

2016-04-06

The introduction of agriculture into Ireland: a review of the plant macro-remains evidence

McClatchie, M

<http://hdl.handle.net/10026.1/4431>

10.15184/aqy.2015.212

Antiquity

All content in PEARL is protected by copyright law. Author manuscripts are made available in accordance with publisher policies. Please cite only the published version using the details provided on the item record or document. In the absence of an open licence (e.g. Creative Commons), permissions for further reuse of content should be sought from the publisher or author.

Farming and foraging in Neolithic Ireland: an archaeobotanical perspective

Meriel McClatchie^{1,2}, Amy Bogaard³, Sue Colledge⁴, Nicki J. Whitehouse^{2,5}, Rick J. Schulting³, Philip Barratt^{2,5} & T. Rowan McLaughlin²

¹ School of Archaeology, University College Dublin, Newman Building, Belfield, Dublin 4, Republic of Ireland (Email: meriel.mcclatchie@gmail.com)

² School of Geography, Archaeology and Palaeoecology, Queen's University Belfast, Belfast BT7 1NN, UK

³ School of Archaeology, University of Oxford, 36 Beaumont Street Oxford OX1 2PG, UK

⁴ Institute of Archaeology, University College London, 31–34 Gordon Square, London WC1H 0PY, UK

⁵ School of Geography, Earth and Environmental Sciences, Plymouth University, Drake Circus, Plymouth PL4 8AA, UK

Ireland has often been seen as marginal in the spread of the Neolithic and early farming throughout Europe, in part due to the paucity of available data. By integrating and analysing a wealth of evidence from unpublished reports, a much more detailed picture of early arable agriculture has now been developed. The improved chronological resolution reveals changing patterns in the exploitation of different plant species during the course of the Neolithic that belie simplistic notions of a steady intensification in farming, juxtaposed with a concomitant decline in foraging. It is possible that here, as in other areas of Europe, cereal cultivation became less important in the later Neolithic.

Keywords: Ireland, Neolithic, farming, foraging, archaeobotany

Introduction

The introduction of agriculture is one of the defining characteristics of the Neolithic in Europe. Ireland, located at Europe's north-western margin, experienced this transition during the fourth millennium cal BC. The main crops in Neolithic Ireland (4000–2500 cal BC) were wheat (*Triticum* spp.) and barley (*Hordeum* spp.), but until

recently we knew little about their relative importance, the intensity of agricultural activity or how their distribution varied across space and time. International narratives on prehistoric agriculture rarely mention the Irish evidence, except as an adjunct to British research, despite indications of divergence between the two regions (Cooney 2000; Bradley 2007). It is not clear if early agriculture in Ireland reflects primarily special or symbolic consumption in ‘ritual’ contexts (Edmonds 1999; Thomas 2003, 2008), or if crops provided a major component of daily subsistence, as has been proposed for parts of central Europe (Monk 2000; Jones & Rowley-Conwy 2007). New findings from a major study of plant macro-remains from Neolithic Ireland provide insight into the variety of crops recorded at different times and locations, broadening our knowledge of Neolithic society.

Arable agriculture in Neolithic Ireland: the story so far

Recent perspectives on the arrival of agriculture into Ireland were based upon a limited published archaeobotanical dataset, consisting of 10 sites at most (Monk 2000; Colledge *et al.* 2005; Jones & Rowley-Conwy 2007; Stevens & Fuller 2012). New archaeobotanical data have recently become available as a result of the many excavations associated with large-scale infrastructural developments over the past two decades (Grogan 2002; Smyth 2014; McClatchie *in press*). The excavation reports are, in most cases, completed but unpublished: the so-called ‘grey literature’. A major research project, “Cultivating Societies: Assessing the Evidence for Agriculture in Neolithic Ireland”, was established to re-evaluate the nature, timing and extent of agricultural activity (Whitehouse *et al.* 2010, 2014). This paper presents the results of an analysis of the plant macro-remains, exploring changes between the earlier and later Neolithic. Further results are provided elsewhere, including comparison of data from Ireland and Europe, and analysis of the management of cultivation plots (McClatchie *et al.* 2014).

Methods of analysis

Archaeobotanical data were collated from 52 excavated sites (Figure 1), around two-thirds of which were unpublished at the time of collation. Cereals were recorded at a further 17 Neolithic sites (Figure 1), but excluded from analysis because final excavation reports were incomplete. As well as collating available radiocarbon dates, the ‘Cultivating Societies’ project undertook an extensive, targeted AMS ¹⁴C dating

programme, which provided 187 additional dates to refine site chronologies further (Whitehouse *et al.* 2014). The dates were obtained from short-lived species (mainly cereal grains and hazelnut shell, *Corylus avellana* L.). They were calibrated and modelled in OxCal (Bronk Ramsey 2008), using Bayesian statistics to improve precision. Based on these results and associated archaeological evidence, five chronological phases were defined: Early Neolithic (I & II), Middle Neolithic (I & II) and Late Neolithic (Table 1; Whitehouse *et al.* 2014). For the purposes of the present analysis, the Middle Neolithic II and Late Neolithic sites were combined due to the small number of sites available (five Middle Neolithic II, four Late Neolithic and two Middle Neolithic II/Late Neolithic). Where calibrated date ranges spanned different periods, sites were assigned to a broader Neolithic category (NEO). Analyses explored the frequency of different categories of plants across time and space, including the use of cumulative and summed radiocarbon calibrations (cf. Rick 1987) to investigate dated plant remains. For the purposes of quantification, three cereal grain fragments were counted as one whole grain. Assessment of grains per litre of soil could not be undertaken because very few reports recorded the volume of soil from each individual sample.

Category and chronology of sites

Data from plant macro-remains were available from a total of 437 samples from 390 contexts at 52 sites (Table 2; Online supplementary material Table S1). The 52 sites were recorded over the course of 47 excavations, most of which yielded material from a single chronological phase; two excavations produced evidence for multi-phase activity (Knowth and Lismullin), with each phase treated separately (see Table S1). The new ¹⁴C dating programme revealed that several sites contained later material that had become incorporated into Neolithic deposits (Table S1; Whitehouse *et al.* 2014). For example, plant remains dating to the early medieval and later periods were recorded within Neolithic deposits at Castletown Tara, Knowth, Tankardstown South, Kilgobbin and Lismullin. Additionally, Mesolithic deposits at Clowanstown contained plant remains dating to the Neolithic period. The presence of intrusive material underlines the importance of obtaining multiple ¹⁴C determinations when attempting to understand the chronology of Neolithic sites.

Archaeobotanical data were not obtainable from any Early Neolithic I sites, which reflects the paucity of sites dating to this period (Whitehouse *et al.* 2014).

Archaeobotanical data from a total of 28 Early Neolithic II sites were examined (Table 2), the majority of which were rectangular structures/houses. Pit and post-hole complexes, some of which probably represent the fragmentary remains of structures, dominated the 10 Middle Neolithic I sites examined (Table 2). Eleven sites were dated from the Middle Neolithic II to the Late Neolithic period (Table 2), including pit/post-hole complexes, structures and passage tombs. Three sites were assigned to the NEO period, as they could not be dated to any specific sub-period (Table 2). Plant remains were present in a wide variety of contexts (Figure 2). At the Early Neolithic II sites, they were mainly recorded in structural features, such as slot-trenches and post-holes. Plant remains were also recorded in pits, ditches, hearths and burnt mounds/troughs. At the Middle Neolithic I sites, most plant remains were recorded in pits and occasionally in structural features. Most plant remains at the Middle Neolithic II to Late Neolithic sites were found in structural features and pits, as well as in hearths, and turf layers and mound deposits associated with tombs. The vast majority of plant remains were preserved by charring. Waterlogged remains were recorded at just three sites: Clowanstown burnt mounds, turf layers at Newgrange passage tomb and ditch fills at Rathdooney Beg barrow.

Plant categories recorded

Several plant categories were recorded at the 52 examined sites. Hazelnut-shell remains were most common, being present at 87% of sites (45/52), closely followed by cereal remains, which were recorded at 77% (40/52). Fruit remains were present at approximately one-fifth of sites (19%; 10/52), dominated by crab-apple (*Malus sylvestris* L.) and bramble (*Rubus* spp.), with occasional evidence for elder (*Sambucus nigra* L.). Other wild plant remains were found at almost half of the examined sites (46%; 24/52); many appear to represent inadvertent harvesting of arable weeds growing alongside the cereals. Flax (*Linum usitatissimum* L.) remains were relatively rare, being recorded at only 4% of sites (2/52; including ¹⁴C-dated flax). Fabaceae seeds (pea family) were present at 2% of sites (1/52), but it is probable that these represent wild plants rather than cultivated legumes. Although pea (*Pisum sativum* L.) remains were found in a Neolithic deposit at Castletown Tara, ¹⁴C dating revealed that they were medieval (UBA-14682: 374±28 BP, cal AD 1447–1631). Analysis of the types of plants recorded during different time periods revealed interesting patterns (Figure 3). Cereals were present at 86% (24/28) and 90% (9/10) of

the Early Neolithic II and Middle Neolithic I sites, respectively. This contrasts sharply with evidence from the Middle Neolithic II to Late Neolithic sites, where cereals were recorded at only 36% of sites (4/11; two Middle Neolithic II sites and two Late Neolithic sites). Furthermore, none of the Middle Neolithic II to Late Neolithic cereals have been directly dated, and it is possible that at least some may reflect later activity at Neolithic sites. While the difference between earlier and later periods seems striking, formal statistical testing is not straightforward, because insufficient information is available on the number and volume of deposits sampled at each site, and it is possible that the pattern is influenced by differences in sampling strategies (discussed in greater detail below). Cumulative radiocarbon calibrations of directly dated cereal remains (Figure 4; S2) indicate that agriculture appeared simultaneously in all areas of Ireland during the Early Neolithic II period. Very few radiocarbon dates are available from either cereals or hazelnut shell during the later Neolithic (Figure 5). Hazelnut shell remains were commonly present at both the Early Neolithic II and Middle Neolithic I sites (93% or 26/28 Early Neolithic II sites; 90% or 9/10 Middle Neolithic I sites). During the Middle Neolithic II to Late Neolithic period, there was a decrease in the number of sites where nutshell remains were recorded (73% or 8/11 sites), although not as marked as that seen with cereals. Fruit remains were recorded at just under one-fifth of Early Neolithic II sites (5/28), absent from the Middle Neolithic I sites and present at just over one-third of the Middle Neolithic II to Late Neolithic sites (4/11). Remains of other wild plants were found at around half of all the Early Neolithic II and Middle Neolithic II to Late Neolithic sites (14/28, 6/11), but at just under one-third of the Middle Neolithic I sites (3/10). Flax was present at a small number of the Early Neolithic II sites (2/28) but absent from later deposits. A further discovery of flax, directly ¹⁴C-dated to the Middle Neolithic I, was reported at Tullahedy in County Tipperary, after the collation of data was completed (McClatchie 2011).

Many of the cereal remains from the Early Neolithic II sites were associated with rectangular structures. Cereals were most often found in the slot-trenches, but were also present in associated post-holes, post-pits, stake-holes and pits. Almost all of the Middle Neolithic I sites contained cereal remains, most often recovered from pit/post-hole complexes. In contrast, most of the Middle Neolithic II to Late Neolithic sites did not contain cereal remains. Where cereals were recorded, they were associated only

with structures/possible structures. Cereals were absent from the Middle Neolithic II to Late Neolithic burial sites and pit/post-hole complexes.

Where data were available, the number of cereal grains at each site was assessed (30 of the 40 sites where cereals were recorded). Most sites contained between 1 and 25 grains. Large cereal assemblages (more than 100 grains) were recorded at five sites, of which four were dated to Early Neolithic II (>400 grains from possible structure at Caherabbey Upper; >700 grains from rectangular house at Caw; >150 grains from burnt mounds at Clowanstown; >2100 grains from rectangular houses at Tankardstown South), with the fifth being a NEO site (>250 grains from cremation pit complex and other activity at Castletown Tara). The exact quantities were not reported for 10 sites where cereals were present, but re-analysis of the plant remains from Middle Neolithic I Baltinglass passage tomb has revealed another large cereal assemblage (>150 grains).

Cereal types present

The cereal remains consisted of wheat and barley (Figure 6). Wheat dominated at the Early Neolithic II sites, but barley was also recorded at just over half of these. Wheat again dominated at the Middle Neolithic I sites, with barley recorded at less than one-quarter of sites. Barley was found at slightly more of the Middle Neolithic II to Late Neolithic sites than wheat, but this is based on a very small number of sites (four), and may not be representative of cereal preferences during this later period. No geographical or environmental patterning is apparent in the occurrence of wheat and barley, but the lack of sites in western areas limits the reliability of this observation. Although oat was present at eight sites, ¹⁴C dating of the oat grains at two of these sites (Monanny and Lismullin) revealed that the grains were later intrusions rather than Neolithic. Oat remains have, however, been directly radiocarbon dated to the Early Neolithic at Balbridie in Scotland (Fairweather & Ralston 1993). Oat is unlikely to have been cultivated during the Neolithic period, instead reflecting wild oat as a weed of wheat and barley crops (Zohary *et al.* 2012).

Where identifiable beyond indeterminate wheat or barley, a variety of wheat and barley types were recorded, including emmer wheat (*Triticum dicoccum* Schübl.), possible einkorn wheat (*T. monococcum* L.), naked wheat (*T. aestivum/durum/turgidum* L.), hulled barley (*Hordeum vulgare* L.) and naked barley (*H. vulgare* L. var. *nudum*) (Figure 7). Emmer wheat was the dominant cereal type

during the Early Neolithic II and Middle Neolithic I periods. There are also a small number of records of naked wheat and possible einkorn wheat. It should be noted, however, that only grains from naked wheat and possible einkorn wheat were present; chaff rather than grain is a more reliable indicator of wheat species (Hillman *et al.* 1996). Naked barley was more commonly recorded than hulled barley during the Early Neolithic II period.

Turning to the Middle Neolithic II to Late Neolithic sites, although emmer wheat and naked wheat were both present, the small number of sites precludes determination of which wheat type was more important. In the case of naked wheat, chaff was again absent. Barley was present but not identified to type.

Variety of crops present

While cereals were recorded at the majority of examined sites, most individual sites contained evidence for only one crop type (wheat or barley; Figure 8). This trend was most noticeable at the Middle Neolithic I sites, where only 11% (1/9) of sites containing crops revealed evidence for more than one type. By contrast, more than one crop type was recorded at over 40% of the Early Neolithic II sites (10/24). It is notable that where barley was present, it was often a component of a mixed assemblage. Flax was similarly only recorded at sites where a variety of crops was present.

It is probable that the number of bulk soil samples analysed from each site has influenced the variety of crops recovered. Most sites do not have a record of the total number of samples analysed (i.e. the number of samples where plant remains were present and absent), but an assessment could be undertaken of the number of samples where plant remains were recorded. At sites where cereals were absent (Figure 9), only five or fewer samples at each site contained any type of non-wood plant macroremains. This was particularly apparent at the Middle Neolithic II to Late Neolithic sites; cereals were absent from many of these, but wild plants were also relatively rare, being present in very few deposits. This suggests that either plant-related activities were not significant at these sites or, more probably, that too few samples were taken to reflect plant use properly. Conversely, a wider variety of crops was more often found at sites where plant remains were present in a larger number of samples.

Discussion

The inclusion of unpublished sources along with published literature reveals a much larger quantity and variety of evidence than acknowledged in previous studies.

Cereals, hazelnut shells and fruits have, in fact, been found at many sites. Emmer wheat was the most important cereal, while barley (naked and hulled) and flax were also recorded. The earliest evidence for cereals was mainly associated with the Early Neolithic II rectangular houses. Although these rectangular houses were relatively short-lived, having been built and occupied for not more than a century (McSparron 2008; Whitehouse *et al.* 2014), agriculture persisted, continuing into the Middle Neolithic I period. There does appear to have been a significant shift in behaviour, however, from the Middle Neolithic II period, when both cereals and ‘domestic’ structures become rarer in the archaeological record. Interpreting this change is made difficult by the fact that rectangular houses are the most intensively sampled sites, and their disappearance provides us with far fewer well-sampled sites.

Although radiocarbon dates indicate that cereals were present across Ireland in the Early Neolithic II period, 3750–3600 cal BC (Figure 4), the geographical distribution of Irish sites containing cereals suggests an eastern and southern bias (Figures 1 & 4). It would be unwise to infer that this indicates early agriculture was focused on the eastern and southern seaboard, as this distribution is strongly influenced by the locations of recent infrastructural developments that involved large numbers of archaeological excavations. Fewer large-scale infrastructural projects have been carried out in western and northern areas of Ireland, which may explain why fewer Neolithic excavations have been undertaken there. Interestingly, the Irish pollen record reveals strong evidence for early agriculture around the north and west coasts of Ireland (Whitehouse *et al.* 2014). When combined, the plant macro-remains and palynological evidence indicate that farming activities were probably carried out in all coastal areas of the island. In contrast, sites in the Irish midlands often show rather muted or unclear anthropogenic signals in their pollen records (Selby *et al.* 2005), suggesting limited landscape use by farming communities. This corresponds with archaeological evidence, as there are relatively few Early Neolithic II sites in the midlands, despite the completion of many modern infrastructural projects in the region (Whitehouse *et al.* 2014).

The earliest cereal macro-remains in Ireland date to the Early Neolithic II period, suggesting that arable farming was not firmly established until *c.* 3750 cal BC,

although there are occasional examples where the date ranges extend earlier (Figure 4; S2). The absence, thus far, of cereal remains from the Early Neolithic I period is significant. The earliest evidence for domesticated animal remains in Ireland has been found at Ferriter's Cove, County Kerry, where cattle bone was dated to the mid-fifth millennium cal BC, thus pre-dating the Neolithic by some centuries (Woodman *et al.* 1999). No further secure records (that do not suffer from large age ranges) of early domesticated animal remains have been uncovered, and thus Ferriter's Cove may represent an early phase of contact, 'failed' colonisation or simply the remains of a joint of meat transported over to Ireland (Sheridan 2010; Rowley-Conwy 2011). During the Early Neolithic I period, there are rare examples of engagement with Neolithic practices; for example, the construction of Magheraboy causewayed enclosure, although dating of this site is potentially problematic, given how much earlier it is than similar enclosures across Britain (Cooney *et al.* 2011). More secure is the recent comprehensive dating and Bayesian modelling of human bone from the Poulabrone portal tomb, placing the beginning of deposition here firmly before 3750 cal BC (Schulting 2014). It was not until the Early Neolithic II period, however, that the full Neolithic 'package', including arable farming was embraced across Ireland. Due to a paucity of sites, the economic basis of the preceding Early Neolithic I period remains unclear and should be a focus for further research.

Cereals were mainly associated with the Early Neolithic II and Middle Neolithic I sites, having been recovered from over 85% of them. Early Neolithic II rectangular houses, Middle Neolithic I pit complexes and other 'domestic' features dominate among the sites where cereals were recorded. Sites that were not 'domestic' in character, such as Baltinglass passage tomb, also contained ¹⁴C-dated cereal remains, highlighting their use in many different locations and circumstances. Cereals were recorded in large quantities at several sites, emphasising the importance of agriculture to at least some communities. Even where cereals were recorded in small quantities, the significance of gaining access to this new food, and the importance of farming in developing new identities, and relationships should not be underestimated. It is the regularity, rather than the quantity, with which cereals are recorded from earlier sites that is more important, especially given the truncated nature of many sites. This regularity of appearance in many different contexts probably reflects daily, recurrent behaviour, instead of special activities (see Fuller *et al.* 2014).

Earlier Neolithic communities were creating a sense of place not only through the houses and tombs they built, but also through cultivation plots, which were long-lived rather than temporary. Analysis of the ecological attributes of arable weeds reveal that the earliest farmers in Neolithic Ireland, Britain and elsewhere in northern Europe were engaged in intensive management of relatively long-lived plots of at least 10 years (McClatchie *et al.* 2014). Considerable resources were invested in the creation and maintenance of plots, and when we also consider the evidence for widespread uptake of farming, we can surmise that agriculture had a significant impact on the daily lives of communities. This does not mean that people turned away from foraging, which continued to play a role, as evidenced by the recovery of hazelnut remains at many sites, as well as fruits and other edible and useful wild plants. Farming and foraging can be complementary components in food-procurement strategies. Nut- and fruit-producing trees and shrubs can quickly become established at the borders of ground cleared for arable plots, thereby creating, perhaps temporarily, a more productive and diverse food base. Such niches may also have been deliberately encouraged along hedgerows, in the corners of fields or in set-aside plots (Johnston 2005: 216).

Several European studies have highlighted an increase in the use of wild plants during the later Neolithic; for example, in southern Scotland (Bishop *et al.* 2009) and alpine areas of central Europe (Jacomet 2007). In the latter region, extensive waterlogged preservation has enabled recovery of a greater variety of Neolithic wild-plant foods than those found in charred assemblages (College & Conolly 2014). In the case of Ireland, a decrease in the incidence of hazelnut shell and an increase in fruit remains occurred during the Middle Neolithic II to Late Neolithic period (fruits were found at the same number of sites as cereals: 4/11 sites). The increase in fruit remains may reflect diversification in food strategies or an increase in suitable habitats for fruit procurement, such as increasingly open woodlands, and perhaps promotional strategies to encourage growth (Brozio *et al.* 2014; Whitehouse & Kirleis 2014).

One of the most remarkable aspects of the archaeobotanical record from later Neolithic Ireland relates to cereals. When compared with the earlier Neolithic (Early Neolithic II and Middle Neolithic I), cereals were present at very few of the Middle Neolithic II to Late Neolithic sites (only two Middle Neolithic II and two Late Neolithic sites). This may reflect changes in storage, cooking or housing facilities, which would affect the recovery of archaeobotanical remains, as has been argued for

in Spain (Antolín *et al.* 2015). Alternatively, the decrease may imply that cereals became less important during the Middle Neolithic II period; this situation may have continued into the Late Neolithic period. Indeed, Stevens and Fuller (2012) have argued that cereals were largely abandoned during the later Neolithic in parts of Britain, based on a paucity of directly dated cereal remains when compared with directly dated wild-plant remains. More recent analyses indicate, however, that arable agriculture continued to be an important activity in several regions of Scotland during the later Neolithic (Bishop 2015). The picture from Ireland is also somewhat more complex. While there are very few directly dated cereal remains from the later Neolithic, there are also very few directly dated wild-plant remains (Figure 5), providing a contrast with Stevens and Fuller's model.

The archaeobotanical evidence from Ireland does not support a clear-cut increase in gathered foods at the expense of cereals, and we cannot assume that there was a simple shift from cultivated to wild plant food strategies. Furthermore, the human stable carbon and nitrogen isotope data do not indicate any return to the use of marine foods along the coasts at this time (Schulting 2013), which one might expect had farming comprehensively 'failed'. The pollen data suggest a period of woodland regeneration, perhaps at the expense of agricultural land (Whitehouse *et al.* 2014), but this may not necessarily reflect increased pastoralism. Existing Irish data for animal bone (Schulting 2013) and pottery lipids (Cramp *et al.* 2014) have yet to provide a clear indication of maintained or increased pastoral activity when compared with the earlier Neolithic. It thus remains far from clear what the varying contribution of cultivars *vs* pastoral foods was at this time.

Conclusions

This study represents the most comprehensive investigation of plant macro-remains evidence from Neolithic Ireland to date. Cereals were present at many sites during the earlier Neolithic, sometimes in large quantities. Emmer wheat was the dominant crop, but barley was also recorded at many sites. Flax was a further component of early agriculture in Ireland, but cultivated legumes were not. Cereals were recorded mainly at house structures and pit complexes, but also at tombs and other 'non-domestic' locations. Analysis of arable weeds indicated that Ireland's earliest farmers created a sense of place and ownership by investing in fixed-plot intensive agriculture.

The picture from later Neolithic Ireland is far less clear. Plant remains have been found at only a small number of sites. The rarity of cereals may reflect a decrease in the importance of arable agriculture, but a corresponding shift towards wild plants should not be automatically assumed. The results of this study enable Ireland to be considered in more detail when exploring the introduction and development of agriculture in Neolithic Europe than has previously been possible due to the unpublished status of much of the data.

Acknowledgements

The work reported here was funded by the Heritage Council, Ireland, under the INSTAR programme 2008–2010 for the project ‘Cultivating Societies: Assessing the Evidence for Agriculture in Neolithic Ireland’ (Reference 16682 to Whitehouse, Schulting, Bogaard and McClatchie). We would like to express our thanks to our project partners, who provided invaluable advice and assistance: Jane Bunting (University of Hull); Finbar McCormick (QUB); Finola O’Carroll (CRDS Ltd, Republic of Ireland); Alison Sheridan (National Museums Scotland); Jessica Smyth (University of Cardiff); Rónán Swan (National Roads Authority); and Graeme Warren (UCD). The following archaeologists, archaeobotanists and organisations are thanked for discussions, and for providing access to Neolithic data and plant remains: ACS; ADS; Aegis Archaeology; AML Archaeology; Arthur ApSimon; Centre for Archaeological Fieldwork, QUB; James Conolly, Trent University; CRDS; Department of Archaeology, UCC; Catherine Dunne; Eachtra Archaeological Projects; Allan Hall, University of York; Rubicon Heritage; IAC; Judith Carroll Network Archaeology; Kilkenny Archaeology; Susan Lyons; Margaret Gowen; NAC; National Monuments Service; National Museum of Ireland; National Roads Authority; School of Archaeology, UCD; Stafford McLoughlin Archaeology; Stephen Shennan, UCL; TVAS Ireland; Ulster Museum; Valerie J. Keeley. We would finally like to thank the editors and reviewers of this paper for their helpful comments.

Online supplementary material

To view online supplementary material for this article, please visit

References

- ANTOLÍN, F., S. JACOMET & R. BUXÓ. 2015. The hard-knock life. Archaeobotanical data on farming practices during the Neolithic (5400–2300 cal BC) in the NE of the Iberian Peninsula. *Journal of Archaeological Science* 61: 90–104. <http://dx.doi.org/10.1016/j.jas.2015.05.007>
- BISHOP, R.R. 2015. Did Late Neolithic farming fail or flourish? A Scottish perspective on the evidence for Late Neolithic arable cultivation in the British Isles. *World Archaeology* 47: 834–55.
- BISHOP, R.R., M.J. CHURCH & P.A. ROWLEY-CONWY. 2009. Cereals, fruits and nuts in the Scottish Neolithic. *Proceedings of the Society of Antiquaries of Scotland* 135: 47–103.
- BRADLEY, R. 2007. *The prehistory of Britain and Ireland*. Cambridge: Cambridge University Press. <http://dx.doi.org/10.1017/CBO9780511618574>
- BRONK RAMSEY, C. 2008. Deposition models for chronological records. *Quaternary Science Reviews* 27: 42–60. <http://dx.doi.org/10.1016/j.quascirev.2007.01.019>
- BROZIO, J.P., W. DÖRFLER, I. FEESER, W. KIRLEIS, S. KLOOB & J. MÜLLER. 2014. A Middle Neolithic well from northern Germany: a precise source to reconstruct water supply management, subsistence economy, and deposition practices. *Journal of Archaeological Science* 51: 135–53. <http://dx.doi.org/10.1016/j.jas.2013.03.029>
- COLLEDGE, S. & J. CONOLLY. 2014. Wild plant use in European Neolithic subsistence economies: a formal assessment of preservation bias in archaeobotanical assemblages and the implications for understanding changes in plant diet breadth. *Quaternary Science Reviews* 101: 193–206. <http://dx.doi.org/10.1016/j.quascirev.2014.07.013>
- COLLEDGE, S., J.W. CONOLLY & S.J. SHENNAN. 2005. The evolution of Neolithic farming from SW Asian origins to NW European limits. *European Journal of Archaeology* 8: 137–56. <http://dx.doi.org/10.1177/1461957105066937>
- COONEY, G. 2000. *Landscapes of Neolithic Ireland*. London: Routledge.
- COONEY, G., A. BAYLISS, F. HEALY, A. WHITTLE, E. DANAHER, L. CAGNEY, J.P. MALLORY, J. SMYTH, T. KADOR & M. O’SULLIVAN. 2011. Ireland, in A. Whittle, F. Healy & A. Bayliss (ed.) *Gathering time: dating the Early Neolithic enclosures of southern Britain and Ireland*: 562–669. Oxford: Oxbow.
- CRAMP, L.J.E., J. JONES, A. SHERIDAN, J. SMYTH, H. WHELTON, J. MULVILLE, N. SHARPLES & R.P. EVERSLED. 2014. Immediate replacement of fishing with dairying

by the earliest farmers of the northeast Atlantic archipelagos. *Proceedings of the Royal Society B* 281: 20132372. <http://dx.doi.org/10.1098/rspb.2013.2372>

Cultivating societies n.d. Available at: <http://www.chrono.qub.ac.uk/instar> (accessed 9 December 2015)

EDMONDS, M. 1999. *Ancestral geographies of the Neolithic: landscape, monuments and memory*. London: Routledge.

FAIRWEATHER, A.D. & I.B.M. RALSTON. 1993. The Neolithic timber hall at Balbridie, Grampian region, Scotland: the building, the date, the plant macrofossils. *Antiquity* 67: 313–23.

FULLER D.Q., C.J. STEVENS & M. MCCLATCHIE. 2014. Routine activities, tertiary refuse and labor organization: social inferences from everyday archaeobotany, in M. Madella, C. Lancelotti & M. Savard (ed.) *Ancient plants and people: contemporary trends in archaeobotany*: 174–217. Tucson: University of Arizona Press.

GROGAN, E. 2002. Neolithic houses in Ireland: a broader perspective. *Antiquity* 76: 517–25. <http://dx.doi.org/10.1017/S0003598X00090645>

HILLMAN G.C., S. MASON, D. DE MOULINS & M. NESBITT. 1996. Identification of archaeological remains of wheat: the 1992 London workshop. *Circaea* 12: 195–209.

JACOMET, S. 2007. Neolithic plant economies in the northern alpine foreland from 5500–3500 cal BC, in S. Colledge & J. Conolly (ed.) *The origins and spread of domestic plants in southwest Asia and Europe*: 221–58. Walnut Creek (CA): Left Coast.

JOHNSTON, R. 2005. A social archaeology of garden plots in the Bronze Age of northern and western Britain. *World Archaeology* 37: 211–23. <http://dx.doi.org/10.1080/00438240500094853>

JONES, G. & P. ROWLEY-CONWY. 2007. On the importance of cereal cultivation in the British Neolithic, in S. Colledge & J. Conolly (ed.) *The origins and spread of domestic plants in southwest Asia and Europe*: 391–419. Walnut Creek (CA): Left Coast.

MCCLATCHIE, M. 2011. Analysis of non-wood plant macro-remains, in R.M. Cleary & H. Kelleher (ed.) *Archaeological excavations at Tullahedy, County Tipperary: Neolithic settlement in north Munster*: 162–85. Cork: Collins.

– In press. Cultivating societies: assessing the evidence for cereal remains in Neolithic Ireland, in M. McClatchie, N.J. Whitehouse & R.J. Schulting (ed.) *Living landscapes: exploring Neolithic Ireland and its wider context*.

- MCCLATCHIE M., A. BOGAARD, S. COLLEDGE, N.J. WHITEHOUSE, R.J. SCHULTING, P. BARRATT & T.R. MCLAUGHLIN. 2014. Neolithic farming in north-western Europe: archaeobotanical evidence from Ireland. *Journal of Archaeological Science* 51: 206–15. <http://dx.doi.org/10.1016/j.jas.2012.10.022>
- MCSPARRON, C. 2008. Have you no homes to go to? *Archaeology Ireland* 22(3): 18–21.
- MONK, M.A. 2000. Seeds and soils of discontent: an environmental archaeological contribution to the nature of the Early Neolithic, in A. Desmond, G. Johnson, M. McCarthy, J. Sheehan & E. Shee Twohig (ed.) *New agendas in Irish prehistory: papers in commemoration of Liz Anderson*: 67–87. Bray: Wordwell.
- RICK, J.W. 1987. Dates as data: an examination of the Peruvian preceramic radiocarbon record. *American Antiquity* 52: 55–73. <http://dx.doi.org/10.2307/281060>
- ROWLEY-CONWY, P. 2011. Westward Ho! The spread of agriculturalism from central Europe to the Atlantic. *Current Anthropology* 52(S4): S431–51. <http://dx.doi.org/10.1086/658368>
- SCHULTING, R.J. 2013. On the northwestern fringes: earlier Neolithic subsistence in Britain and Ireland as seen through faunal remains and stable isotopes, in S. Colledge, J. Conolly, K. Dobney, K. Manning & S. Shennan (ed.) *The origins and spread of stock-keeping in the Near East and Europe*: 313–38. Walnut Creek (CA): Left Coast.
- 2014. The dating of Poulnabrone, Co. Clare, in A. Lynch (ed.) *Poulnabrone: an early Neolithic portal tomb in Ireland*: 93–113. Dublin: Wordwell.
- SELBY, K.A., C.E. O'BRIEN, A.G. BROWN & I. STUIJTS. 2005. A multi-proxy study of Holocene lake development, lake settlement and vegetation history in central Ireland. *Journal of Quaternary Science* 20: 147–68. <http://dx.doi.org/10.1002/jqs.891>
- SHERIDAN, A. 2010. The Neolithization of Britain and Ireland: the 'big picture', in B. Finlayson & G. Warren (ed.) *Landscapes in transition*: 89–105. Oxford: Oxbow.
- SMYTH, J. 2014. *Settlements in the Irish Neolithic: new discoveries on the edge of Europe* (Prehistoric Society Research Papers 6). Oxford: Oxbow.
- STEVENS, C.J. & D.Q. FULLER. 2012. Did Neolithic farming fail? The case for a Bronze Age agricultural revolution in the British Isles. *Antiquity* 86: 707–22. <http://dx.doi.org/10.1017/S0003598X00047864>
- THOMAS, J. 2003. Thoughts on the 'repacked' Neolithic revolution. *Antiquity* 77: 67–74. <http://dx.doi.org/10.1017/S0003598X00061354>

- 2008. The Mesolithic–Neolithic transition in Britain, in J. Pollard (ed.) *Prehistoric Britain*: 58–89. Oxford: Blackwell.
- WHITEHOUSE, N.J. & W. KIRLEIS. 2014. The world reshaped: practices and impacts of early agrarian societies. *Journal of Archaeological Science* 51: 1–11.
<http://dx.doi.org/10.1016/j.jas.2014.08.007>
- WHITEHOUSE, N.J., M. MCCLATCHIE, P. BARRATT, R. SCHULTING, T.R. MCCLAUGHLIN & A. BOGAARD. 2010. INSTAR—Cultivating societies. *Archaeology Ireland* 24: 16–19.
- WHITEHOUSE, N.J., R.J. SCHULTING, M. MCCLATCHIE, P. BARRATT, T.R. MCCLAUGHLIN, A. BOGAARD, S. COLLEDGE, R. MARCHANT, J. GAFFREY, P. REIMER & M.J. BUNTING. 2014. Neolithic agriculture on the European western frontier: the boom and bust of early farming in Ireland. *Journal of Archaeological Science* 51: 181–205. <http://dx.doi.org/10.1016/j.jas.2013.08.009>
- WOODMAN, P.C., E. ANDERSON & N. FINLAY. 1999. *Excavations at Ferriter's Cove, 1983–95: last foragers, first farmers in the Dingle Peninsula*. Bray: Wordwell.
- ZOHARY, D., M. HOPF & E. WEISS. 2012. *Domestication of plants in the Old World*. Oxford: Oxford University Press.
<http://dx.doi.org/10.1093/acprof:osobl/9780199549061.001.0001>

Figures

Figure 1. Map of Ireland showing locations of sites with plant remains.

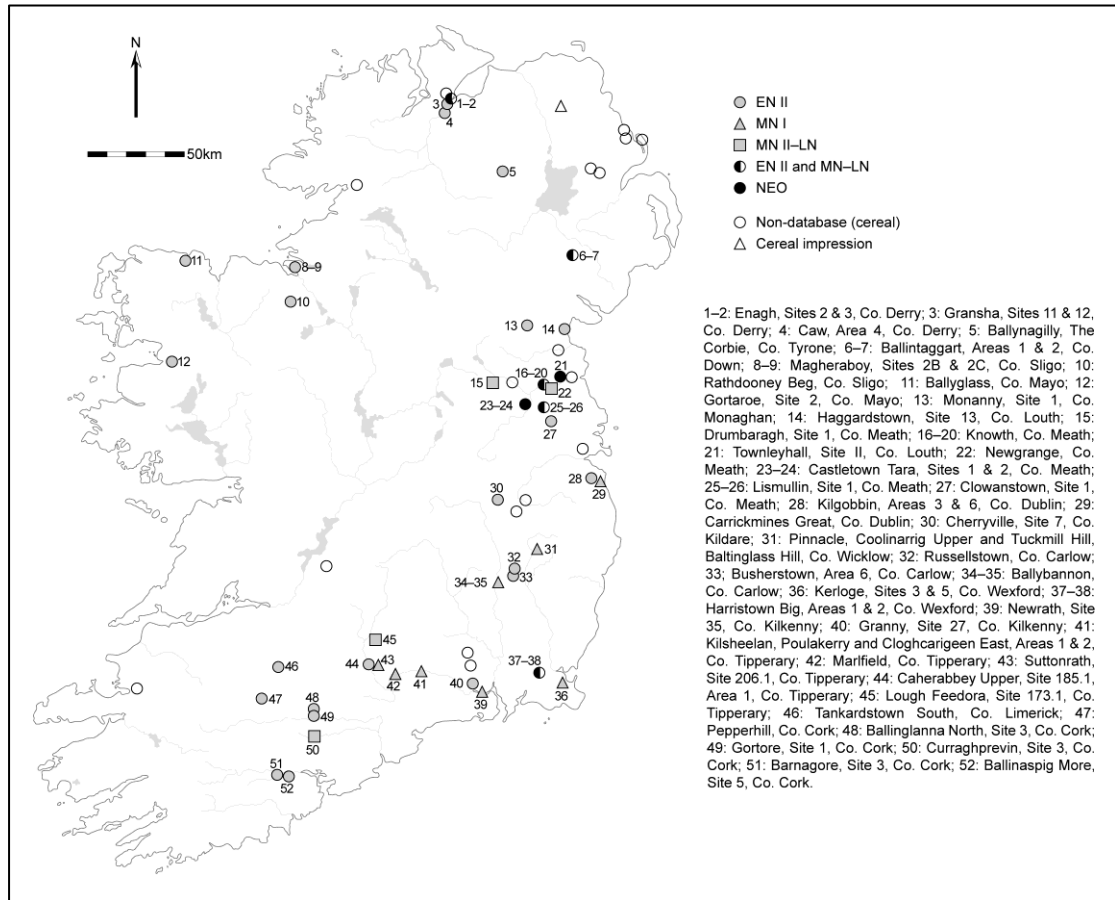


Figure 2. Relative occurrence of contexts containing plant remains at Early Neolithic II, Middle Neolithic I and Middle Neolithic II to Late Neolithic sites (contexts $n = 372$; sites $n = 49$).

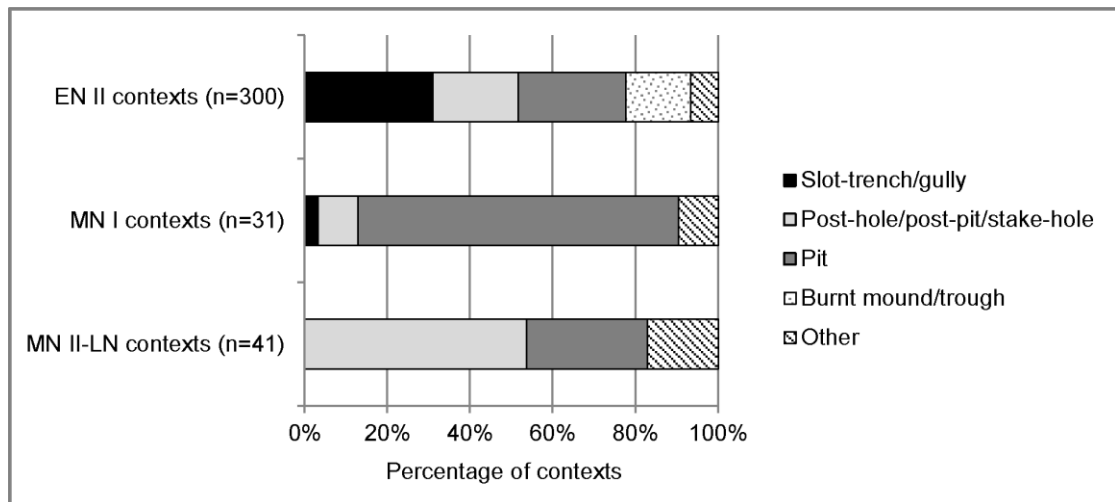


Figure 3. Relative occurrence of plant categories at Early Neolithic II, Middle Neolithic I and Middle Neolithic II to Late Neolithic sites (sites n = 49).

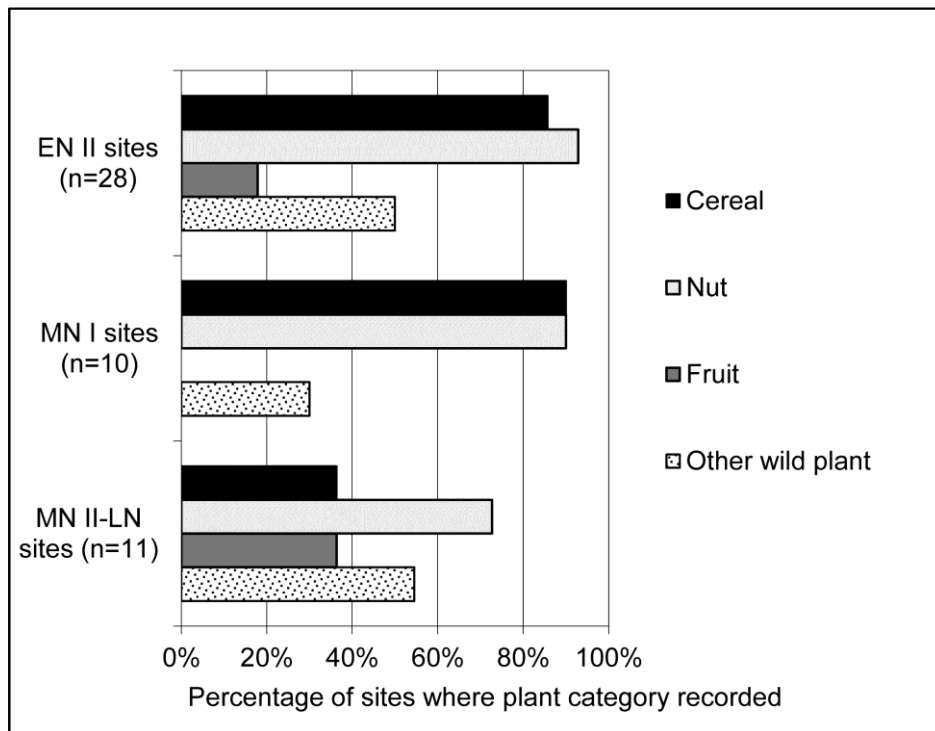


Figure 4. Cumulative ^{14}C dates from cereal grains at Irish Neolithic sites (dates n = 158; east sites n = 75; north sites n = 30; south sites n = 51; west sites n = 2).

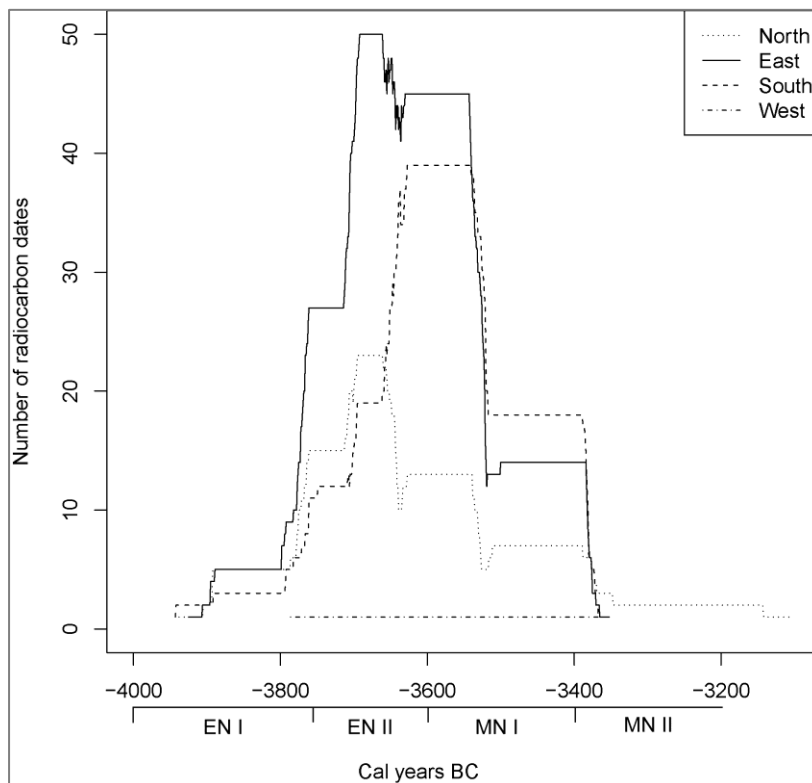


Figure 5. Summed probabilities of ^{14}C dates from cereal grains and hazelnut shell at Irish Neolithic sites (cereal dates $n = 158$, hazelnut shell dates $n = 154$).

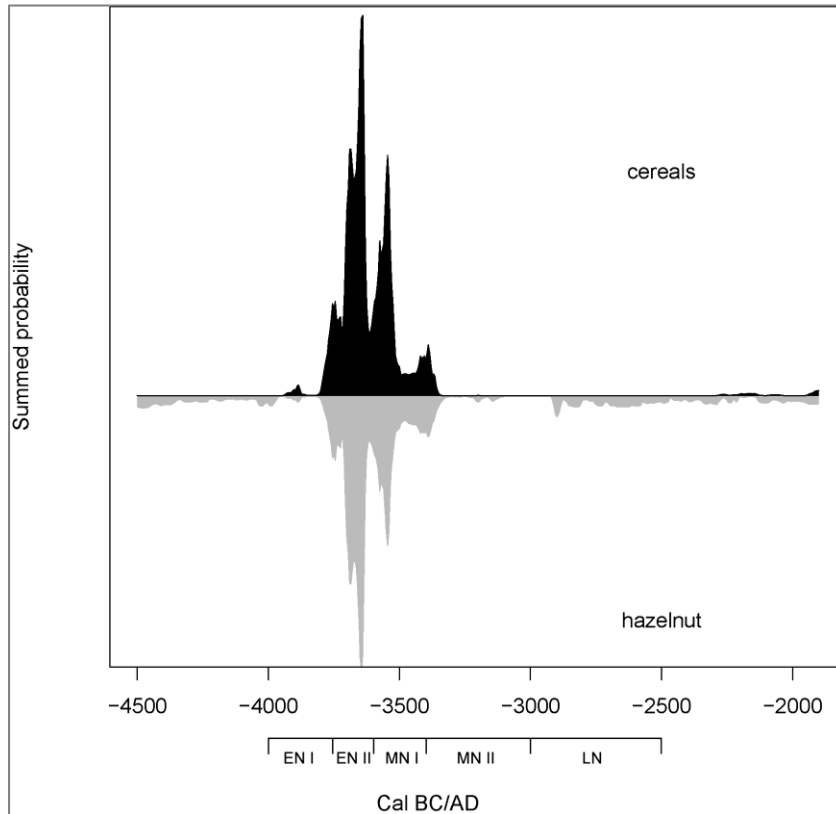


Figure 6. Relative occurrence of wheat and barley at Early Neolithic II, Middle Neolithic I and Middle Neolithic II to Late Neolithic sites where cereals present (sites $n = 37$).

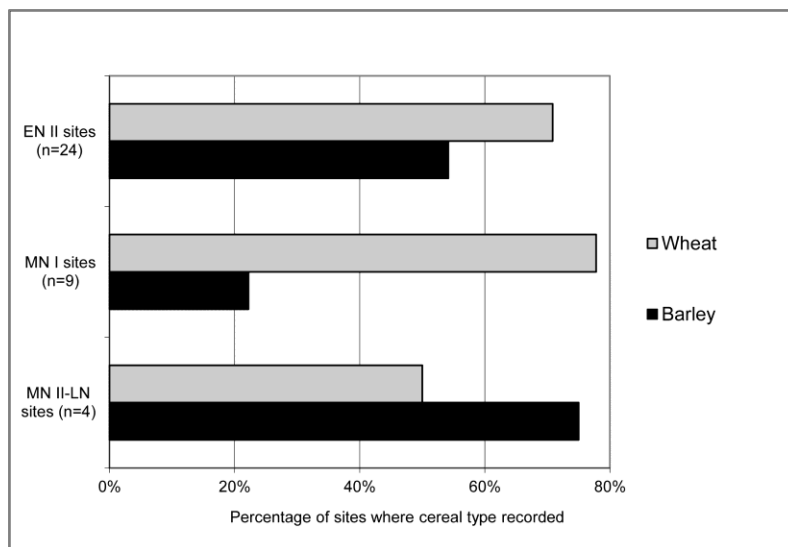


Figure 7. Relative occurrence of cereal types at Early Neolithic II, Middle Neolithic I and Middle Neolithic II to Late Neolithic sites where cereals present (sites n = 37).

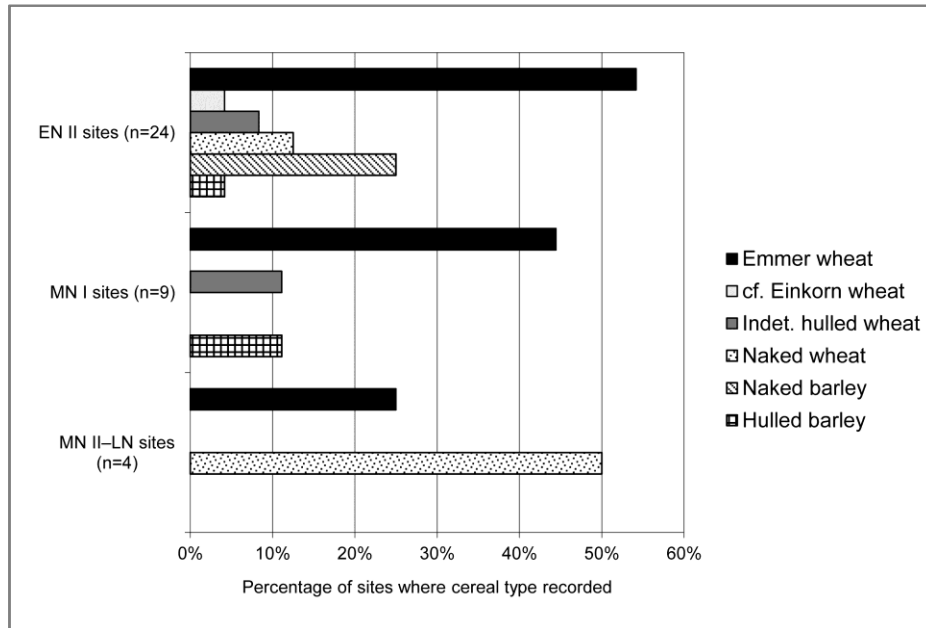


Figure 8. Relative occurrence of crops at Early Neolithic II, Middle Neolithic I and Middle Neolithic II to Late Neolithic sites where cereals present; sites n = 37).

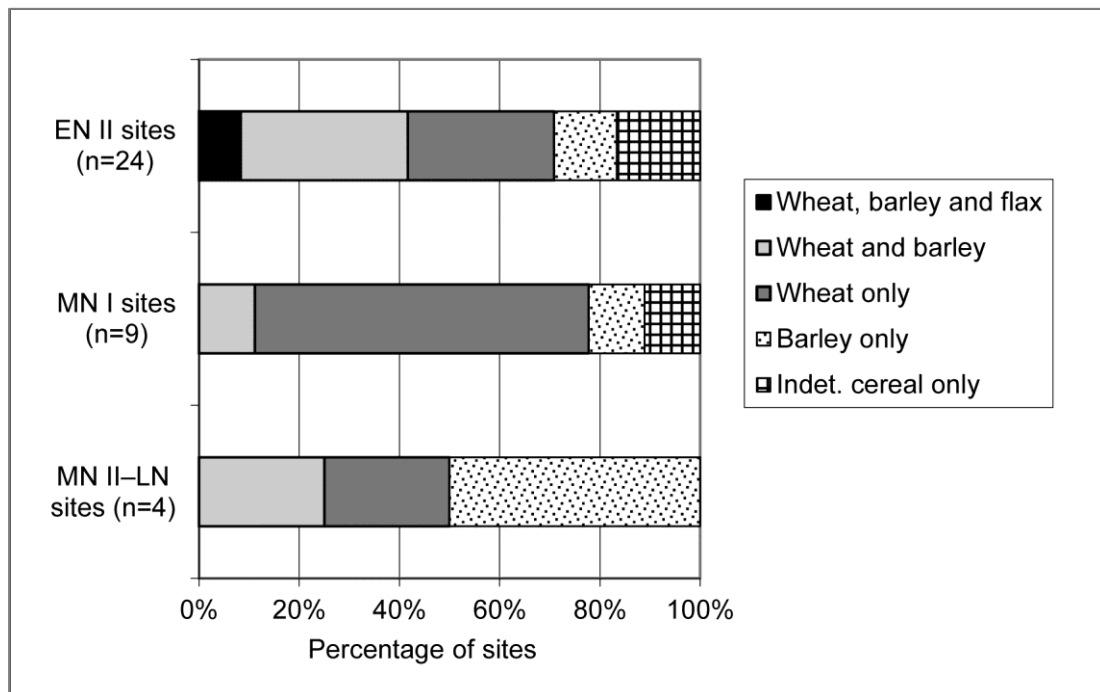


Figure 9. Relative occurrence of crops examined by number of soil samples from an individual site (sites n = 52).

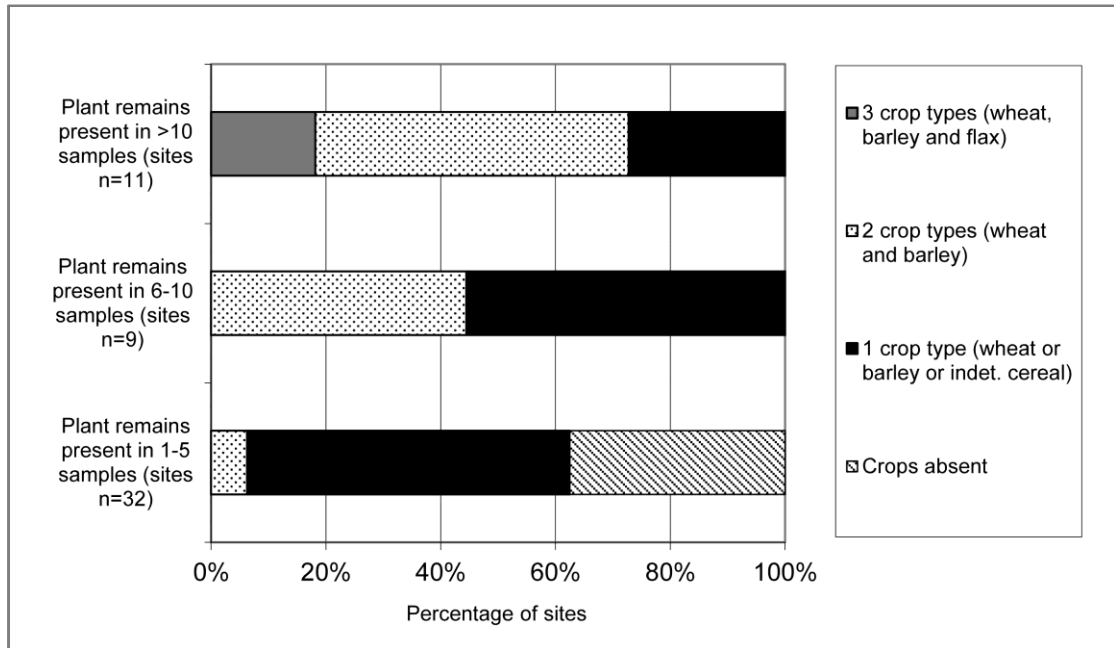


Table 1. Chronology of the Neolithic in Ireland

Period	Date range	
Early Neolithic	I	4000–3750 cal BC
	II	3750–3600 cal BC
Middle Neolithic	I	3600–3400 cal BC
	II	3400–3000 cal BC
Late Neolithic	3000–2500 cal BC	

Table 2. Types of site where archaeobotanical remains were recorded.

Period	No. sites	Types of sites
Early Neolithic I	28	17 rectangular structures or ‘houses’ (single and multiple),
Neolithic II		3 pit complexes, 3 non-rectangular structures, 1 causewayed enclosure (2 sites), 1 barrow, 2 burnt mounds
Middle Neolithic I	10	7 pit/post-hole complexes, 2 structures, 1 passage tomb
Middle Neolithic II to Late Neolithic	11	5 pit/post-hole complexes, 4 structures, 2 passage tombs
NEO	3	1 cremation pit complex and settlement, 1 structure, 1 palisade

Table S1. Locations, chronology and references for sites with recorded plant remains from Neolithic Ireland; see also the Cultivating Societies project website (Cultivating societies n.d.) to access a version of the archaeobotanical database

Figure 1	County	Townland/ Site name	Chronology	References	Notes
1, 2	Londonderry	Enagh, Sites 2 & 3	EN II, MN II	MCSPARRON, C. 2003. The excavation of a Neolithic house and other structures at Enagh, Co. Derry. <i>Ulster Journal of Archaeology</i> 62: 1–15.	
3	Londonderry	Gransha, Sites 11 & 12	EN II	CHAPPLE, R.M. 2008. The excavation of Early Neolithic and Early Bronze Age sites at Oakgrove, Gransha, County Londonderry. <i>Ulster Journal of Archaeology</i> 67: 22–59.	
4	Londonderry	Caw, Area 4	EN II	BOWEN, P. 2007. Archaeological excavations at Caw, Waterfoot, Co. Derry. Report prepared for ADS Ltd.	
5	Tyrone	Ballynagilly, The Corbie	EN II	APSIMON, A. 1969. An Early Neolithic house in Co. Tyrone. <i>Journal of the Royal Society of Antiquaries of Ireland</i> 99: 165–68. – 1971. Ballynagilly. <i>Current Archaeology</i> 24: 11–13. – 1976. Ballynagilly and the beginning and end of the Irish Neolithic, in S.J. de Laet (ed.) <i>Acculturation and continuity in Atlantic Europe mainly during the Neolithic period and Bronze Age</i> : 15–30. Brugge: De Tempel.	
6, 7	Down	Ballintaggart, Areas 1 & 2	EN II, LN	CHAPPLE, R.M., C. DUNLOP, S. GILMORE & L. HEANEY. 2009. <i>Archaeological investigations along the A1 Dualling Scheme, Loughbrickland to Beech Hill, Co. Down, N. Ireland (2005)</i> (British Archaeological Reports British series 479). Oxford: British Archaeological Reports.	
8, 9	Sligo	Magheraboy, Sites 2B & 2C	EN II	DANAHER, E. & L. CAGNEY. 2005. Report on the archaeological excavation of an Early Neolithic causewayed enclosure at Area 2C, Magheraboy, Sligo. Excavation report prepared for ACS Ltd. DANAHER, E. 2007. <i>Monumental beginnings: the archaeology of the N4 Sligo Inner Relief Road</i> (NRA Scheme Monographs 1). Dublin: National Roads Authority. O NEILL, T. 2005. Report on the archaeological excavation of an Early Medieval enclosure and Early Neolithic enclosure ditch with associated features at Area 2B, Magheraboy, Sligo. Report prepared for ACS Ltd.	Two excavations undertaken at this site. EN I 14C dates are associated with the ditch at Magheraboy (based upon charcoal). The non-wood plant macro-remains were recovered only from the interior of the causewayed enclosure, where activity was dated to the EN II period.
10	Sligo	Rathdooney Beg	EN II	MOUNT, C. 1999. Excavation and environmental analysis of a Neolithic mound and Iron Age barrow cemetery at Rathdooney Beg, County Sligo, Ireland. <i>Proceedings of the Prehistoric Society</i> 65: 337–71.	

11	Mayo	Ballyglass	EN II	Ó NUALLÁIN, S. 1972. A Neolithic house at Ballyglass, near Ballycastle, Co. Mayo. <i>Journal of the Royal Society of Antiquaries of Ireland</i> 102: 49–57. Ó NUALLÁIN, S. & S. GREENE. In press. <i>Excavation of the centre-court tomb and underlying house site at Ballyglass, Co. Mayo</i> (Seandálaíocht Monograph 3). Dublin: University College Dublin, School of Archaeology.	
12	Mayo	Gortaroe, Site 2	EN II	GILLESPIE, R. 2002. Neolithic house at Gortaroe, Westport, Co. Mayo. <i>Archaeology Ireland</i> 16: 7.	
13	Monaghan	Monanny, Site 1	EN II	WALSH, F. 2009. N2 Carrickmacross-Aclint road re-alignment, Site 110: Monanny 1, final report. Report prepared for IAC Ltd.	Oat grains 14C dated to the post-medieval period.
14	Louth	Haggardstown, Site 13	EN II	McLOUGHLIN, G. 2009. Archaeological excavation at Haynestown-Haggardstown, Dundalk, Co. Louth, Site 13: Haggardstown. Report prepared for IAC Ltd.	
15	Meath	Drumbaragh, Site 1	LN	DANAHER, E. & R. O'HARA. 2008. Report on the archaeological excavation of Drumbaragh 1, Co. Meath. Report prepared for ACS Ltd.	
16, 17, 18, 19, 20	Meath	Knowth	EN II, MN II, LN, NEO	EOGAN, G. 1984. <i>Excavations at Knowth 1: smaller passage tombs, Neolithic occupation and Beaker activity</i> . Dublin: Royal Irish Academy. – 1991. Prehistoric and Early Historic culture change at Brugh na Bóinne. <i>Proceedings of the Royal Irish Academy</i> 91C: 105–32. EOGAN, G., H. ROCHE. 1997. <i>Excavations at Knowth 2: settlement and ritual sites of the fourth and third millennia BC</i> . Dublin: Royal Irish Academy. EOGAN, G., H. ROCHE. 1998. Further habitation evidence for Neolithic habitation at Knowth, Co. Meath. <i>Ríocht na Midhe</i> 9: 1–9.	Early Western Neolithic Complex: new "Cultivating societies" dates revealed that cereals from this site dated to both the EN II and early medieval/medieval periods. Grooved Ware Complex: cereals from this site dated as part of the "Cultivating societies" project were not Neolithic (instead reflecting later activity), but the dated wild plant remains were confirmed LN; further 14C dating is required to establish if any of the cereals from this site are actually Neolithic. Later Western Neolithic Complex: this multiple palisade is the only examined site that has not been directly 14C dated. Given the site's location, stratigraphy and artefactual assemblage, however, it has been assigned to the NEO category.

21	Louth	Townleyhall, Site II	NEO	EOGAN, G. 1963. A Neolithic habitation-site and megalithic tomb in Townleyhall Townland, Co. Louth. <i>Journal of the Royal Society of Antiquaries of Ireland</i> 93: 37–81. GROGAN E. 1991. Appendix: Radiocarbon dates from Brugh na Bóinne, 126-132, in G. Eogan, Prehistoric and Early Historic culture change at Brugh na Bóinne. <i>Proceedings of the Royal Irish Academy</i> 91C: 105–32.	The 14C date range from this site spans more than 800 years (BM-170: 4680±150 BP, 3774–2944 cal BC). This sites is therefore considered under the NEO category.
22	Meath	Newgrange	MN II	O'KELLY, M.J. 1982. <i>Newgrange: archaeology, art and legend</i> . London: Thames and Hudson.	
23, 24	Meath	Castletown Tara, Sites 1 & 2	LN, NEO	ELDER, S.D. 2009. Report on the archaeological excavation of Castletown Tara 1, Co. Meath. Report prepared for ACS Ltd. ELDER, S.D. 2009. Report on the archaeological excavation of Castletown Tara 2, Co. Meath. Report prepared for ACS Ltd.	Castletown Tara, Site 1: Previous 14C dates indicated LN activity; new "Cultivating societies" dates indicate that MN I activity was also taking place at this location. The date for this site has therefore been reassigned as NEO. New "Cultivating societies" dates also revealed the presence of early medieval/medieval cereals. Pea remains were also dated to the medieval period (UBA-14682: 374±28 BP, cal AD 1447–1631).
25, 26	Meath	Lismullin, Site 1	EN II, MN I	O'CONNELL, A. 2009. Report on the archaeological excavation of Lismullin 1, Co. Meath. Report prepared for ACS Ltd.	Cereals from MNI deposits at this site that were dated as part of the "Cultivating societies" project were not Neolithic (instead reflecting later activity), but the dated wild plant remains were confirmed as MN I; further 14C dating is required to establish if any of the cereals from MN I deposits at this site are actually Neolithic. Oat grains proved to be early medieval (UBA-14784: 1077±23 BP, cal AD 896–1017).

27	Meath	Clowanstown , Site 1	EN II	MOSSOP, M. & E. MOSSOP. 2009. Report on the archaeological excavation of Clowanstown 1, Co. Meath. Report prepared for ACS Ltd.	New "Cultivating societies" dates revealed that Mesolithic deposits at this site contained EN II cereals. The presence of definite EN II flax at Clowanstown 1, Co. Meath, as established by the "Cultivating societies" dating programme (UBA-14733: 5003±32 BP, 3942–3701 cal BC), is the earliest definite plant macro-remains evidence for flax in Ireland
28	Dublin	Kilgobbin, Areas 3 & 6	EN II	HAGEN, I. 2004. Archaeological excavations interim report, Phase 3 development, Kilgobbin, Co. Dublin. Excavation report prepared for Margaret Gowen & Co. Ltd.	New "Cultivating societies" dates revealed that cereals dated to EN II and early medieval/medieval periods.
29	Dublin	Carrickmines Great	MN I	Ó DRISCEOIL, C. 2006. A Neolithic disc-bead necklace from Carrickmines Great, Co. Dublin. <i>Journal of the Royal Society of Antiquaries of Ireland</i> 136: 141–56.	
30	Kildare	Cherryville, Site 7	EN II	BREEN, T. 2008. Kildare Town Bypass: archaeological resolution of a burnt spread, final report, 01E0479, Site 7, Cherryville Townland, Co. Kildare. Report prepared for Valerie J. Keeley Ltd.	
31	Wicklow	Pinnacle, Coolinarrig Upper and Tuckmill Hill, Baltinglass Hill	MN I	WALSHE, P.T. 1941. The excavation of a burial cairn on Baltinglass Hill, Co. Wicklow. <i>Proceedings of the Royal Irish Academy</i> 46C: 221–36.	Baltinglass tomb. Activity at this site spans the Neolithic period. New "Cultivating societies" dating of cereal remains indicates that they are MN I in date (UBA-14812: 4718±26 BP, 3632–3376 cal BC; UBA-14813: 4729±27 BP, 3635–3377 cal BC).
32	Carlow	Russellstown	EN II	O'CONNELL, T. J. 2009. Final Report on archaeological investigations at Site E2571, in the townland of Russellstown, Co. Carlow. Excavation report prepared for Headland Archaeology Ltd.	
33	Carlow	Busherstown , Area 6	EN II	O'NEILL, N. 2009. Final Report on archaeological investigations, NMS Number E2581, in the townland of Busherstown, Co. Carlow. Excavation report prepared for Headland Archaeology Ltd.	

34, 35	Carlow	Ballybannon	MN I	BREEN, G., D. KOZLOWSKA & L. CLARK. 2009. Final report on archaeological investigations at site E2612, in the townland of Ballybannon, Co. Carlow. Report prepared for Headland Archaeology Ltd. O'CONNELL, T.J. 2009. Final report on archaeological investigations at Site E2610, in the townland of Ballybannon, Co. Carlow. Report prepared for Headland Archaeology Ltd.	
36	Wexford	Kerloge, Sites 3 & 5	MN I	McLOUGHLIN, C. 2003. Kerloge, Co. Wexford, 02E0606. Report prepared for Stafford McLoughlin Archaeology.	
37, 38	Wexford	Harristown Big, Areas 1 & 2	EN II, MN II-LN	TIERNEY, M. & P. JOHNSTON. 2006. Final excavation report, Harristown Big, N25 Harristown to Rathskillagh, Co. Wexford. Report prepared for Eachtra Archaeological Projects Ltd.	Charcoal from this site produced an EN I date (Beta-219134: 5150±50 BP, 4046–3799 cal BC), but may reflect the old-wood effect. The site is more likely to date to the EN II period.
39	Kilkenny	Newrath, Site 35	MN I	WILKINS, B. 2006. Final report on archaeological investigations at Site 35 in the townland of Newrath, Co Kilkenny. Report prepared for Headland Archaeology Ltd.	
40	Kilkenny	Granny, Site 27	EN II	HUGHES, J. 2006. Final report on archaeological investigations at Sites 24–30 in the townland of Granny, Co Kilkenny. Report prepared for Headland Archaeology Ltd.	
41	Tipperary	Kilsheelan, Poulakerry and Cloghcarrigeen East, Areas 1 & 2	MN I	DRUM, M. 2007. Archaeological excavation report: Poulakerry, Kilsheelan and Cloghcarrigeen East, Kilsheelan, Clonmel, Co. Tipperary. Report prepared for Eachtra Archaeological Projects Ltd.	
42	Tipperary	Marlfield	MN I	B. Withers (AML Archaeology), pers. comm.	
43	Tipperary	Suttonrath, Site 206.1	MN I	McQUADE, M. 2007. Final report at Suttonrath, N8 Cashel to Mitchelstown Road Improvement Scheme. Report prepared for Margaret Gowen & Co. Ltd.	
44	Tipperary	Caherabbey Upper, Site 185.1, Area 1	EN II	MOLLOW, B. 2007. Final report: Caherabbey Upper, Co. Tipperary. Report prepared for Margaret Gowen & Co. Ltd.	
45	Tipperary	Lough Feedora, Site 173.1	MN II	DOODY, M. 2008. Final report: Lough Feedora, Co. Tipperary. Report prepared for Margaret Gowen & Co. Ltd.	

46	Limerick	Tankardstown South	EN II	GOWEN, M. 1987. Tankardstown, Co. Limerick: a Neolithic house. <i>Archaeology Ireland</i> 1: 6-10. – 1988. House site, in M. Gowen (ed.), <i>Three Irish gas pipelines: new archaeological evidence in Munster</i> . 26–43. Dublin: Wordwell. GOWEN, M. & C. TARBETT. 1988. A third season at Tankardstown. <i>Archaeology Ireland</i> 2: 156.	New "Cultivating societies" dates revealed that cereals dated to EN II and early medieval/medieval periods. The earliest dated cereal grain from Ireland derives from Tankardstown South and was dated as part of the 'Cultivating Societies' project. The emmer wheat grain comes from a post-pit fill (C.35) in a rectangular house and was dated to 3942–3707 cal BC (UBA-14739: 5013±31 BP). It should be noted that another emmer wheat grain from the same deposit produced a date of 3760–3636 cal BC (UBA-14738: 4890±33 BP)
47	Cork	Pepperhill	EN II	GOWEN M. 1988. Structure and occupation site, in M. Gowen, <i>Three Irish gas pipelines: new archaeological evidence in Munster</i> . 44–51. Dublin: Wordwell.	
48	Cork	Ballinglanna North, Site 3	EN II	JOHNSTON, P. & J. TIERNEY. 2010. Archaeological excavation report: two Neolithic structures and two fulachta fiadh. Ballinglanna North 3, Co. Cork. Report prepared for Eachtra Archaeological Projects Ltd.	
49	Cork	Gortore, Site 1	EN II	O'DONOGHUE, J. 2006. Final excavation report of a Neolithic house at Gortore, N8 Rathcormac-Fermoy, Co. Cork. Report prepared for Eachtra Archaeological Projects Ltd.	
50	Cork	Curraghprevin, Site 3	MN II-LN	O NEILL, T. 2006. Final report on archaeological excavation of Curraghprevin 3. Report prepared for ACS Ltd.	
51	Cork	Barnagore, Site 3	EN II	DANAHER, E. 2003. A final report on the archaeological excavation of an Early Neolithic house and three Bronze Age pits at Barnagore, Ballincollig, Co. Cork (Licence No: 02E0384). Report prepared for ACS Ltd.	
52	Cork	Ballinaspig More, Site 5	EN II	DANAHER, E. & L. CAGNEY. 2004. Report on the archaeological excavation of a multi-phased site at Ballinaspig More 5, Ballincollig, Co. Cork. Report prepared for ACS Ltd.	

Table S2. Radiocarbon dates and site locations for directly dated cereal grains from Neolithic Ireland.

Lab. ID	Townland/Site name	North/South /East/ West (Figure 4)	OSI Easting	OSI Northings	Date BP	Error	Cal BC minimu m	Cal BC maximu m	Cereal grains dated
UBA-14739	Tankardstown South	S	158398	128236	5013	31	-3943	-3707	<i>Triticum dicoccum</i>
OxA-1476	Tankardstown South	S	158398	128236	4890	80	-3942	-3386	<i>Triticum cf. dicoccum</i>
UBA-14796	Monanny	N	284266	305232	5000	29	-3938	-3702	<i>Hordeum sp. (naked)</i>
UBA-14719	Clowanstown	E	295518	257771	4976	35	-3925	-3659	<i>Triticum cf. dicoccum</i>
UBA-14722	Clowanstown	E	295518	257771	4962	37	-3906	-3653	<i>Triticum cf. dicoccum</i>
UBA-14801	Haggardstown	N	305560	303090	4974	30	-3905	-3661	Cerealia
UBA-14805	Russellstown	E	278344	178957	4971	31	-3895	-3659	<i>Triticum cf. dicoccum</i>
UBA-14704	Corbally	E	285000	213000	4971	30	-3895	-3660	<i>Triticum sp.</i>
UBA-14657	Caw	N	245974	418232	4941	43	-3892	-3644	<i>Hordeum sp. (hulled)</i>
UBA-14656	Caw	N	245974	418232	4950	39	-3892	-3649	<i>Triticum /Hordeum sp.</i>
UBA-14780	Tankardstown South	S	158398	128236	4952	38	-3891	-3651	<i>Triticum dicoccum</i>
UBA-14690	Corbally	E	285000	213000	4968	30	-3889	-3661	<i>Triticum sp.</i>
UBA-14787	Cherryville	E	268661	211680	4968	29	-3798	-3661	<i>Hordeum sp.</i>
GrA-13697	Corbally	E	285000	213000	4910	50	-3798	-3542	<i>Triticum sp.</i>
UBA-14725	Clowanstown	E	295518	257771	4935	42	-3794	-3644	<i>Triticum cf. dicoccum</i>
OxA-1477	Tankardstown South	S	158398	128236	4840	80	-3793	-3377	<i>Triticum cf. dicoccum</i>
UBA-14737	Tankardstown South	S	158398	128236	4958	30	-3792	-3659	<i>Triticum dicoccum</i>
GrA-13700	Corbally	E	285000	213000	4900	50	-3792	-3539	<i>Triticum sp.</i>
UB-8571	Ballyglass	W	109633	338193	4948	32	-3786	-3655	Cerealia
UBA-14800	Haggardstown	N	305560	303090	4949	30	-3786	-3656	<i>Triticum dicoccum</i>
UBA-14742	Tankardstown South	S	158398	128236	4947	30	-3782	-3656	Cerealia
UBA-14729	Clowanstown	E	295518	257771	4947	30	-3782	-3656	<i>Triticum cf. dicoccum</i>
UBA-13078	Ballintaggart	N	310953	340311	4919	40	-3778	-3642	<i>Triticum sp.</i>
UBA-14653	Caw	N	245974	418232	4920	39	-3777	-3642	<i>Triticum cf. dicoccum</i>
UBA-14721	Clowanstown	E	295518	257771	4939	30	-3777	-3653	<i>Triticum cf. dicoccum</i>
GrA-13702	Corbally	E	285000	213000	4880	50	-3777	-3534	<i>Triticum sp.</i>
GrN-24212	Corbally	E	285000	213000	4885	45	-3776	-3537	Unknown
UBA-14794	Monanny	N	284266	305232	4935	30	-3775	-3652	<i>Triticum dicoccum</i>
UBA-14795	Monanny	N	284266	305232	4941	28	-3775	-3655	<i>Triticum dicoccum</i>
UBA-14728	Clowanstown	E	295518	257771	4926	33	-3772	-3648	<i>Triticum cf. dicoccum</i>
UBA-14703	Corbally	E	285000	213000	4934	28	-3772	-3653	<i>Triticum sp.</i>
UBA-14683	Granny	E	257840	115440	4926	33	-3772	-3648	<i>Triticum sp.</i>
UBA-14797	Monanny	N	284266	305232	4939	26	-3771	-3656	Cerealia

UBA-14743	Tankardstown South	S	158398	128236	4923	33	-3771	-3647	<i>Triticum</i> sp.
UBA-14731	Clowanstown	E	295518	257771	4923	31	-3768	-3648	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14651	Caw	N	245974	418232	4907	39	-3767	-3640	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14686	Granny	E	257840	115440	4918	32	-3766	-3645	Cerealialia
UBA-14684	Granny	E	257840	115440	4911	32	-3766	-3642	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14740	Tankardstown South	S	158398	128236	4899	37	-3766	-3637	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14712	Corbally	E	285000	213000	4918	30	-3766	-3646	<i>Triticum</i> sp.
UBA-14654	Caw	N	245974	418232	4880	39	-3764	-3539	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14702	Corbally	E	285000	213000	4914	30	-3764	-3644	<i>Triticum</i> <i>dicoccum</i>
UBA-14655	Caw	N	245974	418232	4880	39	-3764	-3539	<i>Triticum</i> sp.
UBA-14687	Corbally	E	285000	213000	4893	34	-3762	-3637	cf. <i>Triticum</i> sp.
UBA-14730	Clowanstown	E	295518	257771	4899	33	-3762	-3638	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-10043	Gransha	N	246070	419930	4914	26	-3761	-3645	<i>Hordeum</i> sp. (naked)
UBA-14727	Clowanstown	E	295518	257771	4906	29	-3761	-3640	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14734	Tankardstown South	S	158398	128236	4895	33	-3761	-3637	<i>Triticum</i> <i>dicoccum</i>
UBA-14735	Tankardstown South	S	158398	128236	4897	32	-3761	-3637	<i>Triticum</i> <i>dicoccum</i>
UBA-14738	Tankardstown South	S	158398	128236	4890	33	-3761	-3636	<i>Triticum</i> <i>dicoccum</i>
UBA-14736	Tankardstown South	S	158398	128236	4891	31	-3749	-3637	<i>Triticum</i> <i>dicoccum</i>
UBA-14685	Granny	E	257840	115440	4884	32	-3713	-3635	Cerealialia
UBA-14652	Caw	N	245974	418232	4861	39	-3712	-3531	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14664	Knowth	E	299684	273431	4877	34	-3712	-3540	<i>Triticum</i> <i>dicoccum</i>
UBA-14786	Cherryville	E	268661	211680	4877	32	-3711	-3543	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14708	Corbally	E	285000	213000	4896	28	-3711	-3638	<i>Triticum</i> <i>dicoccum</i>
UBA-14726	Clowanstown	E	295518	257771	4860	38	-3710	-3532	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-10039	Gransha	N	246070	419930	4831	49	-3709	-3389	<i>Triticum</i> sp.
UBA-14788	Pepperhill	S	152586	108182	4892	28	-3708	-3640	Cerealialia
UBA-13075	Ballintaggart	N	310953	340311	4898	25	-3708	-3643	<i>Triticum</i> sp.
GrA-21213	Corbally	E	285000	213000	4840	45	-3708	-3522	Unknown
UBA-14802	Russellstown	E	278344	178957	4866	31	-3706	-3541	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14710	Corbally	E	285000	213000	4836	45	-3706	-3522	<i>Triticum</i> <i>dicoccum</i>
UBA-13077	Ballintaggart	N	310953	340311	4897	24	-3706	-3644	<i>Triticum</i> sp.
UBA-14714	Corbally	E	285000	213000	4884	29	-3706	-3638	<i>Triticum</i> sp.
UBA-10038	Gransha	N	246070	419930	4851	36	-3706	-3532	<i>Triticum</i> sp.
UBA-14408	Caherabbey Upper	S	204163	126059	4856	30	-3705	-3537	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14803	Russellstown	E	278344	178957	4895	23	-3705	-3644	<i>Triticum</i> cf. <i>dicoccum</i>
UBA-14701	Corbally	E	285000	213000	4864	29	-3705	-3542	<i>Triticum</i> <i>dicoccum</i>

UBA-14709	Corbally	E	285000	213000	4854	31	-3705	-3536	<i>Triticum dicoccum</i>
UBA-14663	Knowth	E	299684	273431	4863	28	-3704	-3543	<i>Triticum dicoccum</i>
UBA-14409	Caherabbey Upper	S	204163	126059	4850	29	-3702	-3536	<i>Triticum cf. dicoccum</i>
UBA-14403	Kerloge	E	305205	119080	4883	26	-3702	-3640	<i>Triticum sp.</i>
UBA-14406	Caherabbey Upper	S	204163	126059	4849	28	-3701	-3536	<i>Triticum cf. dicoccum</i>
UBA-13076	Ballintaggart	N	310953	340311	4880	24	-3700	-3640	<i>Triticum sp.</i>
UBA-14752	Castletown Tara 1	E	292003	261818	4847	30	-3699	-3536	<i>Triticum cf. dicoccum</i>
UBA-13079	Ballintaggart	N	310953	340311	4839	34	-3699	-3529	<i>Triticum sp.</i>
Beta-247172	Drumbaragh 1	E	269442	275667	4830	40	-3698	-3523	<i>Hordeum sp.</i>
UBA-14667	Knowth	E	299684	273431	4856	26	-3697	-3541	<i>Triticum dicoccum</i>
UBA-14749	Kilgobbin	E	318845	224787	4822	44	-3697	-3520	<i>Triticum sp.</i>
UBA-14662	Knowth	E	299684	273431	4853	25	-3696	-3539	<i>Triticum dicoccum</i>
UBA-13080	Ballintaggart	N	310953	340311	4845	28	-3696	-3536	<i>Triticum sp.</i>
UBA-14670	Kilsheelan, Poulakerry and Cloghcarigeen East	S	228826	123519	4839	30	-3696	-3532	<i>Triticum sp.</i>
UB-6639	Newrath 35	E	259150	114460	4827	39	-3696	-3523	<i>Triticum sp.</i>
UBA-10041	Gransha	N	246070	419930	4832	32	-3695	-3527	<i>Hordeum sp. (naked)</i>
UBA-14723	Clowanstown	E	295518	257771	4838	29	-3695	-3532	<i>Triticum cf. dicoccum</i>
UBA-14724	Clowanstown	E	295518	257771	4830	29	-3693	-3528	<i>Triticum cf. dicoccum</i>
Poz-11604	Carrickmines Great	E	322287	223772	4820	35	-3692	-3522	<i>Triticum sp.</i>
UBA-14790	Pepperhill	S	152586	108182	4827	28	-3661	-3527	<i>Triticum dicoccum</i>
UBA-14707	Corbally	E	285000	213000	4823	29	-3659	-3526	<i>Triticum dicoccum</i>
UBA-14411	Caherabbey Upper	S	204163	126059	4822	30	-3658	-3526	<i>Triticum cf. dicoccum</i>
UBA-14677	Castletown Tara 1	E	292003	261818	4807	37	-3656	-3520	<i>Triticum cf. dicoccum</i>
UBA-14658	Caw	N	245974	418232	4818	26	-3655	-3528	<i>Hordeum sp. (hulled)</i>
UBA-14748	Kilgobbin	E	318845	224787	4809	33	-3655	-3522	<i>Triticum sp.</i>
UBA-14804	Russellstown	E	278344	178957	4818	25	-3654	-3529	<i>Triticum cf. dicoccum</i>
UBA-14720	Clowanstown	E	295518	257771	4814	29	-3654	-3526	<i>Triticum sp.</i>
GrN-28255	Corbally	E	285000	213000	4770	60	-3653	-3376	Unknown
UBA-14806	Ballybannon	E	271748	170627	4809	30	-3652	-3525	<i>Triticum cf. dicoccum</i>
UBA-14673	Kilsheelan, Poulakerry and Cloghcarigeen East	S	228826	123519	4793	36	-3651	-3518	Cerealia
UBA-14671	Kilsheelan, Poulakerry and Cloghcarigeen East	S	228826	123519	4799	33	-3651	-3521	<i>Triticum sp.</i>
UBA-14798	Newrath 35	E	259150	114460	4809	26	-3651	-3526	<i>Triticum sp.</i>
UBA-14792	Marfield	S	216417	122022	4800	31	-3650	-3522	<i>Triticum cf. dicoccum</i>

UBA-14404	Kerloge	E	305205	119080	4799	31	-3649	-3522	<i>Triticum dicoccum</i>
UBA-14407	Caherabbey Upper	S	204163	126059	4801	28	-3647	-3524	<i>Triticum cf. dicoccum</i>
UBA-14672	Kilsheelan, Poulakerry and Cloghcarigeen East	S	228826	123519	4786	34	-3647	-3389	<i>Triticum sp.</i>
UBA-14751	Ballybannon	E	271748	170627	4793	30	-3646	-3521	<i>Triticum cf. dicoccum</i>
UBA-14676	Castletown Tara 1	E	292003	261818	4776	40	-3646	-3382	<i>Triticum cf. dicoccum</i>
UBA-14402	Kerloge	E	305205	119080	4796	26	-3645	-3524	<i>Triticum sp.</i>
UBA-14678	Castletown Tara 1	E	292003	261818	4773	32	-3642	-3384	<i>Triticum cf. dicoccum</i>
UBA-14405	Kerloge	E	305205	119080	4769	37	-3642	-3383	<i>Triticum dicoccum</i>
UBA-14809	Suttonrath	S	207724	126029	4789	24	-3641	-3523	<i>Triticum cf. dicoccum</i>
UBA-14810	Suttonrath	S	207724	126029	4778	26	-3640	-3521	Cerealia
UBA-14666	Knowth	E	299684	273431	4778	25	-3640	-3521	cf. <i>Triticum sp.</i>
UBA-14750	Ballybannon	E	271748	170627	4753	30	-3638	-3382	<i>Triticum cf. dicoccum</i>
UBA-14717	Clowanstown	E	295518	257771	4753	29	-3637	-3383	<i>Triticum cf. dicoccum</i>
UBA-14799	Newrath 35	E	259150	114460	4754	27	-3637	-3384	<i>Triticum cf. dicoccum</i>
UBA-14793	Marfield	S	216417	122022	4747	32	-3636	-3381	<i>Triticum cf. dicoccum</i>
UBA-14400	Kerloge	E	305205	119080	4739	27	-3635	-3380	<i>Triticum dicoccum</i>
UBA-14401	Kerloge	E	305205	119080	4743	29	-3635	-3381	<i>Triticum sp.</i>
UBA-14813	Pinnacle, Coolinarrig Upper and Tuckmill Hill	E	288552	189243	4729	27	-3635	-3377	<i>Triticum sp.</i>
UBA-13082	Ballyboley	N	338285	409130	4727	30	-3634	-3377	<i>Triticum sp.</i>
UBA-13087	Ballyboley	N	338285	409130	4723	24	-3633	-3377	<i>Triticum sp.</i>
UBA-14812	Pinnacle, Coolinarrig Upper and Tuckmill Hill	E	288552	189243	4718	26	-3632	-3376	<i>Triticum sp.</i>
UBA-14410	Caherabbey Upper	S	204163	126059	4693	43	-3631	-3368	<i>Triticum cf. dicoccum</i>
UBA-14746	Kilgobbin	E	318845	224787	4696	32	-3630	-3371	<i>Triticum sp.</i>
UBA-13083	Ballyboley	N	338285	409130	4687	30	-3627	-3370	<i>Hordeum sp.</i>
UBA-14700	Corbally	E	285000	213000	4658	28	-3518	-3366	<i>Triticum sp.</i>
UBA-13086	Ballyboley	N	338285	409130	4623	32	-3516	-3348	<i>Triticum sp.</i>
UBA-14397	Enagh 2	N	246241	420278	4610	31	-3511	-3143	<i>Hordeum sp.</i>
UBA-14399	Kerloge	E	305205	119080	4617	25	-3500	-3352	<i>Triticum dicoccum</i>