeology Service 1995). Overall, on the basis of the limited ard mark evidence, it seems more likely that ards rather than mouldboard ploughs were generally in use in Roman Britain, with some instances of more developed ploughs in the later Roman period, consistent with the material culture evidence outlined above.

Weed ecology evidence for ploughing

In contrast to the limited distribution of ard marks and artefactual remains, charred plant remains have a much greater capacity to inform us about the type and frequency of tillage used to cultivate fields across Roman Britain. Mouldboard ploughing is considered to cause an increase in the proportion of annual arable weeds (Van der Veen 1992, 137–8), such as *Polygonum aviculare* (knotgrass) and *Fallopia convolvulus* (black bindweed), which can survive disturbance. In contrast, less intensive practices would cause an increase in the proportion of perennials such as *Rumex* spp. (docks) and *Taraxacum officinale* (dandelion) (Pollard and Cussans 1976). Martin Jones (2009) has suggested that seed dormancy and the ability to regenerate despite soil disturbance could also be used as ways to separate arding and ploughing, though this remains unsubstantiated. While variations in the proportions of annual and perennial weeds may relate to the frequency of

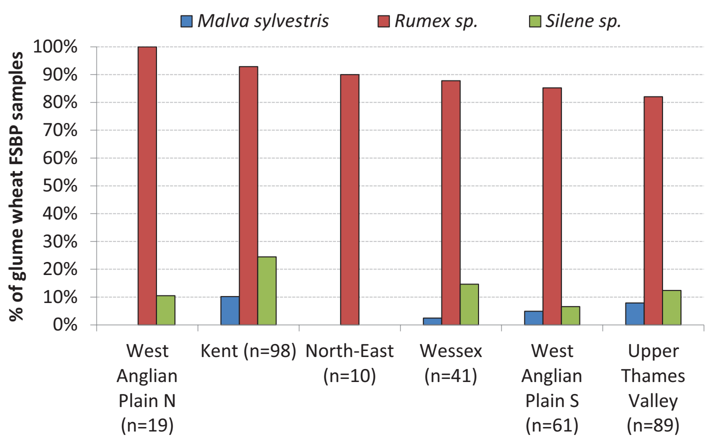

FIG. 2.29. Frequency of perennial weed taxa in glume wheat FSBP samples by case study area

tillage rather than ploughing (Stevens 2004, 364), as a simple method to assess an increase in the intensity of tillage it is considered useful here. A move from arding to mouldboard ploughing can be expected to result in a decrease in the proportions of perennial weed taxa, with perennial weeds that can regenerate from rhizomes, such as *Potentilla reptans* (cinquefoil) and *Ranunculus repens* (creeping buttercup) categorised as annuals (Hillman 1981, 145).

Overall, there is a dominance of annual weed taxa, with very few perennial taxa present in any area (FIG. 2.29). The only perennials present in the reduced weed dataset are *Rumex* sp., *Silene* sp. and *Malva sylvestris*. The *Rumex* sp. category does not include *R. acetosella*, which can regenerate from rhizomes. *Rumex* sp. (docks) are consistently common in glume wheat FSBP from all areas, indicating that tillage practices were not intensive enough to completely remove perennial weeds from the arable weed flora. The other perennials are much rarer. When individual case study areas are considered chronologically (FIG. 2.30), no consistent changes can be observed over time. The Upper Thames Valley has a slight decrease in the frequency of *Rumex* sp. from 93 per cent in the early Roman period to 77 per cent in the late Roman period, while Kent has a slight increase from 77 per cent in the late Iron Age/early Roman to 100 per cent in the mid-Roman period. In all cases, *Rumex* sp. is still a common arable weed by the mid–late Roman period. Hence there is no evidence for a significant change in tillage technology from the late Iron Age to late Roman period, and it seems most likely that arding continued from the Iron Age into the Roman period.

SOWING

The choice of when to sow seed-corn would have been a significant factor in labour scheduling, risk buffering, and the social organisation of agricultural practices. There are three key variables within sowing: the method of sowing, how much seed-corn was used and the season of sowing. Evidence for the first two factors mainly comprises iconographic depictions and written evidence from elsewhere in the Roman world, though Rees (2011, 97) has suggested that the iron prongs typically interpreted as harvesting rakes may sometimes have been components of harrows for soil preparation and seed covering.

Broadcasting is the only recorded method of sowing, described by Pliny and depicted in a mosaic from first–second century A.D. Cherchell, Algeria (White 1970, 178–80), with Roman agronomists suggesting sowing rates of 135 kg of seed-corn per hectare in Italy (Goodchild 2013). Sowing can either be carried out in the autumn, soon after the harvest, or in spring, with autumn crops being harvested earlier in the following summer. Based upon written sources, White (1970, 80) argued that autumn would have been the main sowing time in the Mediterranean, with

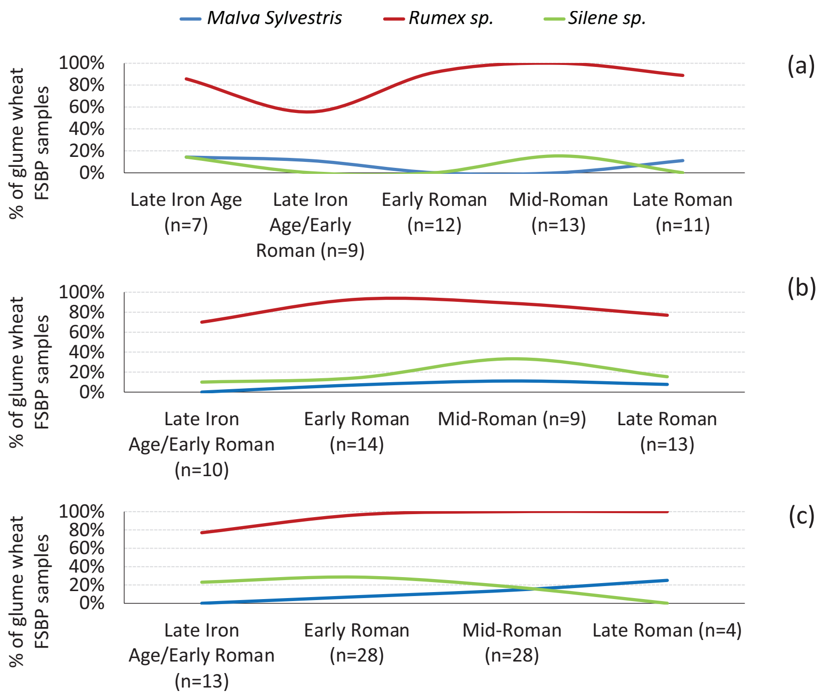

FIG. 2.30. Frequency of perennial weeds within glume wheat FSBP samples over time in (a) the West Anglian Plain south, (b) the Upper Thames Valley, and (c) Kent

spring sowing occurring only if the autumn crop failed, or multi-cropping was being practised. Some previous syntheses for Roman Britain made assumptions based upon more recent crop cultivation regimes, with, for example, spelt wheat being seen as more suited to autumn sowing because it is vigorous enough to survive cold and wet winters, and emmer more likely to be spring sown as it is less resistant to frost (Percival 1921, 326; Applebaum 1972). However, these presumptions have been criticised, as the wild ancestors of these cereals are autumn germinating, and spring sowing is seen as a high-risk strategy by contemporary traditional farmers (Hillman 1981; Van der Veen 1992, 130). Qualitative syntheses have suggested both spring and autumn sowing of spelt and barley were taking place in the Upper Thames Valley in the Roman period (Booth *et al.* 2007, 285), yet these typically draw on the presence of a few species, especially *Galium aparine* (Van der Veen 1992, 133).

Archaeobotanical attempts to reconstruct sowing time have drawn on two aspects of arable weeds, the time of germination and the onset and duration of the flowering period. Van der Veen's analysis of Iron Age and Roman archaeobotanical data from north-east England, utilising the germination time of weed seeds, was inconclusive (Van der Veen 1992, 132–3). Since then, an analysis of modern floristic data on weed communities from spring- and autumn-sown crops grown in Germany found that specific functional attributes, in this case the time of onset and length of the flowering period, best separated the weed associations into those of spring and autumn crops (Bogaard *et al.* 2001). This classification was applied to a recent study of archaeobotanical data from the east of England, which concluded that autumn sowing was the norm, with spring sowing only identified at exceptional sites such as mid-Iron Age Isle of Ely, Cambridgeshire, and late Iron Age–early Roman Heybridge, Essex (Parks 2012, 244). The only other detailed analysis of Iron Age/Roman sowing time was on the dataset produced by the Danebury environs programme, which considered the overall frequency and range of percentage per sample of *Avena* (oats) and *Bromus* S. *Bromus* (brome grass) seeds. The Iron Age analysis found that as the frequency of *Avena* seeds increased, *Bromus* S. *Bromus* decreased, interpreted as a move from autumn sowing of spelt and barley in the early and middle Iron Age to spring sowing of barley and autumn sowing of spelt wheat in the late Iron Age (Campbell 2000a, 48–50, 55–6). The Roman data from the same areas showed a continuation of this pattern (Campbell 2008a, 68).

The presence of *Avena* sp. (flowers July–September; late and long group) and *Bromus* S. *Bromus* (flowers May–July or June–July; short and early group) in the glume wheat FSBP have been assessed from each case study area (FIG. 2.31), showing that *Bromus* S. *Bromus* is more common in the North-East, West Anglian Plain and Wessex, while *Avena* sp. is more common in Kent and the Upper Thames Valley. Overall, the continued presence of short and early weeds indicates autumn sowing of wheat is more likely. Considering all weed seeds present, samples have been classified as group A (no short and early taxa), group B (1–20 per cent short and early taxa) and group C (over 20 per cent short and early taxa) (FIG. 2.32). There are some samples in Kent, West Anglian Plain south, Wessex and the Upper Thames Valley that lack any short and early flowering taxa, representing candidates for spring sowing. Of these, the number of arable weeds of intermediate flowering onset and duration nearly always outnumber those of late flowering and long flowering duration, making it impossible to identify spring sowing. Areas with

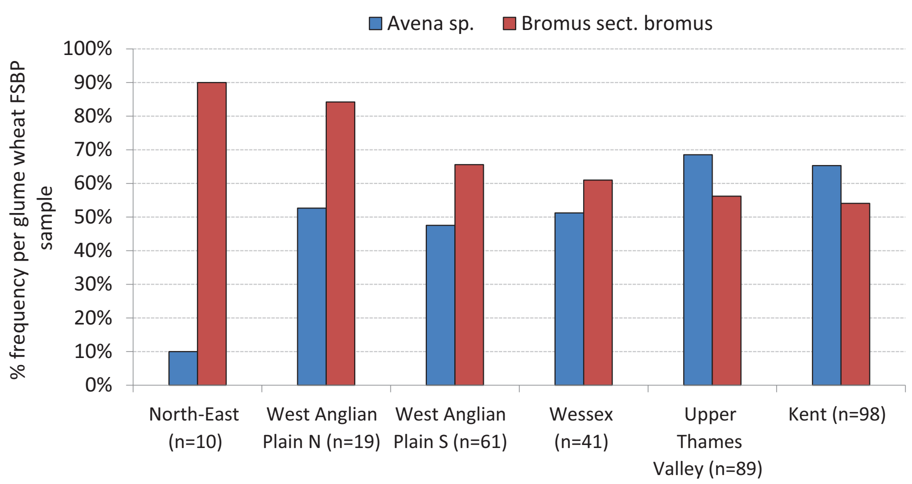

FIG. 2.31. Frequency of *Bromus* and *Avena* within glume wheat FSBP samples in each case study area

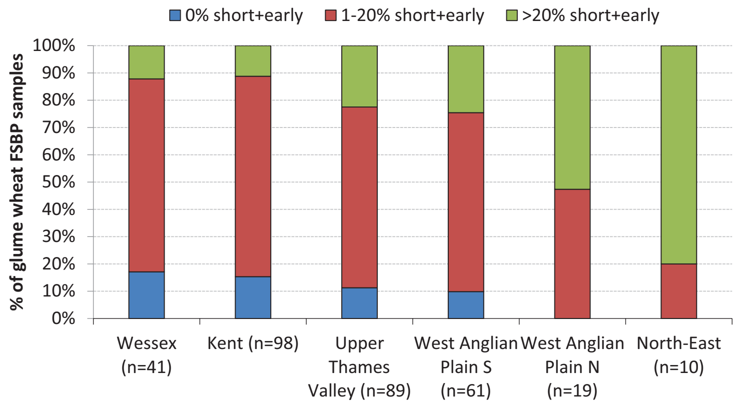

FIG. 2.32. Proportion of glume wheat FSBP samples per case study area with 0%, 1–20% and over 20% short and early flowering taxa

a high frequency of *Bromus*, especially the North-East, also have high proportions (80 per cent) of samples with over 20 per cent short and early weeds, as in the West Anglian Plain north. This pattern indicates that people are likely to have been practising autumn sowing in these regions. Higher frequencies of *Avena* in Kent and the Upper Thames Valley are matched by over 10 per cent of samples containing no short and early taxa, indicating at least some spring sowing of crops was conducted in these areas. Overall, no secure conclusion can be drawn on sowing time, other than it seems more likely that autumn sowing remained the norm, with perhaps individual communities (including those in some villas) practising multiple sowing periods. This fits with modern ethnographic data, which have highlighted the flexibility of sowing times, depending on weather, access to animals and available labour, but also crop preference (Halstead 2014, 22–3).

HARVESTING

Following tillage and sowing, cereals would require weeding and protection from theft and birds until harvest time. The harvest of cereals typically takes place in August, although timing would depend on local variations in weather, soil type and sowing time, with large fields requiring the rapid mobilisation of labour. Hence, harvest time would be a labour-intensive part of the year as well as a period of much social interaction. Key variables in harvesting are the method of harvesting and the height at which the cereal ears are cut from the stem.

Harvest methods

By Lisa Lodwick and Tom Brindle

The three main harvest methods are plucking, uprooting and sickle-harvesting, though mowing with reaping-boards or combs and the use of the Gallic *vallus* are recorded in other parts of the Roman Empire (White 1970, 182–3). Iron sickles have been recovered from a range of sites of Iron Age and Roman date, although, as with ard/plough parts (see above p. 42), relatively few examples have survived, being recorded on just 2 per cent of sites in the project database. Farmsteads are the least-well represented site type with evidence for sickles in comparison to villas and nucleated settlements, though, as with many types of artefact, they were recovered from a greater proportion of complex farmsteads than enclosed farmsteads (5 per cent compared with 2 per cent). Although the numbers are small, this does indicate increased use of the sickle for harvesting in the Roman period, particularly at sites in parts of lowland Britain where complex farmsteads are concentrated. The very occasional recovery of sickles from farmsteads in the South-West (e.g. Carlidnack Round, Mawnan and St Mawgan-in-Pydar, both Cornwall) and in north and south Wales (Coygan Camp, Carmarthenshire; Cefn Graeanog II, Gwynedd), does, however, indicate that the use of the sickle was by no means restricted to sites in the southern lowlands.

When fragmentary, sickles are not always clearly distinguishable from the other artefacts with curved blades known as reaping hooks, which are also well known and occur in a wide variety of shapes and sizes (Rees 2011, 103). Such tools may have had a range of uses and were not all necessarily used for cutting grain, although their presence in assemblages that also include other agricultural tools such as sickles and scythes suggests that some may have been, or were at least associated with agricultural activity of some sort. Objects interpreted as reaping hooks occur in broadly similar numbers to sickles and at the same proportion of sites, and they share similar geographical and social distributions, with a greater emphasis on nucleated settlements and villas than farmsteads. Scythes, usually regarded as a Roman-period introduction, have also been

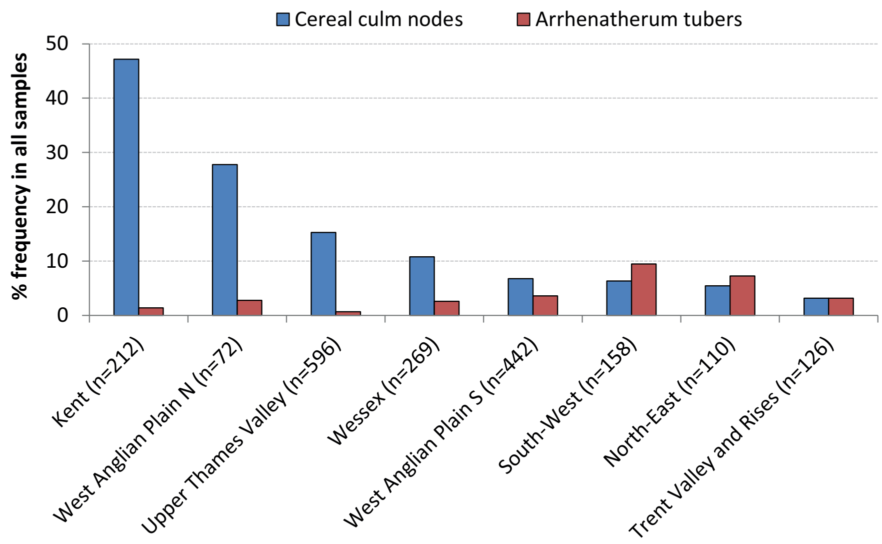

FIG. 2.33. Frequency of *Arrhenatherum* sp. tubers and culm nodes in all samples from all case study areas

recovered from a very small proportion (1 per cent) of rural sites, again more frequently from roadside settlements and villas than farmsteads. Many of these may have been used for harvesting hay for fodder as opposed to grain (Rees 2011, 104). In addition to sickles, reaping hooks and scythes, other crop-cutting tools included billhooks and a wide variety of other smaller curved blades usually termed pruning hooks. Like reaping hooks, these could have had a range of functions, and many are more likely to be associated with horticultural practices rather than large-scale arable production (see below, p. 80).

Given the evidence just outlined for crop-cutting tools in Iron Age and Roman Britain, plucking appears an unlikely method of crop harvesting, though uprooting has been identified in the middle Iron Age Danebury environs sites, based on the presence of rhizomes and tubers alongside crop-processing waste (Campbell 2000a, 55–6). Tubers are generally poorly represented in the case study datasets, occurring, for instance, in only 4 per cent of samples from the West Anglian Plain south. To take *Arrhenatherum* tubers (false oat-grass) as an example, they are present in less than 10 per cent of samples from all regions (FIG. 2.33). The highest frequencies are from the South-West (9 per cent) and North-East (7 per cent), although we cannot be sure that all these samples derive from crop processing, with other potential sources such as burnt turves (Hall and Huntley 2007, 213). Another factor to consider is the frequency of culm nodes. FIGURE 2.33 shows the frequency of culm nodes in all samples from all case study areas. Culm nodes are very frequent in Kent, and the West Anglian Plain north, but less so in other areas. Culm nodes are removed at early stages in crop processing, winnowing and threshing, which typically take place in the fields (Hillman 1981; G. Jones 1984). Therefore, the presence or absence of culm nodes in crop-processing residues identified from settlements does not have significant implications. It seems possible that some uprooting was taking place, but the majority of harvesting was probably conducted by sickle cutting.

Harvest height

A high harvest height, leaving much of the cereal stem still attached to the plant, would imply that the straw was not required, or animals grazed on the remaining straw in the fields. Conversely, a low harvest height would imply that the straw was required for fodder, thatching, flooring and other uses. The height of harvesting can be identified by assessing the maximum height of the lowest growing weed present in a selected fine-sieve by-product sample (Bogaard 2011, 158–61). The presence of low-growing taxa, such as *Prunella vulgaris* (self-heal) and *Rumex acetosella* (sheep's sorrel) (<40 cm) would infer that harvesting took place low on the stalk; medium height taxa (40–70 cm) such as *Tripleurospermum inodorum* (scentless mayweed) and *Anthemis cotula* (stinking chamomile) would imply harvesting took place at a medium height, with some straw retained. The presence of only high-growing taxa over 70 cm (*Bromus* S. *bromus*, *Rumex* sp.) would show harvesting took place high on the cereal stalk. FIGURE 2.34 shows selected fine-sieving by-product samples grouped by the lowest maximum weed height present within each sample. About 80 per cent of samples from most areas include low-growing taxa, indicating that sickle cutting low on the stalk was the common harvesting technique across Britain. Considering individual taxa,

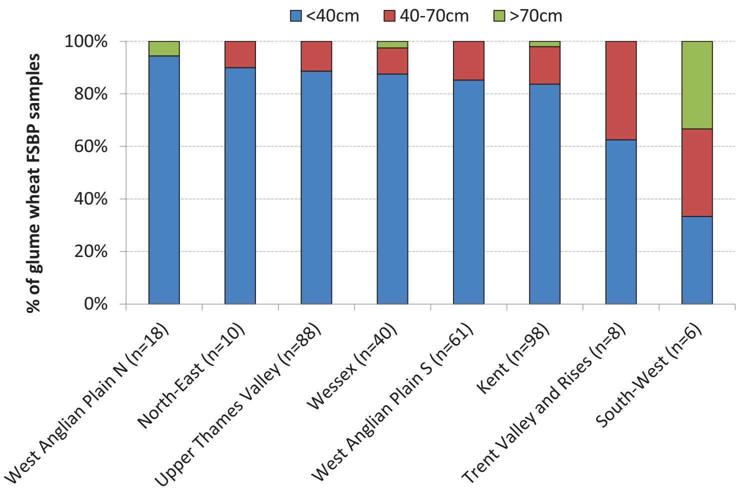

FIG. 2.34. Proportion of glume wheat FSBP samples from each case study area where the lowest maximum seed height falls into each group

Aphanes arvensis (parsley-piert), with a maximum height of 10 cm, was present in 22 of the FSBP samples from all of the main areas, and *Valerianella dentata* (narrow-fruited cornsalad), 15 cm, was present in 32 samples, indicating the harvest height was close to the ground. Where harvesting appears to have been higher, in the South-West and Trent Valley and Rises, interpretation is limited by a low number of samples. Overall, it is likely that straw would have been an abundant resource in rural Roman Britain, and a marketable commodity, sold for fodder or fuel (Foxhall 1998).

LAND PREPARATION AND HARVESTING: SUMMARY

Archaeobotanical and archaeological evidence for methods of crop cultivation above all indicates continuity from the Iron Age, with limited variation in practices between regions. Expansion of the area under crop is supported by an increase in the cultivation of wet soils in the early Roman period, and an increased cultivation of clay soils in the late Roman period. Where available, ceramic scatters from survey data shows substantial manuring was taking place, most likely in reaction to an early Roman expansion of land for arable farming, which led to a drop in soil fertility as indicated by the weed flora. Continuity from the Iron Age is also seen in the predominant mode of autumn sowing, and by harvesting crops low on the straw. Agricultural innovations in crop cultivation, which would have enabled greater production per unit, are not observed until the later Roman period, where iron foreshares and coulters were in use in some areas after a previous reliance on ards. This review does not enable the clear identification of cereal cultivation as either *intensive* – high labour and resource input and crop output per area, low return per capita, or *extensive* – low labour and resource input and output per area (Van der Veen and O'Connor 1998). Based on current evidence, Romano-British arable farming can be characterised as initially expanding, using the same cultivation practices as in the Iron Age, before extensification in some areas, as more advanced ploughing technology and larger cattle enabled greater areas to be cultivated with less labour. The lack of clear chronological or regional variation in the arable weed flora shows that more detailed analysis is required to investigate how communities varied their cultivation techniques, or if the homogeneity indicated here is supported.

CROP PROCESSING

Following the harvest, cereal crops require processing until they can be satisfactorily stored on the farmstead or transferred to a roadside settlement, villa, town or fort. Large quantities of cereals were required by the urban and military populations in Roman Britain, and burnt grain stores at sites such as London and South Shields, Tyne and Wear, indicate that grain was received at these settlements having been fully cleaned (see *Storage* below, p. 66). Identifying which types of settlement were engaged in the processing of cereals to reach this stage is vital for understanding the articulation of the rural economy.

In Britain, it is presumed that spikelet storage, essentially semi-cleaned grain, was required for glume wheats as it protects cereal grains from pests, rodents and grain infestations (Sigaut 1988). Barley grains are protected by the fused paleas, and so were probably stored after completing the cleaning process through threshing and sieving. The stages of cereal processing, which transform harvested cereal ears into clean cereal grain, have been observed through ethnographic work in

Greece and Turkey (G. Jones 1984; Hillman 1981). The main stages are threshing, to separate the ears from the culm, winnowing, to remove the light chaff, pounding for glume wheats to remove the glumes, before coarse sieving, fine sieving and hand cleaning. There is very little evidence from artefacts that contributes directly to our understanding of crop processing. Pitchforks of wood or iron are likely to have been used during winnowing, although there is nothing that allows us to identify examples specifically dedicated to this process. No sieves, which would have presumably been used to separate cereal grain from chaff and weeds, have been recovered from Roman Britain (Rees 1979; 2011).

Dedicated structures for crop processing, other than corndryers, are equally hard to identify in the archaeological record. Hence, most information on crop processing derives from the remains of charred cereal grains, chaff and weed seeds, which form the main basis for the discussion below.

THRESHING FLOORS

After harvest, the first stage in cereal processing is threshing, which separates cereal spikelets from straw through physical force. The by-product of threshing, straw, is unlikely to survive in assemblages of charred plant remains. No heat is required in the threshing process, and cereal culm nodes, the identifiable parts of straw, are less likely to survive charring as they turn to ash at lower temperatures than cereal grains (Boardman and Jones 1990). In general, any defined circular area with a compact surface can be used for threshing, manually with a flail or stick, using animals to tread the harvest, or a threshing sledge (White 1970, 184–6).

Threshing floors have been interpreted at 22 sites in the project database, although many of these rely on tenuous identifications. The identification of a circular stone-kerbed 'threshing floor' at Ditchley Park villa, Oxfordshire, for instance, was heavily influenced by the descriptions of Roman agronomists (White 1970, 184–6; Booth 1999, 46). Other sites suggested as having threshing floors include the farmstead at Swinford Wind Farm, Leicestershire, where a substantial second-century A.D. stone platform was revealed, with a ditch on the northern side and a stone kerb (Morris 2012). Further metalled or cobbled surfaces have been identified as threshing floors within late Roman farmsteads at Leadenham Quarry, Lincolnshire (WYAS 2001) and Rectory Lane, Appleby Magna, Leicestershire (Clarke 2010). Negative features have also been suggested as threshing areas, such as a depression that was filled with hundreds of rough flints at Chew Park Farm, Somerset (Rahtz and Greenfield 1977), and two cellared rectangular buildings at Frost Hill (Site 44), Bullock Down, East Sussex (Rudling 1982). Where the internal floors of aisled buildings have survived, specific features have occasionally been identified as threshing areas, as for example at Darenth villa, Kent (Philp 1973). In medieval and post-medieval Britain, threshing took place within barns (Fowler 2002, 171), and it would seem likely that internal spaces, such as at Darenth, are the most likely location of threshing areas, at least on villa estates and larger farmsteads, where such agricultural buildings are more common (Smith 2016b, 57–60).

CROP-PROCESSING ACTIVITIES

Identifying practice

It has long been recognised that the majority of charred plant remains recovered from settlements are cereal grains, cereal chaff and arable weeds (Knörzer 1971; Körber-Grohne 1981). Ethnographic studies established that discrete crop-processing by-products and products can be identified based on the proportions of grain, chaff, and weeds in samples (Hillman 1981; G. Jones 1984). However, how we identify these stages in archaeological samples has been much debated. Approaches using the proportions of grain, chaff and large and small weed seeds (M. Jones 1985; Hillman 1984; Stevens 2003) have been considered too simplistic, as they combine two types of crops – glume wheats (spelt and emmer) and free-threshing cereals (barley and free-threshing wheat). These cereals have different ratios, and different survivability rates, of grain and chaff (G. Jones 1990; Van der Veen and Jones 2006).

Spelt wheat, which has been shown to be the main cereal crop in Roman Britain (see above, p. 17), requires several stages of processing (Hillman 1981, 132–3). As a glume wheat, the cereal ear separates into individual spikelets, whereby two cereal grains are encased within tough glumes. In order to remove these glumes, the spikelets are parched to make them brittle, and then pounded to separate the grains from the spikelets. This material is then passed through a fine sieve, to retain fine-sieve products (cereal grain) and remove glume bases and small weeds – the fine-sieve by-product. The large quantities of glume bases removed would have been used as fuel or fodder (Van der Veen 2007). In Roman Britain, the majority of charred plant remains are thought to derive either from burning chaff as fuel or through accidental burning of spikelets during parching (Campbell 2008a).

The optimal approach when investigating crop-processing activities is to distinguish samples as crop-processing stages, based on the ratios of cereal items in combination with discriminant analysis of physical weed types (Bogaard 2011; see TABLE 2.4). A second option is to consider the density of cereal chaff as a proxy for the scale of processing (Van der Veen and Jones 2006; Van der Veen 2016), although it is important to bear in mind that the use of chaff as fodder would affect the availability of chaff to use as fuel, and hence the density of charred crop remains (Campbell 2000a, 54–5). Both approaches are used here in order to identify regional and chronological variations in the processing of cereals to produce clean cereal grain.

The sample level approach

All samples from sites in the case study areas have been assigned to four crop-processing stages; glume wheat fine-sieve by-products, glume wheat fine-sieve products (FSP), glume wheat spikelets and barley fine-sieve products (see Appendix). The early by-products of crop processing, where straw and barley rachis are removed, are elusive in the British archaeobotanical record. For instance, just one sample from the Upper Thames Valley was identified as a barley early stage by-product (Claydon Pike), consisting mainly of barley rachis. Instead, spelt fine-sieve by-products, i.e. samples representing the final stages of spelt wheat cleaning, are the most common crop-processing stage in all periods and all areas, showing continuity in how crops were processed (TABLE 2.18). In the West Anglian Plain (north and south combined), there is a marked increase in the proportion of product samples, i.e. clean grain, in the late Iron Age/early Roman period, which declines to 7 per cent or less for the early, mid- and late Roman periods. The proportion of samples identified as barley fine-sieve product in this area decreases from the late Iron Age/early Roman period onwards, representing just 2 per cent of samples in the mid- and late Roman periods. In the Upper Thames Valley, the proportion of spelt fine-sieve product and spikelet samples fluctuates between periods. Unlike other case study areas, in Wessex there are less pronounced differences in the proportions of spelt fine-sieve by-products relative to spelt fine-sieve products, though the former remain more common.

In comparison, the South-West, where there are fewer indications of large-scale arable farming, has a high proportion of spelt fine-sieve by-products – 88 per cent of late Iron Age samples and 70 per cent of Roman samples. This pattern tentatively suggests that it is the increased proportions of product samples that indicate production beyond the needs of the immediate community. Periods where there are higher proportions of product samples, i.e. the late Iron Age/early Roman and the late Roman Upper Thames Valley, the mid–late Roman period on the Wessex chalk, and the late Iron Age/early Roman period on the West Anglian Plain, may represent times when the handling of clean grain increased.

TABLE 2.18: PROPORTIONS OF CROP-PROCESSING STAGES IN THE CASE STUDY AREAS

	Spelt fine-sieve by-product	*Spelt spikelets*	*Spelt fine-sieve product*	*Barley fine-sieve product*	*Free-threshing wheat fine-sieve product*
SOUTH					
Wessex					
LIA (n=31)	58%	3%	23%	16%	0%
LIA/ER (n=31)	65%	3%	26%	6%	0%
ER (n=14)	57%	0%	29%	14%	0%
M/LR (n=71)	45%	12%	38%	4%	1%
CENTRAL BELT					
Upper Thames Valley					
LIA (n=27)	41%	19%	26%	15%	0%
LIA/ER (n=14)	43%	0%	29%	21%	7%
ER (n=28)	82%	14%	4%	0%	0%
MR (n=35)	80%	6%	11%	0%	3%
LR (n=43)	56%	2%	28%	7%	7%
West Anglian Plain					
LIA (n=28)	86%	0%	0%	14%	0%
LIA/ER (n=23)	52%	9%	17%	22%	0%
ER (n=45)	91%	4%	0%	4%	0%
MR (n=59)	90%	3%	5%	2%	0%
LR (n=41)	91%	0%	7%	2%	0%

The density approach

To address the scale of arable farming more accurately, the density of items per unit of sediment can be calculated. Here, the total number of glume wheat glume bases per litre of sediment per sample has been used as a way to address specific aspects of crop processing, using the following scale: below one glume base/L (sparse), one to ten glume bases/L (intermediate), over ten glume bases/L (dense).

In the West Anglian Plain, there is a gradual increase in the proportion of dense glume base samples from the late Iron Age onwards, with the mid- and late Roman periods having the highest proportions (FIG. 2.35). In the Upper Thames Valley, there is an increase in the proportion of samples with a high density of glume bases in the early Roman period, but relative continuity from that point onwards (FIG. 2.36). Compared with other case study areas, the Upper Thames Valley has lower proportions of dense glume base samples, under 20 per cent in all periods. In Wessex, the key period of change is the mid- and late Roman period, where the proportion of dense glume base samples increases to 53 per cent (FIG. 2.37). One aspect of this is the use of spelt chaff as fuel in corndryers, as evidenced at High Post and Figheldean in Wiltshire and Fordington Bottom in Dorset, although this in itself indicates the large-scale processing of cereals. These findings suggest that the de-husking of glume wheats was occurring at an increased scale during the mid- and late Roman periods in the West Anglian Plain and Wessex, with essentially more clean grain being produced. There are no indications of such shifts in scale in the Upper Thames Valley.

Inter-site analysis

The limitation with the analysis presented above is that sites with many samples are having a large effect on the regional patterns. In this section, the proportion of crop-processing stages and densities are compared at individual sites. In the Upper Thames Valley, samples from complex farmsteads at Weedon Hill, Cotswold Community, Gravelley Guy, Claydon Pike (mid-Roman) and Denchworth Road were largely classified as fine-sieve by-products, that is to say the de-husking of spelt spikelets was the main activity contributing to the charred plant assemblage. Meanwhile, at enclosed farmsteads, Guiting Manor Farm, Claydon Pike (late Roman), and Aston Clinton Bypass, a range of crop-processing stages were represented, with higher proportions of fine-sieve products and spikelets (FIG. 2.38). This may suggest that complex farmsteads were focused on the de-husking of glume wheats and sending the clean grain elsewhere. To complement this pattern, when samples are grouped by the density of glume bases, the highest proportion of 'dense' and intermediate samples, implying large-scale processing, is also at certain complex farmsteads – Weedon Hill and Cotswold Community – as well as at roadside settlements and villas (FIG. 2.39). Enclosed farmsteads have higher proportions of sparse samples, implying a lower scale of glume wheat processing was taking place.

While the pattern from the Upper Thames Valley fits with the accepted view that complex farmsteads were more focused upon production for the market (Allen and Smith 2016, 33), the West Anglian Plain produces a somewhat different pattern. The late Iron Age/early Roman complex farmstead at Bedford Academy (Ingham and Pilkinton 2012) has high proportions of samples classified as free-threshing wheat product, but the majority of complex farmsteads appear similar to the enclosed farmsteads, in so far as they produce primarily glume wheat fine-sieve by-products, with smaller proportions of fine-sieve product (FIG. 2.40). The density of glume bases (FIG. 2.41) also does not show any clear separation between enclosed and complex farmsteads, with, for example, a mid-Roman enclosed farmstead at The Grange (C. Stevens 2009a) on the clay uplands of west Cambridgeshire containing largely samples with over ten glume bases/L, indicating large-scale processing, and nearby complex farmsteads at Childerley Gate (Abrams and Ingham 2008) and North-West Cambridge Sites IV-V (Evans and Newman 2010) having higher proportions of sparse glume bases samples, indicating small-scale crop processing. This suggests that the location of large-scale crop processing varied between regions, being focused at complex farmsteads in the Upper Thames Valley, but more variable by site type in the West Anglian Plain. The range of factors affecting the density of charred plant remains means addressing variations in the scale of crop-processing activities may not be possible on an inter-site basis.

Other stages

The regional analyses of samples by the crop-processing stage and the density of glume bases has shown that most site types were engaged in the de-husking of glume wheat, but there was variation in the scale at which this was undertaken. A further approach to addressing the movement of cereal grain between sites has been to assess the proportion of pre-sieved and un-sieved spikelets, separating spelt spikelets where small weed seeds have been removed prior to the storage or movement of the crop, and those that have been stored without having been pre-sieved (Stevens

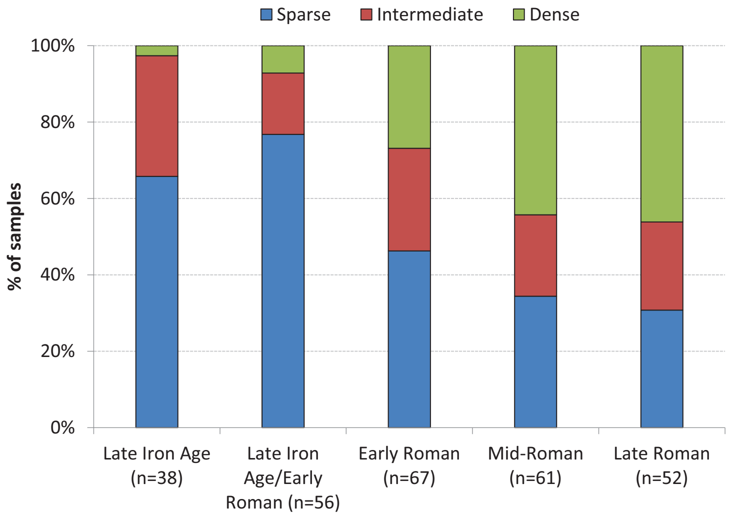

FIG. 2.35. Proportions of samples in the West Anglian Plain classified by glume base density

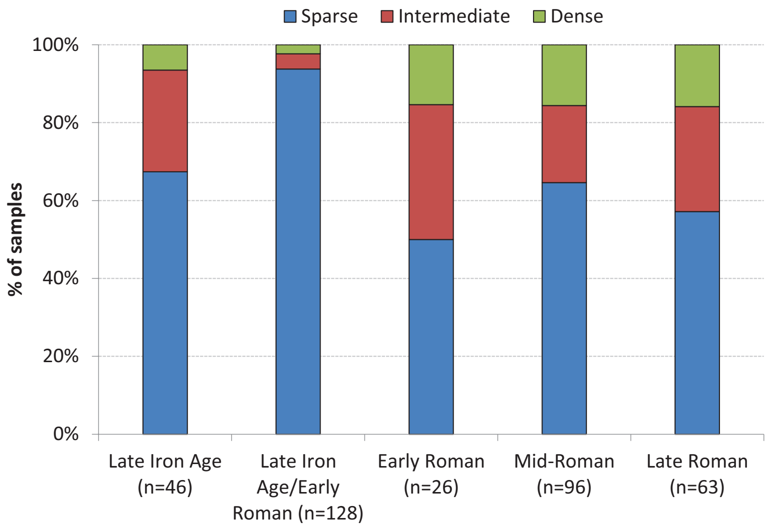

FIG. 2.36. Proportions of samples in the Upper Thames Valley classified by glume base density

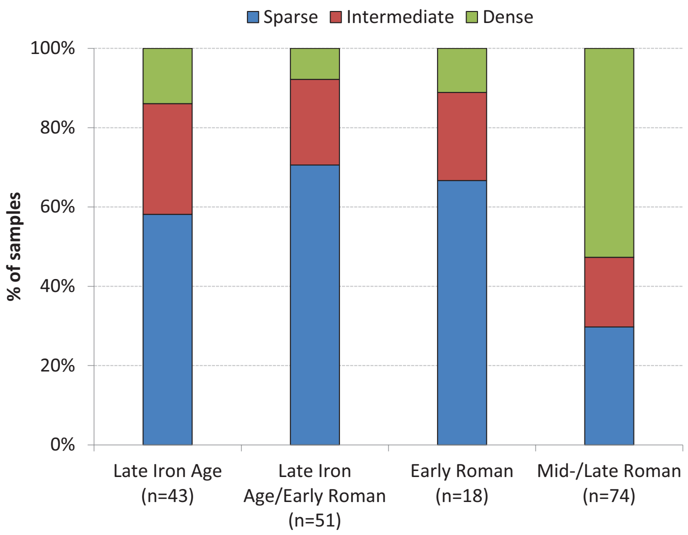

FIG. 2.37. Proportion of samples in Wessex classified by glume base density

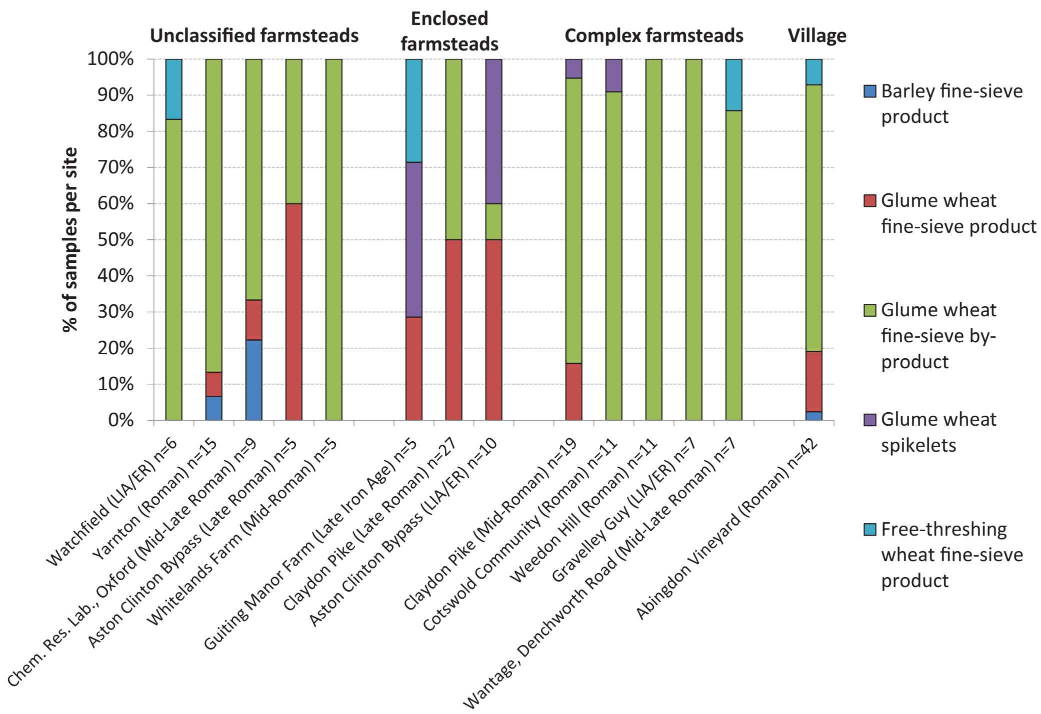

FIG. 2.38. Proportion of samples assigned to each crop-processing stage per site in the Upper Thames Valley

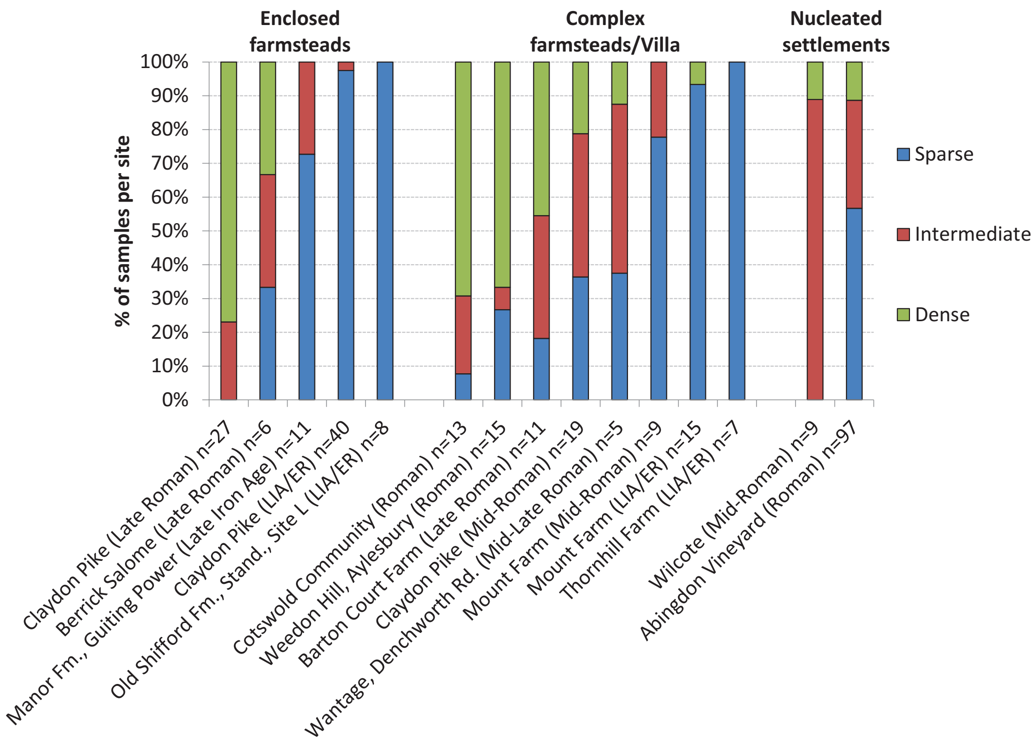

FIG. 2.39. Proportion of samples assigned to each glume base density group per site in the Upper Thames Valley

2003, 69–71; Bogaard 2011, 152; Van der Veen and Jones 2006, 110). While there is no known ethnographic record of pre-sieving being conducted, benefits would include a decreased number of weed seeds to provide food for grain pests, the facilitation of de-husking, increased storage efficiency, and a more standardised unit of grain per unit of measure. Parks (2012, 127–8) identified the sieving by-products from spikelet sieving (small weeds), pre-sieved spikelets (glume bases and weed seeds), and the fine-sieve by-products of de-husked pre-sieved spikelets (glume bases). She concluded that most samples identified as spelt spikelets from mid- and late Roman sites in the East of England had been pre-sieved, i.e. had their small weed seeds removed.

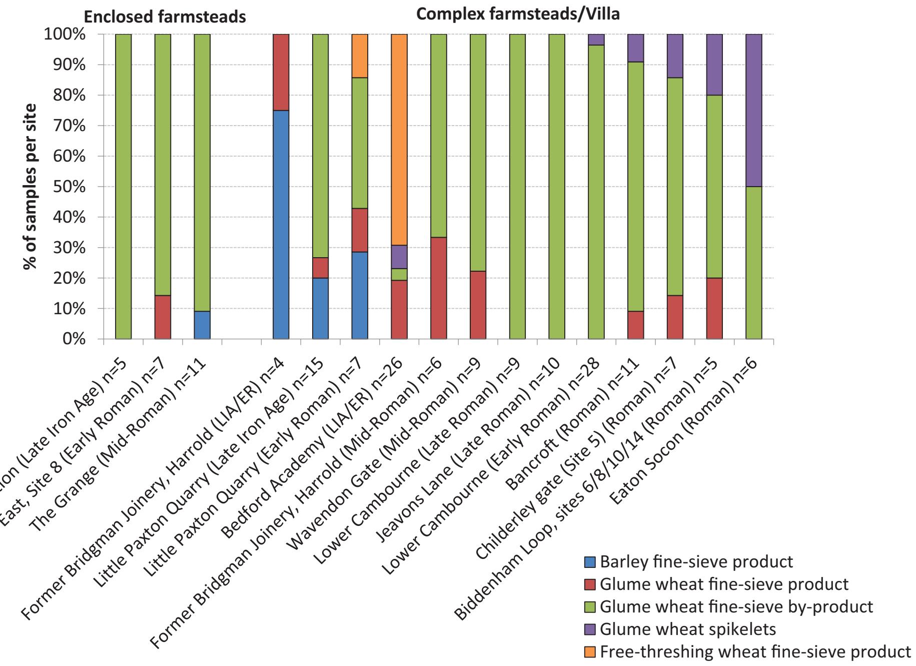

FIG. 2.40. Proportion of samples assigned to each crop-processing stage per site in the West Anglian Plain

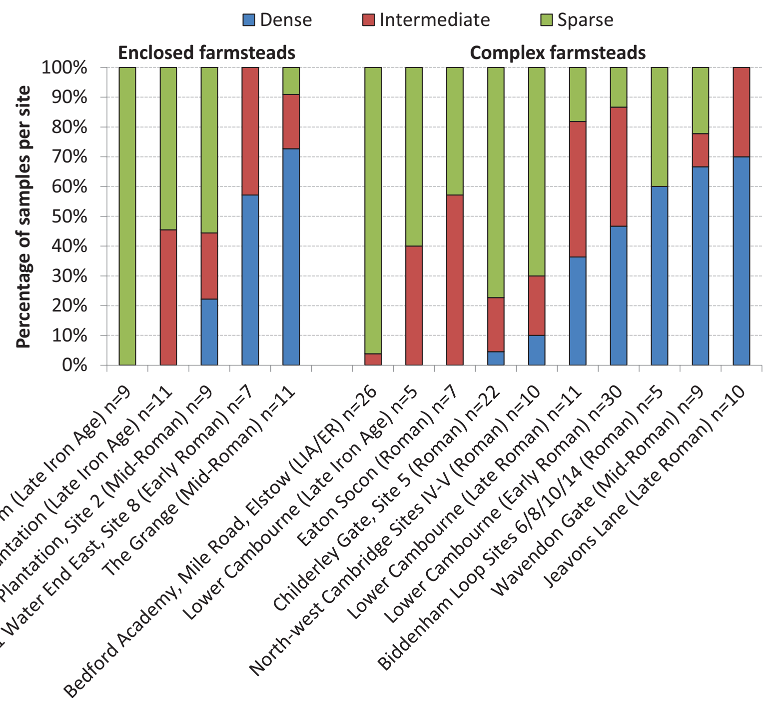

FIG. 2.41. Proportion of samples assigned to each glume base density group per site in the West Anglian Plain

Evidence of spikelet sieving was recorded at sites where spikelets were also processed (e.g. Camp Ground and Childerley Gate in Cambridgeshire; C. Evans 2013; Abrams and Ingham 2008), while elsewhere spikelet sieving took place prior to malting (e.g. Beck Row, Suffolk; Bales 2004), indicating that pre-sieving was conducted for a range of reasons.

The final stage of crop processing is that of hand-cleaning cereal grains by removing large weed seeds that stay with the grain throughout the threshing, winnowing, de-husking and sieving process. This stage is most likely to take place prior to the milling of grain for flour, and its importance is in maintaining the quality of flour and avoiding health problems. *Agrostemma githago* (corncockle) became a common arable weed in the Roman period, after being introduced to southern England in the later first millennium B.C., and contains a poisonous glycoside with the potential to cause illness in young and old people (Campbell 2000a; Preston *et al.* 2004; Hall 1981). Evidence for the removal of corncockle seeds from cereal grain is known at the military granary at South Shields, where mineralised *A. githago* seeds were found near the entrance, with tentative suggestions that they may have been removed when grain was collected from the granary. The stored grain within the granary contained grain mimic weeds *Bromus*, *Avena*, *Agrostemma* and *Raphanus* (Van der Veen 1988, 363). Unfortunately, the lack of storage deposits of clean cereal grain from rural settlements in Roman Britain means it is not possible to evaluate how much labour was required to hand-clean cereal grain.

Summary

This section has considered the preparation of harvested cereals for consumption and/or transport away from farms. In the absence of distinctive threshing structures and processing tools, charred cereal remains have shown that there is broad continuity across time and space in how cereals were processed, as suggested through the presence of both crop-processing by-products and products. Within each case study area, the scale of crop processing, as indicated by the density of glume bases, varied at different times. In the West Anglian Plain, there was a gradual increase in the proportion of dense glume base samples from the late Iron Age/early Roman period onwards, while in Wessex there was a substantial change in the mid–late Roman period. No discernible change took place in the Upper Thames Valley, though in this area, a number of complex farmsteads, together with a roadside settlement and a villa, had higher proportions of fine-sieve by-product samples, and a higher proportion of dense glume base samples, showing a greater intensity of crop processing was taking place at these site types. Enclosed and complex farmsteads in the West Anglian Plain were not separated by these factors, with both farm types being focused on spelt wheat cultivation. Given the fragility of charred plant remains, and the uses of chaff as fuel and fodder, which strongly influence how much chaff becomes charred, a more reliable indicator for the scale of cultivation at individual settlements is the presence of corndryers.

CORNDRYERS

Corndryers are large oven-like structures occurring widely in parts of the Romano-British countryside, being 'the most easily identifiable structure found in Roman Britain' (Morris 1979, 5), akin to olive and wine presses in the Mediterranean world. These structures have been recorded at 358 excavated rural settlements in Roman Britain, and also occur in towns. Corndryers are primarily considered to have been used to dry glume wheats prior to de-husking, or to dry grain as part of the malting process, with numerous other minor uses also suggested (Reynolds and Langley 1979; Van der Veen 1989). The varying arguments for their function draw on archaeobotanical, experimental and historical evidence. However, regardless of precise function, these structures are clearly evidence for the large-scale processing of cereals in the countryside (Van der Veen 2016), and their spatial and chronological distribution can be used as a proxy for the surplus production of cereals. This section describes the types of corndryers recorded in Roman Britain, presents the national distribution of these structures, analyses the archaeobotanical evidence for their use in the case study areas, and assesses their implication for the wider arable economy.

TYPOLOGY AND FUNCTION

Structures classified as corndryers have the shared characteristic of having once had a heated floor area of at least two square metres, but there is great diversity in the material and form of construction. The corndryer typology devised by Morris (1979) was based on around 60 examples, and remains a useful categorisation of the range of corndryer structures in Britain. The major types are summarised in FIGS 2.42–4. All dryers share the features of a stoking area, often below ground level and circular/oval or rectilinear in shape, a fire-place within the start of the flue, a long flue with various bends and sub-sections, and an over-lying drying floor, which is rarely preserved. Bowl or long-hearths are the simplest form of corndryer, consisting of a long narrow flue, with a stokehole at one end leading to a straight flue (e.g. Swan Valley Community School, Kent; Mackinder 2010; FIG. 2.42). T-shaped corndryers are the most commonly identified, with a long, main flue split into a short cross flue (FIG. 2.42). Some T-shaped corndryers have a rectangular enclosing wall built around the flue (e.g. Manor Farm, Monk Sherborne, Hampshire; Teague 2005), while others have only simple earth-cut flues. Alternative single-flue types comprise L-shaped ovens, and rectangular ovens, where the flue turns to complete a square, as seen at Northfleet villa (Andrews *et al.* 2011) and Wainscott in Kent (Clark *et al.* 2009). In the reversed-tuning-fork type, the cross flues of a T-shaped oven both turn back on the main flue, as at Orton Hall Farm, Cambridgeshire (Morris 1979, 168).

The second group of corndryers have two main flues housed within the same structure, deriving from one stokehole, with many different variants (FIG. 2.43). This development would have enabled a larger surface area to be heated, increasing the scale and efficiency at which the processing of crops could take place. The most advanced multiple-flue forms include the circular corndryer

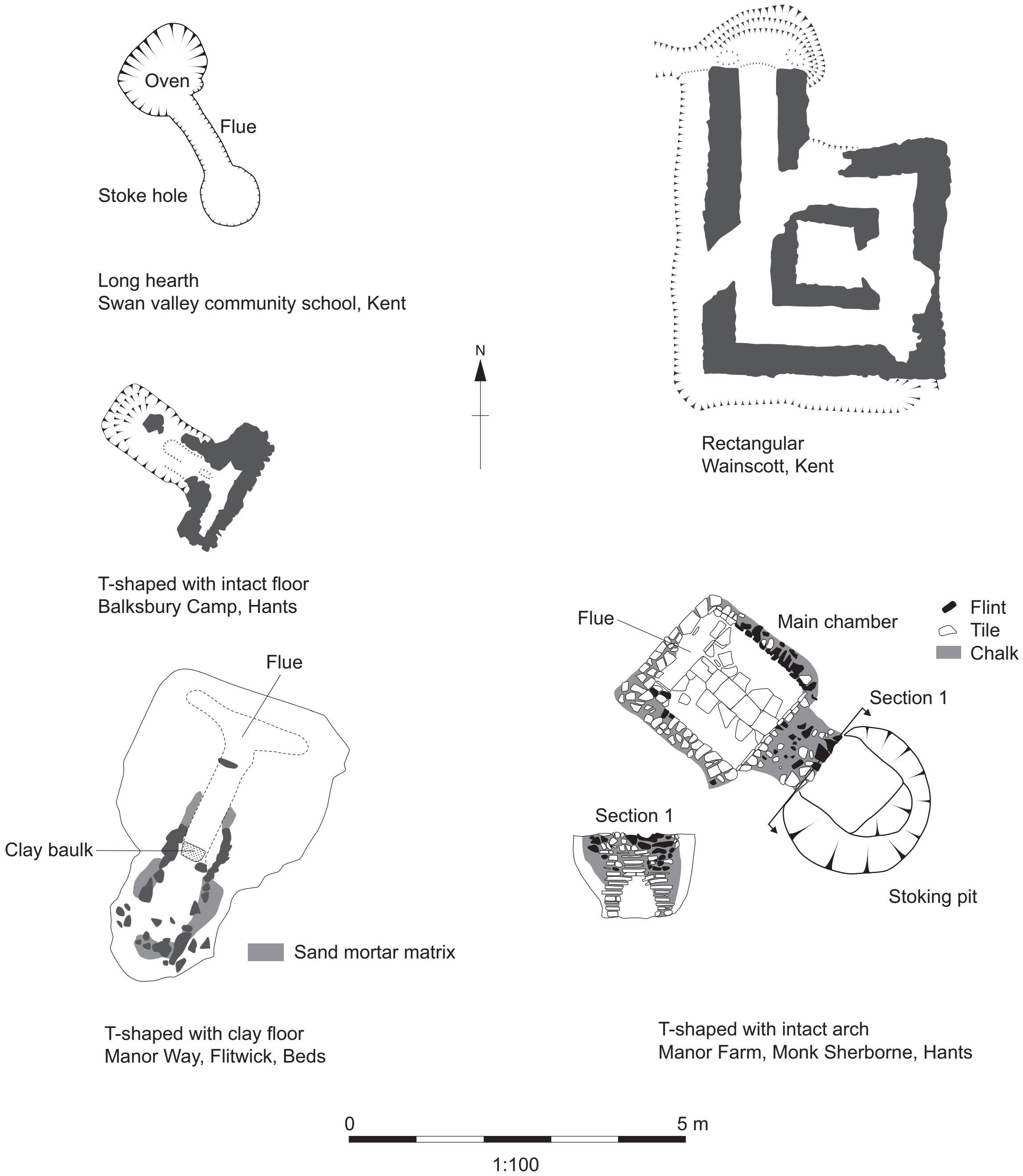

FIG. 2.42. Corndryer typology 1 – single flue (Mackinder 2010; Clark *et al.* 2009; Fadden 1976; Teague 2005; Wainwright and Davies 1995)

at Great Casterton, Rutland (Corder 1951; FIG. 2.44), and the channelled corndryer at Darenth in Kent (Philp 1973, 128), while an elaborate corndryer at Fullerton villa in Hampshire had a total of six flues, arranged in an X-shape (Cunliffe and Poole 2008b). Occasional other forms have been reported, including a cruciform structure at Cotswold Community on the Gloucestershire/Wiltshire border (Powell *et al.* 2010, 130). It is unclear whether these other forms represent corndryers or other processing structures involving heat.

Clearly, much effort was expounded upon constructing a diverse range of corndryer structures in Roman Britain. They were initially thought to be used for corn-drying owing to the recovery of charred cereal grains from their flues (Goodchild 1943). However, experiments using a reconstruction of an example excavated at Foxholes Farm, Hertford, showed that with a floor surface often reaching a temperature of 40–80 °C, 50 kg of barley took 3.5 hours to dry successfully, with the implication that 700 hours, or around two months, would be needed to dry a 10 tonne harvest. It was concluded that such a long time investment, combined with the impermeable floor design limiting the movement of hot air through the floor, meant a function in malting was far more likely (Reynolds and Langley 1979; Van der Veen 1989, 314).

However, these experiments used barley rather than spelt wheat, the most common cereal found associated with corndryers. Furthermore, a reliance on this experimental evidence obscures the wide diversity in the structure of corndryers. Floor materials range from a baked clay surface at Manor Way, Flitwick, Bedfordshire (Fadden 1976), to limestone slabs at Balksbury Camp,

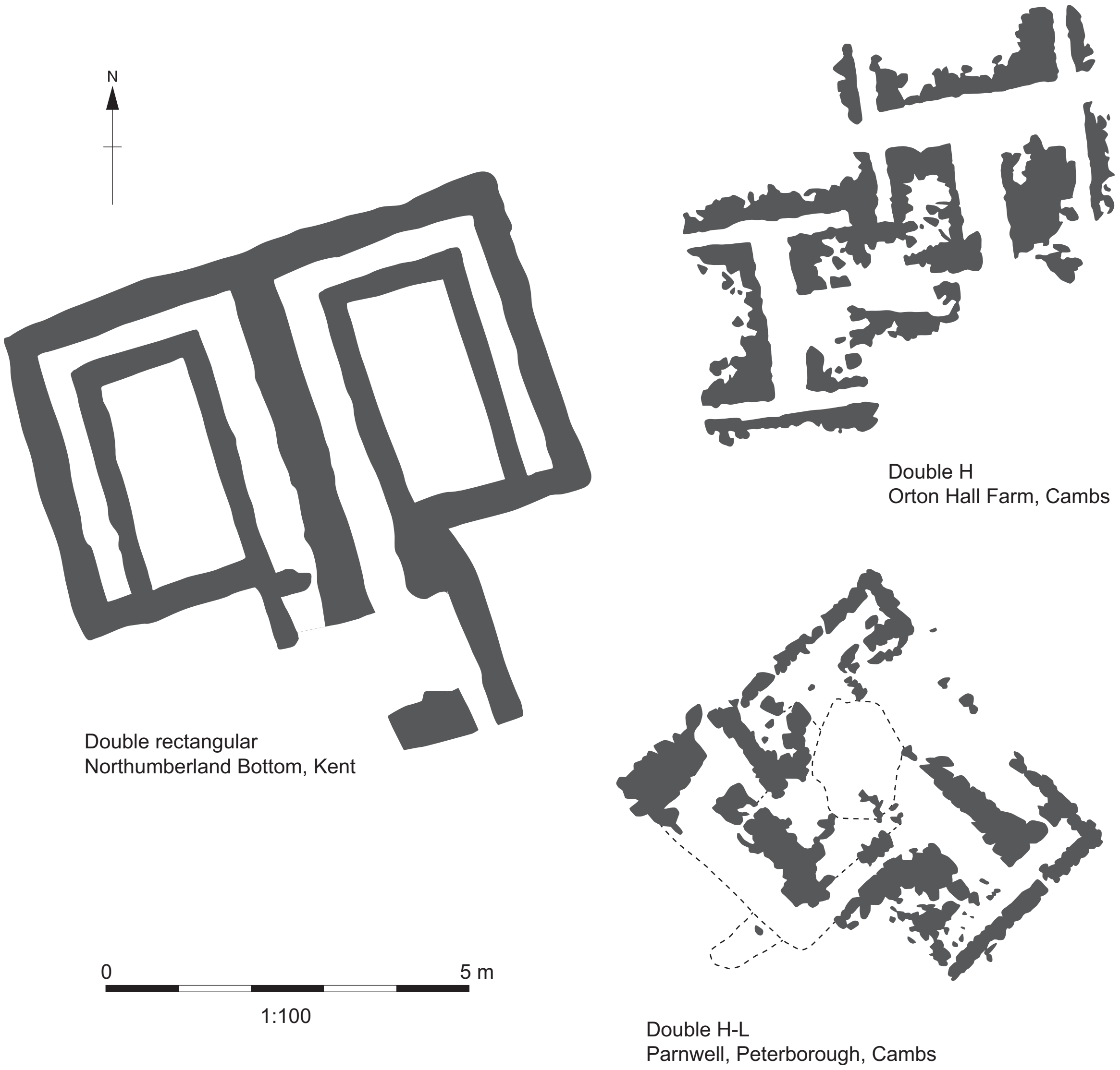

FIG. 2.43. Corndryer typology 2 – double flue (Mackreth 1996; Askew and Booth 2006; Webley 2007)

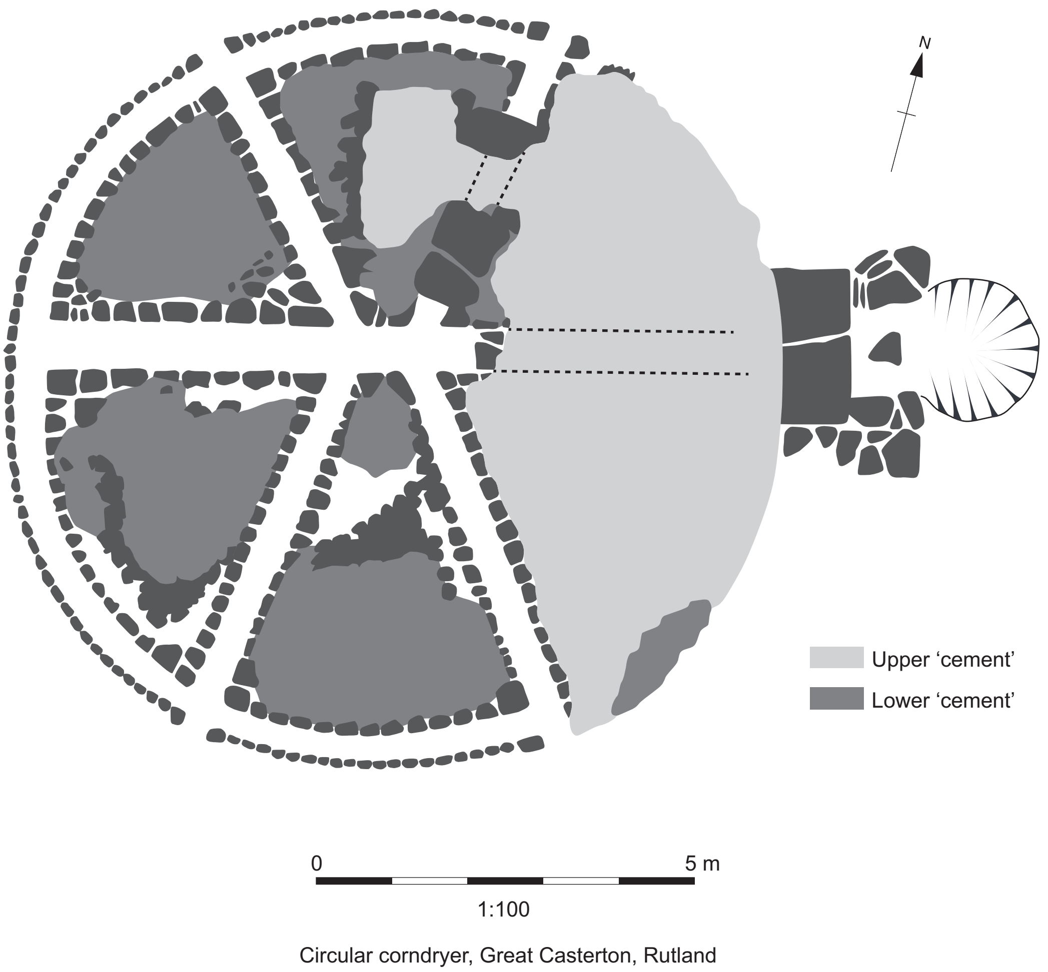

FIG. 2.44. Corndryer typology 3 – multiple flue (Corder 1951)

Hampshire (Wainwright and Davies 1995, 27) and a chalk block floor at Durrington Walls, Wiltshire (Wainwright 1971b). Elsewhere, ceramic building material was utilised, as at Gatehampton Farm, Oxfordshire (Allen 1995, 41), and Amesbury, Wiltshire (Fitzpatrick and Seager Smith 2000), or wooden floors at Haynes Park, Bedfordshire (Luke and Shotliff 2004), and Atworth, Wiltshire (Shaw-Mellor and Goodchild 1942). The wide range of floor materials used clearly shows that no general conclusions can be inferred on the function of corndryers based on the Butser experiments.

DISTRIBUTION AND CONTEXT OF CORNDRYERS

Corndryers are most common in the Central Belt (165) and South (106) regions, but at least twenty sites have been recorded with corndryers in the East and the North-East. Within these regions, there are clusters of corndryers on the Wessex chalk downlands, the Sussex coastal plain, the Upper Thames Valley and Cotswolds, the Ouse and Nene valleys and the outskirts of London (see FIG. 2.1). Just four examples have been recorded in Upland Wales and the Central West, including from the villa at Glasfryn, Tremadog, Gwynedd (Kenney 2006), and at the roadside settlement at Tai Cochion, Anglesey (Hopewell and Smith 2012). One corndryer has been recorded from the South-West, at the roadside settlement at Topsham in Devon (Dyer 1999). Within the regions where corndryers are concentrated there is substantial variation in their occurrence by site type, with, for example, a much greater proliferation at roadside settlements in the Central Belt and the East (FIG. 2.45). In all regions corndryers are more than twice as frequent at complex farmsteads than enclosed farmsteads, while in the South, they are also a common feature of villages. The close association between corndryers and complex farmsteads is particularly marked in the Central Belt, where they have been revealed on 32 such settlements, compared with only 11 at enclosed farmsteads and just one on an unenclosed farmstead.

Establishing a date range for the use of a corndryer is difficult as ceramics and coins derive only from the back-filling of these features, though archaeomagnetic dating has been used successfully

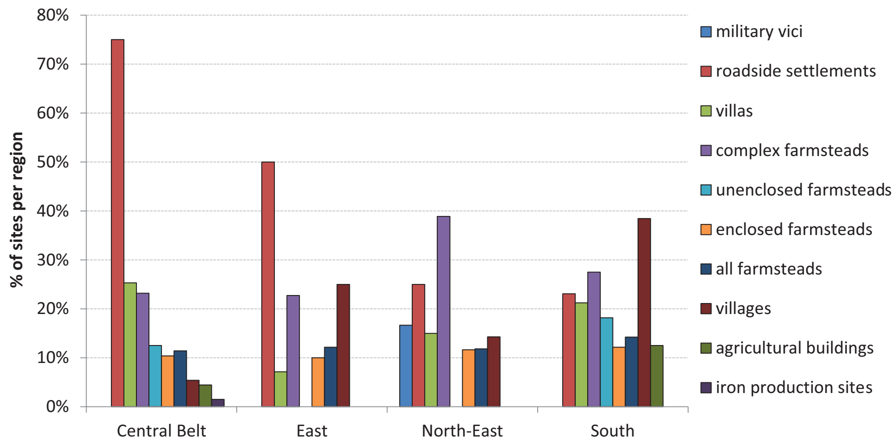

FIG. 2.45. Frequency of corndryers by site type in the main regions

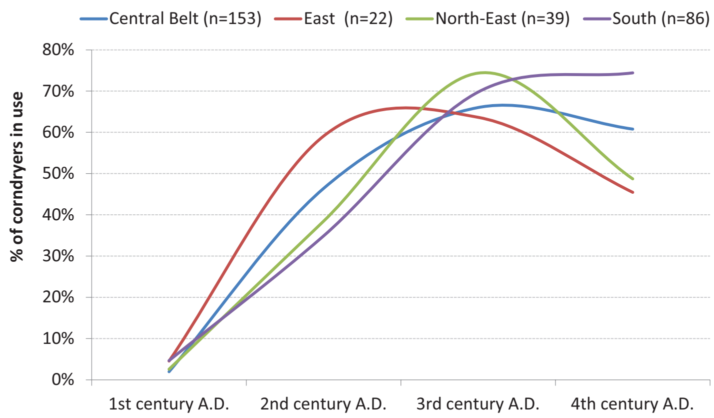

FIG. 2.46. Frequency of all corndryers in use over time in four selected regions

at Haynes Park, Bedfordshire, to date the use/construction of a T-shaped corndryer to A.D. 60–160 (95 per cent confidence) (Luke and Shotliff 2004). FIGURE 2.46 displays the percentage of corndryers in use over time out of all those that could be dated to within two centuries. All regions display a similar pattern, with less than 10 per cent in use in the first century A.D., of which only one was of T-shaped design, in use at the Springhead roadside/religious settlement in Kent (Andrews *et al.* 2011, 50). There was a steep increase in the proportion of corndryers in use during the second and third centuries A.D., with many single-flue T-shaped examples and also a few multi-flue corndryers already in use in the second century A.D. (e.g. reversed-tuning-fork oven at Carterton (site 2), Oxfordshire; Coleman and Hancocks 2004). A sharp decline in corndryer use took place in the North-East and the East in the fourth century A.D., with a more gradual decrease in the Central Belt, while an increase in the South is the result of the expanding number of corndryers on the chalk downlands in the west of this region. These trends parallel the evidence for settlements in these regions (Smith *et al.* 2016). In the third and fourth centuries, more elaborate corndryers were constructed, such as the circular example at Great Casterton villa, Rutland (Corder 1951), H-shaped dryers in Barnack, Cambridgeshire (Simpson 1993) and at Leadenham Quarry, Lincolnshire (WYAS 2001), and a fourth-century, triangular oven at Broughton Manor Farm, Buckinghamshire (Atkins *et al.* 2014).

The variation in the chronology of corndryer use has previously been related both to climatic changes and socio-economic change, with Applebaum (1958, 81) suggesting that a wetter climate meant drying ovens became necessary to prepare cereals for export. The period between *c.* A.D. 250–600 has been established as one of greater climate instability in central Europe (Büntgen *et al.* 2011), yet neither this, nor the precise periods of increased precipitation established from multiproxy environmental evidence from Britain (Charman 2010), coincide with the widespread use of corndryers in the second century A.D.

The phenomenon of corndryers being inserted into high-status villa buildings in the fourth century A.D. has long been recognised (Collingwood

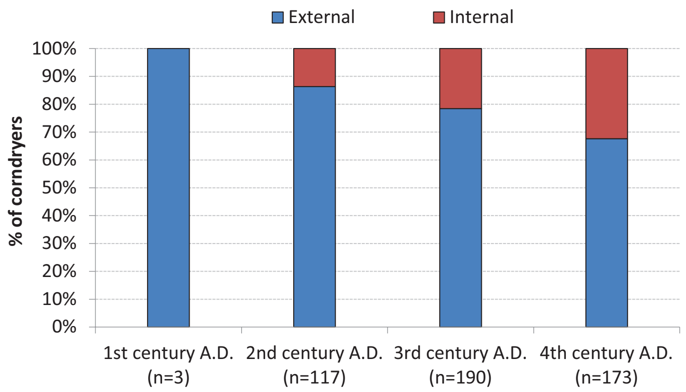

FIG. 2.47. Proportion of sites with external and internal corndryers over time (sites with both external and internal corndryers per period are included twice)

and Richmond 1969, 138; Smith 2016b, 57–8), with examples at Atworth, Wiltshire (Erskine and Ellis 2008), Ilchester Mead, Somerset (Hayward 1982) and Ingleby Barwick, Stockton-on-Tees (Willis and Carne 2013). Gerrard has argued that the movement of corndryers from the peripheries of low-status settlements to the interiors of high-status buildings indicates the need for local leaders to supervise the production of grain surpluses in the increasingly unstable fourth century A.D. (Gerrard 2013, 255–9). Corndryers are found in a range of locations, from settlement enclosures, free-standing covered buildings to aisled barns and previous bath complexes. While corndryers are often considered to have been free-standing structures, several well-preserved examples indicate the presence of enclosing structures. For instance, daub fragments from the fill of a long hearth indicate a superstructure at South of Tunbridge Lane, Bottisham, Cambridgeshire (Newton 2014), and at Manor Way, Flitwick, Bedfordshire, a central posthole and a series of surrounding ones were interpreted as support for a roof covering (Fadden 1976).

A simplification of the location of corndryers into 'internal' and 'external' (FIG. 2.47) shows that there is a gradual movement of corndryers from external locations to internal locations, with 32 per cent of fourth-century A.D. corndryers situated within buildings. Rather than Gerrard's association of this change with a sudden fourth-century shock, it can instead be seen as part of a gradual process whereby agricultural-processing becomes more central to the main structures of farms and villas.

CORNDRYERS IN THE CASE STUDY AREAS

Establishing the function of corndryers relies upon a consideration of the plant remains recovered from these structures. Charred plant remains are usually recovered from the stokehole and flue, representing the fuel used to fire the oven rather than the material that the oven was used to heat. The best evidence for the material being processed within a corndryer derives from Grateley South villa, Hampshire, where a corndryer burnt down during use. A 5–10 cm thick layer of charred grain was preserved *in situ* within the drying chamber, containing both individual spelt grains and spikelets. There was a higher proportion of sprouted spelt wheat grain in the left-hand flue than the right-hand flue, suggesting one was being used for processing germinated grain for malt and the other for processing grain for flour (Campbell 2008c). Evidence for the use of a corndryer for malting derives from the presence of substantial proportions of germinated grains (over 20 per cent) and detached embryos (coleoptiles), which together indicate that cereal grains have been deliberately germinated and then heated to arrest the germination process (Van der Veen 1989). This process is discussed in detail below (p. 62). Nearly all corndryers were used to process glume wheats, primarily spelt, as indicated by chaff used to fire the ovens, and grain accidentally burnt while the ovens were in use.

Evidence for the types of corndryer and the ways in which they were used can best be explored through more detailed analysis of two case study areas. On the Wessex Downs, information from 38 sites showed that T-shaped corndryers were the most common type, occurring at 28 sites, including enclosed farmsteads (e.g. Park Prewett Hospital, Basingstoke; Coles *et al.* 2011), complex farmsteads (e.g. Balksbury Camp), villas (e.g. Fullerton) and roadside settlements such as East Anton, where twelve corndryers were in use (Firth 2011). More simple forms, long hearths, were also in use at some sites, such as the farmstead at Fir Hill, Bossington (Brown 2009). There was a marked increase in the number of corndryers in use from the second century A.D. (10) to third and fourth centuries A.D. (47). The majority of these sites did not provide definitive evidence for malting, with many samples from corndryers identified as spelt glume bases used as fuel. Unmalted spikelets were identified from a corndryer at Park Prewett Hospital and High Post, Salisbury (Powell 2011b), suggesting a function in heating un-parched spikelets prior to pounding. Definitive evidence for a malting function was recovered only from villas at Fullerton and Grateley.

A contrasting pattern occurs in the West Anglian Plain, where there appears to have been a fairly rapid construction of corndryers in the second century A.D., consisting mainly of T-shaped and long hearth ovens. Ovens with double flues were in use from the second century A.D. onwards (H-shaped, triangular, double-H and double-T), but did not increase in proportion over time. Nucleated settlements, such as Stanwick in Northamptonshire (Crosby and Muldowney 2011), often contained multiple corndryers, but still of the standard T-shaped form. There was a wide range of corndryers at some complex farmsteads, such as at Orton Hall Farm, Cambridgeshire, where H-shaped, double-H and reversed tuning fork ovens were in use (Mackreth 1996). In contrast, the only corndryer type present at enclosed farmsteads comprised long hearths, such as at Mawsley New Village, Northamptonshire (Harvey 2012). Evidence for malting in the form of charred spelt glume bases and coleoptiles derives from a range of corndryers, including elaborate structures such as the H-shaped, bent-T corndryer at Parnwell, Peterborough. In contrast, a T-shaped corndryer at Wavendon Gate (Williams *et al.* 1996) and a triangular oven at Windmill Hill (Zeepvat *et al.* 1987), both in Milton Keynes, did not produce evidence for malting, but showed spelt glume bases used as fuel.

CORNDRYERS: SUMMARY

Analysis of corndryers has confirmed that there is evidence for an increase in scale of arable cultivation over the course of the first to fourth centuries A.D., confirming current models of arable farming in Roman Britain. The variation in structure and floor material of corndryers, together with the mixed charred cereal remains recovered from them, clearly indicates a diversity of function. Previous emphasis on malting has perhaps down-played the extent to which some settlements were focused on cereal processing, with multi-dryer installations at sites such as Yewden villa in Buckinghamshire (14 corndryers; Eyers 2011), East Anton roadside settlement in Hampshire (12 corndryers) and Orton Hall complex farmstead in Cambridgeshire (4 corndryers) having substantial processing capabilities. Even if a large proportion of these were directed at malt rather than grain, this is still a practice aimed at providing food for the population of Roman Britain, as ale is high in calories. The large surface area for drying cereals for grain or malt, totalling around 20 m² for dryers at Parnwell and Orton Hall Farm, clearly shows that the processing of cereals was taking place beyond the level of household supply. The number of corndryers in use peaks in the third century A.D. In order to justify the capital investment and labour needed to construct, fuel, and supervise a corndryer, the benefits of being able to process large volumes of cereals must have outweighed the costs. One option, suggested by Martin Jones (1981, 115), is that corndryers enabled farmers to produce cash crops at points of the year when extra money was required. However, the extent to which malted grain increased in value compared to unmalted grain is unclear, as the final stage of brewing would still need to take place to produce ale. Producing a product for the market was clearly a factor, as the distribution of multi-flue corndryers at villas and roadside settlements matches the major concentration of coins (see Ch. 6). The parching of spelt spikelets would enable easier de-husking, and allow clean grain to be sold on the market, which makes it more efficient for transport, and easier to standardise weight. Beyond the production of a marketable commodity, the de-husking of glume wheats aided by corndryers would have focused crop-processing activities at a certain point of the year, permitting labour to be deployed on other activities, such as ironworking, pottery production or textile processing, allowing economic growth through a more efficient use of labour (Erdkamp 2015).

Corndryers were not only present in Roman Britain, but occurred at villas in *Germania Inferior* and *Superior*, and *Raetia*, such as at Weitersbach (Wightman 1970, 142, 185) and the villa of Dietikon, Zurich (Ebnöther 1995). Corndryers are also recorded in north-east France (Van Ossel 1992, 137–51), but are absent from the sand and clay regions of the northern Rhineland (Roymans 1996, 79; Roymans *et al.* 2015). The lack of a comprehensive review of corndryers on the Continent means it is currently not possible to conclude where different forms of corndryers first developed in the Roman world, and whether they represent a genuine agricultural innovation or not. However, further detailed studies investigating their processing capabilities, contextual evidence for use, and the spread of different corndryer forms, have the strong potential to advance our understanding of changes in the scale of cereal production.

MALTING

The diversity in structural form and archaeobotanical contents of corndryers indicates that they were not solely used for the production of malt for ale (see above), although the existence of a brewing industry in Roman Britain is evidenced by writing tablets found at Vindolanda and London (Bowman 2003; Tomlin 2016). Within the brewing process, malting involves the partial germination of cereal grains to produce diastase enzymes. Spikelets are first soaked in water before being allowed to germinate on the malting floor, which converts the starch contained in the endosperm to sugar. The grains are then heated to stop germination, this activity taking place in some corndryers, before being dried and rubbed to removed glume bases and sprouts. This process results in the *product*, malt, which can be mashed with hot water and brewed, and the *by-product* of sprouts and cereal chaff (Cool 2006, 140–3). Charred germinated grains can be identified in the archaeobotanical record due to their shrivelled appearance, and allow the activity of malting to be identified archaeologically. Evidence from classical literary sources and from contemporary writing tablets point to the popularity of brewed beverages in the north-western provinces, both among the natives, according to Pliny the Elder's and Tacitus' descriptions of the Gallic tribes (Pliny *NH* XIV.29; Tacitus *Germania* I:23.1), and also among members of the military posted in Britain (Bowman and Thomas 1994, 24–9, 32–5). Tankards and butt beakers were believed to have been used in the later Iron Age as vessels to drink ale (Horn 2015, 334; Pitts 2005), but no specialised brewing structures or deposits of germinated grain are currently known in prehistoric Britain, implying that if brewing was taking place, it was only on a small, household scale. The Egyptian method of brewing, producing malt cakes of sprouted spikelets and chaff, which can be used when needed, does not require fire or specialist equipment, and may have been practised in British prehistory. However, the Babylonian method of roasting germinated spikelets and then rubbing them to remove the chaff and sprouts (Corran 1975, 11–22), appears to have been taking place in Roman Britain. The recognition of malting as a rural industry in Roman Britain is a relatively recent occurrence, following the widespread application of archaeobotanical techniques (Van der Veen 2016), and is absent from earlier syntheses (Millett 1990; Fulford 1989a; 2004). This section reviews the architectural and archaeobotanical evidence for malting, in order to identify the chronological and regional extent of this practice, and the scale at which the malting 'industry' was operating.

MALTING: ARCHITECTURAL AND ARCHAEOBOTANICAL EVIDENCE

Unfortunately, brewing leaves few distinctive architectural traces (Cool 2006, 142–3). The two main requirements are water, in which to soak the grain to encourage germination 'steeping' and to conduct mashing and brewing, and a heat source to stop germination once the grain has reached the required stage (Andrews *et al.* 2011, 224–6). Wooden barrels and wooden tubs decompose unless buried in waterlogged conditions, and the presence of tanks at a site may derive from a range of industries, from salt-making (see Ch. 5), to dyeing. The presence of germinated grain is commonly seen as an indicator of malting, but can also be an accidental product of grain that has been stored in damp conditions. However, a high proportion of germinated grain can be considered a good indication of deliberate germination (over 20 per cent, following Parks 2012, 129–37).

Distinctive malting by-products and products can be more precisely identified in archaeobotanical samples (Hillman 1982; W. Smith 2011; Stevens *et al.* 2011; Van der Veen 1989), and the components of each stage are outlined in TABLE 2.19. Accidental

TABLE 2.19: ARCHAEOBOTANICAL CRITERIA FOR TYPES OF MALTING WASTE

	Description	*Origins*	*GW grain: GW glume bases*	*Coleoptiles*	*Pseudonyms*
A: Waste/'Comings'	Glume bases and coleoptiles	Removed by de-husking and sieving after germination, used as fuel	0:1	++	FSBP + coleoptiles
B: Malted grain in spikelets	Germinated grains in spikelets	Accidentally charred malted grain prior to de-husking	1:1	++	Spikelets
C: Malt	Germinated grains	Accidentally charred product of malting process	1:0		FSP

charring may happen at three stages: malted grains within their spikelets, which have become accidentally burnt (type B); germinated grains (malt) once they have been removed from their spikelets (type C); and waste or 'comings' (glume bases and coleoptiles), once they have been removed from the cereal grains after de-husking and used as fuel (type A). Hence, malting can be identified through the proportion of germinated grains, the presence of coleoptiles or detached embryos, and the ratio of grain to glume bases. The lengths of the sprouts and the uniformity of sprout length have also been used as positive indicators of malting (Murphy 1992), but these are rarely recorded. The occurrence of evidence for malting in multiple samples across one site provides stronger evidence for large-scale malting. As sprouted embryos (coleoptiles) and non-sprouted embryos were not always distinguished in reports, they are treated here as a combined category.

Several rural settlements have produced good architectural and archaeobotanical evidence for malting and are summarised here. At Stebbing Green, Essex, a second–third-century A.D. timber building thought to be associated with a villa estate contained wooden supports for a timber tank and flue bases for ovens. The charred plant remains contained many spelt glume bases and germinated grains (Bedwin and Bedwin 1999). Nearby at The Old Sugar Beet Works, Felsted, a mid-Roman farmstead contained a wooden cistern with a wooden pipe leading to a culvert, and a similar assemblage of plant remains (Valentin and Robinson 2002). At Whitelands Farm, a farmstead to the south-east of Alchester in Oxfordshire, stone-lined tanks and culverts and a corndryer were in use during the second and third centuries A.D., and several samples of charred plant remains were classified as spelt wheat glume bases and sprouts, removed after de-husking germinated grain. Of the nine samples analysed from this site, coleoptiles/embryos and germinated grains were present in six (Martin 2011). Further east, on Akeman Street, a stone-lined pit and a corndryer were located inside a timber building within a complex farmstead at Weedon Hill, Buckinghamshire, dated to the second to fourth centuries A.D. (FIG. 2.48). Three type A samples were identified, representing the malting by-product used as fuel, and of the fifteen samples analysed from the site, detached coleoptiles were present in ten and germinated grains in eleven (Wakeham and Bradley 2013).

In Kent, exceptional evidence for malting has been identified in the Northfleet area. At the early

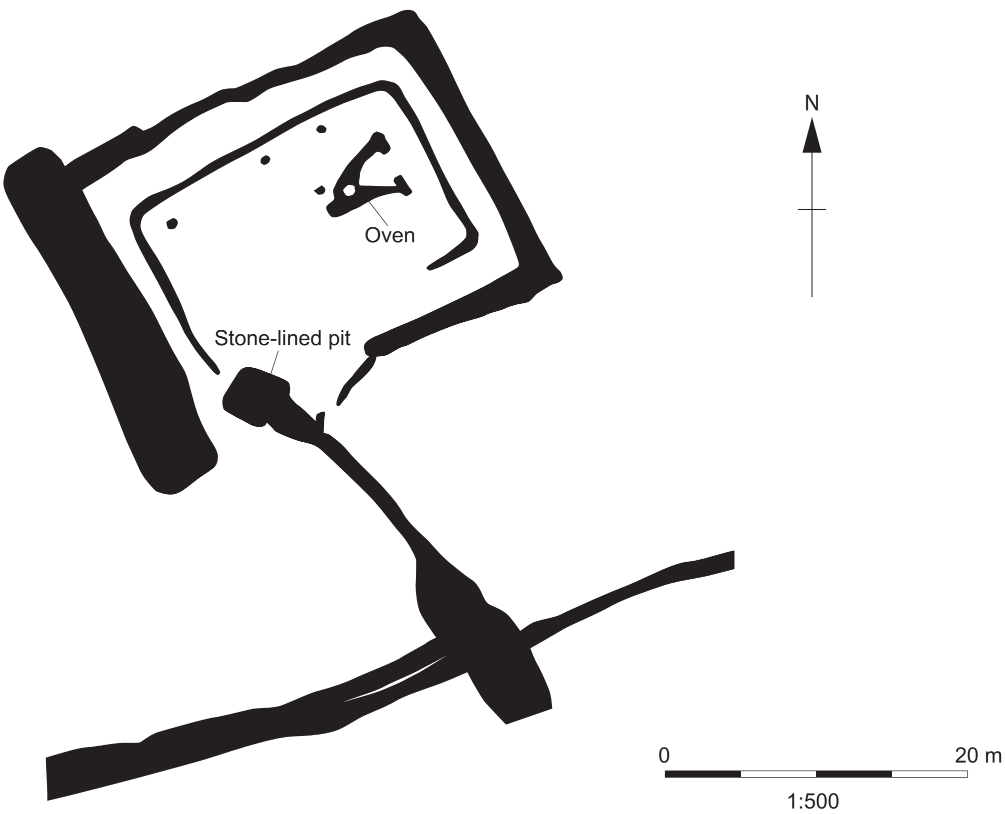

FIG. 2.48. Plan of a malt house at Weedon Hill, Aylesbury, Buckinghamshire (Wakeham and Bradley 2013)

to mid-Roman roadside settlement at Springhead, germinated grain and coleoptiles were very common within certain 'property plots', representing comings used as fuel (Stevens 2011b). At nearby Northfleet villa, dedicated malting structures were identified, which included a cistern, wood-lined pits, a malting oven and an aisled barn, all located near a quayside, where products could easily be transported along the Thames Estuary (Andrews *et al.* 2011, 224–6). Germinated grains and coleoptiles were present in all 28 samples, and all three categories of malting sample were recorded (W. Smith 2011). Another notable site is the roadside settlement at Catsgore, Somerset, where samples from corndryers consisted primarily of charred spelt glume bases, detached coleoptiles and germinated spelt grains (Hillman 1982).

There are other examples of sites with sunken-lined features or tanks that may have been used in the malting process, including a complex farmstead at Former Bridgman Joinery Works, Bedfordshire (Luke and Preece 2003), a villa at Whitton Lodge, South Glamorgan (Jarrett and Wrathmell 1981), Halstock villa, Dorset (Lucas 1993) and Keston villa, Kent (Philp *et al.* 1991). The weakness of such structural data alone, however, is that without supporting archaeobotanical evidence it cannot be established whether they were specifically associated with malting.

MALTING: PROVINCIAL DATASET OF ARCHAEOBOTANICAL EVIDENCE

All archaeobotanical assemblages where the specialist suggested malting had taken place were recorded in the project database. Only single incidences were reported from the South-West (Nancemere Fields, Cornwall: Higgins 2009) and Upland Wales and the Marches (Glasfryn, Tremadog, Gwynedd: Kenney 2006), two from the Central West (Wellington Quarry, Herefordshire: Jackson and Miller 2011, and Billingley Drive, South Yorkshire: Neal and Fraser 2004) and three from the North-East (Mount Pleasant House (Willis 2013b), Newport (Trimble 1994) and The Bridles (Allen and Rylatt 2002), all Lincolnshire). It is clear that evidence for malting is concentrated in the Central Belt, South and East, and FIG. 2.49 shows the frequency of site types with archaeobotanical samples indicating malting within two of these three regions. In all of them, malting was more frequently recorded at complex farmsteads, roadside settlements and villas than enclosed farmsteads. In the East, malting was recorded at all seven of the analysed villas, while in the South it was recorded in four of the twelve villages. Over time, occurrences of high numbers of germinated grain markedly increase, from being recorded at just 2 per cent of late Iron Age sites to 6 per cent of early Roman sites and peaking at 14 per cent of mid-Roman sites. This pattern could indicate a peak in malting and/or a peak in the bulk storage of cereals in the mid-Roman period. Where recorded (80 assemblages), 89 per cent of all germinated grain assemblages were primarily spelt, 10 per cent were a mixture of spelt and barley and only one site produced samples dominated by germinated barley grains (Grange Park, Courteenhall, Area 5, Northamptonshire: L. Jones *et al.* 2006). This pattern is in contrast to the common assumption that barley was cultivated for ale, based on modern preferences (Applebaum 1972, 112). Hops (*Humulus lupus*) has mostly been recorded from a few military and major town sites in Roman Britain (Van der Veen 2008, 88). This means the brewed beverage was ale rather than beer, which is flavoured with hops although other flavourings

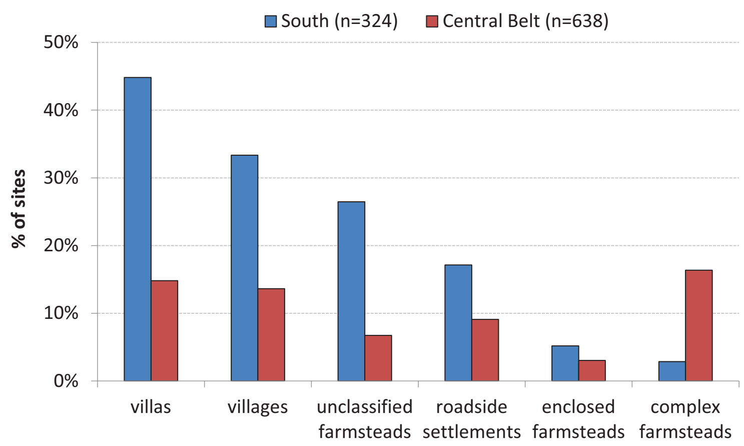

FIG. 2.49. Frequency of sites with archaeobotanical records in the Central Belt and South regions where malting has been suggested

may have been used. The only occurrence of hops from rural Roman Britain is at All Souls Farm Quarry, Buckinghamshire, on the outskirts of Slough, in the form of a single charred seed from a late Iron Age/early Roman sample (McKenna 2012). Although hops is native to central and southern Britain (Stace 2010, 284), and the practice of using hops as a preservative in brewing is considered to be a medieval innovation (Tomlinson and Hall 1996), its occurrence at All Souls Farm alongside grape tentatively suggests involvement in beverage production at this complex farmstead.

MALTING: CASE STUDY AREAS

In the Upper Thames Valley, other than at Weedon Hill and Whitelands Farm, very few samples contained over 20 per cent germinated grains. At Gatehampton Farm, Goring, a single sample from a corndryer at a Roman villa contained a mixture of germinated grains and sprouted embryos (Letts 1995). Elsewhere, malting was considered an unlikely source of germinated grains at Abingdon West Central (Pelling 2007), Berrick Salome (Wilson 2008) and The Ditches (Trow *et al.* 2009), with the low density of germinated barley grains more likely to be linked to storage conditions. Finally, a late Roman sample from a farmstead at the CRL/Mansfield College site in Oxford was identified as type A stage malting waste, with detached coleoptiles/embryos present in all ten analysed samples (Pelling 2000).

On the Wessex Downs, malting also appears to be a rare activity. One type A sample was identified at Merton Rise, Basingstoke (Wright *et al*. 2009b), but only a single coleoptile was present from other samples. At Fullerton villa, a sample from a corndryer flue was classified as a type A sample, with only a small amount of grain compared to coleoptiles and glume bases, indicating the use of comings for fuel, while traces of germinated grain and coleoptiles were also recovered alongside barley rachis from a keyhole oven (Campbell 2008b). At nearby Grateley, type A samples from identified mid- and late Roman features contained substantial numbers of coleoptiles and germinated spelt grains, and a sample from a drying floor of a corndryer was classified as type C – germinated spelt grains (Campbell 2008c). Germinated barley and spelt/emmer grains were also recovered from the late Iron Age settlement at Suddern Farm (Campbell 2000b). Overall, definitive evidence for malting activity is limited to late Roman villa sites on the Wessex Downs.

In the West Anglian Plain, one sample from Bancroft Roman villa in Buckinghamshire was classified as type A, with thousands of glume bases and germinated grains (Pearson and Robinson 1994). At Lower Cambourne, Cambridgeshire, type A samples with sprouted coleoptiles and 25–44 per cent germinated spelt grain were recovered from an early Roman ditch and a late Roman oven within the complex farmstead, with detached embryos and germinated grains also present in other samples (C. Stevens 2009a). Single type C samples were identified at a mid-Roman farmstead at Luton Road, Wilstead (Luke and Preece 2010), and also at Biddenham Loop farmstead 6/8/10/14 (Luke 2009) in the Ouse Valley, but neither produced coleoptiles or sprouts, and there was only a minor presence of coleoptiles and germinated grains in other samples. To the north in the Nene Valley, a spelt type A sample was recovered from the stoking pit of a corndryer at a mid-Roman farmstead at Parnwell (Webley 2007), indicating the use of comings as fuel. Of the sixteen samples analysed, coleoptiles were present in ten and germinated grain in seven.

The best evidence for malting derives from Kent, further supported by the architectural evidence from sites such as Darenth (Philp 1973), which do not have an archaeobotanical dataset. Beyond the evidence from Springhead and Northfleet described above, early Roman malting is indicated at several sites within the Isle of Thanet. Spelt type A samples were present at a village (zones 6 and 7), complex farmstead (zones 9 and 10), field system (zone 11) and enclosed farmstead (zone 13) excavated during work on the East Kent Access road (Hunter 2015). The nearby village at Monkton produced one sample with germinated barley and spelt grains, but coleoptiles were present in ten out of eleven samples (Pelling 2008). Further possible evidence derived from Downlands Walmer and the roadside settlement at Westhawk Farm. Beyond the numerous sites with indications for malting, Kent also has arguably produced the earliest definite evidence. At Nonington, an unclassified late Iron Age/early Roman farmstead between Canterbury and the east coast, a cellared building produced five samples classified as spelt type C samples – germinated grains and abundant coleoptiles (Helm and Carruthers 2011).

MALTING: SUMMARY

Overall, malting was relatively restricted as a specialist industry, with only a few excavated sites in each region where malting was practised on a large enough scale to be recognised archaeobotanically. Kent is the exception, where several sites have produced early Roman evidence for malting, and there is abundant evidence from Springhead, Northfleet, and nearby farmsteads. Malting was an activity undertaken at villas, complex farmsteads and roadside settlements, alongside defended 'small towns' such as Ilchester (Stevens 1999), Alcester (Colledge 1989) and Droitwich (de Moulins 2006; Straker 2006), major towns such as Verulamium (Niblett *et al.* 2006) and at military sites, such as Colchester (Culver Street) and Pakenham (Parks 2012, 131). These sites span the whole Roman period, although early Roman malting appears restricted to Kent, the Boudican town at Colchester, the fort at Pakenham, Suffolk, and some roadside settlements further afield. Based on the size of tanks at Northfleet villa, it was suggested that brewing peaked here in the late first to mid-second century A.D. (Andrews *et al.* 2011, 225). Elsewhere, malting activity at Whitelands Farm appears to have declined after the early third century A.D., though at Weedon Hill it may have continued through to the fourth century, based on radiocarbon dates of cereal grain.

While ale has a short shelf-life, ground malt can be stored for up to a year (Corran 1975, 16), and so stored spelt wheat could be transformed into malt in quieter parts of the agricultural year, in order to provide an additional commodity (M. Jones 1981, 115–18; Van der Veen and O'Connor 1998, 134). However, the extent to which the value of malt would increase in comparison with unmalted spelt wheat is unclear as the malt would still need to be converted to ale before it could be sold to the consumer. No brewing sites are known that do not have the capacity to malt their own cereals. Once produced, malt would be at risk from grain pests and mould, as the grains were no longer protected by spikelets. Furthermore, spelt wheat intended for malting has to be stored within spikelets, to ensure that the embryo is protected, and the grain can still germinate when required. Hence, the farmer would need to decide after harvest how much grain to retain for malting alongside that kept for seed-corn. Given these considerations, it seems unlikely that malt was being produced at farmsteads to be sold for brewing elsewhere.

At many villas, grain may well have been malted primarily for ale consumption within the settlement and/or any wider estate. However, there is a correlation between sites where malting has been identified and a location near the Roman road network, a pattern recently highlighted by Stevens *et al.* (2011, 242). Weedon Hill and Whitelands Farm are both close to Akeman Street, the sites in Kent are close to ports and Watling Street, and the roadside settlement at Catsgore, Somerset, was located on a main road to the north of Ilchester (Hillman 1982). This would ensure malt could be transported easily to the urban populations, or alternatively to provide produce for road travellers (Stevens *et al.* 2011, 242).

STORAGE

Cereals need to be stored for a number of reasons, including the provision of the next year's seed-corn, to sell on the market at a time of the farmer's choosing, to feed to local dependants of the agricultural landholding (including villa estates), and to pay taxes. The condition in which grain is stored, as clean grain, spikelets, or unprocessed grain, has implications for the ease in which grain can be used to produce malt or flour, or be used as seed-corn. The location of storage facilities at farmsteads, villas and roadside settlements is suggestive of large-scale cereal processing, while also possibly demonstrating an architectural form of conspicuous elite display (Perring 2002, 43; Taylor 2012). There were major changes in the types of cereal storage features in use over time, from a combination of below and above ground storage in storage pits and four-post structures in the Iron Age, to a range of rectangular above-ground structures in the Roman period (Van der Veen and Jones 2006; Van der Veen 2016; Smith 2016b, 58–60). Distinctive structures such as granaries and aisled barns are present at some villas and farmsteads, but the function of these structures as grain stores is usually reliant upon the recovery of charred cereal grain deposits. Evidence for smaller scale storage, both within these larger structures, and within domestic homes and shops, is very limited. Wicker baskets and bins have been claimed at the small town of Godmanchester, Cambridgeshire (Green 1975), stone-lined storage bins at Shepton Mallet, Somerset (Leach 2001), and there are indications of textile bags at 1 Poultry, London, and Culver Street, Colchester (Hill and Rowsome 2011; Murphy 1992).

STORAGE PITS

Storage pits were a common feature of Iron Age farmsteads, functioning by providing a hermetically sealed environment for cereal grain. Any oxygen is swiftly used up in the decay of external layers of grain, preserving the remaining grain for several years (Bersu 1940; Fenton 1983; Sigaut 1988; Van der Veen and Jones 2006). Storage pits have been associated with the need for long-term grain storage (Reynolds 1974; G. Jones 1984; Cunliffe 1992), and, more recently, it has been argued that they were intended to store cereals for feasting events associated with hillfort communities (Van der Veen and Jones 2006). They can be identified by their distinctive beehive shaped sections, and their direct association with the storage of cereal grain is reliant on the exceptional recovery of *in situ* grain-rich samples from their fills, with notable examples at Danebury hillfort, Hampshire

(M. Jones 1984) and Hascombe hillfort, Surrey (Murphy 1979). The pits are found mainly in central southern Britain, although their existence is dependent on local soil conditions, and they range in date from between 800 to 100 B.C. Their decline is associated with a switch away from feasting-centred hillfort communities, to surplus cereals being exchanged for imported material culture (Cunliffe 1992; Van der Veen and Jones 2006). However, the perceived late Iron Age cessation in storage pit use has been countered to some degree by the excavation of latest Iron Age storage pits at Grateley and Suddern Farm on the Hampshire Downs (Campbell 2008a, 70).

A small number of settlements in the project database have evidence for the use of storage pits in the Roman period. Hawkes' reanalysis at Woodcuts, Dorset, phased storage pits at the settlement as in use from the mid-second to early fourth century A.D. (Hawkes 1947), while the continuation of the late Iron Age enclosed farmstead at Gussage All Saints, Dorset, until the end of the first century A.D. included the continued use of storage pits and four-post structures (Wainwright 1979). Elsewhere, at the complex farmstead at Owslebury, Hampshire, storage pits remained in use from the late Iron Age into the second century A.D. (Collis 1968; 1970), and storage pits have been dated to the late Iron Age and early Roman period at an enclosed farmstead at Waterstone Park, Stone Castle, Kent (Haslam 2009). The only other excavated rural settlement with evidence for storage pits is at Cams Hill School, Hampshire, on the south coast, where several storage pits and a sunken-featured building dating to the late Roman period have been associated with Germanic influence (Eddisford 2009). It is clear that storage pits only continued to be used at a small number of farmsteads on calcareous geologies, primarily on the Wessex Downs and in Kent, and did not extend much beyond the first century A.D. There was, therefore, a major change in certain areas from small-scale below-ground storage of cereal grain in the Iron Age to above-ground or off-farm storage during the Roman period.

FOUR-POST STRUCTURES

Four-post structures consist of four postholes arranged in a rectangular shape from which the presence of an elevated storage structure has been inferred, identified as such by Pitt-Rivers on Cranborne Chase and Bersu at Little Woodbury, Wiltshire (Pitt-Rivers 1888; Bersu 1940). These structures are primarily associated with grain storage, elevating cereal grain to prevent the build-up of heat and moisture and attack by vermin, and are considered to have been used for regularly accessible grain in the Iron Age (Van der Veen and Jones 2006). However, the potential for other uses, and the wider implications of storage beyond food supply, have also been highlighted for these structures (Gent 1983; Chadwick 2012, 298; Hodder 2012). Alternative uses have been suggested as mill houses, gateways, shrines or towers (C. Evans 2013, 69), or storage for fodder or straw (Lambrick and Robinson 2009, 271–2). The direct identification of these structures as grain stores is reliant on the recovery of charred cereal grains from postholes, as at Rotherley, Wiltshire (Pitt-Rivers 1888, 57), and Sutton Common, South Yorkshire (Hall and Kenward 2007), although the latter example may actually be a foundation offering of cereal grain prior to the construction of the four-poster, as opposed to direct evidence of use (Chadwick 2012, 290; Van de Noort *et al.* 2007, 38–9).

Four-post structures were very common in Iron Age Britain, distributed across much of the British Isles, but with a concentration in central southern England (Gent 1983). In contrast to storage pits,

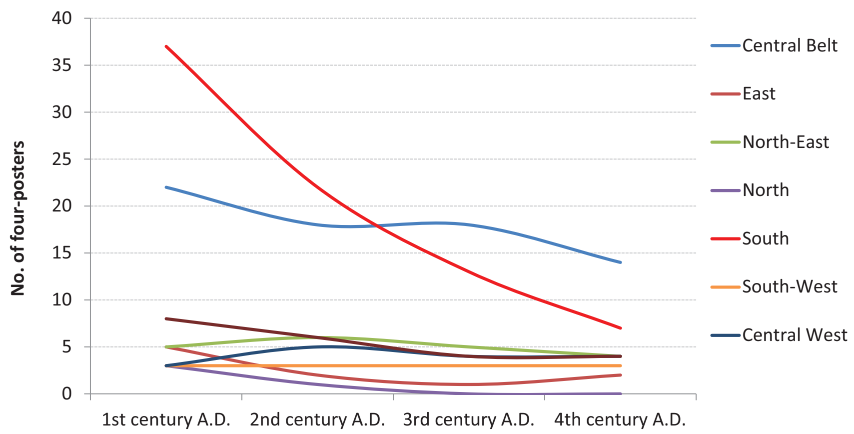

FIG. 2.50. The number of four-post structures in use by region over time

there is much greater continuity in the use of four-post structures throughout the Roman period (Smith 2016b, 58–60), often linked with the need for regular access to grain, as at Wainscott, Kent, where a four-post structure was located adjacent to a rectangular corndryer, probably storing grain prior to processing (Clark *et al.* 2009).

Four-post structures were present at a total of 114 excavated settlements in the project database. Dating these structures is difficult owing to the small number of datable artefacts recovered from postholes but, of those recorded, 80 were possibly in use, and 36 were definitely in use during the Roman period. As with storage pits, however, they may be under-recognised, especially if constructed on flat surfaces or post-pads. The number of four-post structures in use in each region from the first to fourth centuries A.D. is shown in FIG. 2.50, with a general decline noted everywhere, especially in the South. In the South-West, North-East, Central West and the East the decline is very slight, although these regions are beyond the main area of four-poster use during the Iron Age. In the South, 37 settlements with four-post structures were possibly in use in the first century A.D., decreasing to only seven by the fourth century A.D. In the Central Belt, there is a more gradual decline from 22 settlements with four-post structures in the first century A.D., to eighteen in the second century A.D. and fourteen in the fourth century A.D. Four-post structures were most common at farmsteads, particularly of unenclosed type, with less than 4 per cent located at villas and villages. They remain absent from roadside settlements. Overall, given the substantial number of rural farmsteads excavated, four-posters appear to be a rare form of storage, and their decline signals the move to larger-scale storage.

AISLED BUILDINGS AND GRANARIES

As the use of storage pits and four-post structures decreased in rural Roman Britain, the use of larger, above-ground, purpose-built storage and multi-functional agricultural structures increased. Aisled buildings have long been recognised as components of some rural settlements (Smith 1963; Cunliffe 2013), and the regional distribution of these structures has been discussed in detail in Volume 1 (Smith 2016b, 66–9). They occur over much of rural Roman Britain, although are very rare in the North and South-West, and have been identified at 168 excavated sites, totalling 219 structures, with a peak in numbers during the third century A.D. A wide range of functions have been identified for aisled buildings, including domestic, industrial, and, of significance here, agricultural. The general absence of evidence for structures related to animal husbandry, such as stalls, may indicate that many of the non-developed aisled buildings were dedicated to crop processing (Taylor 2012, 187), although it is rare that levels of preservation are sufficient for such features to be detected. Crop-processing structures located within aisled buildings include threshing floors and corndryers, while the 'open hall' types would have contained plenty of space for crop storage.

Analysis of buildings interpreted as granaries in Volume 1 (Smith 2016b, 58–60) identified them at 41 settlements, mainly located in the Central Belt and in the hinterlands of London, alongside some military sites in the north-west. Thirteen of these sites are farmsteads, alongside seventeen villas, seven roadside settlements and three military *vici*, although, as just noted, there are many more structures such as aisled barns that could have had a storage function. The structures identified as granaries are quite varied, though include several examples of substantial, military-style grain stores, with buttressed, masonry walls (Morris 1979, 32–3). These were not limited to military settlements, with, for example, villas at Lullingstone, Eccles and Horton Kirby in Kent all containing substantial granaries, with estimates that they could have held 150–220 tonnes of grain (Philp and Mills 1991, 16; Taylor 2012). The village settlement at Mucking in Essex contained a military-type beam slot granary, measuring 8.6 m by 4.3 m (Lucy and Evans 2016), and a farmstead at Cleevelands, Gloucestershire, had a probable masonry granary with a raised floor, dated to the second and third centuries A.D. (Joyce 2010). The remaining structures suggested as granaries are of timber posthole or beam-slot construction.

Tower granaries, with multiple stories, have been identified in earlier excavations within the towns of Colchester and Silchester (Crummy 1992, 108; Boon 1974, 256–7), the small town at Godmanchester (Green 1975, 198, 207), the villa at Gorhambury, Hertfordshire (Neal *et al.* 1990), and most recently at a probable roadside settlement at Wantage, Oxfordshire (Holbrook and Thomas 1996).

STORAGE: ARCHAEOBOTANICAL EVIDENCE

While the diverse range of storage structures clearly indicates variation in the scale and location at which crops were stored and mobilised, identifying which crops were stored and in what form is difficult. Storage deposits representing spikelets or clean grain, burnt *in situ* within a storage structure, are extremely rare. This absence is unfortunate, given that the grain, chaff and weeds seeds in such deposits can provide vital information on sowing techniques, the form of storage, crop cleaning, pests and the spatial use of storage facilities (Murphy *et al.* 2000). While various early excavations uncovered substantial quantities of charred cereal grain at villas, such as at Park Street, Verulamium (O'Neil 1947) and Great Weldon villa, Northamptonshire (D.J. Smith *et al.* 1990; for further examples see Morris 1979, 35), none of these projects included archaeobotanical analysis. Only four excavated examples of definite storage deposits are known from rural settlements. One derives from an aisled building excavated at a villa at Great Holts Farm, Essex (Murphy *et al.* 2000). Here, ten samples from postholes and a central tiled area produced different proportions of crops, showing that pulses, wheat (probably spelt) and barley were being stored separately, and were very clean. Another deposit is from an aisled barn at Grateley South, Hampshire, where cereal grain thought to be stored in the roof of a burnt-down building consisted almost entirely of clean spelt and barley grains (Campbell 2008c). A third example is from Bredon's Norton in Worcestershire, where a layer of charred cereal grain, radiocarbon dated cal. A.D. 345–430, was found in a bathhouse, preserved when a conflagration destroyed the building. In contrast to the first two sites, the cereals here were composed of spelt wheat grains still stored within spikelets (K. Hunter 2016). Finally, at Dinnington villa, Somerset, a layer of charred wheat grain, radiocarbon dated cal. A.D. 410–570, was recorded overlying a mosaic, though no detail is currently available on the composition of this assemblage (King and Grande 2015). Whether any of these assemblages represent grain stored for the consumption of the villa estate community or for sale on the market is unclear.

Many more storage deposits have been identified from urban and military sites, and, where data are available, these are nearly all stores of clean (i.e. de-husked) grain, and almost always spelt, with a ratio of glume wheat grain:glume base greater than 1.5. Examples include Boudican destruction deposits at Balkerne Lane, Cups Hotel and Culver Street, Colchester (Murphy 1984; 1992), the Forum, 168 Fenchurch Street and 1 Poultry in London, and several sites in Southwark (Davis 2003; 2004; Smith and Davis 2011; Giorgi 2009; Straker 1984). These finds are all of early Roman date. Seeds from arable weeds not found in Britain (*Agrostemma githago* and *Vicia ervilia*) indicate that the Forum grain deposit was imported from the Continent, and it is possible that more of these stores could represent imported grain (Fulford 1984).

Further clean grain stores have been recorded from the mid-Roman period, at Coney Street and Rougier Street in York (Kenward and Williams 1979; Hall and Kenward 1990), and also in Verulamium (Helbaek 1952, 213). Significantly, the only known urban storage deposit of spelt wheat stored in spikelet form is at Insula XIII, Verulamium, where a deposit of fully cleaned spelt grain was found in the vicinity of a malt house (Fryer 2006). Storage deposits recovered from military granaries have also been of clean grain, with, for example, the spelt wheat component of the late third or early fourth century A.D. granary at South Shields, stored alongside free-threshing wheat (Van der Veen 1988; 1994). Similar findings were also made at Rocester, Staffordshire (Moffett 1989) and Ambleside, Cumbria (Carruthers 1993).

Other military deposits were studied before the advent of systematic sampling and processing techniques; hence the absence of chaff may be due to recovery bias, for instance at Castlecary, on the Antonine Wall, Malton, North Yorkshire (Jessen and Helbaek 1944) and Papcastle, Cumbria (Irwin 1924). Spikelets associated with non-native weed seeds were recorded from a timber structure outside the fort at Caerleon in South Wales (Helbaek 1964), and a large, second-century timber granary at the small town at Alcester, Warwickshire, was associated with a substantial spread of charred spelt glume bases (Colledge 1989), perhaps indicating that spelt wheat was being de-husked on site, before or after storage, or that chaff was being stored for use as fodder.

The majority of early and mid-Roman storage deposits are of clean grain, inferring that spelt wheat was de-husked before it entered storage at urban and military sites. Whether this de-husking was taking place at the location of production or storage is unclear. There is limited evidence for crop processing in the form of charred cereal remains from urban centres. Samples containing high proportions of glume bases have been recovered from several first-century A.D. sites in London, such as 1 Poultry (Smith and Davis 2011) and Leadenhall Court (Davis 1993), and elsewhere at County Hall, Dorchester (Ede 1993), Causeway Lane, Leicester (Monckton 1999), and Northgate House, Winchester (Carruthers 2011). In contrast, mid- and late Roman samples from these urban sites tend to produce rare cereal chaff, with hardly any glume bases recovered from the second century A.D. onwards at Insula IX, Silchester (Robinson 2012a). Where substantial deposits of crop-processing waste have been observed from urban centres, they tend to be at the periphery, such as the County Hospital site, Dorchester (C. Stevens 2008), and Pilgrim's School, Winchester (Champness *et al.* 2012). Therefore, it would appear that the final stages of crop processing were mostly taking place outside towns, and bulk consignments of cereals had already been cleaned on arrival.

Based on the presence of charred crop-processing waste in corndryers (see above, p. 61), the de-husking of spelt wheat happened at a range of settlements, including roadside settlements, farmsteads and villas, implying that spelt wheat was transported from these sites as clean grain. While de-husked spelt grain is considered to be more at risk from fungal attack, mites, insects and rodents (Sigaut 1988, 13; Hillman 1981), it has also been argued that the logistical benefits of removing the volume and weight of chaff prior to transport or exchange would outweigh the loss of grain from spoilage (Pals and Hakbijl 1992). Ground malt could also be transported and stored in a similar way, as it will survive for up to a year after production (Corran 1975, 10), and may increase in value due to the additional labour input. Ground flour has a shelf-life of only several months (Bennion 1967), and is likely to have been produced close to the place of consumption.

GRAIN PESTS

The presence of grain pests in Roman Britain is evidence for the change to bulk storage of cereals above ground (Van der Veen 2016). Remains of these grain pests are primarily recovered from waterlogged sediments, with similar biases as summarised in Chapter 1 (p. 3) for waterlogged plant remains. Limited charred insect remains have been recovered (Kenward *et al.* 2008; Smith and Kenward 2011), and charred cereal grains with evidence for insect damage can also indicate the presence of grain pests. Four main species of insect pests have been found in Roman Britain, reviewed recently by Smith and Kenward (2011). *Sitophilus granarius* (granary weevil) feeds on whole cereal grains, while *Oryzaephilus surinamensis* (sawtoothed granary beetle) and *Laemophloeus ferrugineus* (rust-red grain beetle) feed on grain already attacked by the granary weevil. These three beetles can over-winter within unheated granaries in Britain, but the fourth species, *Tribolium castaneum* (rust-red grain beetle), is unlikely to survive in the British climate, and is therefore an indicator of direct grain trade with warmer regions, such as at pre-Boudican 1 Poultry, London. The established archaeological distribution of these grain pests indicates that they are almost entirely restricted to urban centres, military sites and villas (Smith and Kenward 2011; Robinson 2015). Examples from urban sites include first-century A.D. records at 1 Poultry, London and the Coney Street warehouse, York (Kenward and Williams 1979), and the mid–late second century A.D. site at Birch Abbey Alcester (Osborne 1971a). Grain pests from military sites include Ribchester, Carlisle (Zant 2002), South Shields (Osborne 1994), the conquest fortress annexe at Alchester (Booth *et al.* 2007, 24) and Exeter (Straker *et al.* 1984), as well as from the harbour at Fishbourne, West Sussex (Osborne 1971b). Insect-damaged, charred cereal grains have been observed at Rougier Street, York (Hall and Kenward 1990, 411), and at Northgate House, Winchester (Carruthers 2011).

The presence of grain beetles was only noted in the project database when highlighted as a significant aspect within site reports, and so it is not a comprehensive survey from all rural sites. Nevertheless, the occurrences of grain pests can be grouped into settlements in the North-East, linked to military supply routes, and villas and nucleated settlements in the Central Belt and South regions. In the North-East grain pests have been noted in the nucleated settlement at Dragonby, Lincolnshire (Buckland 1996), from a complex farmstead at Sandtoft, South Yorkshire (Samuels and Buckland 1978), and from a farmstead at the foot of the Yorkshire wolds at Burnby Lane, Hayton, East Riding (Kenward 2015). Further north, *S. granarius*, *C. ferrugineus* and *O. surinamensis* were recovered from waterlogged sediments from excavations of part of a military *vicus* at Park View School, Chester Le Street, Co. Durham (Proctor 2006). Sites in the South and Central Belt regions include Dunkirt Barn and Grateley, where charred wheat and barley grains had been attacked by *S. granarius* (Campbell 2008a). At Barnsley Park villa, near Cirencester, *O. surinamensis* was recovered from a Roman well (Cooper and Osborne 1968) and at the roadside settlement in Catsgore, Somerset, grain pests were recovered from a late Roman well (Girling 1982). At Droitwich, Worcestershire, a dense deposit of charred cereal grain from a masonry building produced *O. surinamensis*, *T. castaneum* as well as *Cryptolestes ferrugineus* (Osborne 1977). Finally, at Northfleet villa in Kent, grain pests were recovered from late first and early second-century A.D. samples from ditches and a timber-lined cistern (D. Smith 2011). The general absence of grain pests from rural Roman Britain is reinforced by the detailed work on waterlogged assemblages from the Upper Thames Valley, where no grain pests have been identified (Booth *et al.* 2007, 24). This distribution suggests that grain storage was not occurring at a large enough scale for grain pests to become established, or that connections were not close enough between rural settlements and military and urban sites for grain pests to spread. Alternatively, sufficient measures may have been put in place to avoid grain infestation, but given the lack of specialised storage structures at most rural settlements this seems unlikely. The presence of grain pests at settlements in north-east Britain suggests that these were spread by the northwards movement of cereal grain to supply the military, or that grain was harder to store in the wetter environment and pests were more successful. Further south, the villas and nucleated settlements may be the only locations where grain was stored at a large enough scale for grain pests to gain a foothold.

Beyond insect pests, *Mus musculus* ssp. *domesticus*, or house mice, are also an important aspect to factor into grain storage. House mice were introduced to Britain in the Iron Age, and bones have been recorded at numerous sites in the Roman period, including towns and military forts (Searle *et al.* 2009; O'Connor 2010), and the roadside settlement at Ewell, Surrey (Orton 1997). Charred droppings of house mice have been recovered from Iron Age and Roman sites in the Danebury environs project, with the strong possibility that these could have been overlooked elsewhere by some specialists (Campbell 2008a, 69).

CROP STORAGE: SUMMARY

The Roman period saw major changes in the nature and capacity of crop storage in rural Britain, with the abandonment of storage pits and reduction in the use of four-post structures. Structures that have been specifically interpreted as granaries appear to be largely concentrated within villas, roadside settlements and military *vici*, while grain pests are also restricted to these sites, indicating large-scale grain storage. However, a range of other agricultural structures, including aisled buildings, were found across a broader spectrum of site types, and would undoubtedly have been used in some capacity for crop storage. Given the presence of stores of entirely clean grain in towns, forts and some villas, it is considered most likely that grain was being fully cleaned at the place of production with the assistance of corndryers before being transported. The structural emphasis (i.e. corndryers) at numerous farmsteads on processing rather than storage, combined with the absence of grain pests from many sites, indicates that grain was being stored at farmsteads for a reasonably limited period of time, before being processed in bulk and removed to be sold or used to pay tax.

MILLING AND GRINDING

By Tom Brindle

Before grain can be made into bread it requires grinding into flour, and quernstones and millstones represent our main forms of evidence for this activity. Quernstones are ubiquitous finds at sites across the province, and continue from the pre-Roman Iron Age throughout the Roman period, occurring at 34 per cent of all sites recorded in the project database. They are recovered at all types of sites, in varying numbers. At most sites grain is likely to have been ground at the level of the individual household, with most houses having their own querns. The sites with the greatest number of quernstones are therefore usually nucleated settlements, which would have had the largest populations; hundreds of fragments of quernstones have been recovered from some roadside settlements and villages. At farmsteads the numbers are usually far smaller, often with just one or two stones being recovered, although the fragmentary state of quernstones often hinders precise quantification.

Quernstones occur in a range of forms, and there have been several typological and petrographic studies of them (e.g. Curwen 1937; 1941; Shaffrey 2006). There is insufficient space here to present a detailed discussion of the geographical or social distribution of quernstones of different types, and it was beyond the remit of the project to collect detailed information on them. It is, however, possible to outline some very broad patterns. Saddle querns – a prehistoric form of quernstone characterised by a large concave stone on which stone rubbers were used for grinding – were used at many sites in all regions during the Iron Age, but may not all have been used for milling. These quernstones became considerably rarer after the Roman conquest, although they do occasionally occur at rural sites, most often in areas where traditional forms of enclosed farmstead remained dominant, as in the North and the South-West. They are very rarely recovered from villas or roadside settlements. Rotary querns were also used during the late Iron Age, occasionally alongside saddle querns, while in some instances rotary querns were re-used as saddle querns (e.g. Penfold Lane, Rustington, West Sussex: Rudling and Gilkes 2000; Gosden Road, Littlehampton, West Sussex: Gilkes 1993), and so the two types do not always represent a straightforward sequence of chronological development from one type to the other. Late Iron Age rotary querns comprise a range of forms often generically referred to as the 'Beehive' type, on account of their hemispherical shape. Thicker querns such as the Beehive and Wessex types continued to be used at rural sites into the Roman period in some regions, particularly in the north, although they are seldom recovered from Roman-period rural sites in the south that did not have clear origins in the Iron Age. They are rare at roadside settlements, villas or complex farmsteads, occurring more frequently at enclosed farmsteads. The most common types of quern at sites of

Roman date are the range of flatter types, with larger diameters.

Whereas quernstones are ubiquitous and widespread, the larger millstones suggestive of powered mills (operated by water, animals or humans; Peacock 2013) are considerably more restricted in their distribution. Although it can be difficult to distinguish between millstones and quernstones, especially when fragmentary, Shaffrey (2015, 56) has suggested that stones with diameters greater than 570 mm are almost certainly millstones, while Peacock (2013, 3) suggested a threshold of 600 mm, and this measurement has been used as the basis for identifying millstones for this project. Millstones were identified at just 5 per cent of sites on the project database, and, as might be expected, they are concentrated at roadside settlements (18 per cent of sites), villages (16 per cent) and villas (15 per cent), with only 4 per cent of sites characterised as farmsteads producing millstones, though this percentage rises to 14 per cent of complex farmsteads. Consequently, there is a strong geographical concentration on the south and east of the province, where nucleated settlements, villas and complex farmsteads are focused.

While it is not always clear that the presence of a millstone, especially when fragmentary, can necessarily be regarded as evidence for a working mill, it does at the very least suggest the presence of a mill nearby, as it is most likely that broken stones would have been deposited in the immediate vicinity of the mill (Shaffrey 2015, 65). Direct structural evidence for mills is rare, however, and features believed to be related to a mill building itself were identified at just seventeen sites, predominantly villas and roadside settlements (see discussion in Vol. 1; Smith 2016b, 60). Most of these were interpreted as watermills, although structural evidence for animal (or human) powered mills is likely to be much less easily recognisable, and these types are considered to have been by far the most common form of mill (Peacock 2013, 113; Shaffrey 2015, 72). A rare example was identified at Stanwick, Northamptonshire, where a circular stone track within a building, which had wear marks possibly created by the hooves of an animal, was interpreted as evidence for a donkey-powered mill (Neal 1996, 42).

Although the recovery of millstones from a site is suggestive of the presence of a mill, they do not automatically indicate that all of the site's occupants had access to ready ground flour. Some sites that have produced good evidence for mills have also produced many quernstones, this being particularly true at many of the roadside settlements in the Central Belt region, suggesting that some people continued to grind their own grain by hand, even when a mill was present. Indeed, the flour produced at settlements with mills need not have been destined for the mouths of the site's occupants at all, and in many cases it seems likely that much of the flour ground at rural sites was distributed to other settlements in the vicinity, including major urban and religious centres; the aforementioned geographical emphasis of mills in the south and east of the province also corresponds with the broad distribution of these centres. The situation was clearly not static, and there appears to have been considerable change and development throughout the Roman period; although early Roman mills are known, Shaffrey has demonstrated how they are infrequent until the later Roman period, with the third century identified as the point at which milling became most widespread, and most millstones are of later Roman date (Shaffrey 2015, 63, 72). This indicates a shift towards increasing centralisation for grain processing during the late Roman period, at least in the south and east.

In some cases the occurrence in tandem of both querns and millstones may reflect the fact that mills were used, not for grinding flour for bread, but for the production of malt, as suggested on the basis of environmental evidence from the villa at Northfleet in Kent (Shaffrey 2015, 70–2). Similarly, however, querns could have had a range of uses, and may sometimes have been used for purposes other than grinding grain for flour. It is exceptionally difficult to recognise whether mills were used for flour production or grinding malted grains for brewing, and there is little to say that they could not be used for multiple functions at different times (*ibid.*, 71). Environmental evidence for malting (principally, as discussed above, in the form of substantial quantities of sprouted grain and detached embryos) was identified at 29 (16 per cent) sites with millstones, compared with 3 per cent of sites overall. This does not, of course, imply that any mills present at these sites were necessarily dedicated to malting as opposed to flour production, although it does indicate a frequent association.

HORTICULTURE, VITICULTURE, FODDER AND HONEY

Horticulture has been proposed as a major aspect of the rural economy (Van der Veen 2008). The small-scale importation of new food plants began in the late Iron Age (Lodwick 2014), followed by the introduction of around 50 new plant foods following the Claudian invasion, including fruits, nuts, flavourings and vegetables. These were consumed first at urban and military centres, before reaching rural settlements from the second century A.D. onwards and, in the case of some, entering into cultivation (Van der Veen *et al.* 2008). Elsewhere in the Roman world, horticulture has been recognised on the basis of water cisterns and irrigation channels (Wilson 2009), whereas in Britain it has been identified primarily on the basis of archaeobotanical evidence (Van der Veen 2016). New plant foods known from Roman Britain, which were likely to have been cultivated, include fruits (bullace, cherries, damsons, plums, apples/pears), flavourings (celery, coriander, dill, summer savory) and vegetables (leaf beet, cabbage, turnip) (Van der Veen *et al.* 2008). This section summarises the archaeological evidence for horticulture and viticulture, in the form of bedding trenches and vineyards, before an assessment is made of the artefactual and archaeobotanical evidence. Finally, an account is made of the production of fodder and honey.

BEDDING TRENCHES

Bedding trenches, often referred to as 'lazybeds', are narrow, parallel trenches thought to be constructed for the cultivation of horticultural crops such as fruit trees. However, the commonly used term of 'lazybed' is misleading, since lazybeds refer to the planting of potatoes on raised soil ridges with accompanying drainage ditches. The Romano-British bedding trenches discussed here are those where plants are presumed to have been grown in the trenches rather than the ground in-between. At Eye Quarry, Cambridgeshire, a detailed account was provided of 'typical' bedding trenches, located within an area of 61 × 59 m, comprising fifteen parallel trenches, 48 m long, 0.2 m deep and spaced 8 m apart, with steep sides and a concave base (Patten 2004). The distribution and chronology of these features was discussed in Volume 1, which concluded that they were largely restricted to eastern parts of the Central Belt region, and to the early and mid-Roman periods (Smith 2016a, 182–3; FIG. 2.51). Outside of the eastern Central Belt and the East region, bedding trenches have only been tentatively identified at two other sites. A farmstead at Burnby Lane, Hayton, to the south-east of York, had two shallow parallel ditches along the course of a stream, which were interpreted as shallow agricultural features for watercress (Halkon *et al.* 2015, 199), though cultivation of osiers-willow stems is an alternative use of these features (White 1975, 234). At Innova Park, Enfield, in the lower Lea Valley, an area of bedding trenches was reported to the west of the settlement, but the features were poorly dated and little information was available (Ritchie 2008). Elsewhere, horticultural plots have

TABLE 2.20: PHYSICAL CHARACTERISTICS OF POSSIBLE BEDDING TRENCHES WITHIN SELECTED SITES

	Site type	*Date*	*Cross-section*	*Depth/m*	*Width/m*	*Spacing/m*	*Area/ha*	*Post-holes*	*Reference*
Brize's Lodge, Leafield	Farmstead	150–400	–	–	0.5	1	0.0006	–	Hart and Moore 2005
Clapham to Ravensden, south-west of Ravensden	Farmstead	70–300	U-shaped	0.75	1.5	2	0.025	–	Mason 2007
Clay Farm, Trumpington	Complex farmstead	80–300	–		–	5	0.04	–	Mortimer and Phillips 2012
Eye Quarry, Peterborough	Farmstead	100–300	Square	0.2	–	8	0.36	–	Patten 2004
Home Farm Cranfield	Enclosed farmstead	100–300	Square	0.4	0.8	5	5	–	Abrams 2005
Hundred Road, March	Field system	80–120	Square	0.3	0.4–0.8	5	75m × ?	–	Hutton and Standring 2008
Low Fen, Fen Drayton	Field system	300–400	Square	0.3	0.7	4	0.75	–	Mortimer 1995
Parnwell, Peterborough	Farmstead	100–300	–	–	–	11	0.08	–	Webley 2007
School Lane, Waddesdon	Field system	50–200	Square	0.3	0.9–1.2	5	0.12	–	Keir and Wells 2006
Westley Hall Farm, Westley	Field system	80–200	Square	0.6	0.8	7–10	0.21	–	Vaughan Beverton 2011
Woodlands Park, Great Dunmow	Field system	200–300	–	0.2–0.5	0.5	3	0.04	Yes	Barker 2003

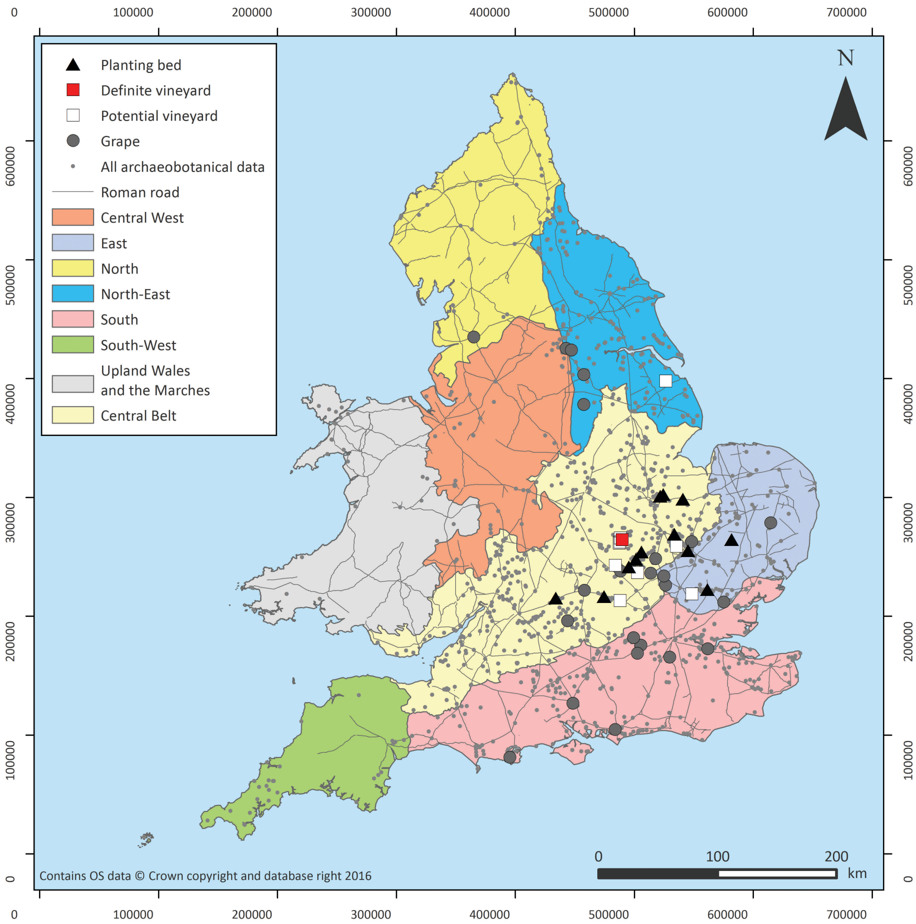

FIG. 2.51. Distribution of bedding trenches, vineyards and grape pips in rural Roman Britain

been reported as associated with military sites, including the Lancaster *vicus* (Mitchell's brewery site, Lancashire, Newman 1993; Van der Veen 2008, 103).

No *in situ* archaeobotanical remains have been recovered from bedding trenches that could indicate which crops were grown, and, furthermore, the separation between 'bedding trenches' and 'vineyards' appears blurred. TABLE 2.20 lists the bedding trenches where measurements were available. In section, bedding trenches are usually vertical sided with a concave base, described here as 'square', implying that the trench was backfilled quickly with fertile soil. The area that bedding trenches cover is nearly always under 1 ha, with often very restricted areas such as 20 × 20 m at Clay Farm, Trumpington, Cambridgeshire, and 30 × 40 m at School Lane, Waddesdon, Buckinghamshire, although in some cases larger areas may well have existed beyond the limits of excavation.

Aside from bedding trenches, other features have been associated with horticulture. At Ditchley villa, Oxfordshire, a series of planting pits have been identified as an orchard (Applebaum 1972). Elsewhere, small enclosures have been associated with market gardening, such as stone-built enclosures at Tower Knowe, Wellhaugh, Northumberland (Jobey 1973), 4 m wide garden plots at Chisenbury Warren, Wiltshire (Fulford *et al.* 2006, 60–1), and 200–400 sq metre fields at Duncote Farm, 2.5 km outside of Wroxeter, Shropshire (Ellis *et al.* 1994).

Another source of evidence for the trade in plants, and therefore pomiculture and viticulture, are *ollae perforatae* – planting pots with drainage holes made prior to firing. These indicate the trade in saplings, thought to originate from nurseries in Kent based on the London examples being produced in Eccles ware (Davies *et al.* 1994, 37; Macaulay-Lewis 2006). No *ollae perforatae* were recorded in the project database, although other examples may well be in existence, and so the national distribution of this evidence remains limited to London, Fishbourne and Bancroft villa.

VINEYARDS

The presence of vineyards in Roman Britain has been long debated, on the basis of historical and limited archaeobotanical evidence (D. Williams 1977; Frere 1987, 285, 294; Applebaum 1972, 103–4, 117–20). Cultivation of the domestic grape

TABLE 2.21: ROMANO-BRITISH SITES IDENTIFIED AS POSSIBLE VINEYARDS

	Site type	*Date (A.D.)*	*Cross-section*	*Depth/m*	*Width/m*	*Length/m*	*Spacing/m*	*Area/ha*	*Postholes*	*Manuring*	*Reference*
Caldecote Highfields	Farmstead	*c.* 2nd C									Kenney 2007
College Road, Aston Clinton	Complex farm	*c.* 1st C	Square	0.5	0.3–0.9		6	0.35		Yes	Simmonds and Walker 2014
Grendon Quarry, Area 1	Industrial site/Field system	50–200									Jackson 1995
School Lane, Waddesdon	Field system	50–200	U-shaped		0.9–1.2		4.5–6				Keir and Wells 2006
Stanton Low	Villa	Early Roman	U-shaped	1.2		110	9.15				Woodfield and Johnson 1989
Tavistock Avenue, Bedford	Field system	75–150	Square	0.4–0.5	0.7–0.95	150	7	3.75		Yes	Brown 2010
Whittington Way, Bishop's Stortford	Farmstead	Early Roman		0.3	0.7	100	5–10	7.5			Williams 2008
Wilby Way, Wellingborough	Field system		Square		0.45		7				Cotswold Archaeology 1996
Wollaston I	Field system	100–300	Square	0.3	0.85	150	5	7.5	Yes		Brown *et al.* 2001
Wollaston II	Field system	50–400	Square						Yes		Brown *et al.* 2001

vine (*Vitis vinifera* L. subsp. *vinifera*) had spread to southern Gaul by at least the fourth century B.C. (Bouby *et al.* 2014). In A.D. 90/91 Domitian placed restrictions on the cultivation of vines in the provinces (Suet. *Dom.* 7, 2), which were later lifted by Probus, who explicitly permitted vine cultivation in Britain (SHA *Prob.* 18, 8). Planting beds identified specifically with vines have now been identified definitively at Wollaston in the Nene Valley (Brown *et al.* 2001).

Archaeobotanical evidence for grape pips in rural Roman Britain is relatively scarce. Other than from cremations, grape has only been recorded at 20 sites in the current dataset, including three military *vici* (Doncaster, Ribchester, Castleford) (FIG. 2.51). These finds are all just grape pips, with no evidence for grape-pressing by-products such as skin and peduncles (Margaritis and Jones 2006). Exceptions are putative finds of vine stems reported from Boxmoor villa by Collingwood (1937). Pollen evidence can also indicate the presence of grapes, although experimental evidence has shown that the deposition of *Vitis* pollen in vineyards is very variable, with a high loss of pollen grains (Turner and Brown 2004). However, grape pollen has been recorded at the Wollaston vineyard, Northamptonshire (Brown *et al.* 2001), and also in the roadside settlement at Scole, on the Norfolk/Suffolk border, where two single grains from a later second–third century A.D. wood-lined pit were considered to be from the disposal of grapes among domestic waste (Wiltshire 2014, 416).

Archaeological evidence for grape cultivation is based on the recognition of *pastinatio*-type vineyards, as described by Columella in *De Re Rustica* (4.25, 424–7). These consist of parallel trenches with flat bottoms and vertical sides, with postholes for stakes to support growing vines. Numerous examples have now been recorded through excavation in southern France, consisting of extensive planting trenches and pits within field systems (Bouby *et al.* 2014). A group of eleven sites in Britain can now be suggested as having evidence for vineyards, based on the larger area and form of planting beds (TABLE 2.21). The most convincing evidence comes from the Nene Valley. At the site of Wollaston I, 7.5 ha of parallel bedding trenches were revealed, measuring 0.85 m wide, 0.3 m deep and lying 5 m apart, with stakeholes and a consistent but low presence of *Vitis* pollen, dated to the second–third centuries A.D.

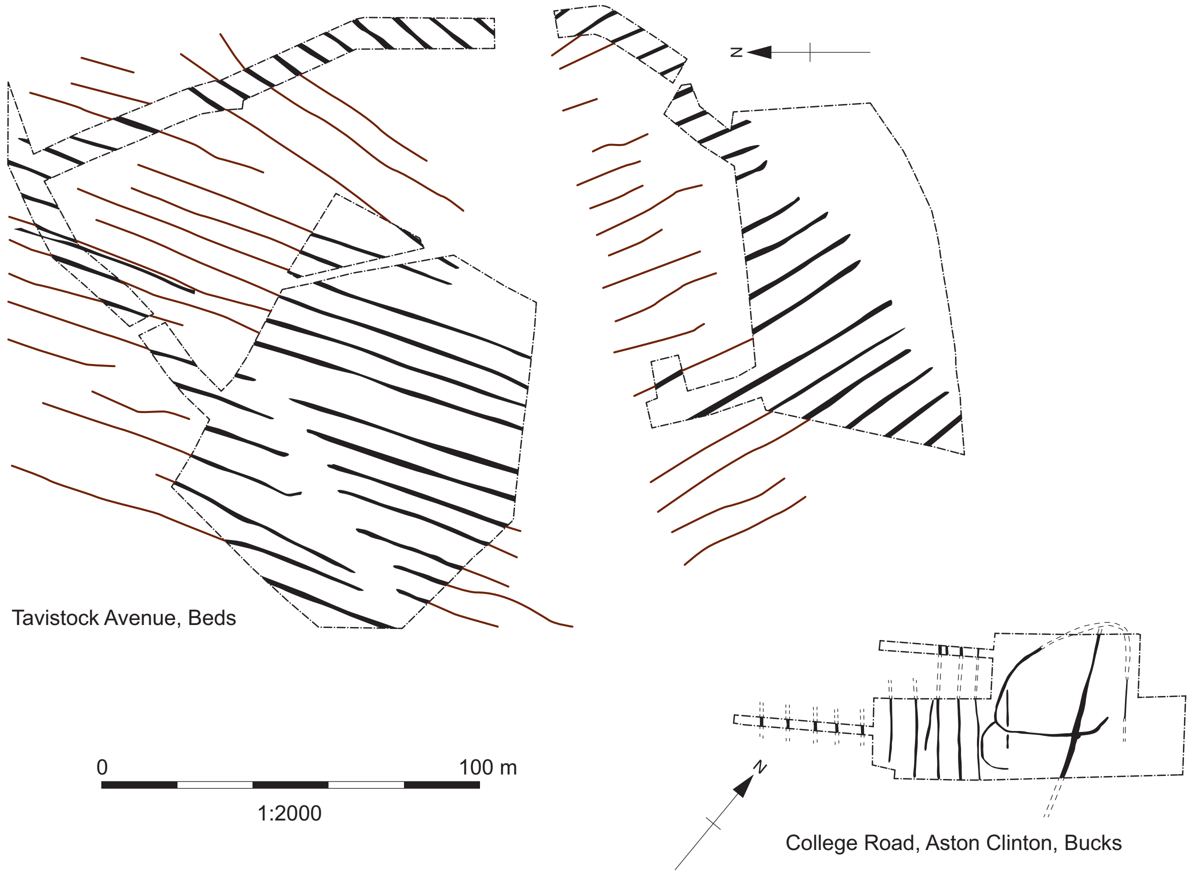

FIG. 2.52. Plans of selected sites identified as vineyards (Simmonds and Walker 2014; Brown 2010)

To the south-west, at Wollaston II, a field system with non-structural postholes but no bedding trenches, broadly dated to the Roman period, was recorded. An adjacent excavation at Grendon Quarry, Northamptonshire, recovered similar bedding trenches dated to the first–second centuries A.D. Lying 2 km to the north of Wollaston I, an evaluation at Wilby Way, Wellingborough, was highlighted as another possible vineyard site (Brown *et al.* 2001), but the interpretation of ditches as bedding trenches was dismissed in the original report. Parts of further possible vineyards have been recorded in Buckinghamshire, at College Road, Aston Clinton near the Icknield Way, where bedding trenches were spaced at 6 m intervals, with flat bases and vertical sides. The fills included heavily abraded pottery indicating manuring (FIG. 2.52). The features covered an area of 0.35 ha and were dated by ceramics to the later first century A.D. A little further north, lying close to Akeman Street, a series of nine parallel bedding trenches, 0.9–1.2 m wide and 4.5–6 m apart, were excavated at Waddesdon, Buckinghamshire, dating from the mid-first to second century A.D.

Further possible vineyards have been suggested at Whittington Way, Bishop's Stortford, Hertfordshire, Stanton Low, Buckinghamshire, and at Caldecote Highfields, Cambridgeshire. Beyond Wollaston, the most convincing candidate is Tavistock Avenue, Bedfordshire, in the Ouse valley. A ditched enclosure, dated to A.D. 75–100, contained parallel cultivation rows spaced 7 m apart, with impressions from root systems and abraded ceramics with cessy concretions indicating manuring (FIG. 2.52). Palynological evidence indicated open grassland, comparable to that recorded at Wollaston, but without *Vitis* pollen.

While many of these sites remain individually unconvincing, their similarity in size, profile and arrangement of bedding trenches strongly suggests that vineyards existed in the east of the Central Belt. Several sites possibly began in the later first century A.D., but the second century A.D. seems to represent the zenith of this activity. The absence of plant macrofossil evidence for *Vitis* is not unexpected, as uncharred remains are unlikely to be preserved. By way of illustration, extensive sampling of an unequivocal vineyard at Gasquinoy near Béziers in southern Gaul produced no *Vitis* plant remains from bedding trenches and planting pits (Figueiral *et al.* 2010). It does therefore seem that vineyards were present in several areas of the eastern Central Belt, and not just the Nene Valley. These vineyards would have been a considerable financial and economic investment, in land, trees and labour (Van der Veen 2008), and are likely to have had a major impact on the character of the landscape (Mattingly 2006, 34; Sykes 2009). Supporting evidence for the presence of vineyards in this region comes from the manufacture of Verulamium white ware Dressel 2–4 amphorae at Brockley Hill in the late first and early second centuries A.D. While these may have been receptacles for wine imported in larger containers (Castle *et al.* 1978), given the locality of numerous vineyards, a local source of wine appears likely. The extent to which this wine industry offset the import of wine is unclear, especially as no structural or archaeobotanical evidence for wine pressing has been uncovered from Roman Britain to date.

ARCHAEOBOTANICAL EVIDENCE FOR HORTICULTURE

Beyond the presence of planting beds, horticultural cultivation can be studied through plant remains. This line of investigation is, however, hindered by the fact that, in contrast to cereals, horticultural crops are unlikely to come into contact with fire and become preserved through charring (Murphy and Scaife 1991, 85), meaning the detection of horticultural production is largely reliant on the presence of waterlogged sediments. Furthermore, the vegetative part of several plant foods are consumed, meaning seeds will not necessarily be present (Van der Veen 2008). Several quantitative measures can be used to discern whether the plant foods recorded are the result of on-site cultivation, including the abundance of seeds per sample, frequency per assemblage and range of crops at one site (Van der Veen and O'Connor 1998; Cowan and Hinton 2008, 78). The presence of plant foods in specific contexts can also be used to argue for on-site cultivation, for instance opium poppy seeds in a bedding trench at Fishbourne palace A27 site (Cunliffe *et al.* 1996), and abundant celery seeds in the primary fill of a well at early Roman Insula IX Silchester (Lodwick 2016). Finally, the specific type or condition of plant macrofossil can indicate cultivation, for example fruit attachments and abundant seeds of *Brassica nigra* (black mustard) from a late Roman site at High St Staines, Surrey (McKinley 2004, 5).

A recent project has synthesised the archaeobotanical evidence for new plant foods (Van der Veen *et al.* 2007; 2008; Van der Veen 2008). The project established the presence of discrete consumer groups and, arguably, the widespread presence of horticultural activity in Roman Britain, to which the current results can only confirm established patterns and identify new plant foods. The 2008 project collated presence/absence data per major period for each site from all accessible archaeobotanical reports relevant to Roman Britain, with a total of 102 rural records producing evidence for one or more plant foods (Van der Veen *et al.* 2008, 12, table 4). The key patterns relating to rural horticulture were that access to new plant foods was not separated by rural site type (elite/nucleated/lesser), that fruits and nuts were well represented at rural sites, increasing in frequency over time, indicating cultivation, and that herbs were also common at rural sites and likely to be cultivated (coriander, opium poppy, celery, dill, summer savory) (*ibid.*, 24–5, 27, 32). The expansion of horticultural practice at rural sites was suggested by an increase over time in the recovery of cherries, plums, damson, walnuts, coriander, celery, mint, carrot and poppy seed (*ibid.*), yet the total number of rural records contributing to these patterns was low. For instance, coriander was recorded at only sixteen rural sites in all periods. Rural settlements, industrial sites and minor towns were found to have the same range of plant foods (*ibid.*, 25).

The Roman Rural Settlement Project dataset consists of 45 sites with records of imported plant foods, and 97 sites with horticultural crops, both subjective categories that should be treated cautiously. The mode of preservation in which each taxa occurred was not consistently recorded, hence the data cannot be analysed in detail. Nevertheless, key patterns that can be confirmed are the continued absence of new plant foods from the South-West and the North regions, beyond the military sites at Maryport, Lancaster and Ribchester. Exotic foods, which are unlikely to have been cultivated in Roman Britain (almond, black pepper, date), are still absent from rural farmsteads. Significantly, several imported and potentially imported plant foods have now been recovered from numerous cremations outside of London. These include grapes at Maryport cremation cemetery in Cumbria (Kirby 2011), dates, fig, grape, lentil, pine nut and walnut at Doncaster, South Yorkshire (Miller 2013), lentil at Ryknield Street, Wall, Staffordshire (McKinley 2008) and fig, grape and lentil at Springhead, Pepper Hill, Kent (Biddulph and Booth 2006). The only additional plant food to be identified is onion. One charred onion (*Allium cepa*) has been recorded at the Springhead Sanctuary Complex (Stevens 2011b) and at Grange Park, Courteenhall Area 5, Northamptonshire (cf. *Allium* sp.) (Ciaraldi 2006).

Given that van der Veen *et al.*'s 2008 study only considered three categories of rural sites; elite (villas), nucleated, and lesser, the opportunity has been taken to consider whether horticultural crops occur more often at complex, enclosed or open farmsteads, roadside settlements or villas (TABLE 2.22). A limited range of horticultural crops has

TABLE 2.22: DISTRIBUTION OF SELECTED HORTICULTURAL CROPS BY SITE TYPE (NO. OF SITES)

Plant food	*Latin name*	*Unclassified farmstead*	*Enclosed farmstead*	*Complex farmstead*	*Roadside settlement*	*Industry*	*Funerary/ temple/shine*	*Military vicus*	*Villa*	*Village*
Coriander	*Coriandrum sativum* L.	2	4	7	4	1	2	4	4	
Beet	*Beta vulgaris* L.	2		1	3					
Dill	*Anethum graveolens* L.		1	1				2	1	
Fennel	*Foeniculum vulgare* L.		1	1	1					
Lentil	*Lens culinaris* L.	5	1	2	3		3		6	1
Summer savory	*Satureja hortensis* L.								2	
Walnut	*Juglans regia* L.			2	2	1	1	2		

been considered here. *Beta vulgaris* L. (Leaf Beet) is a plant grown for its roots and leaves, whose wild form only grows in coastal areas in Britain (Stace 2010, 490), but the cultivated form does occur in Roman Germany (Zohary *et al.* 2012, 159–60). The crop is harvested before seed setting, implying that any occurrences of seeds are significant (Bakels 2009, 60). The project database has six records of sites with beet, including two farmsteads in the Central West region, both dated to the second century, two sites in the eastern Central Belt (a complex farmstead at Lower Cambourne and the nucleated settlement at Camp Ground, Colne Fen, both in Cambridgeshire), and two roadside settlements – Weedon Hill, Aylesbury and Springhead in Kent. The distribution of beet is quite wide, and all sites are located on the road or river transport system, implying the importance of production for the market.

Lentil is a pulse crop introduced to Britain during the Roman period and is mainly restricted to urban and military sites (Van der Veen *et al.* 2008, 21). However, additional data now show it to be more widespread at rural sites and possibly cultivated, primarily occurring at villas (Fishbourne in Sussex, Fullerton in Hampshire, and North Leigh in Oxfordshire), complex farmsteads (Langtoft, Lincolnshire and Longstanton site XX, Cambridgeshire), and nucleated sites (Gill Mill in Oxfordshire, Sandy in Bedfordshire and Stonea Grange in the Cambridgeshire Fens), mainly in the Central Belt, and a single enclosed farmstead in the South at Gussage All Saints, Dorset (TABLE 2.22). Beyond these regions, lentil has only been recovered from funerary sites. The flavouring coriander was considered to be cultivated, occurring at sixteen rural sites and increasing in frequency over time (*ibid.*, 32). Examination by site type indicates that complex farmsteads most commonly produced coriander, followed by roadside settlements and enclosed farmsteads, the latter mainly in the Thames Valley (late Roman Claydon Pike, Farmoor, and Thorpe Lea Nurseries). Walnut, considered to have been cultivated in Roman Britain (*ibid.*), was recorded at a total of eight rural sites, including two complex farmsteads (Chew Park, Somerset, and Eastcotts, Bedfordshire) and two roadside settlements (Neatham, Hampshire, and Scole, Norfolk). Beyond these, finds of walnut shell and pollen have also been recorded at several sites in London (Sidell 2008, 66). A further possible cultivated tree crop is the Mediterranean stone pine. Numerous charred nut shells have been recorded from rural settlements in south-east England, possibly indicating small-scale cultivation (Lodwick 2015b).

In order to ascertain those settlements where horticulture is likely, TABLE 2.23 lists sites where three or more horticultural crops have been identified. It must be stressed that this only includes plants whose cultivated status is established, and these sites all had plant remains preserved by mineralisation and/or waterlogging. Horticultural practices at comparable sites lacking such preservation, for instance in much of the Wessex region, would not be recognised by the analysis of plant macrofossils. The sites consist of four villas, five roadside settlements, five complex farmsteads, three military *vici*, and two enclosed farmsteads, one of these (Claydon Pike, Gloucestershire) representing a late Roman development from an earlier mid-Roman complex farmstead. Pruning hooks were also recorded at three of these sites in the Central Belt (Bancroft Villa in Buckinghamshire, Claydon Pike and Frocester Court, Gloucestershire), providing further indication that these sites were cultivating fruit trees. The majority of these sites are in the Central Belt and South, with a single site in the East. Several horticultural crops were also recorded

TABLE 2.23: SITES WITH THREE OR MORE HORTICULTURAL CROPS

				Fruit and nut trees					*Pulses and vegetables*		*Flavourings*				
Site	*Site type*	*Region*	*Pruning hooks*	*Apple/Pear*	*Cherry*	*Damson/Plum*	*Grape*	*Walnut*	*Beet*	*Lentil*	*Celery*	*Coriander*	*Dill*	*Fennel*	*Summer savory*
Bancroft Villa	Villa	Central Belt	+			+					+	+			+
Barton Court Farm	Villa	Central Belt		+		+						+	+		
Bucknowle	Villa	South		+		+	+								
Castleford	*Vicus*	Central West				+	+	+							
Chew Park	Complex farmstead	South		+	+	+		+				+			
Claydon Pike (mid-Roman)	Complex farmstead	Central Belt	+	+	+	+					+	+	+		
Claydon Pike (late Roman)	Enclosed farmstead	Central Belt	+			+					+	+		+	
Cleveland Farm, Ashton Keynes	Complex farmstead	Central Belt		+		+						+			
Doncaster	*Vicus*	North-East		+		+	+								
Eastcotts, Bedford	Complex farmstead	Central Belt			+			+			+				
Farmoor	Enclosed farmstead	Central Belt				+						+	+		
Frocester Court	Villa	Central Belt	+			+		+				+			
Glapthorn Road, Oundle	Complex farmstead	Central Belt				+						+	+		
Higham Ferrers	Roadside settlement	Central Belt									+	+		+	
Neatham	Roadside settlement	South			+	+		+				+			
Ribchester	*Vicus*	North		+	+		+					+	+		
Sandy	Roadside settlement	Central Belt			+	+	+			+					
Scole	Roadside settlement	East				+	+	+							
Springhead	Roadside settlement	South		+	+	+	+		+			+			
Wavendon Gate	Complex farmstead	Central Belt			+	+					+	+			+

in military *vici* at Castleford in West Yorkshire, Doncaster in South Yorkshire, and Ribchester in Lancashire, although whether these were grown on site or imported from the south is uncertain. There is no pattern between site types engaged in fruit or flavouring cultivation; indeed, most sites appear to be investing in a range of horticultural crops, including some fruit or nut trees. This is particularly significant as trees are seen as a strong indicator of social investment in an area of land, as they take over five years to grow (Van der Veen 2016). Beyond horticultural crops, the collection of wild plant foods such as hazelnuts, elderberries and brambles would have been an aspect of the rural economy (Van der Veen 2008).

ARTEFACTUAL EVIDENCE FOR HORTICULTURE

By Tom Brindle

There are a range of artefacts recovered from rural settlements that are likely to be in some way associated with horticultural practices, although some may also have been used in larger scale arable farming (discussed above, p. 47). Objects associated with the preparation of the soil include spades, spuds, turf cutters, and mattocks, and almost all of those that survive are of iron. As with plough shares, such tools were often made from wood and tipped with 'shoes' of iron for increased durability. It is usually only the iron tips that survive, though a wooden spade of ash with an iron shoe was recently recovered from a probable ritual deposit in a well at Rothwell Haigh, Leeds, West Yorkshire (Cool and Richardson 2013), and others are known from Silchester (Rees 1979, fig. 107; 2011, 100). Such tools were recovered from just 2 per cent of settlements and, as with ploughs, the surviving evidence is strongly weighted towards villas and nucleated settlements. This almost certainly reflects access to the best and most expensive equipment at these sites, and we can expect unshod wooden digging equipment to have been the norm at most rural settlements (Rees 1979, 326). Where such objects have been recovered from sites characterised as farmsteads they are most commonly of complex form, and usually have large artefact assemblages indicative of a higher degree of wealth and status. Multiple types of hoe are known, used for weeding and aerating soil. Although often recovered from urban sites (Rees 2011, 98–9) they are surprisingly rare at rural settlements, with certain or possible examples identified at just sixteen sites, predominantly roadside settlements and villages, with few examples from villas; a pattern previously noted by Rees (*ibid.*).

Objects identified as billhooks, which could be used for a number of purposes including hedge trimming and coppicing, have been recovered from a range of sites. They are more common at villas and roadside settlements, but have also been recovered from a number of farmsteads of both complex and enclosed form. Iron Age examples are well known, including from the hillforts at Bredon Hill, Worcestershire, and Hod Hill, Dorset, as well as a number from Glastonbury and Meare Lake villages in Somerset (Rees 2011, 107). The range of tools with curved blades, often recorded as pruning hooks, may have been used to harvest crops, fruit and vegetables, but they may also have had other functions (*ibid.,* 108). Again, the distribution of these tools favours the sites that are well represented by tools in general, the nucleated settlements and villas, although they occur occasionally as finds at enclosed and complex farmsteads. Such iron tools would have been of great benefit to those engaged in horticulture, although they are of course not prerequisites for it; wood, bone and antler tools are likely to have been far more common.

FODDER CROPS

Beyond the cereals, fruits, flavourings and vegetables required for human consumption, the large numbers of horses, cattle, sheep and pig in rural Roman Britain also required substantial plant resources for fodder and bedding. Three main categories of plants were used as fodder in the Roman world; crop-processing by-products, hay, and specific fodder crops such as vetches (Foxhall 1998; Kron 2000). Separating crops recorded in the archaeobotanical record into food for humans and food for animals is difficult, as demonstrated by the status of barley in Roman Britain (see above, p. 18). Furthermore, there is always a spectrum in how a certain crop is used, dependent on inter-annual harvest variations and market requirements (G. Jones 1998; Halstead 2014). In the Mediterranean Roman world, it is considered that grass and leguminous fodder crops, such as broad beans, vetch and lupines, were sown, perhaps in rotation with cereals (Kron 2000). In Roman Britain, where only archaeobotanical evidence is available, the limited records of such fodder crops, such as *Vicia ervilia* (bitter vetch) at County Hospital, Dorchester, are more likely to be have been imported accidentally with grain (Stevens 2008). Rather than being separate crops, areas of grassland appear to have been managed in distinctive ways to produce hay. The co-occurrence of several key taxa, namely *Rhinanthus minor* (yellow rattle), *Filipendula ulmaria* (meadowsweet) and *Centaurea nigra* (common knapweed) have been compared to the botanical composition of specific modern grassland communities (Greig 1984; 1988; Lodwick 2016) and interpreted as evidence for comparable management practices in the past.

Hay has been recorded at 40 sites in the project database, although these classifications must be taken cautiously, as reliable identification of past grassland management practices requires good-quality assemblages and detailed comparison with modern day ecological information (e.g. Hodgson *et al.* 1999). There are no late Iron Age or late Iron Age/early Roman occurrences, confirming that the current earliest evidence for hay meadow management is from the latest Iron Age phase of the territorial *oppidum* at Silchester in Hampshire (Lodwick 2016).

Hay has, however, been recorded at 4 per cent of early Roman, 3 per cent of mid-Roman and 5 per cent of late Roman sampled sites. While it appears that hay is comparatively rare, this is the result of fodder crops being rarely preserved as charred plant remains, which is the most common form of archaeobotanical preservation encountered in rural Roman Britain. The distribution of hay records by site type shows little variation between roadside settlements, villages, and villas, being found at 4–6 per cent of sites. There are, however, more notable differences between complex farmsteads, where hay is indicated at 8 per cent of sites, and enclosed farmsteads, where this figure lies at just 1 per cent. All of the sites are concentrated in the Central Belt (23 sites), followed by the South (9) and North-East (4), with only a few sites in the East and Central West. This distribution matches that of scythes (see above, p. 46). Hay would have been produced at these settlements either to provide storable fodder to feed animals through the winter and/or as a surplus product for military or urban populations. At Claydon Pike in Gloucestershire, for example, it was suggested, based on extensive evidence for hay meadow management (Robinson 2007), that hay was being produced for export to nearby Cirencester (Booth *et al.* 2007, 48). Indeed, hay is a common occurrence in waterlogged deposits from urban and military sites, such as Ribchester, Lancashire (Huntley 2000), generally in combination with other components of the 'stable manure' package. This type of assemblage is composed of fodder (hay, crop-processing waste), bedding material (bracken, gorse) and animal dung (cereal bran), indicating the presence of on-site animals, with examples at York, London and Lancaster (Kenward and Hall 2012). Stable manure appears relatively rare at rural settlements, and although the absence of waterlogging is a major limitation, it perhaps indicates that much of the hay produced at these settlements was destined for urban and military sites rather than on-site stabling.

HONEY AND MEDICINE

Beyond fruits, nuts, vegetables, flavourings and pulses, the final category to consider is apiculture and the growth of plants for medical purposes. Although rarely recorded in the archaeological dataset, these commodities would have been required by urban and military dwellers and were therefore part of the rural economy.

Without sugar, honey was the main sweetener in the Roman world. Honey bees (*Apis mellifera* L.) were exploited in Britain since at least the Neolithic (Carreck 2008), with residue analysis showing the occasional presence of beeswax in prehistoric ceramics (Roffet-Salque *et al.* 2015). While written sources indicate that honey was collected from the wild, agronomists also describe beekeeping (Dalby 2003, 179; Columella *Rust* 9.2-16), and the Vindolanda tablets document requests for honey from soldiers resident at the fort (Bowman and Thomas 1994, 157). Palynological evidence has also indicated the consumption of honey, with pollen spectra identified as originating from plants targeted by bees in a mid-second-century A.D. pit at Castleford, West Yorkshire (Bastow 1999), and from the spout of a strainer vessel in the doctor's grave at Stanway, Essex (Wiltshire 2007).

No material culture associated with bee keeping is known from Roman Britain. Hence, the only way to identify beekeeping is through records of honey bee recovered from waterlogged sediments. Honey bees have been identified from an early Roman enclosed farmstead at Thorpe Lea Nurseries near Staines in the Middle Thames Valley (Robinson 2012b), and nearby from a mid-Roman waterhole in the complex farmstead excavated at Heathrow Terminal 5 (Robinson 2006). Further examples from the Upper Thames Valley are the complex farmstead at Old Shifford Farm, Standlake (Robinson 1996), and the late Roman enclosed farmstead at Claydon Pike (Robinson 2007). Away from the Thames Valley, honey bee remains have been identified at the complex farmstead at Royal Naval Air Station, Yeovilton, Somerset (Lovell 2005), at a late Roman farmstead at Hunt's Hill Farm, Havering, Greater London (Giorgi 2006), and at the villa at Rectory Field, Godmanchester, in Cambridgeshire. While beekeeping appears to be an activity largely limited to complex farmsteads, villas and towns such as Silchester (Robinson 2011), this distribution is very much affected by the distribution of waterlogged sediments sampled for palaeo-entomological remains.

One use of honey was in medicines, and many plants would also have been used this way, as indicated by written and archaeological evidence (Baker 2016). Plants with conspicuous medical/psychotic uses often occur in archaeobotanical assemblages, such as *Atropa belladonna* (deadly nightshade), *Hyoscyamus niger* (henbane) and *Conium maculatum* (hemlock), but establishing a definite medicinal use for these plants is very difficult (Hall and Kenward 2003). An exceptional deposit of charred medicinal deposits from a Roman hospital at Neuss in the Rhineland (Knörzer 1970) indicates that the cultivation of medicinal plants such as henbane, vervain and St

John's wort, or collection of wild plants, must have been an aspect of rural life, but identifying the settlements engaged with this must rely on a contextual examination of site-based archaeobotanical datasets.

HORTICULTURE, VITICULTURE, FODDER AND HONEY: SUMMARY

The cultivation of plant products beyond cereals was clearly a significant activity in rural Roman Britain. This review has demonstrated how some settlements were cultivating vines, fruit trees, vegetables and herbs, managing hay meadows and beekeeping alongside the growing and processing of cereal crops. Rather than specialising in these new products, these settlements were diversifying their range of produce alongside cereals. No specialised processing or storage structures have been identified, and agricultural tools specifically associated with horticulture are relatively rare. These practices would have required the learning of specialist skills and intensive care of the crops year round, especially with fruit trees, where imported rootstock would be needed, or the knowledge of grafting; either way there was a 5–10 year wait before the trees yielded fruit (Van der Veen 2008, 102–6). The settlements engaged with horticultural activity appear to be predominantly located in the Central Belt, South and East regions, although the scale at which production was taking place is difficult to assess. The laying out of vineyards in the eastern Central Belt does, however, indicate a decision to invest in a particular strategy. Importing vines would have been an expensive and risky undertaking, and the first century A.D. dates of some likely vineyards indicate, perhaps, arrivals from Gaul attempting to exploit economic opportunities in the new province (cf. Van der Veen 2008, 104). The period of climatic stability from *c.* 100 B.C. to A.D. 200, with mean July temperatures around 1°C higher than the mid-twentieth century, would have helped those experimenting in vine cultivation (McCormick *et al.* 2012, 180). Unfortunately, none of the vineyards in the Nene Valley are associated with settlements, but it was surely those settlements with higher material wealth – complex farmsteads, roadside settlements and villas – that were better able to engage in the production of these new products.

Beyond the specialist skills needed to produce these new crops, logistical capabilities would be needed to ensure that the seasonable produce did not perish (Van der Veen 2016). The distribution of these sites primarily in the Central Belt may largely be concerned with supplying urban centres, themselves, and perhaps the northern and western military populations.

CONCLUSIONS

CHANGE AND CONTINUITY IN ARABLE FARMING

The analysis undertaken within this chapter has confirmed previous understandings of the character and organisation of arable farming in rural Roman Britain and, crucially, supported this with quantitative assessment of charred crops and their accompanying weeds from a substantial corpus of archaeobotanical data. Romano-British arable farming was essentially a continuation of the crops and cultivation practices of the Iron Age, but with an expansion in the areas under crop, an increase in scale leading to surplus production of cereals, and varying levels of specialisation. Spelt wheat and barley continued as the major cultivated cereals throughout the Roman period, with emmer continuing its late first millennium B.C. decline. There was also a small presence of flax, free-threshing wheat, rye, pea and Celtic bean, with oats remaining as an infrequent occurrence, its status as a minor crop or weed unable to be determined. Iron Age cultivation practices continued largely unchanged, with autumn sowing, arding, sickle-harvesting and crop processing. An expansion in the area under cultivation in the early Roman period is indicated by the increasing occurrence of weeds of wet ground alongside weeds indicating decreased soil fertility. The evidence for manuring from substantial ceramic scatters, and the drop in frequency of these weeds indicates soil fertility recovered. Whether farmers were pursuing intensive or extensive arable regimes is not clear, although the dominance of spelt wheat indicates a move towards more extensive cultivation practices. Innovations in arable farming that would have greatly increased production occur in the later Roman period, namely changes in plough technology, the growth in the size of cattle (see Ch. 3) and the increasing number of mills, although corndryers appear to have been widespread from the mid-second century A.D.

This chapter has highlighted previously unknown regional and chronological variations in the relative proportions of the two main cereal crops, spelt and barley, the former becoming increasingly dominant with evidence for a growing surplus of production. This was evidenced by an increased proportion of dense glume base samples, and by growing numbers of structures used to process and store the crop harvests – corndryers and granaries. In the West Anglian Plain and Kent, these shifts took place in the first and second centuries A.D., though they did not occur until the third and fourth centuries A.D. in Wessex. This east–west time chronological split is also recognised in the coin data (see Ch. 6), and may represent the point at which these areas became more integrated into a market economy.

In addition to cereals, a range of fruits, vegetables, flavourings, wine, fodder and honey was also being produced, primarily by complex farmsteads, villas and nucleated settlements. However, the overall scarcity of this evidence, and a lack of specialised material culture or processing structures, caution the extent to which this should be seen as production for the urban market as opposed to production for on-site consumption. For the most part, these products were additions alongside cereals, rather than being representative of specialisations in non-cereal agriculture.

REGIONAL VARIATION IN CROPS AND CULTIVATION

While many of the crops and farming practices of rural Roman Britain were a continuation from the late Iron Age, there was still a great deal of regional variation. For example, the West Anglian Plain north has very high proportions of spelt wheat cultivated on less fertile fields, the presence of Celtic bean but not pea, and a concentration of vineyards. The Upper Thames Valley and the Wessex Downs, in contrast, were cultivating higher proportions of barley. Emmer wheat remains a higher proportion of charred cereal assemblages in Kent, and pea and Celtic bean are better represented here. In the North-East and South-West, emmer wheat persisted longer, and cultivation practices appear to differ, with the possibility of uprooting of cereals in the South-West (as opposed to sickle-harvesting), although the small number of samples limits these conclusions. These variations are surely interlinked, with, for example, the high proportion of spelt wheat in the West Anglian Plain north being associated with more extensive cultivation practices, which may have released labour for cultivation of vineyards. Furthermore, the Upper Thames Valley can be seen to have less emphasis on cereal cultivation than the West Anglian Plain and Wessex, given an absence of a shift towards glume wheat dominated cereal assemblages and a lower proportion of dense glume base samples. These observed variations crucially do not map on to underlying soil variations and instead derive from long-term traditions and different reactions to the major socio-economic changes of the Roman period.

EXPANSION AND THE MARKET

The increased scale at which crops were being processed at many settlements from the second century A.D. onwards indicates that cereals were being produced in quantities beyond those needed by the immediate community. The presence of cereal remains representing the final stages of crop processing, and the introduction of corndryers, including large, multi-dryer installations at villas, roadside settlements and complex farmsteads, indicates widespread involvement in the production of surplus cereals, either taken as tax or sold as a commodity. In the second half of the first century A.D. and the second century A.D., the presence of imported grain in London (Straker 1984) suggests that rural settlements could not support the new urban populations alone, although this grain may have been intended for redistribution beyond the city. Either way, the continued importation of exotic plant foods throughout the Roman period shows that the province was never completely self-sufficient for food (Van der Veen 2016); there are no indications of actual grain imports by the third and fourth centuries A.D. Given the evidence for British arable expansion just outlined, there is no reason to doubt the widespread assertions that substantial quantities of cereals were being produced in certain areas by the later Roman period, with the capacity for large grain exports to the Continent. The literary evidence of Zosimus' (III, 5, 2) account of ship construction in order to transport British grain to the Rhine frontier, and Ammianus' (XVIII, 2, 3) description of granaries supplied with grain from Britain (Ireland 2008, 144), in combination with the phenomenon of inserting corndryers into previous villa buildings, indicates the importance of arable production in this period.

The production of grain surpluses was at least partly achieved through the large-scale cultivation of spelt wheat at certain settlements, such as the complex farmstead at Orton Hall Farm, Cambs, as seen through the dominance of spelt wheat in archaeobotanical assemblages, and the use of multiple corndryers. However, many of these sites were also undertaking other economic activities. For example, at Bancroft villa, Buckinghamshire, the emphasis appears firmly on spelt cultivation, though malting, production of horticultural crops, as well as metalworking, also contributed towards the site's overall economy. The growth of arable production seems to have primarily occurred through improved infrastructure, such as processing and storage structures, more efficient use of labour through, for example, the use of corndryers, and greater social and economic integration through the Roman road system. Technological innovations did spread throughout parts of the countryside during the mid- to late Roman period, but the extent to which these substantially increased the scale of arable production is unclear.

MILITARY PROCUREMENT

The specific impact of the military on the production of cereals and other crops remains uncertain, and has featured less in debates over military procurement than faunal evidence (Thomas and Stallibrass 2008). During the period of initial military occupation, whether the invading army could or could not have been sustained on local produce has been much debated (Millett 1990, 56–7; Frere and Fulford 2001; Sauer 2001). The possible occurrences of famine (Mattingly 2006, 113) and major socio-economic upheavals of the mid- to later first century A.D., would surely suggest that some long-distance food supply was required by the military, and there is direct evidence for the import of cereals within legionary fortresses at Alchester, Caerleon and Exeter (Helbaek 1964; Straker *et al.* 1984; Sauer 2001). It took several generations before corndryers were first constructed at farmsteads, and cultivation techniques adjusted to cope with the new demand for cereals.

Military forts in the north were largely being sustained by cereals supplied from the rest of Britain, with spelt wheat and six-row hulled barley being the main cereals recorded along Hadrian's Wall (Hall and Huntley 2007), with a similar situation at second-century A.D. Ambleside in Cumbria (Carruthers 1993). Storage deposits at South Shields, Tyne and Wear, contained a mix of spelt and bread wheat suggestive of foreign supply, albeit with no non-British weeds (Van der Veen 1994). Early military levels at Castleford, West Yorkshire, mainly consisted of barley, interpreted as evidence for local supply (Bastow 1999), while the presence of barley rachis from the *horreum* at Birdoswald on Hadrian's Wall was taken as indication of local supply of whole barley ears (Huntley 1997). The Vindolanda tablets also show members of the military both collecting barley and purchasing cereals and a wide range of other foods, including unthreshed cereal grain, indicating the combination of local and long-distance supply (Pearce 2002, 934; Bowman 2003, 38). The widespread distribution of corndryers within the Central Belt, the South, the East, and the North-East indicate that hundreds, if not thousands, of farming settlements were engaged in some surplus production, of which a proportion could have been requisitioned or taken in tax payments in order to support the military.

FUTURE WORK

The review of arable farming and production of other plant resources in rural Roman Britain presented in this chapter has confirmed the established model of continuity, expansion, and an increase in scale and specialisation and, crucially, established regional and chronological differences in the patterns of crops and crop processing. While relatively limited regional variation was highlighted in the methods of cultivation, future work should investigate whether this can be supported, through detailed intra- and inter-site analysis, of arable weeds and crop stable isotope analysis (e.g. Bogaard *et al.* 2016). Accurate identification of cultivation practices would also enable estimates to be made concerning the yield of cereal crops. This chapter has assessed the differences between arable farming practices associated with the major settlement types outlined in Volume 1 (Smith *et al.* 2016). Despite decades of archaeobotanical analysis, we are still lacking good quality datasets from villas and roadside settlements, and the production of such datasets should be a research priority in the future. A range of archaeological and archaeobotanical evidence has been presented here in order to illustrate current knowledge of the stages of arable farming and horticulture in Roman Britain, although many of these aspects can provide only limited quantitative information on the scale of the Roman agricultural economy. It is considered here that the most promising datasets for future analysis are those relating to cereal cultivation, through detailed weed and isotope analysis, and cereal processing, through detailed analysis of corndryers and their contents.