Excavations at Farranastack, Co. Kerry: evidence for the use of shaft furnaces in medieval iron production

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Recent archaeological excavations in Farranastack townland, Co. Kerry, revealed a pit that contained a small but interesting collection of industrial residues. Farranastack takes its place among a growing number of sites that have produced evidence for the use of shaft furnaces in the manufacture of iron in medieval Ireland. Until recently it was believed that Irish smiths used only the less effective bowl furnace.

INTRODUCTION

In spring 2003, a Kerry County Council project known as the Listowel Regional Water Supply Scheme involved opening a pipeline corridor across the southern slopes of Farranastack Hill in north County Kerry. Three distinct areas of archaeological significance (Fig. 1) were revealed during monitoring, which was carried out by Eachtra Archaeological Projects under licence to Laurence Dunne (licence no. 02E1660). Excavation of Areas I and II was directed by M. Dowd (licence no. 03E0171) and the discoveries in Area II form the subject of this article. The features in Areas I and III were not contemporaneous with activities in Area II and are not discussed here.

SITE LOCATION

Farranastack is in north County Kerry, to the north-west of Listowel town and 8.5km from the coast. The townland lies immediately north of Lisselton village and south-east of Knockanore Mountain. The area of excavation was at an elevation of approximately 130m OD, on pasture and on the south-facing, gentle slopes of Farranastack Hill. The site was approximately 145m east of a minor road leading north from Lisselton village and 50m west of a small stream (Fig. 1). It commands expansive and uninterrupted views over the north Kerry plain to the south, west and, in a more restricted capacity, east.

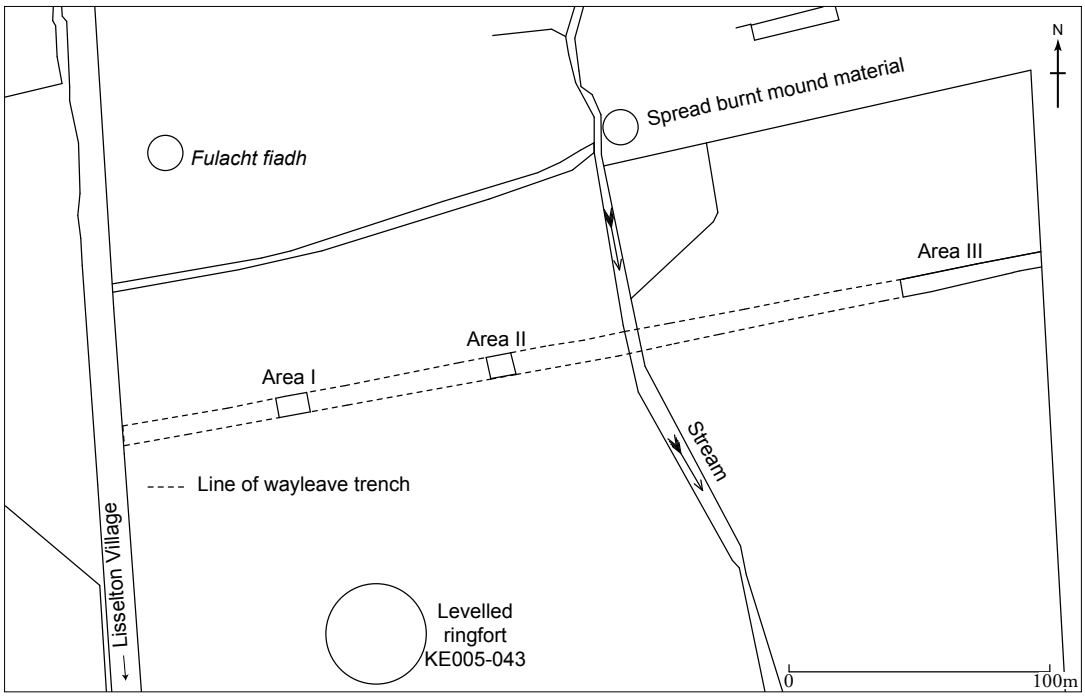

Fig. 1—Areas of excavation at Farranastack, Co. Kerry.

EXCAVATION RESULTS

Just one archaeological feature, a shallow sub-oval pit, was encountered in Area II (5m by 3m) (Fig. 2) (see Appendix 1 for details of contexts). The pit was orientated north–south and its full extent was not exposed as its northern end lay outside the area of excavation. It measured 1.6m (minimum) by 1.54m and was 0.12m deep. The base of the pit was fire-scorched in several places, converting the colour of the natural subsoil to a reddish orange. The pit contained two fills. The primary fill (C.2) consisted of a black, charcoal-rich, loose, sandy clay loam, approximately 0.05m thick. The charcoal consisted exclusively of oak (see Appendix 2). Three oat grains, one fragmentary grain of either barley or wheat and a straw node were also recovered by wet-sieving the pit fill. Cereals are rarely recovered from smelting or smithing sites in Ireland and the small quantity from Farranastack probably represents material used as tinder (see Appendix 3). Six pieces of slag were also found in the pit fill (C.2). Four pieces were clustered in the western part of the pit and amongst them was a relatively large piece of fire-scorched vein quartz. Oak charcoal (twigs and roots) from this primary pit fill (C.2) produced a conventional radiocarbon date of 890±60 BP (Beta-181588), AD 1020–1270 at 95% probability, placing the site in the high medieval period. Overlying this charcoal-rich fill, but confined to the northern half of the pit, was a compact and sterile silty clay loam (C.4).

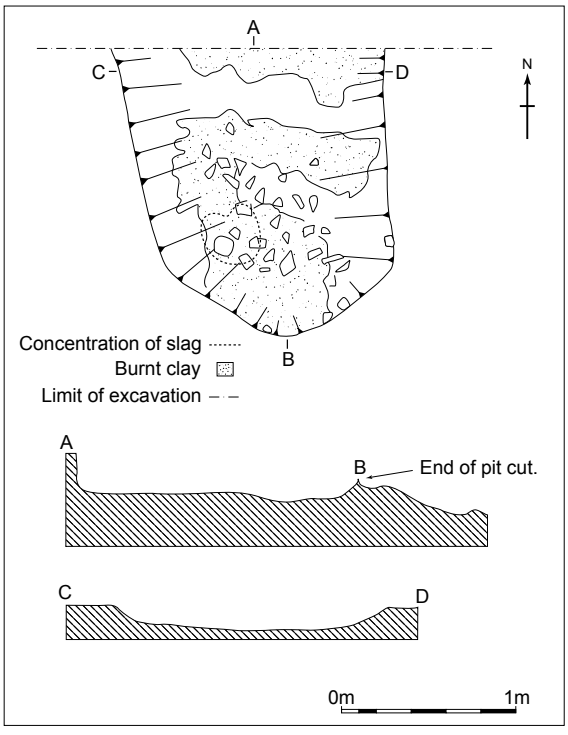

Fig. 2—Plan and sections of pit (C.1).

SLAG FROM FARRANASTACK

The 1258g of slag recovered from the pit fill (C.2) in Area II were examined by Fairburn; the results are discussed here and summarised in Table 1. Slag is the waste material produced during metalworking activities such as smelting, refining and smithing. The particular activity involved can be identified by examining the size, shape and composition of the slag. The Farranastack slag appears to represent the residues of iron smelting.

Table 1—Slag from C.2, Area II, Farranastack.

Find no.	Description	Weight (g)
03E0171:1	Amorphous slag	36
03E0171:2	Amorphous slag	24
03E0171:3	Tap slag	248
03E0171:5	Tap slag	44
03E0171:6	Furnace slag	494
03E0171:4	Furnace slag	412

The slag recovered from the pit at Farranastack primarily consisted of tap slag and furnace slag, together with a small quantity of amorphous slag. As its name indicates, amorphous slag is difficult to classify as it does not have any distinguishing characteristics and is amorphous in shape. The 60g of amorphous slag from Farranastack are more likely to have resulted from the smelting process, as no diagnostic smithing slag was found at the site. Tap slag represents smelting activities (it is *not* produced by smithing) and 292g were found at Farranastack. It is formed when molten slag is drawn off through an arched opening at the bottom of a shaft furnace, flows away in channels and then solidifies. Pieces of tap slag have flat rounded bottoms and contorted upper surfaces with flow patterns and a characteristic ropey shape that resemble a flow of lava. The largest body of slag recovered from the pit at Farranastack consisted of furnace slag that was probably formed at the bottom of a furnace. It was fayalitic, slightly fluid-looking and magnetic—the result of a high temperature. Furnace slag usually comprises the largest quantity of material recovered, by weight, from smelting sites, and the quantity produced from the furnace is usually proportional to the scale of the smelting and the quality of the ore (Crew 1991, 28). Just 906g of furnace slag were found at Farranastack.

The fragment of vein quartz found amongst the pieces of slag may also have been connected with the production of iron. Quartz is piezoelectric and gives off an electrical charge when subject to pressure or heat. In this respect the quartz may have functioned as a 'strike-a-light' to ignite tinder in a shaft furnace.

FARRANASTACK METALWORKING PIT IN CONTEXT

A ringfort (KE005-043), now levelled, is located approximately 200m to the south-west of the pit that contained the slag (Fig. 1). The spatial proximity of the ringfort and pit raises the possibility of contemporaneity; the distance between the two sites might correspond to what may have been considered a safe separation between a settlement and a metalworking area. As the base of the pit was scorched, it is evident that the slag was intensely hot when deposited. While the main concentration of radiocarbon dates for ringforts in Ireland falls between the beginning of the seventh century and the end of the tenth century AD, radiocarbon dates from seven ringforts and a cashel fall within the date obtained for the Farranastack slag (Stout 1997, 24–9). Several of these ringforts have also produced evidence for ironworking, including Lisnagun, Co. Cork, and Mullaghbane, Co. Tyrone (Scott 1991, 221–3), though the dates of the ironworking activities at these ringforts are not known.

FARRANASTACK AND SHAFT FURNACES IN MEDIEVAL IRONWORKING IN IRELAND

The manufacture of an iron artefact from iron ore can be separated into three distinct processes: (1) the smelting of the ore in a furnace, which will produce a bloom of iron as well as fayalitic slag residues; (2) the primary smithing consolidation of the iron bloom into a billet; and (3) secondary smithing—the shaping of the billet into an object. Each of these processes produces a range of industrial residues that have been detailed by Scott (1991, 151–70) and more recently by Crew and Rehren (2002, 83–7). While a significant body of literature exists on the evidence for iron production in Britain and further afield (for example, Crew 1989; 1990; 1991; 1998; Crew and Crew 1995; McDonnell 1988; Pleiner 2000), very little analytical work has been carried out on early Irish ironworking sites. Until recently, slag discovered during archaeological excavations in Ireland has seldom been subject to detailed analysis, and consequently the phase of metalworking represented has not been definitively identified (Edwards 1996, 86).

The only certain indications of an iron smelting site (rather than an iron *smithing* site) are the presence of ores and tap slag or the presence of pieces of the furnace superstructure. Though the quantity of tap slag recovered from Farranastack was not large, it provides definite evidence that iron smelting activities employing a shaft furnace were taking place in the vicinity of the excavation site. It is not possible to say how many episodes of iron smelting the tap slag from Farranastack represents. Experimental work has shown that the iron smelting process produces a much greater quantity of slag, typically 7kg of slag waste per episode from a small shaft furnace (Crew 1991, 35). Medieval ironworking sites in Britain have produced anything from one tonne to hundreds of tonnes of slag. The small quantity of material from Farranastack suggests either that the demand for iron was short-lived, perhaps indicating some urgency in its production, or that further ironworking debris awaits discovery beyond the limits of the present excavation area. Another possibility is that the slag represents the activities of an itinerant or visiting smith who manufactured particular items before moving on.

Tap slag finds in Ireland are anomalously rare compared with the evidence from Britain. Consequently, their presence at Farranastack—in an archaeological context—is worthy of note. The Farranastack tap slag reflects an iron smelting site where a slag-tapping shaft furnace was in operation. Shaft furnaces were built of clay and could have been up to 1.5m tall and 0.3m in diameter (Fig. 3). They were in use in Britain from the Iron Age through to the high medieval period. Considerable quantities of clay would have been used in the construction of shaft furnaces. It is the large quantities of vitrified remains of furnace superstructure that help to identify the remains of shaft furnaces; no such remains were found in the excavated area at Farranastack. Shaft furnaces were loaded from the top with alternate layers of iron ore and charcoal. Molten slag was drawn off through an arched opening at the base of the shaft, draining away in channels and later solidifying into a lava-like appearance (Fig. 3). Shaft furnaces achieved a higher temperature than bowl furnaces, thereby increasing the carbon content of the iron, and could also successfully produce larger quantities of iron.

In Britain, the majority of smelting furnaces are of the shaft type, with provision for slag-tapping. Until recently, however, bowl furnaces were believed to be the only type of smelting furnace that was used in Ireland from the Iron Age into the medieval period (Scott 1991, 155, 159; Pleiner 2000, 147). Bowl furnaces consisted of open, or possibly covered, bowl-shaped depressions in the ground which may or may not have been lined with a clay ceramic or a layer of refractory stones (Scott 1991, 159; Tylecote 1986, 133). Bowl furnaces associated with iron smelting have been identified at a number of early medieval ringforts and ecclesiastical sites, including Clogher, Co. Tyrone (Scott 1983, 61), Liathmore, Co. Tipperary (Leask and Macalister 1945; Tylecote 1986, 188), Garryduff 1, Co. Cork (O'Kelly 1962), Ballyvourney, Co. Cork (O'Kelly 1952), Reask, Co. Kerry (Fanning 1981), and Aghavea, Co. Fermanagh (Ó Baoill 2002).

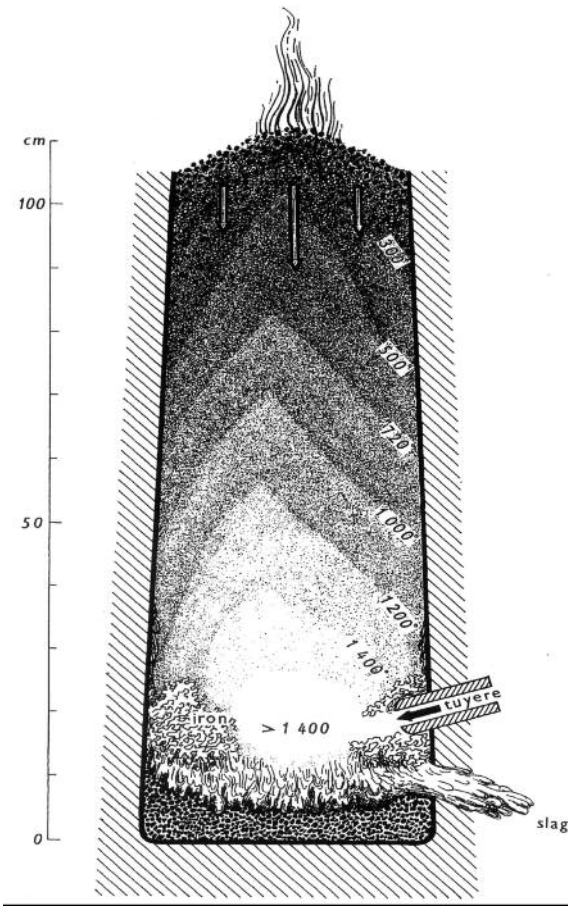

Fig. 3—Reconstruction drawing of shaft furnace, showing reduction of iron ore with tap slag flowing from base of furnace (adapted from Pleiner 2000, 134).

Following excavations at Ballyvourney, O'Kelly attempted to smelt iron in a bowl furnace and encountered difficulties in doing so (O'Kelly 1961). Nevertheless, he maintained that the bowl furnace was the commonest type used in Irish and British smelting (*ibid.*, 462; Tylecote and Merkel 1997, 9), a theory later supported by Scott (1991). Subsequent experimental work illustrated that the quantity of iron produced from bowl furnaces is relatively low and therefore that this is not a very efficient method of iron production (Wynne and Tylecote 1958). More recent experimental work (undertaken in laboratory conditions) has indicated that to produce 200–300g of iron using a bowl furnace, between 5kg and 7kg of ore and 60kg of charcoal are required (Tylecote 1986, 133). In contrast, to produce 1kg of iron using a shaft furnace, 15g of ore and 100kg of charcoal are required (Crew 1991).

The argument that shaft furnaces were not used by Irish smiths was based on the fact that clay furnace structures, clay furnace lining and tap slag—all of which comprise the principal evidence for the use of shaft furnaces—have not been discovered in this country (Scott 1991, 155; Pleiner 2000, 147). Scott (1991, 213–14) therefore suggested that the shaft furnace was not used in Ireland in early medieval and medieval times because this innovative technology was blocked by socio-political developments and poor communication between craftspeople in Ireland and Britain. It is difficult to accept that the shaft furnace should be employed a short distance across the Irish Sea and yet that this more efficient method of iron production would not have been adopted here, despite clear evidence for trade and contact between the two islands throughout the early medieval period. Notwithstanding, communication and contact do not guarantee the adoption of concepts and technologies from other countries or regions. It is also difficult to believe that shaft furnaces were not introduced by the Anglo-Normans. That said, the archaeological evidence for iron smelting in the Anglo-Norman lordship is scarce. The exchequer accounts from the thirteenth century onwards indicate that large quantities of processed ferrous and non-ferrous metals were imported into Ireland with bulk cargoes of salt (Colin Rynne, pers. comm.).

The hypothesis regarding the absence of shaft furnaces in Ireland has recently been challenged by the evidence from a number of sites. The early medieval period in Ireland witnessed a significant increase in iron production, and it is difficult to envisage that bowl furnaces were responsible for this intensified scale of manufacture (Colin Rynne, pers. comm.). In addition, the size of the iron blooms that have been found at a number of sites is larger than that expected of blooms produced in bowl furnaces. For instance, the blooms from Carrigmurrish Cave and Brothers' Cave in County Waterford are quite large (Scott 1991, 162) and suggest that the occupants of the adjacent settlements probably used furnaces of the shaft type. The artefactual assemblages from both caves date from the early medieval period, but in the case of Carrigmurrish Cave the associated enclosure was occupied up to the eleventh–thirteenth centuries (Dowd 2004, 237–8). Unfortunately, because of the lack of reliable stratigraphic information from these two sites the dates of the iron blooms are not known.

However, it is the small but increasing number of recently excavated sites that have produced tap slag that compound the evidence for the use of shaft furnaces in medieval Ireland. It is not so much that new sites are being discovered but rather that slag from Irish excavations is receiving specialist analysis, which was not formerly the case. Such analysis has led to the identification of different types of slag, which in turn has helped to define the technique and stages of iron production in Ireland. Apart from Farranastack, tap slag

has recently been discovered during excavations at Ballydowny, Killarney, Co. Kerry (Fairburn 2003a), and Shandon, Dungarvan, Co. Waterford (Fairburn 2003b). At Ballydowny, tap slag, furnace lining and the remnants of a shaft furnace cut were discovered. Only three pieces of tap slag were found, suggesting that the remaining slag had been removed and disposed of elsewhere. The two pieces of shaft furnace lining were quite large (20kg and 2.5kg respectively) and slag adhered to the interior of the larger fragment (Fairburn 2003a). This fragment was recovered from the ploughed-out remains of a shaft furnace that comprised an oval hollow (over 1m in length) cut into subsoil. One of the furnace fills produced a conventional radiocarbon date of 680±40 BP (Beta-168808), AD 1260–1400 at 95% probability (Jacinta Kiely, pers. comm.). A quantity of tap slag was also discovered during excavations of a subrectangular enclosure of twelfth/thirteenth-century date at Shandon, Co. Waterford (John Tierney, pers. comm.). A pit immediately outside the enclosure produced fourteen pieces of tap slag (290g), with further tap slag (24g) contained in a pit inside the enclosure (Fairburn 2003b). Overall, the evidence from Farranastack, Ballydowny and Shandon serves as a major contribution to our understanding of high medieval metalworking in Ireland and illustrates that shaft furnaces *were* used by ironworkers at this time.

While the present paper focuses on the technological aspects of iron production at Farranastack during the high medieval period, it is necessary to consider that these processes may also have incorporated a symbolic or ritual dimension. Recent archaeological studies on metalworking have drawn on folklore and ethnography to illustrate that the production of metal is a highly symbolic and often ritualised process rather than solely an economic endeavour (Budd and Taylor 1995; Pleiner 2000, 10–12; Barndon 2004; Haaland 2004). The move away from seeing metal production exclusively in mundane economic and technological terms has been dubbed by Budd and Taylor (1995, 138) as 'putting the magic back'. Taylor (1993, 20) observes that ethnographic studies have found that smiths in pre-industrial societies were always 'set apart' from the rest of the community, as either 'revered or reviled' individuals, and sometimes a combination of both. Likewise, Scott (1991, 185) comments on 'the high status afforded the blacksmith in Irish literature, underscoring . . . traces of the magico-religious status of the smith which survived the coming of Christianity, and lasted through to recent times, to be preserved in the folk-tales'. That said, if early iron production in Ireland involved a symbolic or ritual dimension, this element is likely to have gradually diminished in significance from the early medieval period onwards.

CONCLUSIONS

Archaeological excavations undertaken on the southern slopes of Farranastack Hill in 2003 provide a glimpse into the process of iron production in north Kerry during the high medieval period. The discovery of tap slag has extremely important implications. Until recently, there was no known evidence for the use of shaft furnaces in the production of iron in Ireland. In his pioneering and seminal work on early ironworking, Scott (1991, 8, 155, 159) concluded that during the early medieval period, and later, iron smelting was only carried out in simple bowl furnaces in this country. Certainly, the archaeological evidence from early medieval sites supports this theory and hence the logical assumption that the bowl furnace continued to be the only type of furnace used in subsequent centuries. However, the small quantity of tap slag from Farranastack indicates that shaft furnaces were used by smiths during the high medieval period. The likelihood is that, with new discoveries and with further analysis of slag from excavated sites, the evidence will indicate widespread use of the shaft furnace in the high medieval period. Indeed, future discoveries may indicate that their use extended back into the early medieval period. Farranastack can now be considered an important site in metalworking studies, and our knowledge and understanding of the process and development of iron production in Ireland are subject to revision.

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APPENDIX 1

CONTEXTUAL DETAILS

C.	Context type	Dimensions	Description
1	Pit cut	1.6m x 1.54m x 0.12m deep	Sub-oval pit, rounded corners, orientated N–S, runs under baulk at N. Break of slope top gradual, break of slope base gradual. Concave sides, flat base. Base of pit fire-scorched in places. Contained C.2
and			C.4.
2	Pit fill	1.5m x 1.2m x 0.02m deep	Loose black silty clay loam. Frequent charcoal and occasional medium-sized angular stones. Fill of C.1.
4	Pit fill	1m x 1.2m x 0.12m deep	Compact yellow-brown silty clay loam. Moderate stones and occasional charcoal. Possibly redeposited natural. Fill of C.1.

APPENDIX 2

CHARCOAL FROM FARRANASTACK

Abigail Brewer

A soil sample from C.2, the charcoal-rich fill of the pit (C.1) that contained slag, was processed by manual flotation and sieved to extract charcoal and any macroplant remains. The soil sample contained many large fragments of charcoal, 39 of which were examined under a low-powered microscope at x10–x40 magnification and identified to species where possible. Of the 39 pieces of charcoal, 23 were identified as probably oak (cf. *Quercus* sp.); fourteen pieces could not be identified to species owing to their poor state of preservation, though one was a ring-porous species. The poor condition may be due to exposure to high temperatures. As dating of charcoal from species such as oak can lead to the 'old wood' effect, fragments of twig and root were selected for radiocarbon dating.

APPENDIX 3

ARCHAEOBOTANICAL REMAINS FROM FARRANASTACK

Abigail Brewer

A soil sample from C.2 was processed by manual flotation and sieved using sieves with meshes of 1mm, 500μm and 250μm to establish the presence or absence of plant remains. The sample contained three oat grains (*Avena* sp.), one partial grain of either barley or wheat (*Hordeum/Triticum* sp.) and a straw node. Oats have been cultivated in Ireland since the early medieval period and they continued to be a staple cereal throughout the medieval period and into post-medieval times (Monk 1986, 34; McClatchie 2003, 398). Oats were the most common cereal recovered from eleventh- to thirteenth-century deposits in Waterford city, with lesser quantities of barley, wheat and rye (*Secale cereale*) (Tierney and Hannon 1997, 890). Oats were also the dominant species of cereal found in medieval deposits in Cork city. Oats, barley and wheat were present in twelfth- and thirteenth-century contexts, with rye appearing later on in thirteenth/fourteenth-century deposits (McClatchie 2003, 395).

The cereal grains from Farranastack were recovered from a pit that was associated with metalworking. Each stage of crop-processing—threshing, raking, winnowing and sieving—would have resulted in 'waste' material such as straw, chaff, weed seeds and some grain. These by-products would have been used for activities such as thatching and flooring, or as tinder, fodder and temper (Hillman 1981, 132). It is likely that the straw node and the four cereal grains recovered from Farranastack represent the remains of crop-processing waste that was used as tinder during some stage in the metalworking process. That said, in more recent times cereal grains have found their way to the forge via the horses that were shod there (Wallace 2003, 168).

Other recently excavated metalworking sites have produced plant remains but, as at Farranastack, the quantities of plant remains recovered were small. For instance, metalworking areas of medieval date were excavated at Ballydowny, Killarney, Co. Kerry, and produced limited amounts of cereals, arable weeds and straw. The plant remains from Ballydowny were interpreted as material used as tinder during the metalworking process (Brewer 2002). The scarcity of plant remains from metalworking sites such as Farranastack is probably partly due to the fact that at very high temperatures plant remains are likely to burn rather than to char. It is also probable that activities such as crop- and food-processing were carried out at a distance from metalworking sites.