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A meta-analysis of the presence of crop plants in the Dutch and German terp area between 700 BC and AD 1600

Mans Schepers¹ · Karl-Ernst Behre²

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Abstract

There is a long tradition of archaeobotanical research in and around the dwelling mounds, known as terps or Wurten (among other names), along the Wadden Sea coast. The present paper presents an overview of crop plants retrieved from 1,389 samples, from a total of more than 100 sites, spanning the Iron Age to the Early Modern Period. Traditionally, the area has been more associated with animal husbandry than with crop farming. The crops that do occur are often mentioned in the form of a simple list, which is presented as being constant through time and space. Despite the large number of samples available, an overview looking at the potential diversity in crop plant composition in the area across time and space has been lacking until now. The present paper shows clear trends over time, starting long before the permanent embanking of the Wadden Sea salt marshes.

Keywords Salt marsh · Dwelling mounds · Crops · Arable farming · Diachronic developments

Introduction

Over the course of the Neolithic, continuous relative sea level rise resulted in the drowning of a cover sand landscape along the Wadden Sea coast, ultimately forcing human societies to abandon the area. Neolithic remains covered by thick layers of peat and clay testify to this distant past (Raemaekers et al. 2012; Kamstra et al. 2016). From the Early Iron Age onwards, around 700 BC, an entirely new landscape emerged (Vos 2015). This salt marsh landscape, shaped by the sea, attracted the attention of farming communities living on higher Pleistocene ground (Behre 2008; Taayke 2016).

At the start of this salt marsh habitation, people settled directly on the salt marsh surface, but later on they mainly built their dwellings on small, elevated platforms of soil and organic material, which gradually grew into human-made dwelling mounds known as terps (in the Netherlands as

terpen or *wierden* and in Germany as *Wurten* or *Warften*). Various publications provide a broad introduction to various cultural aspects of the terp area (Boersma 2005; Bazelmans et al. 2012; Nieuwhof 2018), the relationships between its inhabitants and the landscape (Behre 1976, 2008; Meier 2001; Nieuwhof and Schepers 2016; Nieuwhof et al. 2019; Schepers and Vos 2020; Schepers et al. 2021), and the vegetation history of the area (Behre 1970, 1979, 1985; Körber-Grohne 1992; Schepers et al. 2013).

These terps, largely consisting of clay, household refuse, and dung, generally have excellent preservation conditions for organic remains. The potential of studying plant remains from terps was recognised at a very early stage of archaeological research in the area (Rijkens 1835; Westerhoff 1871) mentions the presence of straw, which could be considered the first mention of the presence of the remains of crops. However, at that time, researchers were unable to identify to which species of cereal the straw related ('tot welke graansoort het gevondene stroo in den mest behoort', Acker Stratingh 1849, p 208). Westerhoff (1871) and Willem Beijerinck, a Dutch biologist who visited many of the sites commercially excavated for the fertile soil they were made from, to sample for plant remains (1929), were the first to establish the taxonomic identity of the crop plants among the remains.

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From the second half of the 20th century onwards, dozens of (rescue) excavations have been carried out throughout the terp area, and these frequently included archaeobotanical research. Despite the fact that remains of crop plants have been consistently identified in this research, an up-to-date overview of variation over time and space is lacking. Available reviews are either incomplete, out of date and thus incomplete, hidden in (grey literature) site reports, published very locally and aimed at the general public, and/or, with the exception of Table 10 in Behre (1986), restricted to one or other geopolitical area, i.e. either the Netherlands or Germany (van Zeist 1974; Cappers et al. 2005; Schepers 2016).

To fill the gap in our knowledge, this paper presents a review of crop plants identified in archaeobotanical research carried out in the Dutch and German terp area. It addresses the relative importance of various crops in the region and discusses differences through time. In doing so, it makes a substantial amount of data from relatively inaccessible local reports available to an international audience. Moreover, it places some classic, well-published archaeobotanical terp reports in a broader cultural and environmental context. For photos or drawings of the crop species discussed, we refer to earlier work (e.g. Beijerinck 1929; Körber-Grohne 1967; van Zeist 1974; Behre 1976, 1991; Schepers 2016). Although a very relevant debate, this paper does not address local cultivation of the crop species discussed in detail.

Methodology

Demarcation of the area in time and space

Establishing the boundary of the terp area is rather straightforward at first glance. It largely coincides with the distribution of marine or brackish clay deposits on soil maps and the related tidal flats on geomorphological maps. In the German part of the study area in particular, terps also occur on elevated levees along major rivers, such as the Ems. Known terps, generally still easily recognisable in the landscape, are even designated on these maps. However, in the Dutch part of the study area in particular, a substantial number of smaller and lesser-known terps are found in the area between the Pleistocene districts and the clay district, known as the border peat area (border between the clay and the sand region), or ‘clay-on-peat’ area, which has only recently started to receive more attention (e.g. Bakker et al. 2018, 2019; Nicolay 2018). For our demarcation in space, we have included the entire area where periodic high water levels prompted the inhabitants to build their houses on artificial elevations, which in some cases are little bigger in surface area than a single house (‘platforms’), but in other cases developed into entire settlements, often large villages.

Deciding on a start date for the samples to be included was easy, as the earliest terps, and hence samples included in this review, date from around 700 BC, coinciding with the start of the salt marsh habitation (see Introduction). Deciding on an end date was less straightforward. Many of the terps continued to be used for habitation after embankments in the form of dikes started to be built (from approximately AD 1100 onwards) and thus contain late medieval and early modern layers and features as well. In addition, the transition from an open salt marsh landscape to an embanked polder landscape took several centuries, and both terp building and dike building were major elements in human–landscape interaction in this period of major landscape change, although terps gradually decreased in importance over time (Bantelmann 1967; Schroor 1995, p 26; Meier 2001; Knottnerus 2005; Behre 2008). We argue that, in order to understand the characteristics of crop farming in the open system, it is important to include the period during which the major endikements took place. We therefore decided to include samples dating up to AD 1600.

Taxa selection

We restrict our overview to undisputed crop plants. We exclude a number of wild plants that could have been grown as crops but whose find context or concentration do not convincingly point towards them having been grown as a crop (Schepers and Behre 2022). In the study area this includes black mustard (*Brassica nigra*), parsnip (*Pastinaca sativa*), and beet (*Beta vulgaris*).

Sample selection, categorisation, and quantification

This overview includes analyses carried out and published by a large number of different analysts, representing a number of different research traditions. This diversity brings with it major differences in terms of quantification methods. These include presence/absence data (p/a, sometimes merely a short list of taxonomic identifications), abundance categories, abundance estimates, and absolute counts. Since all of the data can at least be represented as p/a, we use p/a data per species per sample to map the major trends and differences. Where possible and where this helps to clarify the overall image, we refer to seed numbers when discussing individual taxa.

We further restrict our overview to samples containing the remains of at least one crop plant. We include identifications at various taxonomic levels, but we exclude genera encompassing (various) wild species known to occur locally, unless the remains from these genera have been identified to the species level or lower (we exclude, for example, identifications to the genus level in the genera *Vicia* and *Hordeum*). The only exception to this rule is the genus *Avena*, which,

depending on the level of preservation of the material, is a notoriously difficult genus within which to identify to the species level.

Chronology and site groups

The phasing we adopted differs from that proposed in the original publications or reports themselves, because (1) their phasing differs considerably depending on the site, the region, and the history of research, and (2) their phasing is often more precise than is warranted for this review. For example, we categorise all samples from Niens (Behre 1991) as ‘Early Middle Ages’, even though the original publication employs four settlement phases.

To enable us to detect chronological developments in the availability of and the ratio between crops, we simplified the chronology used by Nieuwhof (2015, p 13), to define 6 phases, largely following major time periods used in European archaeological tradition (Table 1). These phases differ in the timespan they cover. This is partly explained by the fact that these phases actually represent longer and shorter periods, and partly by methodological decisions that had to be made to allow for a meaningful analysis. For example, we place the entire Iron Age into a single phase because, while there are several terp sites from the Late Iron Age, there are simply too few terp sites dating to the Early Iron Age and the Middle Iron Age to result in an adequate number of samples if we were to subdivide the Iron Age.

The chronology of the terp area itself, like that of most areas, is based on a combination of pottery typology and radiocarbon dates (Taayke 1996), and parts of it are still a matter of debate (e.g. Nieuwhof 2013; Taayke 2016; Krol et al. 2020). Many of the reports included in this meta-analysis, make use of a relatively coarse chronology. Adopting a more detailed phasing here would have resulted in the exclusion of many sites due to insufficient chronological resolution and lower numbers of samples per phase, thus reducing our ability to observe *longue durée* developments. The relatively coarse phasing we use in this review allows for the inclusion of a large number of sites. We include the raw data (ESM 1; ESM 2), as well as references to the original

sources for the individual samples, to enable the reader to apply a different phasing (see also discussion).

The date range (precision) of the samples included in this review differs substantially, from less than 1st century to 7th centuries. To assign a sample to a particular phase, we allowed a maximum of 1st century of overlap with the preceding or following phase. This also applies to the samples at the end of the last phase included here, which therefore stretches into the 17th century. A sample spanning a century either side of the division between two phases is defined as an in-between phase. For example, a sample dated between 200 BC and AD 100 is assigned to the Iron Age, but a sample dated between 100 BC and AD 100 is assigned to the Iron Age/Roman Iron Age. We use the in-between-phase samples in the overview but we exclude them from the comparisons between phases.

We group samples from a single archaeological site that date to the same phase, in order to allow for the separate treatment of (groups of) samples from different phases on sites with a single, multi-phase habitation period or multiple habitation periods. For the remainder of this paper, we use the acronym SG to refer to these site groups.

Exploring trends and differences

We first discuss the most commonly identified individual crop plants and the developments in their presence over time. We refer to individual sites and finds where these provide valuable information to assess the relative importance of the crop plants or add to the debate (particularly prominent in the Netherlands) concerning the likelihood of local cultivation. We refer briefly to the rarer crop plants as well. We then discuss the trends observed, based upon the differences in time and, to a lesser degree, space.

Results and interpretation

General observations and description of the material

The number of archaeological sites in the terp area is substantial and archaeobotanical sampling and analyses are frequently included in excavations. As a result, we were able to obtain data on 107 sites, totalling 195 SG and 1,389 samples (Fig. 1; Table 2; Table 3; ESM 1; ESM 2). Citations for the references to the reports mentioned here are provided in ESM 1. In some cases, a single source refers to multiple sites (e.g. van Zeist 1974; Lempiäinen and Behre 1997; Kroll 2001; Schepers 2023) and in other cases several publications deal with the same site (e.g. Koopstra 2000; Cappers 2008). The sample density per SG is extremely skewed, as 130 SG are made up of no more than 5 studied samples, whereas 3

Table 1 Phasing used in this review to detect change over time

Phase	Time period	Start	End
1	pre-Roman Iron Age	700 BC	1 BC
2	Roman Iron Age	AD 1	AD 400
3	Early Middle Ages	AD 500	AD 900
4	High Middle Ages	AD 900	AD 1200
5	Late Middle Ages and Early Modern	AD 1200	AD 1600

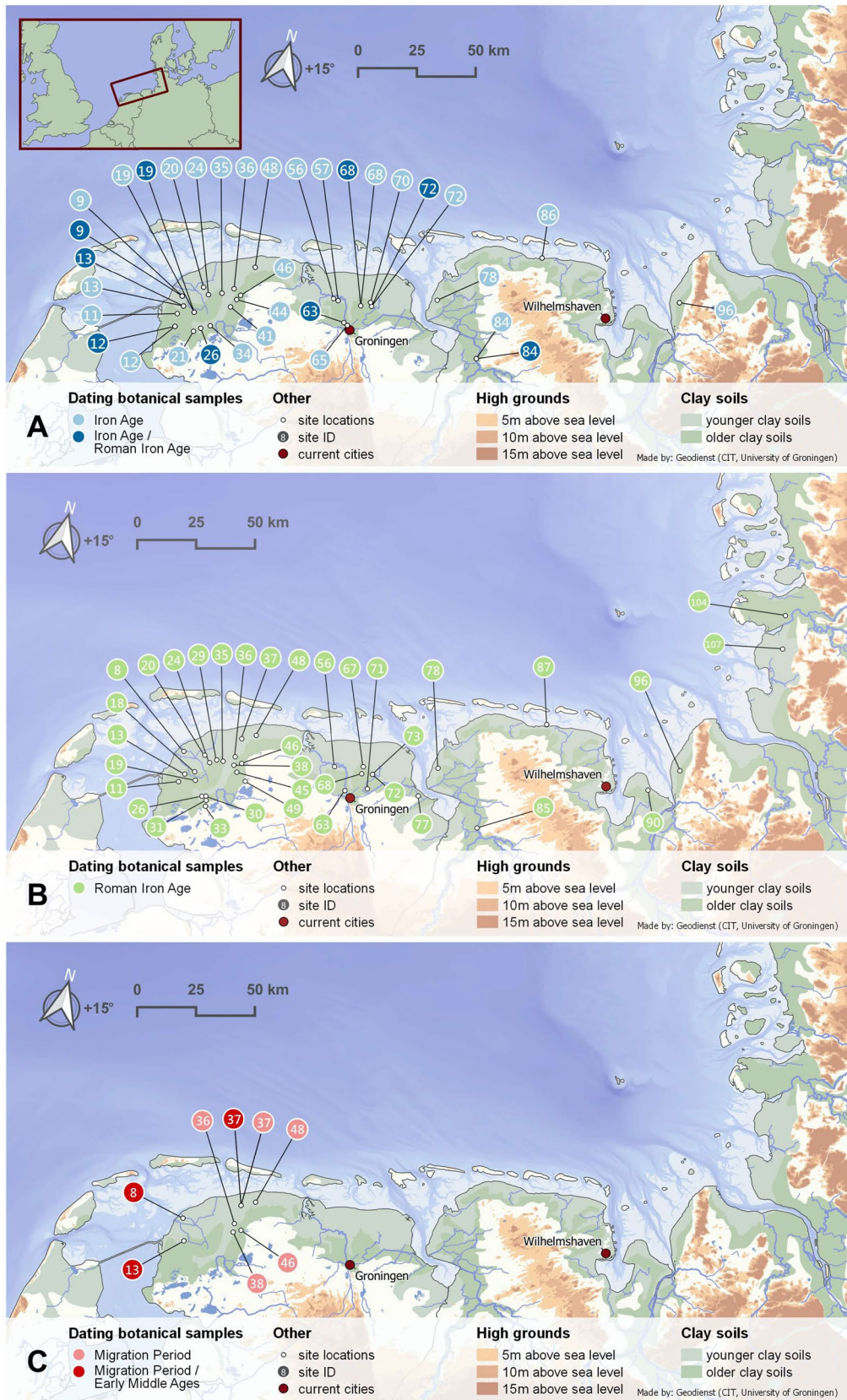


Fig. 1 Distribution of sites included in this review, by phase; see also Tables 1 and 2

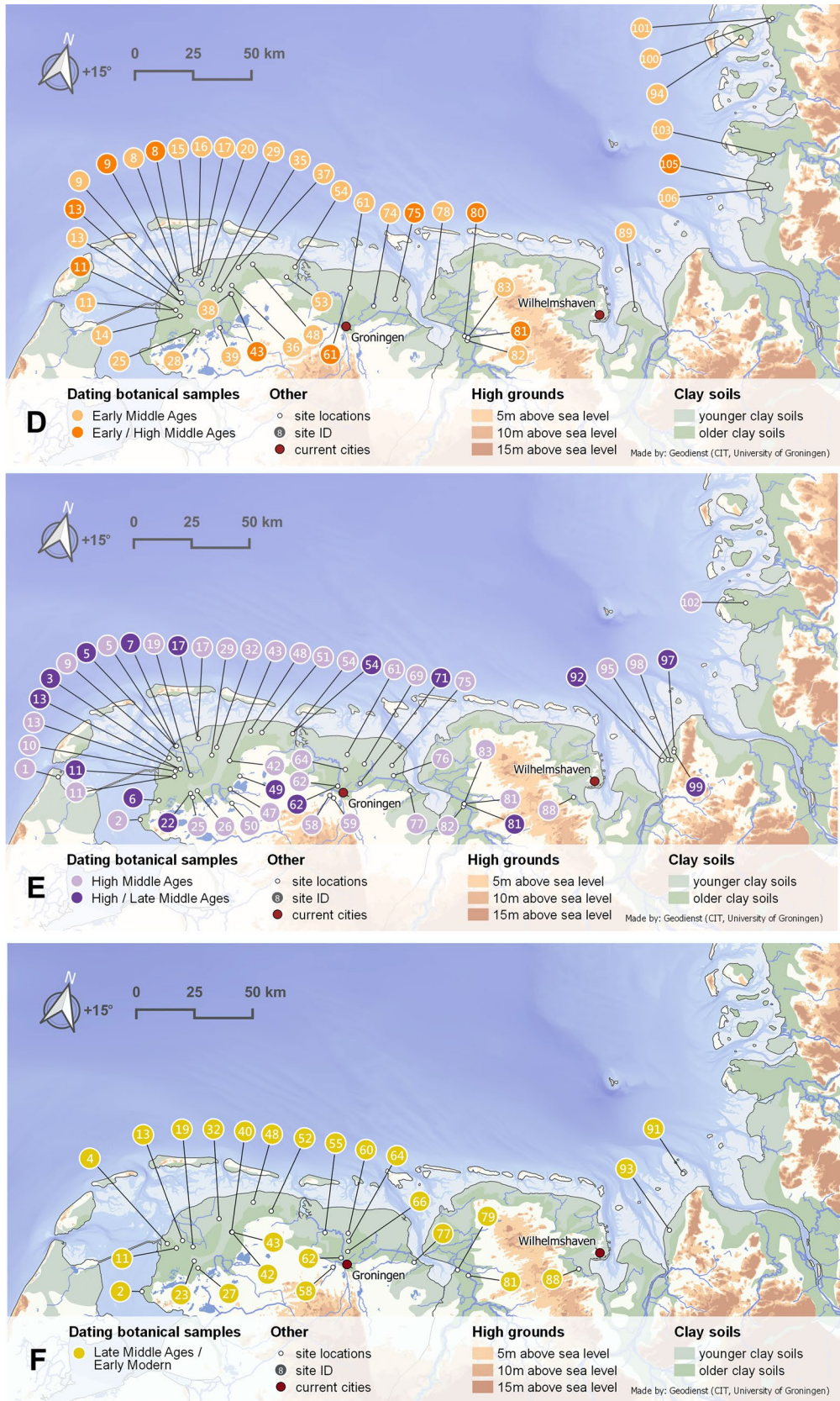


Fig. 1 (continued)

Table 2 The number of samples per site per phase included in this review; see Table 1 for the phasing applied and ESM 1 for references

Site ID	Site name	Phase										
		1	1/2	2	3	3/4	4	4/5	5	5/6	6	N SG
1	Het Torp								2			1
2	Stavoren								1		5	2
3	Kimswerd									7		1
4	Wons										3	1
5	Harlingen Boltastate								1	2		2
6	Workum Nijefurd									3		1
7	Harlingen Haven									9		1
8	Wijnaldum			6		4	40	11				4
9	Achlum	3		6			4	2	20			5
10	Witmarsum								1			1
11	Schettens	7		5			7	4	6	1	2	7
12	Arkum	4		2								2
13	Saksenoord	23	3	21		6	1	2	4	1	11	9
14	Bolsward						1					1
15	Tzummarum-Monnikenterp						4					1
16	Tzummarum						4					1
17	Firdgum						46		5	7		3
18	Tritsum			13								1
19	Wommels-Stapert	19	1	4					4		14	5
20	Peins	12		2			2					3
21	Sneek De Hemmen	1										1
22	Sneek-Stinswier									6		1
23	Tirns										2	1
24	Dronrijp-Zuid	8		42								2
25	Sneek-Waterzuivering						1		1			2
26	Sneek-Harinxmaland		16	10					1			3
27	Sneek-Martiniplein										2	1
28	Sneek-Akkerwinde						3					1
29	Dronrijp-Oost			8			20		4			3
30	Scharnegoutum			1								1
31	Sneek-Stadsrondweg			8								1
32	Beetgumermolen								2		1	2
33	Sneek-Jachthaven			1								1
34	Sibrandabuorren	3										1
35	Marssum	20		13			4					3
36	Jelsum	30		79	10		2					4
37	Hallum			1	1	1	8					4
38	Leeuwarden-Oldehoofsterkerkhof			17	2		20					3
39	Jirnsom-Abbenwier						1					1
40	Leeuwarden-Bollemanssteeg										3	1
41	Goutum	3										1
42	Leeuwarden-Gouverneursplein								10		7	2
43	Leeuwarden-Speelmanstraat							1	3		7	3
44	Leeuwarden-Condensfabriek	2										1
45	Hempens-Teerns			8								1
46	Leeuwarden-Bullepolder	14		29	1							3
47	Grou								1			1
48	Oosterbeintum	1		39	4		11		8		1	6
49	Wartena			18						2		2

Table 2 (continued)

Site ID	Site name	Phase										
		1	1/2	2	3	3/4	4	4/5	5	5/6	6	N SG
50	Oldeboorn								3			1
51	Foudgum								4			1
52	Dokkum										3	1
53	Ee						2					1
54	Anjum						2		5	4		3
55	Aalsum										1	1
56	Englum	3		5								2
57	Ezinge	2										1
58	Onlanden								9		20	2
59	Peize								2			1
60	Winsum										4	1
61	Baflø						2	1	4			3
62	De Held								1	2	1	3
63	Friesestraatweg		1	8								2
64	Groot-Wetsinge								1		1	2
65	Paddepoel		9									1
66	Adorp										1	1
67	Onderdendam			1								1
68	Loppersum mast 698	5	2	5								3
69	Middelstum								1			1
70	Middelstum-Boerdamsterweg	13										1
71	Thesinge-Klooster			1						2		2
72	Hogebeintum	10	1	2								3
73	Loppersum mast 712			22								1
74	Stedum						1					1
75	Godlinze							3	4			2
76	Jukwerd								1			1
77	Heveskesklooster			11					10		11	3
78	Upleward	4		2			3					3
79	Pogum										1	1
80	Klunderborg							2				1
81	Hatzum-Burg						5		1	1	2	4
82	Alte Boomborg							12	6			2
83	Hatzum-Langwurt						5		2			2
84	Jemgumklooster	7	4									2
85	Bentumersiel			20								1
86	Esens 2311	1										1
87	Esens 2211			1								1
88	Ellens								1		2	2
89	Niens						26					1
90	Sillens			1								1
91	Neuwerk Turmbereich										1	1
92	Misselwarden 33									1		1
93	Misselwarden 22										1	1
94	Midlum						2					1
95	Padingbüttel 2								4			1
96	Feddersen Wierde	2		51								2
97	Cappel 40									1		1
98	Dorum 83								4			1

Table 2 (continued)

Site ID	Site name	Phase										
		1	1/2	2	3	3/4	4	4/5	5	5/6	6	N SG
99	Cappel 27									2		1
100	Emmelsbüll-Toftum						3					1
101	Hörsbüll LA45a						1					1
102	Hundorf Poppenbüll								2			1
103	Elisenhof						65					1
104	Tofting			17								1
105	Hasenbüttel							2				1
106	Wellinghusen 38						5					1
107	Haferwisch			8								1
	Samples	197	37	488	18	11	301	40	139	51	107	1,389
	Site groups	24	8	37	5	3	31	10	36	16	25	195

The site ID (identifier) refers to Fig. 1. The sites are sorted from west to east

SG are made up of more than 50 studied samples (Elisenhof, Feddersen Wierde, and Jelsum). The vast majority of the sites with very few studied samples are in the Netherlands. This relates to the fact that in the Netherlands, in general, sites are subject to relatively small-scale, short-term, development-led excavations, whereas in Germany, in general, sites are excavated as part of large-scale research projects, which yield huge numbers of samples.

Cereals

Barley (*Hordeum vulgare*)

Barley occurs in 177 out of 195 SG (91%) and 1,141 out of 1,389 samples (82%). Both grain kernels and rachis fragments are common and often occur in large numbers. All barley finds concern hulled six-row barley. Occasionally, publications refer to four-row barley, which is basically six-row barley with slightly longer, slender internodes, causing the lateral spikelets to fold over the central ones, resulting in a four-row top view (see for example, Behre 1976; van Haaster 2006b). Barley is already present in the earliest samples included in this review. It is the most frequently

Table 3 Summary of the data included for the present study (the major trends for the most common crop taxa are visualised in Figs. 2 and 3): Number of samples, percentage of total number of samples (n = 1,389), number of site groups, and percentage of total number of site groups by taxon (n = 195) sorted in descending order based on the number of samples containing that taxon, except for *Avena* remains identified to the genus level only, which are positioned adjacent to *A. sativa*

	N samples	% samples	N site groups	% site groups
<i>Hordeum vulgare</i>	1,141	82	177	91
<i>Linum usitatissimum</i>	487	35	108	55
<i>Triticum dicoccum</i>	263	19	68	35
<i>Vicia faba</i>	207	15	69	35
<i>Camelina sativa</i>	113	8	38	19
<i>Secale cereale</i>	65	5	34	17
<i>Triticum</i> (free-threshing)	62	4	36	18
<i>Cannabis sativa</i>	54	4	24	12
<i>Avena nsp</i>	115	8	36	18
<i>Avena sativa</i>	48	3	23	12
<i>Panicum miliaceum</i>	28	2	12	6
<i>Triticum spelta</i>	10	1	3	2
<i>Pisum sativum</i>	10	1	7	4
<i>Isatis tinctoria</i>	9	1	5	3
<i>Triticum monococcum</i>	2	<1	2	1
<i>Oryza sativa</i>	1	<1	1	1
<i>Fagopyrum esculentum</i>	1	<1	1	1
Total	1,389	100	195	100

occurring crop in all phases, and it has a consistently high SG frequency across all phases (Fig. 2).

These observations suggest that barley must have been a major staple crop in the area from the Early Iron Age onwards. Repeated finds of barley remains used as pottery temper strengthen the interpretation that it was consistently available in substantial quantities (Scheepers and de Vries 2022). The only SG lacking barley are those with very few samples available. The overall picture gained from this review is that barley was present everywhere throughout the time period under discussion.

Emmer wheat (*Triticum dicoccum*)

Emmer wheat occurs in 68 out of 195 SG (35%) and 263 out of 1,389 samples (19%). Both charred and waterlogged rachis fragments occur, and each of these are more abundant than grain kernels. Emmer wheat already occurs in the earliest samples included in this review. There is a gradual decline in SG frequency from the Iron Age to the Late Middle Ages, by which time it almost disappears (Fig. 2). Emmer wheat finds occur throughout the area.

In the Netherlands in particular, the status of emmer wheat in the terp area has been debated repeatedly. Debate has mainly concerned the likelihood of local cultivation, but various authors have emphasised that the occurrence of emmer wheat is exceptional in the area in general (van Zeist 1989; Bakels 1997; Pals 1999; Boersma 2005). It is beyond the scope of this paper to discuss local cultivation, but the current review does justify us stating that emmer wheat would not have been a rare sight in the area in the Iron Age and the Roman Iron Age.

Free-threshing wheat (*Triticum spp*)

Free-threshing wheats occur in 36 out of 195 SG (18%) and 62 out of 1,389 samples (4%), indicating that,

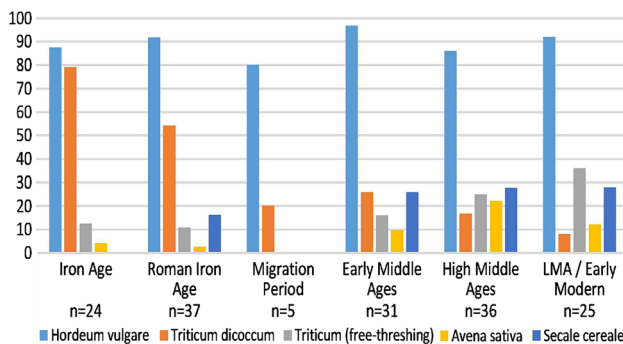


Fig. 2 Proportion of site groups in which the five most commonly identified cereal species occur. Note that relatively few data are available from the Migration period. LMA Late Middle Ages

although it was present in many different sites, the number of samples containing these wheats was rather low. Two closely related species of hexaploid free-threshing wheat have been identified in the study area, namely bread wheat (*Triticum aestivum*) and club wheat (*Triticum compactum*). In many cases, only a few grain kernels were identified, and these could not be distinguished from hard wheat (*Triticum durum*) based on morphology. Grain kernels occur more often than rachis fragments. In all instances where rachis fragments were present, these could be identified as belonging to *T. aestivum* rather than *T. durum*. Free-threshing wheat occurs in low frequencies in the Iron Age and the Roman Iron Age and is absent in the Migration period. From the Early Middle Ages onwards, it occurs more frequently, being present in approximately one third of the SG in the Late Medieval/Early Modern period (Fig. 2).

Over the entire time period covered by this review, free-threshing wheat is less common than emmer wheat. However, the trend in the relative presence through time for free-threshing wheat is the opposite of that for emmer wheat. With a clear increase in ubiquity over time, free-threshing wheat ultimately replaces emmer wheat as the most common wheat type in the area in the High Middle Ages.

Oat (*Avena sativa*)

Oat occurs in 23 out of 195 SG (12%) and 48 out of 1,389 samples (4%). The identification of oats has been discussed repeatedly within the field of archaeobotany, and it is generally agreed that morphological identification to the species level is almost impossible based on the fruits if husk bases are not available. For that reason, many of the oats identified are identified to the level of genus only (*Avena*), which also includes *A. strigosa* on Pleistocene soils and *A. fatua*. We only included identifications to the species level (*A. sativa*) in our direct comparison between the cereal species here (Fig. 2), which will thus probably result in some underrepresentation. A single find of cultivated oat is known from the Late Iron Age (Verbruggen 2012). Domesticated oat has been identified at a single site in the marsh area, dating to the Roman period (Loppersum (mast 712), van Haaster and Lammertsma 2022). Oat occurs in somewhat higher frequency in the Middle Ages, with a tentative peak in the High Middle Ages.

Considering the fact that 488 samples from a total of 37 sites have been included in this review for the Roman period, the near absence of oat in samples dating to this phase is likely to be representative of reality. Oats become more common only in the Middle Ages. In the Early Middle Ages, they are more common in the north-eastern part of the study area.

Rye (*Secale cereale*)

Rye occurs in 34 out of 195 SG (17%) and 65 out of 1,389 samples (5%). Grain kernels occur more often, and in higher numbers, than rachis fragments. Rye finds occasionally occur in samples dated to the Iron Age and the Roman Iron Age, but always in low numbers and sample frequencies. They are absent in the Migration period, and they gradually increase in SG frequency from the Early Middle Ages onwards.

For the pre-Middle Ages finds, there is a reasonable possibility that these relate to remains from plants that grew as a weed (Behre 1992). The trend of a gradual rise from the Early Middle Ages onwards more or less parallels that of the free-threshing wheats. Traditionally, rye has been associated with poor soils, and is indeed much more common in the sand district adjacent to our study area. It is thus noteworthy that both pollen and macro-remains occur in the north-western part of the Dutch province of Friesland (Groenman-van Waateringe 1999; Schepers 2023) where the salt marsh ridges are ‘sandier’ than in other parts of the terp landscape. In the later High Middle Ages in particular, following state formation and urbanization in the area, the import of rye from inland areas or from even greater distances becomes a more plausible explanation (see for example, van Zeist et al. 1987; Maurer 2016).

Other cereals

Broomcorn millet (*Panicum miliaceum*) occurs in 12 out of 195 SG (6%) and 28 out of 1,389 samples (2%). This excludes the two identifications by van Zeist (1970), later revoked by himself (van Zeist 1974, p 363). Broomcorn millet occurs in somewhat higher frequency at Roman Iron Age Bentumersiel (5 out of 20 samples, Behre 1977) and Jemgumkloster in particular (7 out of 11 samples, Behre 1972). Spelt occurs in no more than three site groups, with Early Medieval Niens as the only site where it turns up in a somewhat higher frequency (7 out of 26) of samples (Behre 1991; see also Bakels 2017). The pseudocereal buckwheat (*Fagopyrum esculentum*) and rice (*Oryza sativa*) have been identified in a single sample only, at Late Medieval Sneek (Cappers and Bottema 2008). Einkorn (*Triticum monococcum*) has only been identified from one Iron Age and one Roman Iron Age sample, from Upleward (Bittmann and Wolters 2020).

Non-cereal crop plants

Flax (*Linum usitatissimum*)

Flax occurs in 108 out of 195 SG (55%) and 487 out of 1,389 samples (35%). Both waterlogged seeds and waterlogged

fruit segments occur in high numbers. Flax occurs from the Early Iron Age onwards and is present in more than 70% of the SG in the Iron Age and the Roman Iron Age, whereafter it declines in ubiquity into the High Middle Ages. The decline, however, is mainly driven by the results from sites in the western part of the study area, where flax is not found. In the Late Middle Ages/Early Modern period, the SG frequency of flax rises again.

Flax was among the first crop plants to be identified in the terp area (Westerhoff 1871), and it is almost as common as barley in the early phases. Unlike those of barley, however, ubiquity values of flax clearly drop in Phases 4 and 5, and then rise again in Phase 6. There is no reason to assume that different preservation conditions will affect the archaeobotanical record in the area differently through time. Thus, the gradual relative decrease in flax ubiquity over time is likely to reflect an actual trend and not a methodological artefact. Flax is cultivated both for its seeds and for its fibres (see also Nieuwhof 2017). The more frequent occurrence of hemp (*Cannabis sativa*, see below) in the western part of the study area from the Roman period onwards may explain part of this trend.

Celtic bean (*Vicia faba var. minor*)

Celtic bean occurs in 69 out of 195 SG (35%) and 207 out of 1,389 samples (15%). Whereas seeds occur the most often, pods and vegetative parts are encountered as well (see below). The Celtic bean occurs in three Iron Age SG. Two of these SG date back to the very end of that era, between 200 BC and AD 0 (Jemgumkloster, Behre 1972; Schepers 2015). One Iron Age find only dates back to the Middle Iron Age, (Saksenoord, Schepers and Assië 2019). From the Iron Age onwards, the frequency of Celtic bean varies between 32% (Roman Iron Age) and 47% (Early Middle Ages).

Celtic bean was earlier erroneously reported to be commonly available in the Dutch terp area from the Early Iron Age onwards (Schepers 2016, p 150). Based on the current review, we now know that it was probably not commonly available in the Iron Age. In the north-eastern part of the area, substantial concentrations occur at Roman Iron Age Feddersen Wierde (Körber-Grohne 1967) and Early Medieval Elisenhof (Behre 1976, p 15). Behre (1976) emphasises that the beans (that is, the seeds) themselves were actually rarely identified from these concentrations, but that several hundred seed pods were identified. The rarity of *V. faba* seeds may partly be the result of preservation bias (see also discussion in Treasure and Church 2017).

The kinds of seed pod concentrations recovered from Feddersen Wierde and Elisenhof seem to be truly rare, however, as they have not been identified in any of the samples from the numerous large-scale excavations that have taken place over the past 15 years. Given that explicit attention was

paid to organic remains at these excavations, it is unlikely that ‘heaps of bean straw’ would have been overlooked (e.g. Dijkstra and Nicolay 2008; Nicolay 2010; Nicolay and de Langen 2023).

Gold of pleasure (*Camelina sativa*)

Gold of pleasure occurs in 38 out of 195 SG (19%) and 113 out of 1,389 samples (8%). Both seeds and fruits commonly occur, and waterlogged remains are more common than charred remains. The highest frequencies for this crop occur in the Iron Age and the Roman Iron Age. Gold of pleasure is an oil plant from the Brassicaceae family traditionally associated with the terp area in the literature, but the current review indicates that it is not very common at all in terms of either SG or sample frequency. This species is known to occur also as an arable weed in flax fields, and we note that its chronological trend seems to follow the same trajectory as that of flax, suggesting that it is perhaps present as an arable weed rather than a food crop (Fig. 3). In various locations, however, find conditions and concentrations justify its interpretation as a crop, for example at Goutum and Feddersen Wierde (Körber-Grohne 1967; Out and Kaaijk 2010). This plant, too, occurs more commonly in the north-eastern, German, part of the terp area than in the western, Dutch, part.

Hemp (*Cannabis sativa*)

Hemp occurs in 24 out of 195 SG (12%) and 54 out of 1,389 samples (4%). Most identifications concern the fruits, but hemp fibre rope was found around the neck of a Roman-period pot near Sneek (Fijma 2002). Hemp has been found in several sites in the western part of the study area (in Friesland) in the Iron Age and the Roman Iron Age (see also the

section on flax, above). Hemp is more commonly identified throughout the area in the High Middle Ages.

Other crops

Two other crop plants that are present on sites in the area are Pea (*Pisum sativum*) and Woad (*Isatis tinctoria*). A single Pea was recently identified from Roman Jelsum, and two peas were identified from Early Medieval Wijnaldum (Pals 1999; Schepers 2023). The High to Late Medieval terp site of Zürich-Kimswerderlaan is exceptional, where peas were found in four out of seven samples examined (van Haaster 2006a).

Woad is best known in the area from the detailed description provided by Körber-Grohne for Feddersen Wierde (1967, pp 180–183). This dye plant would never have been cultivated on a substantial scale. Since woad is grown for its leaves and is generally harvested prior to seed setting, the chances of finding remains of this plant are rather low. At Feddersen Wierde, where many samples were examined, the remains were rare.

Discussion

Arable farming is not the first activity that many people associate with the coastal salt marshes prior to major dike construction, which took place in the Late Middle Ages. Animal husbandry is traditionally believed to have been the most important subsistence activity carried out on the marshes, and numerous archaeozoological studies carried out in the area confirm the importance of domesticated animals. A recent overview of archaeozoological analyses relating to the Dutch and German terps shows that, while the big picture of available mammal species remains more or less the same over time, substantial spatial and chronological variation occur as well (Prummel and Küchelmann 2022).

For those not familiar with the area, we emphasise once more that terps were permanently inhabited settlements that lasted for many centuries. Terp habitation was thus a way of life, and it should not be perceived as an initial phase of marsh settlement awaiting permanent embankment (Rippon 2002).

We do not dispute that animal husbandry dominated the salt marsh farming economy, also in terms of economically relevant potential surplus. But we argue that the salt marsh society was essentially a fully developed mixed-farming economy, that did not, or to only a minor extent, depend on the import of plant food products (see also Haarnagel 1979, pp 249–271; Behre 2008, pp 74–75; de Langen and Mol 2022). Although assessing local cultivation is outside the

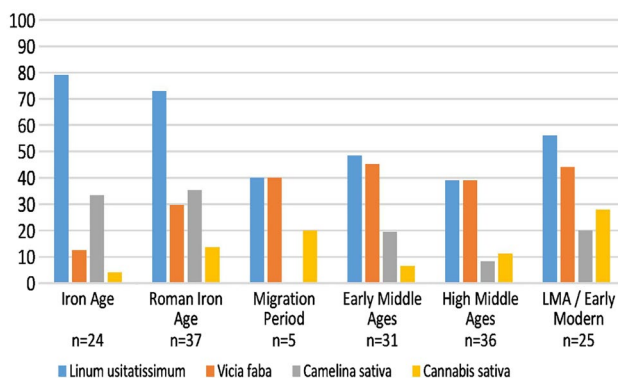


Fig. 3 Percentage of site groups in which the four most commonly identified non-cereal species occur. Note that relatively few data are available from the Migration period. *LMA* Late Middle Ages

scope of this paper, we note that there are various arguments for the local cultivation of crops in the area.

First of all, traces of arable farming have been identified in multiple excavations (for a recent overview, see Nicolay and Huisman 2022). At Feddersen Wierde, even threshing floors could be identified (Haarnagel 1979, p 261). Implements associated with arable farming, such as antler hoes or iron ploughshares, were identified at multiple sites (Roes 1963; Haarnagel 1979, p 264). More circumstantial evidence is provided by pathologies in cattle remains that point to prolonged, intensive labour, which may have included ploughing (Prummel and van Gent 2010; Prummel 2022). There is also ample archaeobotanical evidence for local cultivation. Weeds found in terp excavations generally fit the ecology of the high salt marsh environment (e.g. Körber-Grohne 1967; van Zeist 1974, pp 342–343, 360; Behre 1976). Various crop remains themselves also point to local cultivation, from the pollen of rye (Groenman-van Waateringe 1999), to rachis fragments and fruit kernels of both barley and emmer wheat at many sites (e.g. Körber-Grohne 1967; Behre 1976; Schepers 2023), and to bean stems with root remains attached (Haarnagel 1979, p 261). At Sneek-Harinxmaland, there is a correlation between the ratio of barley to wheat and local environmental change, a correlation that would not be expected if these cereals had been imported (Schepers 2018). Agricultural experiments have shown that various crops can indeed be grown on the salt marsh, and that the chances of success could be increased by well-considered location choices and minor landscape modifications, such as low dikes and simple ditches (Körber-Grohne 1967; van Zeist et al. 1976; Bottema et al. 1980; Schepers and de Langen 2019).

Although there is substantial evidence for the local cultivation of crops, this does not mean that every crop find included in this review originates from a plant that was grown locally. The fact that a crop was grown locally at one site in one particular phase does not necessarily imply that all finds of this particular crop were grown locally. Whether a crop was grown locally or not will have depended on local conditions, environmental conditions, and, possibly, cultural traditions or influences. The construction of major dikes, as mentioned above, is known to have had major consequences for the (former) salt marsh landscape. We thus expected this construction to have had a major effect on the ratios between crop plants in the terp area. However, this review indicates that the ratios between the various crop plants vary across all phases, not just in correlation with major dike construction in the Late Middle Ages.

The general picture of the availability of crops in the area that emerges from this review is as follows: barley was the most commonly used cereal across time and space. It was accompanied in the Iron Age and the Roman Iron Age by emmer wheat, which became less and less common over the

course of the time period under study here. Emmer wheat was gradually replaced by oat, bread wheat, and occasionally rye, but this replacement showed considerable variation per SG and per region. Celtic bean, flax, and gold of pleasure were the most important non-cereal crop plants. All of these show noteworthy changes in relative importance over time considerably prior to medieval dike construction. Hemp is the only crop plant whose ubiquity strongly increases in the Late Middle Ages, although even then it was not abundantly available.

Several differences can be observed between the western and the north-eastern parts of the study area. Millet was found in several sites in the north-eastern part in the pre-Roman Iron Age and the Roman Iron Age but is absent in the intensively studied western part. The opposite is true for hemp, which occurs in various terps in the west in the Roman Iron Age, as well as in the Migration period and the Early Middle Ages, but not in the north-eastern part of the study area. Not only the ubiquity data as presented in this review, but also the descriptions in the reports from Elisenhof (Behre 1976) and Feddersen Wierde (Körber-Grohne 1967), show that Celtic bean will have been commonly available throughout the area from the Roman Iron Age onwards, but that it was clearly of greater importance as a crop in the north-east. More in-depth research is needed to explain this patterning.

Conclusion

The current review allows for a more detailed understanding of the presence of crop plants in the terp area. There is a tradition of simplifying the long history of the area into pre- and post-dike construction. Simply put, the period before dike construction is often portrayed in terms of challenges and limitations, often related to high salinity and moisture values, whereas the period after dike construction is portrayed as a time in which the area transformed into a more cultural landscape (e.g. Bazelmans et al. 2012). This binary view of the area has obscured sufficient acknowledgment of diversity in the area before dike construction for crop plants in particular. Major variation occurs in all other archaeological find categories and features (e.g. ceramics, metal artefacts, building tradition). We thus argue that a scenario in which substantial variation occurred in crop availability as well, is actually more likely. This period before major dike construction, after all, covers a huge swath of time, from the Iron Age right into the High Middle Ages. It also covers a huge area exhibiting not only environmental, but also cultural variation.

This review of almost 1,400 samples from a total of more than a hundred sites shows that substantial variation did occur. Contrary to the traditional view, which held that

emmer wheat was rare in the area, this review shows that it must have been commonly available in the Iron Age and the Roman Iron Age, although it is less ubiquitous than barley. From the Early Middle Ages onwards, emmer wheat was gradually replaced by bread wheat and rye. Celtic bean is the only pulse species of importance throughout the entire period under study, but it is conspicuously rare in the Iron Age. Further research is needed to understand what implications this has for human nutrition and the need to add wild plants to the diet. The occurrence of hemp in some early sites was previously documented only in local reports. Our meta-analysis shows that hemp was already available at various sites in the Roman Iron Age.

On a methodological level, this review illustrates the relevance of sites from which only a very small number of samples were available. Within the context of Dutch contract archaeology in particular, the utility of such samples is sometimes debated because of their limited value on the site level, but we argue that they are definitely useful for this type of diachronic overview.

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